Impact Assessment Summary

The following provides a summary of the key findings of the impact assessment:

(i) During mining, maximum predicted drawdowns of more than 100 m are restricted to ML 80187, in the immediate vicinity of the mine pits. The predicted 10 m drawdown contour is almost wholly constrained between Tooloombah and Deep Creeks, and within ML 80187. The 1 m drawdown contour intercepts the mid-portion of Tooloombah Creek and Deep Creek and the 0.1 m drawdown contour (assumed to represent the zone of drawdown influence) extends to a maximum of approximately 5.5 km northwest and less than 2 km southeast of the mine at around year 10 after mine closure.

(ii) The predicted zone of mine-related drawdown influence is aligned northwest to southeast, and does not interfere with the tidal reach of Styx River.

(iii) The mine pits will be progressively backfilled as mining advances, which removes the possibility of the pits acting as long-term evaporative sinks for the groundwater systems. As a result the groundwater system is conservatively predicted to fully recover sometime after 50 years (but before 100 years) after closure.

(iv) Drawdown of the water table within the Tooloombah and Deep Creek catchments results in dewatering, to some extent, of the alluvial aquifers that likely support the mid- to lower reaches of the two creeks (baseflow reduction) and associated riparian zones (water table depth).

(v) Model predictions and the results of predictive uncertainty support the hydrogeological conceptualisation that the Tooloombah and Deep Creek catchments, within which the Project is located, are essentially closed groundwater catchments.

(vi) The groundwater model is most sensitive to the K of the Styx Coal Measures coal seams and interburden, underburden, alluvium; and recharge rates. Uncertainty analysis has determined the K of the coal seams and interburden, however, is the most critical in terms of predicting catastrophic failure of the groundwater system in response to mine dewatering. K of the coal seams and interburden is shown to unlikely be greater than 0.01 m/d, which is consistent with aquifer testing results.

(vii) Predicted drawdown associated with mine water affecting activities is very unlikely to extend to areas where there is a potential for exposure of ASS, including along the tidal reach of Styx River. Consequently, any threat to marine and aquatic ecosystems associated with ASS is considered negligible.

(viii) The lack of drawdown predicted for the lower reaches of Tooloombah and Deep Creeks, as well as downstream of the confluence of these creeks along Styx River, and the lack of evidence of a seawater-freshwater interface near the confluence of Styx River with Broad Sound indicates the risk of seawater intrusion in response to mine dewatering is low to negligible.

(ix) Predictive uncertainty analysis indicates the calibrated model, and the predictions presented in this report, are representative and consistent with the conceptual hydrogeological model.

(x) The predicted zone of influence from mine dewatering activities is predicted to not change the nature of groundwater – surface water interactions along Styx River, i.e. the river remains a predominantly groundwater discharge zone during and following mining. North of ML 80187 continued groundwater discharge to Tooloombah and Deep Creeks is also predicted.

16.11.4 Monitoring, Management and Mitigation Measures

16.11.4.1 Approach

Central Queensland Coal commits to responsible resource recovery, including mitigation of potentially unacceptable mining related impacts on groundwater resources and connected surface systems in order to protect groundwater EVs and ensure groundwater continues to meet the requirements of identified sensitive groundwater receptors (e.g. GDEs and third party users). To this end, Central Queensland Coal will prepare and implement the following documents:

- A Receiving Environment Monitoring (Management and Mitigation) Program (REMP) to describe how groundwater resources and dependent receptors will be monitored and managed to achieve the Company's commitment to responsible resource recovery, as well as management measures that may be required to mitigate any adverse impacts that might arise as a result of mine-water affecting activities. The REMP will include a Trigger Action Response Plan (TARP) process which will outline the responses required in the event that operations result, or are likely to result, in unacceptable effects to groundwater and connected surface water environments (refer also Section 16.10.7.4); and
- A Water Management Plan (WMP) has an on-site focus, and will prescribe the management of mine-water affecting activities to minimise the risk of adverse impacts on groundwater (and surface water) systems. The WMP will refer to the REMP for all monitoring and mitigation efforts associated with the mine-site water balance (refer Section 16.10.4). It is assumed the WMP will be a requirement of the Project's EA and will be provided to DES for review prior to the commencement of construction and mining activities.

The WMP and REMP together form the approach to management of onsite water usage and storage, and monitoring of EVs in relation to water management (including groundwater drawdown) and water release. The overall monitoring, management and mitigation approach is summarised in Figure 16-127.

Central Queensland Coal will prepare and implement a detailed WMP to describe how groundwater resources will be managed to achieve this objective, as well as mitigation works that may be required to mitigate any identified adverse impacts. Whilst this section of the SEIS has focused on the key groundwater associated effects of mining on groundwater resources and connected systems having the potential for impact, other direct effects will also be addressed by the WMP including (but not limited to) hazardous goods storages, water storages, environmental dams and dust suppression.

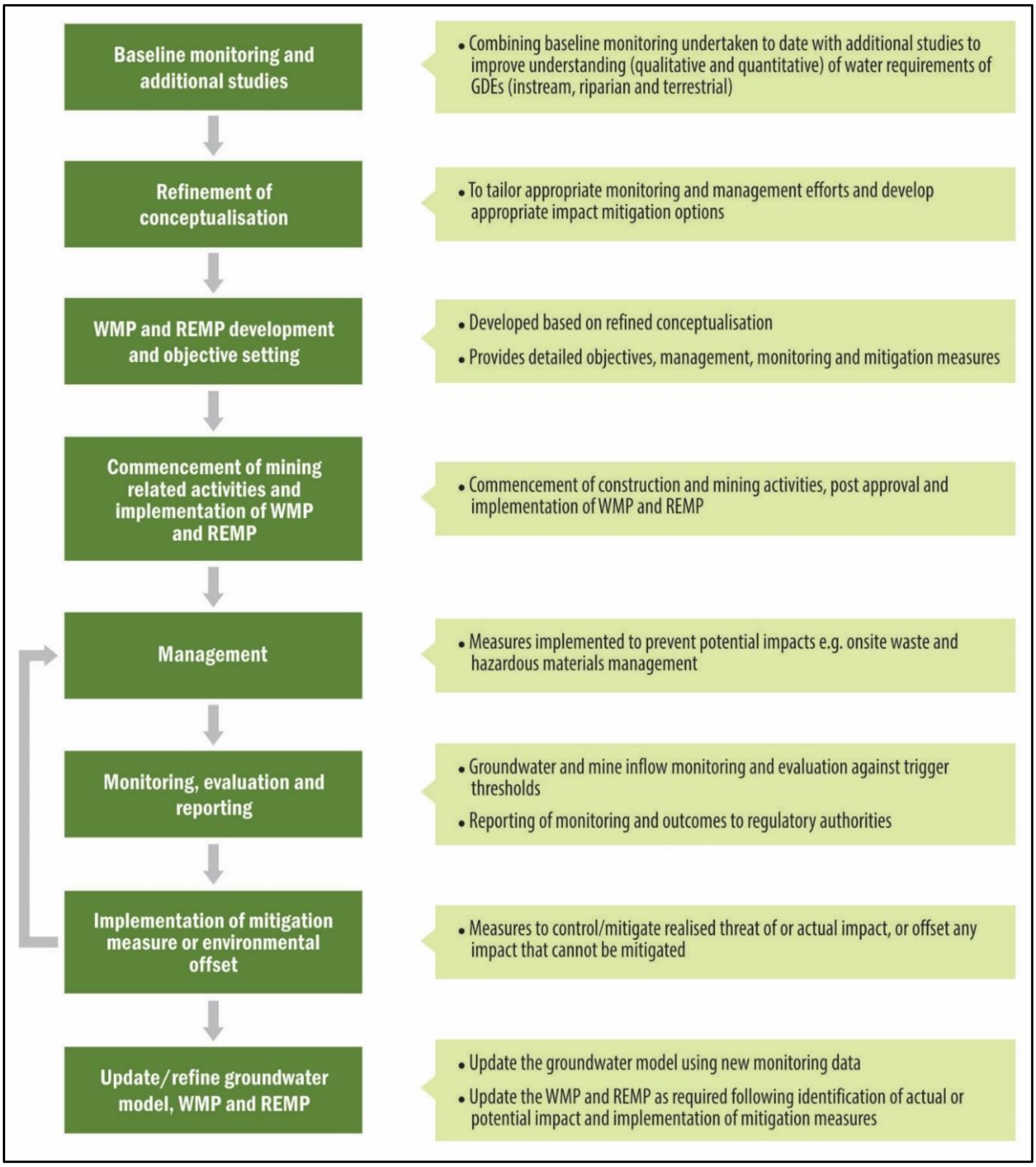

Figure 16-127 Groundwater monitoring, management and mitigation approach

16.11.4.2 Baseline Studies

This Section of the SEIS presents a conceptualisation that has been developed from baseline monitoring data, which suggests some ecosystems within the Project area are likely to be supported (at least to some extent) by groundwater (i.e. those identified as GDEs; refer Section 16.11.2.1). The hypothesis presented is that GDEs are supported to some extent by Alluvial or shallow Styx Coal Measures groundwater resources, either within an aquifer (Type 1 GDEs), expressed at the surface (Type 2 GDEs) or available in the sub-surface (Type 3 GDEs).

The existing baseline investigations are presented in Section 16.11.1 and 16.11.2. The following sets out details of further works planned to provide additional understanding of:

- The degree or frequency of reliance by ecosystems on groundwater to meet environmental water requirements;
- The pre-mine condition (i.e. function) of GDEs, and to establish the possible extent to which they may already be impacted by anthropogenic effects such as clearing, grazing, fire, pests and weeds; and
- The level of resilience and resistance GDEs might have groundwater conditions altered from the baseline.

The outcomes of these investigations will assist in the development of the REMP including:

- Setting management objectives;
- Refinement of the monitoring program; and
- Detailed and effective management and mitigation strategies, should they be required.

Additional and Ongoing Groundwater Monitoring and Assessment of Ecosystem Interactions with Groundwater

Ongoing monitoring and assessment will include:

- Extended baseline hydrological and hydrogeological monitoring (e.g. depth to water table, hydraulic gradients, water quality);
- Isotope analysis of surface waters and groundwaters for assessment of interactions supporting in-stream pools (Type 2 GDEs); and
- Analysis of soil and plant xylem stable isotopes of water, and leaf and soil water potentials at locations of identified potential groundwater dependent vegetation (Type 3 GDEs), to improve the understanding of plant water use and reliance on soil water and groundwater.

In addition to the above, the following investigations will be undertaken:

- Development of a detailed water and solute balance for in-stream pools (Type 2 GDEs; building on from the work documented in Appendix A6 – Groundwater Technical Report) to determine and quantify water source(s) sustaining all permanent pools identified along Tooloombah and Deep Creeks. The work will rely on the following data:
  - outcomes of further 222Rn and major ion sampling
  - in-stream flow measurements to quantify streamflow rates and stage heights
  - pool surveys to map the extent and depth of pools and longevity between stream flow events
  - site specific climate data (rainfall, evaporation)
  - extended record of near-stream groundwater levels through time
- Analytic modelling of leaf water potential data to understand the implications of a declining water table for plant water requirements.

- Development of a soil water reservoir balance to assess the quantity of soil water available to meet plant water requirements between wet seasons.
- Pre-mining GDE condition monitoring including vegetation and aquatic surveys discussed further in Section 16.11.4.5.

16.11.4.3 Water Management Plan

The WMP will describe the mine water balance, key water infrastructure (e.g. water storages, water distribution network, drainage system) and flood protection infrastructure. The WMP will address both the construction and operational phases of the Project. From a groundwater management perspective, the WMP will also:

- Specify the water source for each water storage; and
- Identify the likely water quality for each water storage and possible worst case water quality that could occur under extreme climate conditions.

16.11.4.4 Mine Water Production Monitoring

Mine water inflow monitoring will consist of daily measurements of rates and/or volumes of all water pumped from the mine pit using a suitable method (note: aquifer testing strongly indicates ex-pit dewatering bores will not provide an effective means of mine water control). Mine produced waters will be subject to quarterly:

- Measurements of field water quality parameters (e.g. TDS, EC, pH); and
- Laboratory analyses of major ions, TDS, EC, dissolved metals (including aluminium, arsenic, selenium and vanadium) and hydrocarbons (TPH, TRH and BTEXN) using laboratories that are NATA-registered for the analyses undertaken, using methodologies that are suitable for comparison with the baseline monitoring.

16.11.4.5 Receiving Environment Monitoring Plan

This component of the Project effectively addresses Step 7 (*Monitor, evaluate, review, amend*) of the NWC framework (see Figure 16-127). The REMP will document proposed groundwater monitoring and evaluation commitments, and outline appropriate mitigation measures that can be employed if water management activities are shown to not achieve environmental objectives. The REMP will include:

- Roles and responsibilities;
- Management objectives, with consideration of the Environmental Authority conditions;
- The TARP process, including trigger thresholds and detailed management and mitigation responses;
- Detailed monitoring program:
  - GDE condition monitoring, including vegetation and aquatic surveys
  - groundwater monitoring, including level gauging, water sampling and laboratory testing program, consistent with baseline monitoring analytes

  - monitoring of mine water dewatering rates/volumes and produced water laboratory testing program
  - a monitoring schedule, detailing the required monitoring locations, monitoring frequency, methods and protocols, and analytes to be sampled
  - data evaluation criteria and requirements
  - requirements for revision of the REMP
  - reporting requirements

Each of these REMP components are described below.

Roles and Responsibilities

The various roles associated with water management for the Project will be documented, along with responsibility statements e and the required training that responsible personnel will need to have to fulfil roles.

Management Objectives

The management objectives of the REMP will be prescribed following completion of the baseline studies and will focus on maintaining the EVs of groundwater and connected surface waters surrounding the Project. The water quantity (levels, pressures, fluxes) and quality triggers developed for the REMP form the basis for assessing the success of water management strategies.

Trigger Action Response Plan

TARPs will form part of the REMP and will outline the actions and responses required in the event that operations have or are likely to result in management objectives and approvals conditions not being achieved. TARPs will identify:

- Further investigations to identify EVs and sensitive receptors that may be impacted and to assess level of impact / threat posed to the sensitive receptors, and if pre-determined trigger thresholds are reached;
- Of those mitigation measures identified in the REMP, which are appropriate to manage or remove the specific cause or pathway of the impact / threat and what other mitigation measures may be available to improve outcomes (e.g. new technology);
- Implementation of the mitigation plan(s) deemed most appropriate, including providing notification (where necessary) to relevant authorities and stakeholders;
- Reporting (internal and external) to summarise monitoring results, investigation findings and mitigation approaches, with follow up information provided to relevant authorities and stakeholders; and
- Review and update of the REMP to ensure adequate monitoring of detected impacts and mitigation efforts is incorporated, and to re-assess appropriateness of mitigation measures outlined in the plan (i.e. to ensure the mitigation measures will appropriately address the level of impact identified into the future).

Groundwater quality performance triggers will be based on statistical analysis of the reported ranges in baseline concentrations of identified analytes of concern (e.g. pH, salinity concentrations, and concentrations of dissolved metals such as As, Al, Mo, Se and V). Groundwater 'quantity' (head) performance triggers will be based on a combination of baseline head data for selected monitoring bores as well as comparison of observed and model predicted heads for different stages of mine development (operational and closure).

Two types of triggers will be defined for groundwater quality and quantity, the first will be a performance trigger and the second an early warning trigger (assigned, say, as 75% of the performance trigger). Response (review, further investigations and evaluation) will be required when the early warning trigger is exceeded and, depending on the results, action may be required on implementing mitigation measures to ensure the performance trigger is not exceeded. In terms of groundwater heads, review will also be required if there is divergence of observed from predicted heads.

Groundwater and GDE Monitoring

Groundwater monitoring (water quantity and quality) will occur on the MLs and off-lease during the construction, operational and post-operational phase of the Project to:

1) Determine whether an impact has or will likely be realised, triggering (based on pre-determined trigger thresholds) implementation of appropriate mitigation measures, including initial review and evaluation; and

2) Assess the environmental performance of any adopted management and mitigation measures once implemented, which may require expansion of the monitoring network and analytical program.

The groundwater monitoring program will be designed to monitor the condition of the target 'end point' of the system - in this case, the EVs identified for the Styx River catchment and associated sensitive receptors (Type 1, 2 and 3 GDEs, third party water users).

The location and configuration of monitoring bores is designed to provide sufficient coverage of: identified HSUs and GCZs, as well as sensitive receptors within the Project and surrounding area; to detect and monitor groundwater effects from the Project; and provide a baseline from which management objectives are set, updated or maintained. Groundwater monitoring bore locations are shown in Figure 16-128 and described in Table 16-97. Based on the information collected during the first few years of mining, a need for expansion or rationalisation of the monitoring network may be identified.

The monitoring program will be designed to take into consideration the Environmental Authority conditions, as well as State and National groundwater monitoring guidelines.

The initial monitoring program will include at least:

- Monitoring of groundwater drawdown and depressurisation, which will involve:
  - Gauging of hydraulic head in selected groundwater monitoring bores and landholder bores located within the predicted zone of mine influence (compliance bores, see Table 16-97), as a minimum
  - Automated pressure transducers will be installed at selected monitoring bores to provide daily observations that can be used to distinguish short-term changes, such as seasonal recharge, from potential long-term effects of the Project (dewatering and backfilling

  - Gauging hydraulic heads at selected locations outside of the predicted area of impact to confirm the extent of impact and to assess baseline conditions away from potential mining effects (reference bores, see Table 16-97)
- Monitoring of groundwater quality, which will involve:
  - Quarterly field measurements of EC and pH of groundwater sampled from compliance monitoring bores located on the mine lease (Table 16-97) and monthly field measurements of the same parameters for water pumped from the mine
  - Quarterly field measurements of EC and pH of groundwater sampled from compliance monitoring bores located off the mine lease (Table 16-97)
  - Six monthly sampling (quarterly or more frequently for the first 2 years of mining, or if trigger is reached) of groundwater sampled from compliance monitoring bores (Table 16-97) for laboratory analyses of major ions, TDS, EC, dissolved metals (including aluminium, arsenic, selenium and vanadium) and hydrocarbons (TPH, TRH and BTEXN) using laboratories that are NATA-registered for the analyses undertaken, and methodologies that are suitable for comparison with the baseline monitoring
  - Six monthly sampling (quarterly or more frequently if trigger is reached) of groundwater from reference monitoring bores (located outside the predicted zone of Drawdown influence; Table 16-97) for laboratory analyses of major ions, TDS, EC and dissolved metals using laboratories that are NATA-registered for the analyses undertaken, and methodologies that are suitable for comparison with the baseline monitoring
  - Groundwater chemistry data will be analysed graphically for trends (e.g. using concentration vs. time graphs, Piper plots and Stiff patterns) and any correlation with observed groundwater levels, mine inflow and rainfall
  - Data collected from the recently installed monitoring bores will be assessed and evaluated to allow adjustment of the nominated trigger values for groundwater quality (following 24 months of data collection)
  - If a monitoring trigger is realised, after review and where required the appropriate mitigation measure or offset will be implemented and the monitoring program appropriately adjusted, e.g. if a water quality trigger is realised, sampling frequency for analysis of water quality may be increased from six monthly to quarterly or more frequently, and additional monitoring locations may be incorporated (i.e. between bores where the trigger is reached and the threatened receptor)
- Ongoing GDE condition monitoring, which will involve:
  - Type 1 GDEs

    Sampling event at nominated bores every in accordance with the DES's *Monitoring and Sampling Manual: Environmental Protection (water) Policy 2009* (DES 2018)
  - Type 2 GDEs

    In-stream pool longevity and water sources supporting these water features to identify intra- and inter-annual trends (both natural and potentially Project affected)

    Macroinvertebrate surveys to establish the existing distribution, abundance and richness of macroinvertebrate communities, in association with ongoing water quality monitoring; and

Macroinvertebrate sampling will be conducted in accordance with standards and protocols detailed in *Monitoring and Sampling Manual: Environmental Protection (water) Policy 2009* (DES 2018)

- Type 3 GDEs

  Identification of pre-mine condition (as affected by existing anthropological activities, climate variability)

  Establishment of permanent vegetation monitoring transects to measure structural characteristics and baseline condition of GDE habitats subject to impact (also including the consideration of the need for control sites)

  Monitoring transects will provide dedicated sites for structured and repeatable temporal measurements of Foliage Index / Leaf Area Index using canopy photography / hemispherical lenses

  Temporal measurement of LWP at reference trees when GDE vegetation monitoring sites are established and at subsequent monitoring events, this will provide a direct measure of water stress; and

  capture of high resolution Normalised Differential Vegetation Index (NDVI) imagery over possible impact areas and any control sites, timed to coincide with monitoring events and undertaken biannually for an initial three years to establish a seasonal baseline for ongoing comparison (the data sets provide a measure of all vegetation, rather than selected sites within the transects)

- Comparison of results against observed changes in GDE water budgets to link the cause, if possible, of monitored stress to changes in the water budget attributable to the Project, and other factors such as existing land-use, climate variability, fire, pests and weeds

- Evaluation of data arising to ensure management (and mitigation measures) are achieving the Project's environmental management objectives. It is anticipated that annual compliance reporting will be required.

Evaluation

A critically important aspect of any monitoring program involves the routine evaluation of the data against pre-defined triggers to identify whether there is any divergence from the expected, and whether any divergence is likely to give rise to an adverse effect. In addition, data evaluation will provide the opportunity to revise / update the REMP, if necessary, and to revisit management objectives to ensure they are appropriate for the Project.

Frequency and Reporting

Groundwater compliance reports will be prepared to facilitate the transfer of monitoring data and the evolving knowledge gained to relevant regulatory authorities. The frequency of reporting will be decided in the relevant Project environmental authority. Issues relating to groundwater samples that are reported by the landholder or mine staff will be recorded and documented in the monitoring report, including any corrective actions that have been implemented.

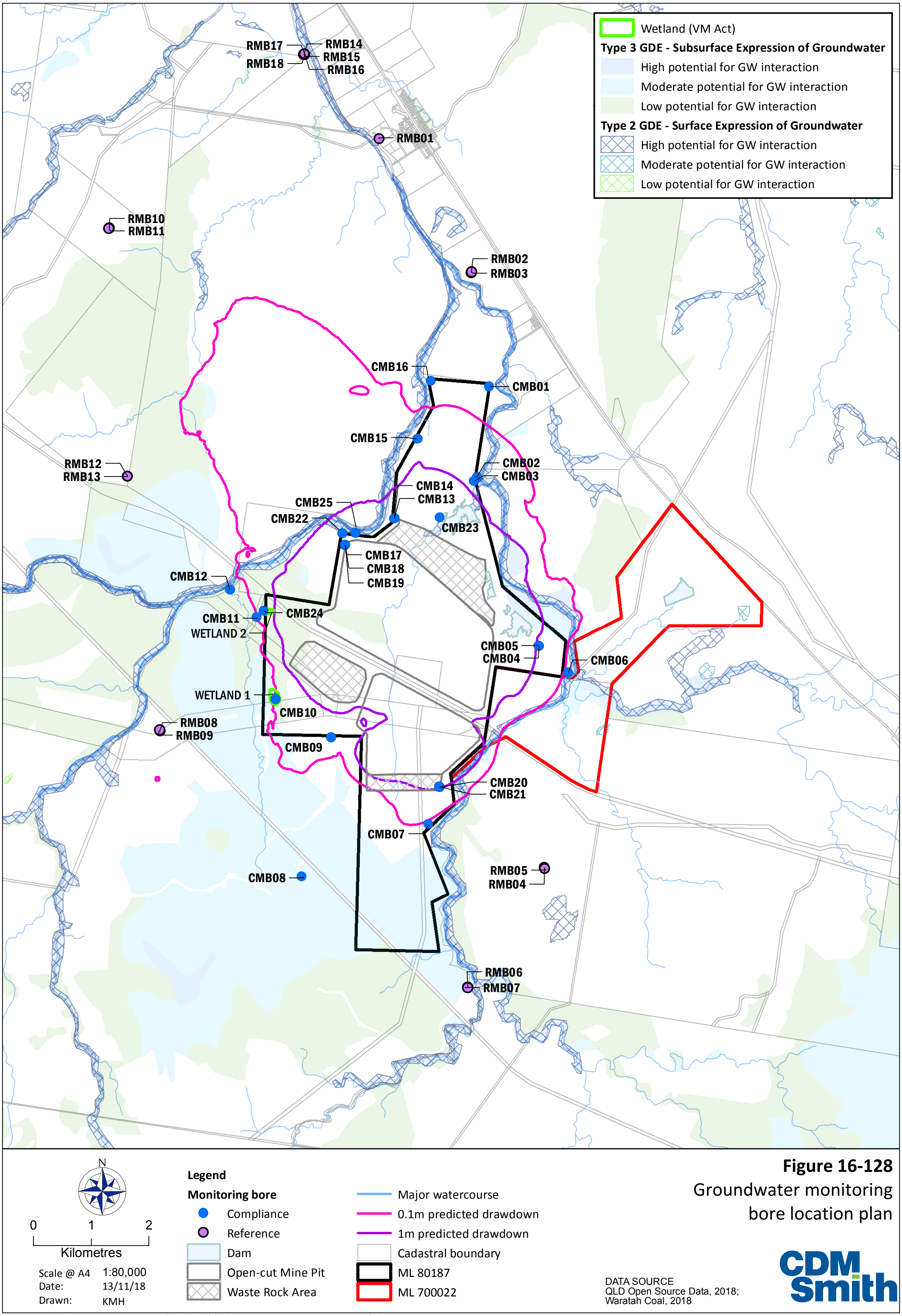

Figure 16-128
Groundwater monitoring bore location plan

DATA SOURCE
QLD Open Source Data, 2018;
Waratah Coal, 2018

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16.11.4.6 Preliminary Management and Mitigation Measures

Mitigation measures will be defined to address any unacceptable impact arising to sensitive receptors from reduced groundwater quantity or diminished groundwater quality, when and where these outcomes arise. The TARPS (see 16.11.4.4) will form the basis for determining when management and mitigation measures will need to be confirmed and implemented.

It is recognised that GDEs within this landscape will have evolved some resilience, whereby they are able to cope with some degree of change to baseline water regimes (quantity, quality and timing). For example, Type 3 terrestrial GDEs may be able to extend the depth of rooting to access deeper soil water or the capillary fringe, and macro-invertebrates may persist in surface water pools that are reduced in surface area and depth compared to what may have existed pre-mining. Resilience levels need to be further assessed by ongoing monitoring but, for the purpose of identifying suitable mitigation measures, at this stage it is conservatively assumed that sensitive ecosystems have no resilience to changed water regimes (i.e. the temporal nature of environmental water requirements is static / unchanging). So, in the first instance, mitigation measures are defined on this 'static' basis, but once environmental water requirements are better understood an adaptive mitigation plan will be able to be implemented.

The following sets out examples of groundwater management and impact mitigation measures for the Project. These and other mitigation measures will be further detailed in the REMP, building on from the baseline understanding of receptor water requirements with understandings developed from ongoing studies (see Section 16.11.4.2). It is anticipated that, where an adverse impact is indicated as part of the approved monitoring, evaluation and reporting program, a wide range of management and mitigation approaches will be considered, not only those that may be detailed in the REMP as additional approaches may evolve with time and technology, and new knowledge gained may lead to the development of new approaches that are not identified here. Any new mitigation measures identified as part of this process will require an update of the REMP.

Physical Disruption to Aquifers

The proposed open cut mining method will physically disrupt and drain the saturated profile below the water table, resulting in groundwater depressurisation of deeper lithologies and decline of the potentiometric surface in the immediate area of the open cut pits during mining – all of which is controlled by HSU hydrogeological properties and final depth of mining. The mine plan has evolved to include the progressive backfilling of mine voids as mining proceeds, which is a primary management and mitigation measure in relation to long-term potential groundwater drawdown.

Placement of waste materials, which is restricted by the area of the ML, has the potential to mechanically load the water table aquifer resulting in reduced porosity and higher pore water pressures in the saturated zone. This effect has the potential to reduce aquifer transmissivity and higher water tables up-hydraulic gradient of the landforms. Backfilling of the mine voids is an important management measure to mitigate this effect, as the remnant waste landforms will be much smaller than would have been otherwise.

Apart from these two strategies there are no other effective mitigation measures that can be implemented to manage the effects of aquifer disruption caused by mining.

Water Quantity

An approach that will be considered to manage impacts where Type 2 and Type 3 GDE access to groundwater might be compromised due to drawdown arising from mine dewatering involves supplementing environmental flows to waterways and soil water stores so that baseline flow/water availability regimes can be maintained or supported. Table 16-96 presents summary details, which are expanded upon below.

Table 16-96 Available management and mitigation measures

Direct effect	In-stream habitat	Riparian habitat	Terrestrial habitat	Third party bores
Change in groundwater quantity, and surface water – groundwater interactions	Supplementary environmental flows provided directly to pools from mine produced water or other groundwater sources (e.g. pumping bores)	Supplementary environmental flows provided via irrigation from mine produced water or other groundwater sources (e.g. pumping bores) Land contouring, which will retard surface water run-off and encourage additional recharge to the soil profile		Lowering of pump/ deepening bore Provision of surplus water from mine dewatering if suitable Provision of an alternative water supply
Change in groundwater quality	Onsite water and hazardous materials management Containment or capture of contaminant/pollutant e.g. cut off walls, pumping bores. Treatment of contaminated/polluted water Geochemical controls, e.g. mixing PAF materials with materials having neutralising capacity			

For Type 2 GDEs, supplementary water can be provided directly to permanent or ephemeral pools in a manner that provides the minimum required volume and frequency to maintain GDE function, the understanding of which will be improved with ongoing monitoring. If surface water is the dominant source of water in at risk pools, the groundwater supplementing pool levels may need to be treated prior to application. However, if groundwater provides a major component of Type 2 GDE water requirements it is probable that water treatment will not be required for this purpose, but this will be further explored as part of REMP development.

Supplementary water can be sourced from excess mine water during the life of mine, but there remains a risk of impact to GDEs after mine closure when mine produced water will not be available. In this circumstance it may be necessary to continue with the mitigation measure at least until sufficient recovery of groundwater heads occurs.

The practice of supplementing surface water flow to maintain aquatic ecosystems and riparian vegetation health is widely used as a management tool in providing environmental flow requirements to waterways and wetlands across Australia. Examples of where the provision of environmental flows is made directly to pools in response to groundwater dewatering include the Collie Basin in southwest Western Australia (2009), and Fortescue Metals Solomon Iron Ore Project Bore Field (FMG 2016) and Rio Tinto's Hope Downs Iron Ore Project in the Pilbara region of Western Australia (WA EPA 2001).

For Type 3 GDEs, supplementary water can be applied to soil water reservoirs (i.e. the root zone) either directly through irrigation or indirectly through leakage from water provided to waterways / wetlands / bunded areas. Contouring of the surface could be considered to encourage ponding of any surface runoff or direct rainfall to encourage additional recharge to the underlying soils. However, the efficacy of this approach also needs to consider impact to creek flow regimes.

The source of supplementary water would ideally be mine produced water, as there would be no associated additional drawdown impacts. Mine water balance modelling, as presented in Section 16.10.4, predicts the mine water supply exceeds the mine water demand for the duration of mining almost all of the time, with a predicted minimum available excess in the order of 40 ML in the worst case dry year, when in-stream pools would be expected to be naturally under stress. This suggests that mine produced water is likely to be a viable source of water to offset any reduction in groundwater baseflow to the dependent pools, with adequate treatment if necessary. However, a supply deficit will exist post-closure when mine produced water is no longer available. Alternatively, sourcing the supplementary flows from a groundwater resource is a strategy that may be considered – whilst the Alluvium aquifer would likely not present as a viable long term option (due to drawdown effects), the Styx Coal Measures, which has similar water quality to the Alluvium (see Section 16.11.1.2) may provide a suitable source.

To provide a preliminary analysis of the amount of water potentially 'consumed' by a pool located near the northwestern boundary of ML 80187 (sample point To2; Figure 16-22) a water balance model has been prepared, the details of which are presented in Appendix A6 – Groundwater Technical Report, Section 4. The water balance model indicates the amount of water required to sustain in-stream pools during the dry season is around 4 mm/d, on average. The numerical groundwater model has been used to assess whether pool-groundwater requirements can be met via abstraction from pumping wells accessing the Styx Coal Measures (discussed in Appendix A6 – Groundwater Technical Report, Section 3.6.2.4). The modelling has shown the Styx Coal Measures is capable of supplying between 0.55 to 0.7 L/s in the long-term, which could sustain around 13,000 to 17,000 m^2 of pools over a dry season, with little additional effect to the predicted drawdown. Solar energy could be used to power these types of bores after closure.

Water Quality

The proposed groundwater monitoring network (Table 16-97 and Figure 16-128) will provide the capacity to identify where there may be situations that water quality is impacted and requires mitigation. However, the circumstances contributing to water quality decline will need to be investigated to identify (natural variability or activity or facility) and rectify the cause of observed trends prior to identifying an appropriate mitigation strategy.

Any evidence of PAF or AMD impacted seepage waters from waste storages, for example, will be addressed immediately by investigating potential scale of impact, and followed up as required by implementing management / mitigation strategies such as mixing or compartmentalising with materials having neutralising capacity, or backfilling to base of pits.

Adverse groundwater quality impacts arising from uncontrolled discharge of possible contaminants can be mitigated through engineered or non-engineered measures that have the objective of containing, intercepting and/or treating impacted groundwater / pollutant source (e.g. cut-off walls, interception trenches or recovery bores), but mitigation strategies outlined in the REMP would need to be adapted for site specific conditions.

To prevent potential contamination of groundwater from uncontrolled release of contaminants , the REMP will detail onsite water and hazardous materials management protocols. These will include:

- Personnel training and awareness in regards to the potential for groundwater quality to be impacted and the requirement to report any spills;
- Provision of appropriate spill control materials including containment booms and absorbent materials at refuelling facilities to contain spills;
- Personnel training in the use of spill control materials, and appropriate reporting protocols;
- Ensure all refuelling facilities, and the storage and handling of hazardous goods and chemical complies with relevant Australian Standards (management and mitigation measures for wastewater are discussed in Chapter 7 - Waste Management); and

- Establish procedures to ensure safe and effective fuel, oil and chemical storage and handling, including storing materials within roofed and bunded areas to contain spills, and prevent uncontrolled discharge to the environment.

All uncontrolled discharges will be reported to the DES under legislative requirements of the EP Act. Control of surface water discharges and dirty water management systems, including storage of mine dewatering water, are discussed in Section 16.10. Reducing the potential for salinisation of pit waters through evapo-concentration of salts will be mitigated by efficiently removing water from sumps. A summary of available indicative management and mitigation measures that may be employed are summarised in Table 16-97.

Third Party Users

If access to groundwater for third party users is compromised by effects from the Project, the following mitigation measures may be implemented:

- Where sufficient available drawdown exists, lowering pumps deeper within the bore column can be undertaken;
- Where sufficient unscreened aquifer interval exists, deepening of a bore can be undertaken or a new bore can be established outside of the area of impact;
- Provision of surplus water from mine dewatering, if the quality is deemed suitable for the existing use; and
- Provision of an alternative water supply of comparable quantity and quality to the meet the existing demand.

Where the Project impacts on third party water use, Central Queensland Coal will liaise with landholders to agree arrangements that will ensure provision of water of adequate yield and quality during and after mining until the aquifers are replenished or access to groundwater for stock water is no longer deemed compromised.

Table 16-97 Indicative location of groundwater monitoring bores

Monitoring bore	Bore ID	Status	Location		Screened depth (mbgl)	GCZ	Aquifer/Aquitard	Receptor monitoring	Purpose	Monitoring frequency
			Latitude (DD)	Longitude (DD)						
Reference bores										
RMB01	WMP13	Existing	-22.621682	149.652024	14.1-21.1	Styx	Alluvium and Styx Coal Measures (overburden)	Type 2 and 3 GDEs, and Styx River	Monitor the extent of drawdown and groundwater quality	Bi-annual
RMB02	WMP11	Existing	-22.642371	149.667884	18-24	Bison	Styx Coal Measures (overburden)	Type 2 and 3 GDEs - Deep Creek/Styx River		
RMB03	WMP11D	Existing	-22.642252	149.667950	30-36	Bison	Styx Coal Measures (overburden)			
RMB04	WMP17	Existing	-22.735128	149.682050	9-12	Uplands	Alluvium	Background		
RMB05	WMP17D	Existing	-22.735326	149.682103	21-24	Uplands	Styx Coal Measures (overburden)			
RMB06	WMP08	Existing	-22.754042	149.669504	10.4-16.4	Uplands	Alluvium	Type 2 and 3GDEs- Deep Creek		
RMB07	WMP08D	Existing	-22.754079	149.669466	24-36	Uplands	Styx Coal Measures (underburden)			
RMB08	WMP19	Existing	-22.714833	149.616881	13.1-16.1	Styx	Weathered Basement	Type 2 and 3 GDEs- Tooloombah Creek		
RMB09	WMP19D	Existing	-22.714690	149.616810	24.9-27.9	Styx	Weathered Basement			
RMB10	WMP16	Existing	-22.636361	149.606853	25.5-31.5	Styx	Styx Coal Measures (overburden)	Type 3 GDEs		
RMB11	WMP16D	Existing	-22.636426	149.606786	35.7-41.7	Styx	Styx Coal Measures (coal seams and interburden)			
RMB12	WMP20	Existing	-22.675143	149.610708	14.5-20.5	Styx	Styx Coal Measures (overburden)			
RMB13	WMP20D	Existing	-22.675161	149.610660	24-30	Styx	Styx Coal Measures (overburden)			
RMB14	WMP29A	Existing	-22.608771	149.639079	6.5-12.5	Styx	Alluvium	Type 2 and 3GDEs - Styx River/estuary	Sentinel for monitoring seawater-fresh water interface Monitor the extent of drawdown and groundwater quality	
RMB15	WMP29B	Existing	-22.608770	149.639108	16-20	Styx	Alluvium			
RMB16	WMP29C	Existing	-22.608686	149.639271	52-58	Styx	Styx Coal Measures (overburden)			
RMB17	WMP29D	Existing	-22.608750	149.639263	115-121	Styx	Styx Coal Measures (coal seams and interburden)			

Monitoring bore	Bore ID	Status	Location		Screened depth (mbgl)	GCZ	Aquifer/Aquitard	Receptor monitoring	Purpose	Monitoring frequency
			Latitude (DD)	Longitude (DD)						
RMB18	WMP29E	Existing	-22.608660	149.639213	222.5-228.5	Styx	Styx Coal Measures (underburden)			
Compliance bores										
CMB01	WMP05	Existing	-22.660106	149.671271	9-12	Bison	Alluvium	Type 2 and 3 GDEs- Deep Creek	Groundwater quality and quantity changes associated with waste rock stockpile, and mine dewatering	Quarterly for field parameters Bi-annual for complete suite of analytes
CMB02	WMP21	Existing	-22.674281	149.669474	6.9-9.9	Uplands	Alluvium	Type 2 and 3 GDEs- Deep Creek	Groundwater quality and quantity changes associated with dam, and mine dewatering	
CMB03	WMP21D	Existing	-22.674903	149.668990	14-20	Uplands	Alluvium and Styx Coal Measures (overburden)			
CMB04	WMP18	Existing	-22.700529	149.680412	9.2-12.2	Uplands	Alluvium		Groundwater quality and quantity changes associated with waste rock stockpile, and mine dewatering	
CMB05	WMP18D	Existing	-22.700458	149.680333	18.5-23.5	Uplands	Styx Coal Measures (overburden)			
CMB06	WMP10	Existing	-22.704560	149.685472	13.9-19.9	Uplands	Alluvium and Styx Coal Measures (overburden)		Extent of drawdown and groundwater quality	
CMB07	WMP09	Existing	-22.728651	149.662403	7.1-15.1	Uplands	Alluvium		Groundwater quality and quantity changes associated with waste rock stockpile, and mine dewatering	
CMB08	WMP07	Existing	-22.737226	149.641208	53-65	Styx	Styx Coal Measures (underburden)	Type 3 GDEs	Extent of drawdown and groundwater quality	
CMB09	WMP15	Existing	-22.715369	149.645751	9.3-21.3	Styx	Alluvium and Styx Coal Measures (underburden)		Extent of drawdown and groundwater quality	
CMB10	WMP25	Existing	-22.709541	149.636279	10.1-13.1	Styx	Alluvium	Type 3 GDEs (Wetland 1)	Extent of drawdown and groundwater quality	
CMB11	WMP14	Existing	-22.696779	149.632833	10-19	Styx	Alluvium and Styx Coal Measures (overburden)		Groundwater quality and quantity changes associated with dam	
CMB12	WMP06	Existing	-22.692585	149.628249	12-18	Styx	Alluvium and Styx Coal Measures (underburden)	Type 2 and 3 GDEs- Tooloombah Creek	Extent of drawdown and groundwater quality	
CMB13	WMP04	Existing	-22.680956	149.655703	12.6-18.6	Uplands	Alluvium		Groundwater quality and quantity changes associated with waste rock stockpile, and mine dewatering	

Monitoring bore	Bore ID	Status	Location		Screened depth (mbgl)	GCZ	Aquifer/Aquitard	Receptor monitoring	Purpose	Monitoring frequency
			Latitude (DD)	Longitude (DD)						
CMB14	WMP04D	Existing	-22.681020	149.655645	21.9-39.9	Uplands	Alluvium and Styx Coal Measures (overburden)		Groundwater quality and quantity changes associated with waste rock stockpile, and mine dewatering	
CMB15	WMP12	Existing	-22.668501	149.659363	11.9-17.9	Uplands	Alluvium and Styx Coal Measures (overburden)	Type 2 and 3 GDEs- Tooloombah Creek	Groundwater quality and quantity changes associated with waste rock stockpile, and mine dewatering	
CMB16	WMP02	Existing	-22.659413	149.661435	13.4-19.4	Bison	Alluvium		Extent of drawdown and groundwater quality	
CMB17	WMP22A	Existing	-22.685308	149.647450	27-30	Uplands	Styx Coal Measures (overburden)	Type 3 GDEs	Extent of drawdown and groundwater quality	
CMB18	WMP22B	Existing	-22.685263	149.647478	50-56	Uplands	Styx Coal Measures (coal seams and interburden)			
CMB19	WMP22C	Existing	-22.685226	149.647487	200-206	Uplands	Styx Coal Measures (underburden)			
CMB20	WMP23A	Existing	-22.722853	149.664159	48.5-54.5	Uplands	Styx Coal Measures (coal seams and interburden)	Type 1 and Type 3 GDEs		
CMB21	WMP23B	Existing	-22.722783	149.664032	187-193	Uplands	Styx Coal Measures (underburden)			
CMB22	WMP24	Existing	-22.683492	149.646996	23.4-26.4	Uplands	Styx Coal Measures (overburden)	Type 2 and Type 3 GDEs – Tooloombah Creek		
CMB23	WMP26	Existing	-22.680702	149.663383	11.5-20.5	Uplands	Alluvium	Type 2 GDEs – Deep Creek tributary	Groundwater quality and quantity changes associated with waste rock stockpile, and mine dewatering	
CMB24	WMP27	Existing	-22.695830	149.634012	14.5-20.5	Styx	Styx Coal Measures (overburden) and minor Alluvium	Type 3 GDE (Wetland 2)	Extent of drawdown and groundwater quality	
CMB25	WMP28	Existing	-22.683402	149.649203	8.9-11.9	Uplands	Styx Coal Measures (overburden)	Type 2 and 3 GDE	Extent of drawdown and groundwater quality	

16.11.4.7 Validation and Updating of the Conceptualisation and Groundwater Model

Future improvements to the numerical groundwater flow model will be undertaken as and when new data become available, particularly where there is a divergence of observed groundwater system response from the predicted. New data may require a revision and update of the conceptual (eco-) hydrogeological model prior to updating and recalibrating the numerical model and re-running of predictive scenarios. Where this is deemed necessary, the REMP and WMP may also need to be updated depending on any reconceptualisation and model predictions.

As mining progresses, a need for further model updates will be assessed every two years based on quarterly reviews and evaluation of groundwater monitoring data and findings of impact verification. It is expected the confidence level of model predictions will increase over time as the model is updated to reflect the observed effects on groundwater from the monitoring program.

Where additional management strategies are required in response to environmental performance, the existing numerical model, or new models depending on the type of impact observed (e.g. density coupled models to simulate seawater intrusion, which has been shown to be unlikely), will be used to test the effectiveness of mitigation measures prior to implementation to improve the outcomes of the proposed measures.

16.11.4.8 Environmental Offsets

A last resort mitigation measure that is available to deal with unacceptable outcomes that cannot be adequately managed involves committing to Project environmental offsets (see Section 16.19).

Central Queensland Coal will commit to an offset for the direct loss of habitat within the mine footprint (e.g. Type 3 GDEs), and will commit to appropriate monitoring and management efforts to monitor for potential indirect loss of habitat outside the mine footprint (i.e. Type 2 and Type 3 GDEs), as appropriate.

16.12 MNES Assessment Methods

MNES were assessed using a combination of desktop assessment methodologies and field surveys. The desktop assessment reviewed existing ecological information pertaining to the Project area, including the Central Queensland Coal mine area and TLF. Seasonal surveys for flora and fauna were subsequently carried out to obtain current ecological information relevant to the Project area and to ground-truth the desktop assessment results.

16.12.1 Desktop Assessment

Desktop studies were undertaken prior to field assessments. The desktop reviews were used to obtain background information relating to the potential presence and distribution of species and ecological communities, including those listed under the EPBC Act and others listed under State legislation. The desktop review sourced information from:

- The Commonwealth EPBC Act Protected Matters Search Tool (25 km radius around a central point of the mine area – accessed 14 December 2016 (refer Appendix A9c – Ecological Desktop Search Results);
- DES Wildlife Online flora and fauna species database (50 km radius around the centre of the mine area) and Species Profile Search results – accessed 14 December 2016 (refer Appendix A9c - Ecological Desktop Search Results);

- Atlas of Living Australia (ALA) species database;
- Current Queensland Regional Ecosystem (RE) mapping, essential habitat mapping for threatened flora and fauna species and sensitive area mapping from DNRME;
- Wetland and watercourse GIS data (DES and Geoscience Australia);
- Great Barrier Reef Catchment Aquatic Conservation Assessments for Non Riverine Wetlands (v1.2) and Riverine Wetlands (v1.1) (DES);
- Styx Coal: Flora and Vegetation Assessment (Oberonia Botanical Services 2011) (refer Appendix A9b – Flora and Vegetation Assessment);
- Reporting of three seasonal fauna assessments for Central Queensland Coal:
    - A preliminary assessment of faunal values within and adjacent to EPC 1029, Styx Basin, central-east Queensland (Meyer 2011a)
    - September 2011 fauna survey results for EPC 1029, Styx Basin, central-east Queensland (Meyer 2011b) and
    - February 2012 fauna survey results for EPC 1029, Styx Basin, central-east Queensland (Meyer 2012) (refer Appendix A9a – Terrestrial Fauna Reports)
- Styx River Catchment Aquatic Baseline Monitoring Program, Waratah Coal Mine Project (ALS Water Resources Group 2011) (refer Appendix A9e – Aquatic Ecology Results); and
- Draft Stygofauna Survey. Report for Central Queensland Coal South Project EM Plan (GHD 2012) (refer Appendix A9f – Stygofauna Results).

16.12.2 Field Surveys

Ecological field surveys were undertaken for the Project to ground-truth desktop information and identify any additional flora and fauna values not identified through the desktop study. Field surveys comprised:

- Comprehensive flora surveys including:
    - Summer (wet season) flora survey of EPC 1029 (five days) 21 to 25 March 2011 by Oberonia Botanical Services (OBS 2011)
    - Spring (dry season) flora survey of EPC 1029 (five days) 25 to 29 September 2011 by Oberonia Botanical Services (OBS 2011)
    - Summer (wet season) flora survey of ML 80187 and immediate surrounds (three days) 8 to 10 February 2017 by Terrestria (led by Dr Andrew Daniel – Terrestria) and
    - Vegetation habitat quality assessments on impact areas and proposed offset sites (wider Mamelon property) in July and August 2018 by David Stanton (3D Environmental);
- Comprehensive fauna surveys including:
    - Detailed summer (wet season) fauna survey of EPC 1029 (five days) 21 to 25 March 2011 by Ed Meyer (ecological consultant)

  - Detailed spring (dry season) fauna survey of EPC 1029 (five days) 25 to 29 September 2011 by Ed Meyer (ecological consultant)
  - Targeted threatened fauna survey of EPC 1029 (four days) 7 to 10 February 2012 by Ed Meyer (ecological consultant) and
  - Detailed summer (wet season) fauna survey of ML 80187 and immediate surrounds (six days) 8 to 13 February 2017 by CDM Smith (led by Brett Taylor)
  - Supplementary fauna data obtained during water quality sampling events on ML 80187 and the wider surrounds from May 2017 to June 2018. Activities included remote camera surveys, bird surveys / nest searches, herpetofauna searches and spotlighting;

- Aquatic ecology surveys including:
  - Comprehensive winter (dry season) aquatic ecology survey of EPC 1029 (six days) 1 to 6 June 2011 by ALS Water Sciences
  - Stygofauna pilot survey (four days) 21 to 24 November 2011, by ALS Water Sciences
  - Detailed summer (wet season) aquatic ecology survey of ML 80187 and immediate surrounds (six days) 11 to 13 February 2017 by CDM Smith (led by Brett Taylor)
  - A general assessment of Groundwater Dependant Ecosystem (GDE) values associated with the Project area carried out in February 2018 and
  - Targeted GDE assessments including stable isotope sampling and leaf water potential measurements on vegetation communities potentially impacted by groundwater drawdown in July and August 2018 by David Stanton (3D Environmental).

The 2011 / 2012 ecological surveys focused on areas within a much larger footprint than the current Project area, although the majority of comprehensive fauna trapping sites were located within or near the current MLs. The February 2017 surveys focused on the MLs and the immediate surrounds including the TLF area. Surveys were conducted to consider seasonal variation and target threatened species. Additional sites were assessed in the Project area surrounds (within a 5 km buffer of the Project area boundary) to provide context. Surveys were designed to encapsulate seasonal variation in species' detectability, and survey sites were selected in representative locations of the key vegetation communities and habitat types present.

Additional fieldworks (associated with ground and surface water quality sampling activities) were carried out by CDM Smith, within and surrounding the mine ML, in the following time periods in 2017: May 1 - 5; August 7 – 10; September 18 – 22; November 7 – 12; and in January 15 – 19, and June 4 - 7 in 2018. Each survey event included an experienced ecologist from CDM Smith.

Updated information provided by the 2017 and 2018 surveys has been incorporated into this chapter. Flora and fauna survey species lists compiled from surveys carried out by CDM Smith personnel (February 2017 to June 2018) are also provided in Appendix A9d – Ecological Field Survey Results.

16.12.2.1 Weather Conditions

Surveys were designed to encapsulate seasonal variation in species' detectability, and survey sites were selected in locations representing the key threatened vegetation communities and dominant habitat types present on the Project area and surrounds. All surveyed areas within the Project area were visited at least once during the site studies. Table 16-98 describes weather conditions for each survey period as recorded at Saint Lawrence (located 37 km north of the Project).

Table 16-98 Weather conditions during site surveys

Survey	Temperatures during study	Rainfall and comments
March 2011	Minimum: 21.9°C Maximum: 34.6°C (source: Meyer 2011a)	23 mm rain recorded during survey. Heavy falls recorded in area in week prior to survey (145 mm). Survey undertaken following an exceptionally wet summer with well-above-average rainfall over most of coastal eastern Queensland. December 2010 rainfall totals were especially high with Marlborough recording over 560 mm of rain.
September 2011	Minimum: 10.8°C Maximum: 26.8°C (source: Meyer 2011b)	Except for August 2011, monthly rainfall totals for Marlborough (to the near south of EPC 1029) were close to average in the 6 months prior to surveys. Little rain was recorded at Marlborough in the month preceding surveys and no rain was recorded during the survey period.
February 2012	Minimum: 21.8°C Maximum: 33.2°C (source: Meyer 2012)	Rainfall in the months preceding surveys was generally at or below average. With significant rainfall in late January and storms on the 7th and 8th of February surface water was plentiful in low-lying parts of the Study area.
February 2017	Minimum: 21.8°C Maximum: 33.2°C (source: BoM 2017)	Conditions during the February 2017 survey were very hot and dry. Excepting a single day in January on which 212 mm was recorded at St Lawrence (located 74 km north of the Project area), mean rainfall in the area was below average in the months preceding the survey and across the entirety of February. How the January rain event affected the Project site is uncertain as no rain was recorded in Rockhampton on the same day.
May 2017	Minimum: 14.8°C Maximum: 29.1°C (source: BoM 2017)	In March 2017, a low-pressure system, associated with Tropical cyclone Debbie, resulted in significant rainfall of up to 145.4 mm. The presence of the recent rainfall events was evident at the site with flow in Deep and Tooloombah Creeks observed. Conditions were dry with 0 mm recorded during the field survey.
August 2017	Minimum: 14.8°C Maximum: 29.1°C (source: BoM 2017)	The site was significantly drier than the May 2017 field survey. Approximately 62 mm had fallen since the last ecological survey in May 2017. Conditions during the survey were dry and cool with no rain recorded at the Strathmuir weather station during this survey.
September 2017	Minimum: 13.9°C Maximum: 30.6°C (source: BoM 2017)	During this field survey the site was dry. 0 mm of rainfall had been recorded at the Strathmuir station since the last field survey. Mean monthly rainfall during August and September 2017 were below average for these months. The mean monthly average recorded in August 2017 at the Strathmuir weather station was 5.5 mm compared to a historic monthly average of 16 mm.
November 2017	Minimum: 16.8°C Maximum: 31.1°C (source: BoM 2017)	Small amount of rain recorded prior to the survey (one day of 9 mm of rain). During the field survey one day of 6 mm of rain was recorded at the Strathmuir weather station.
December 2017	Minimum: 19.9°C Maximum: 31.6°C (source: BoM 2017)	The site visit occurred in late December. At the beginning of December 152 mm of rain fell over six days. During the site visit no rainfall was recorded at the Strathmuir weather station; however, the site was noticeably overgrown and green. Despite the recent rainfall no flow in creeks was recorded.
January 2018	Minimum: 18.4°C Maximum: 32.4 °C (source: BoM 2018)	The survey occurred in mid-January. During the beginning of January 93 mm of rain was recorded over three days. No rain was recorded during the site visit.

16.12.3 MNES Suitably Qualified Study Personnel – CDM Smith

Brett Taylor

Brett is a senior ecological consultant with over ten years field experience in the industry focussing on fauna. His personal and professional interests in ecology and fauna have led Brett to travel to diverse habitats across Australia, as well as Papua New Guinea, Southeast Asia and working as a wildlife guide in South America. He completed his Honours degree project (BSc in Ecology and Conservation Biology) in 2006 and has extensive experience in rainforest research in northern and southeast Queensland. Brett has carried out ecological surveys in a wide variety of habitats surveying both terrestrial and aquatic fauna having worked on projects throughout Queensland.

Dr Andrew Daniel

Andrew has over 20 years' experience in ecological research and management with environmental consultancies and State and government agencies. Trained as a botanist by the Queensland Herbarium, Andrew undertook numerous botanical assessments, mapping and monitoring projects for the Wildlife Ecology Section. He has 12 years of consulting experience specialising in vegetation mapping, EIA, flora and fauna management, offsets appraisal and management, and rehabilitation. Andrew has managed a broad range of projects including assessment within the mining, extractive, industrial and residential sectors. He has extensive experience in remote regions of Australia including baseline ecological assessments for mines in the Northwest Highlands, Gulf Plains, Einasleigh Uplands, Mulga Lands, and Northern and Southern Brigalow Belts of Queensland. Andrew has also authored or co-authored several scientific papers.

Andrew Jensen

Andrew has over ten years professional consulting experience across a range of environmental disciplines, in particular terrestrial ecology. He has extensive field experience focussing of bird surveys across both Great Britain and Australia. His Andrew has managed the terrestrial ecology studies and authored various terrestrial ecology, MNES and environmental offset chapters and submission responses for a range of gas and resource clients. Key aspects of his work include project management, client liaison, preparation of environmental impact statements, ecological reporting and surveying, management of subcontractors and health and safety processes. Andrew routinely reviews environmental technical studies and has developed environmental management plans and environmental approval conditions for projects. Andrew has also been responsible for conducting a number of species impact significance assessments at both Commonwealth and state level.

David Stanton

David has a professional career that spans 24 years, which including three years' working as regional exploration geologist in the Louisade Archipelago of PNG, He has extensive experience in the disciplines of resource mapping (geology and geomorphology), floristic assessment, groundwater and dependent ecosystems, conservation planning and impact and ecological risk assessment. His expertise has been utilised across several industry sectors which include mining, infrastructure as well as a consultant to government and indigenous organisations throughout Queensland, the Northern Territory, north-Western Australia and Papua New Guinea. David has particular expertise in landscape scale ecology and ecological processes including the relationships between vegetation geology, geomorphology, hydrology and hydrogeology.

16.12.4 Flora Survey Methodology

This chapter refers to vegetation communities using the Queensland Herbarium's Regional Ecosystem classification system. Although sometimes different to DotEE's description of TECs and habitat for MNES species, this system allows for specific identification of areas in the chapter that would otherwise be referred to as under broad classifications such as 'eucalypt woodland.'

Three vegetation field assessments were undertaken including March and September 2011 (by Andrew Franks of Oberonia Botanical Services) and February 2017 (Terrestria). A summer survey was conducted in February 2017 to confirm the accuracy of the 2011 vegetation communities presented for remnant and regrowth vegetation within the current Project area. The revised RE mapping is somewhat different from the current DNRME vegetation mapping. The February 2017 field survey confirmed the presence and extent of TECs within the Project area and included targeted searches for threatened flora species. The 2011 surveys included six secondary sites, 34 tertiary sites and 51 quaternary sites across a wide area including the mine ML. The February 2017 survey included 24 RE code sites and 35 quaternary sites within the ML, haul road and TLF. Ground-truthed data along with contemporary aerial imagery was used to determine:

- Potential presence / absence of TECs;
- Known or potential habitat for EPBC listed flora species;
- Accuracy of RE mapping; and
- Presence of threatening processes, particularly pest flora species.

The field assessments were conducted in accordance with the Queensland Herbariums' Methodology for Survey and Mapping of REs and Vegetation Communities in Queensland, Version 3.2 (Neldner et al. 2017). Where discrepancies were identified in the field, areas were traversed by foot to confirm the extent of the change. Additional information was collected where discrepancies with RE attribution were encountered on the ground. The locations of the flora survey sites and potential TECs as per current DNRME vegetation mapping are shown in Figure 16-129.

Regional Ecosystem Code Sites

Regional Ecosystem Code Sites are used to aid in classification and detailed descriptions of REs and vegetation communities during the 2017 survey. Data collected include location, and environmental information such land zone. Structural information such as height and covers are estimated for all structural layers. Generally, only the dominant or conspicuous species that characterise each layer are recorded. Plots are not laid out using a tape, site dimensions are restricted to a commonly occurring vegetation type and condition.

Secondary Assessments

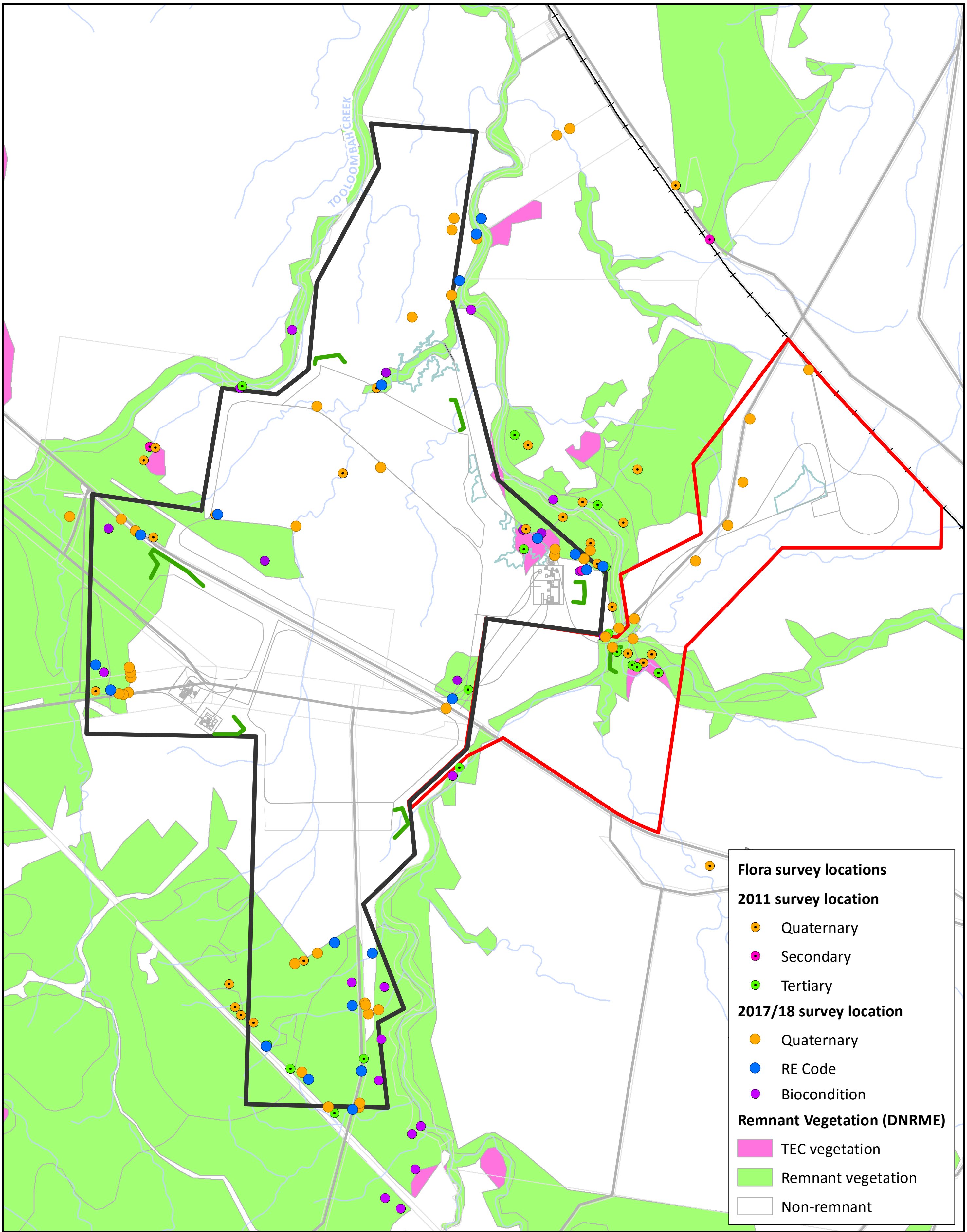
Secondary assessments involve sampling plots of at least 50 m by 10 m in size, within each defined vegetation community. This methodology was; however, subject to the size of the vegetation community, with additional sites surveyed in vegetation communities covering large areas, and a reduction in the number of sites surveyed in small communities.

Tertiary Assessments

Tertiary site assessments were used for classification and detailed descriptions of REs and vegetation communities. Data collected included location, environmental and overall structural information as well as a full species list, estimates of stem density, estimates of basal area (of woody stems using the Bitterlich stick method) and a measure of percentage cover.

Quaternary Observations

Quaternary data were used mainly as a record of field traverses and to verify RE / vegetation mapping. Quaternary sites are used to confirm / change RE polygon attribution to note changes in condition, presence of weed infestations, special habitat features and community boundaries. Site information includes dominance of flora species within structural layers, confirmation of remnant / non-remnant status, soil type, land zone, presence of threatened species and of weed species.



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Legend

- ML 80187
- ML 700022
- Mine infrastructure
- Environmental Dams
- Cadastral boundary
- Main road
- North Coast Rail Line
- Watercourse
- Dam

Figure 16-129
Flora survey locations on current DNRME vegetation mapping

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018

CDM Smith

16.12.5 Fauna Survey Methodology

Four field surveys were undertaken to assess fauna within the Project area, including March and September 2011 and February 2012 (by Ed Meyer) and February 2017 (CDM Smith). A total of eight baseline survey sites were selected within the extended survey area for the 2011 surveys, and a further four sites within ML80187 were added for the February 2017 survey. Site selection was based on RE mapping, land access and the integrity of the habitat. Descriptions of the fauna trapping sites are provided below in Table 16-99 and locations of survey sites are shown in Figure 16-130. Baseline fauna trapping was carried out at each site over a period of five days and four nights at each site.

The general survey approach was to visit and assess representative faunal habitats over the Project area, recording fauna species by sightings, recognition of characteristic vocalisations, and / or identification of animal signs. The surveys focussed on conservation significant fauna species and important habitat. The techniques used during the fauna surveys are provided in Table 16-100.

Table 16-99 Description of fauna trapping sites – 2011 and 2017 surveys

Trap site	Location and coordinates	Habitat description
March 2011		
Site 1	-22.66886 149.69475	Remnant *Eucalyptus crebra* woodland with sparse shrub layer and dense cover of native grasses. Located approximately 2.5 km east of northern extent of Project area
Site 2	-22.61894 149.65978	Remnant gilgaied Brigalow (*Acacia harpophylla*) woodland, near Ogmore. Located approximately 4.5 km north of Project area.
Site 3	-22.718 149.66964	Remnant riparian open forest / woodland along Deep Creek, south of the Bruce Highway. Located on eastern boundary of Project area.
Site 4	-22.71356 149.62136	Remnant *E. crebra* / *E. exserta* woodland / open forest with a mid-dense shrubby understory of *A. rhodoxylon*, adjacent to Mt Bison Road, south of the Bruce Highway. Located approximately 1.3 km west of Project area.
September 2011		
Site 5	-22.66886 149.69475	*E. crebra* woodland with dense grassy understory, upslope from watercourse. Located approximately 300 m west of Project area.
Site 6	-22.61894 149.65978	Mixed eucalypt woodland / open forest on hill slope with sparse shrub layer and sparse grass cover, on sandy soil with small areas of exposed rock. Located approximately 200 m west of southern extent of Project area.
Site 7	-22.718 149.66964	SEVT with emergent *E. tereticornis* and *Corymbia tesselaris* fringing Tooloombah Creek. Located within northwest extent of Project area.
Site 8	-22.71356 149.62136	Remnant gilgaied Brigalow woodland with dense to mid-dense shrub layer dominated by *Carissa ovata*, to the near east of Deep Creek. Located within eastern extent of Project area.
February 2017		
Site 1	-22.7093 149.63409	Remnant *E. platyphylla* woodland with very sparse shrub layer (RE11.5.8a). Native grasses sparse at time of survey due to very dry conditions and ongoing cattle presence. Located uphill from large ephemeral wetland area on western edge of Project area.
Site 2	-22.73334 149.65887	On edge of remnant *E. crebra / E. populnea* dominated woodland (RE11.10.7). Dense understorey dominated by the introduced Lantana (*Lantana camara*) and Red Ash (*Alphitonia exselsa*). Located within southern portion of Project area.
Site 3	-22.68213 149.6625	Thin riparian *E. tereticornis* open forest strip adjacent to dense regrowth Brigalow (RE11.3.25). Dense but patchy lower shrub layer. Small pools of water present in creek. Located within northern portion of Project area.
Site 4	-22.69589 149.68464	Remnant mixed gum woodland (RE11.3.4) with patchy shrub layer dominated by the introduced Lantana Ground layer also patchy with some dense areas of sedges in low drainage channel bisecting site. On eastern edge of Project area.

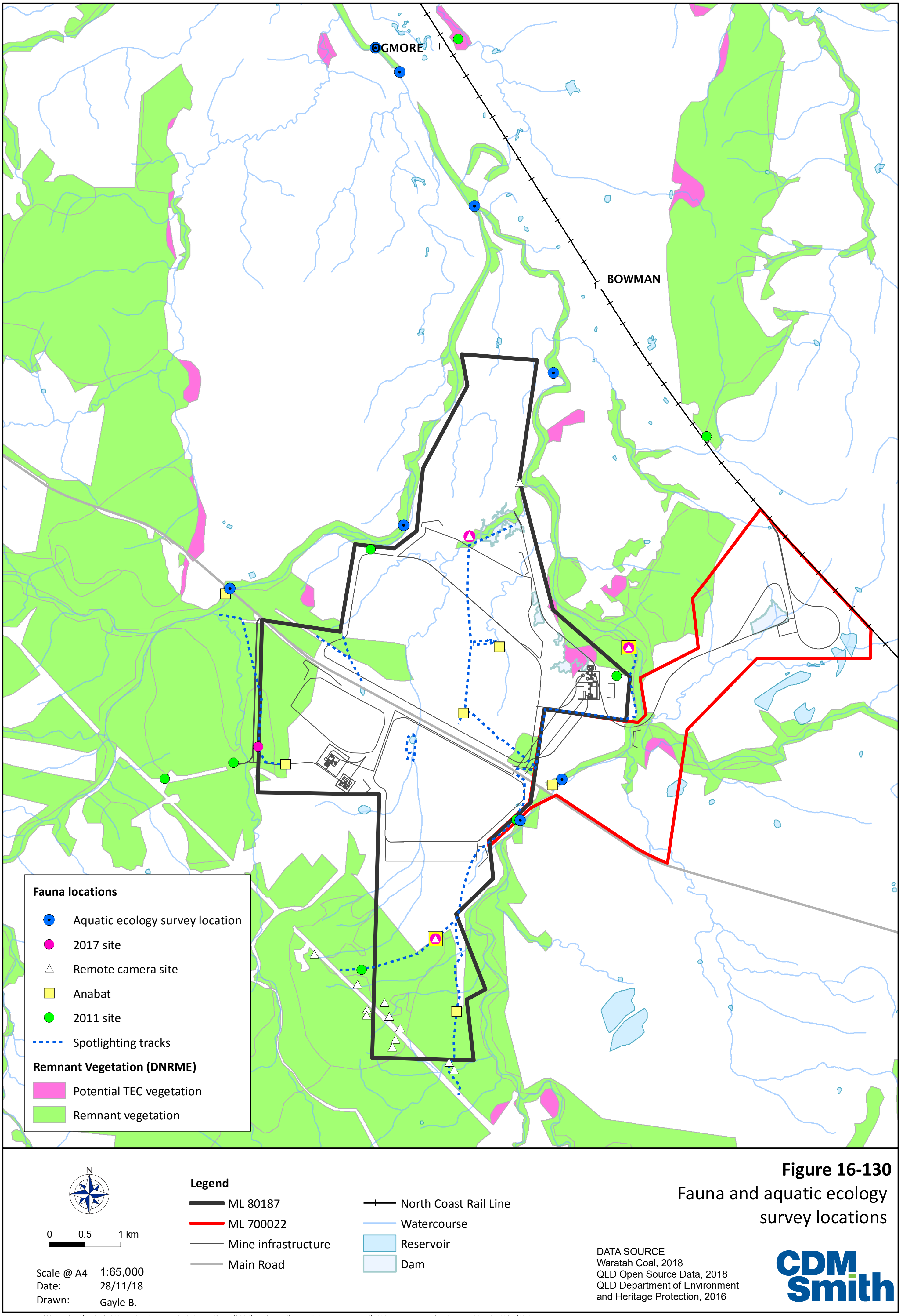

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Figure 16-130
Fauna and aquatic ecology survey locations

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
QLD Department of Environment and Heritage Protection, 2016

CDM Smith

PARNWELLJA \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 Fauna survey locations__16-28.mxd 28/11/2018

Table 16-100 Baseline fauna survey methods

Survey method	Description	Target listed species (as identified in desktop surveys)
Trap sites (all)		
Elliott trapping	20 baited Elliott A and B traps located 10 m apart along a single transect at each site. Traps baited with a standard mixture of peanut butter, oats and vegetable oil.	▪ Northern Quoll; and ▪ Yakka Skink (around potential colonies).
Pitfall / funnel trapping	A pitfall line at each site comprising 4 x 20 L pitfall buckets, 30 m fence and 4 x funnel traps paired at each end of fence line. Positioned where suitable habitat structure occurs (woody debris, shrubby vegetation).	▪ Ornamental Snake; ▪ Dunmall's Snake; and ▪ Collared Delma.
Infrared camera traps	Infrared camera set at each trap site (5 per site in March 2011 and 2 per site in September 2011). Cameras set at four sites in 2017 in front of bait station. Cameras set at 10 sites adjacent to rocky habitat (potentially favouring presence of Northern Quoll) from late September – December 2017. Bait stations set with mixture of peanut butter, oats, vegetable oil and sardines (400 nights total).	▪ Northern Quoll.
General methods (across Project area including trap sites)		
Diurnal bird census	Two 20 minute bird surveys across a 20 ha area at each trap site and opportunistically throughout Study area during all survey periods. Birds identified by direct observation and / or by call.	▪ All bird species.
Diurnal searches for herpetofauna	Searches for frogs and reptiles under leaf litter, debris, logs and rocks. Carried out at each trap site and throughout Study area where appropriate habitat factors occurred (i.e. presence of suitable vegetation, woody debris, leaf litter and/or soil cracks).	▪ Ornamental Snake; ▪ Dunmall's Snake; ▪ Collared Delma; and ▪ Yakka Skink.
Anabat microbat call recording	Passive recording of microbat calls overnight (6 pm to 6 am) using Anabat recording system. Carried out at each trap site and throughout Study area where appropriate habitat factors occurred.	▪ Large-eared Pied Bat; and ▪ South-eastern Long-eared Bat.
Spotlighting surveys	Minimum ½ hour (hr) spotlighting in early evening (two people) at each trap site for nocturnal mammals and herpetofauna. Ornamental Snake targeted where cracking clay soils occurred. Also surveying tracks at night and throughout Study area where appropriate habitat factors occurred. Call playback surveys for nocturnal bird species carried out where considered suitable.	▪ Koala; ▪ Ornamental Snake; ▪ Grey-headed Flying-fox; and ▪ Greater Glider
Terrestrial habitat assessment	Habitat assessed for suitability to provide resources for terrestrial fauna. Habitat characters assessed include: tree hollow abundance, evidence of nesting, leaf litter, large woody debris and weed invasion.	Assessments included searches for Koala and signs of habitat use (tree scratches and scats).
Incidental records	Fauna observations were ongoing throughout the site and all survey periods where an experienced ecologist was present.	N/A

Additional ecological works carried out from May 2017 to January 2018 during scheduled sampling of groundwater bores sand surface water sites associated with the Project included the fauna survey following methods:

- Timed 20 minute bird surveys across a 2 ha area carried out opportunistically around bore sites and targeted surveys throughout the ML, particularly targeting dams/wetland areas for Australian Painted Snipe, and riparian zones for potential nesting Red Goshawk.

  Total of an additional 59 x 20 minute bird surveys;

- Additional trapping for freshwater turtles was carried out in August and September 2017. Trapping targeted Southern Snapping Turtle (*Elseya albagula*) comprised two 'opera house' style traps (70 cm x 50 cm x 30 cm) baited with fruit. Traps were set for a minimum of two hours at a single large waterhole on Deep Creek and Tooloombah Creek. Traps were set overnight in September 2017;

- Spotlighting surveys carried out on foot and in vehicle within the ML targeting dams, wetlands and gilgai/Brigalow (*Acacia harpophylla*) providing potential habitat for Ornamental Snake, or targeting wooded areas for Koala and Greater Glider. Tracks employed during spotlighting surveys for the Project are depicted in Figure 16-130. No spotlighting was carried out in May 2017.

  Total of an additional 22.5 person hours of spotlighting; and

- Remote passive infrared cameras were set at 10 sites located within or close to the southern boundary of the ML. Cameras were set adjacent to rocky habitat assessed as potentially suitable for Northern Quoll (*Dasyurus hallucatus*) den sites. Cameras were located 3 – 5 m in front of a station baited with a combination of oats, peanut butter, macadamia oil and sardines. Camera traps were set at five sites from 29th September until 10th November. The cameras were moved to five new sites and rebaited on the 11th November. Cameras were collected and photos downloaded on the 21st December (refer Figure 16-130 for all sites).

  Total of an additional 400 camera trap nights.

16.12.6 Aquatic Ecology Methods

Two aquatic ecology field assessments were undertaken as follows (refer Figure 16-130):

- Detailed assessments at nine sites were undertaken (refer Table 16-101) on sites adjacent to and surrounding the current Project area from 1 to 6 June 2011:
  - Three sites on Deep Creek (De1, De2 and De3)
  - Three sites on Styx River (St1, St1b and St2)
  - Two sites on Tooloombah Creek (To1 and To2)
  - One site on Granite Creek located to the north of the Project area (Gr1)
- A subsequent less intensive survey was carried out in February 2017 (8 – 9 February) sampled four of the previous creek sites (To1, To2, De1 and De2). A fifth site (De4) was established upstream of De3 which was not able to be accessed at the time.

The local area had experienced wet conditions in the months preceding the survey in 2011 including over 500 mm in December 2010 (long-term December average 124 mm) and nearly 300 mm in March 2011 (long-term December average 133 mm). As a result, sampling conditions were considered suitable with abundant water available in creeks in the area.

Conditions during the February 2017 survey were hot and dry. Excepting a single day in January on which 212 mm was recorded at St Lawrence (located 74 km north of the Project area), mean rainfall in the area was below average in the months preceding the survey and across the entirety of February. How the January rain event affected the Project site is uncertain as no rain was recorded in Rockhampton on the same day. Nevertheless, although no flow was recorded at the time sizeable waterholes remained which were suitable for sampling at the time.

The sampling design followed that set out by DES's *Environmental Protection (Water) Policy 2008* (EPP (Water)). Water quality parameters were assessed against the values identified in the Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives (EHP 2014a).

A range of stream attributes were assessed, including water quality parameters, aquatic and riparian habitat descriptions, macroinvertebrate and vertebrate (fish) sampling. Aquatic habitat sites were described according to the standard proformas from the AusRivAS protocols. Information collected included in-stream and riparian plant cover, woody debris, substrate and site disturbance. Macroinvertebrates were assessed using triangular sweep nets. Water quality parameters were assessed using an onsite water quality meter and off-site laboratory testing.

Fish were sampled at each site using a combination of baited traps and electrofishing. Freshwater turtles were surveyed visually and limited trapping by hand in 2011 and turtle sampling using crab pots baited with bait fish where conducted at all sites surveyed in February 2017.

Table 16-101 Aquatic ecology survey site descriptions

De1 – Upper Deep Creek	
Site coordinates	-22.71803, 149.67018
Description	Adjacent to eastern boundary of MLs. Low flow at time of 2011 survey. Evidence of recent flooding – debris noted approx. 7 m above channel. Steep incised banks 7 m above water level. Substrate comprised small cobbles, gravel and sand. Well vegetated riparian zone at all levels with Lantana dominant in shrub layer. Channel well shaded. Some cattle access evident but likely minor due to steep banks.
Macroinvertebrate Signal score	Riffle – 4.76
Approx. channel size	3 m (riffle) to 6 m (pool)
Mean depth	0.2 m (riffle) to >0.5 m (pool)
De1 pool section – June 2011	**De1 pool section – February 2017**
	

De2 – Deep Creek (below highway)	
Site coordinates	-22.71272, 149.67582
Description	Located north of highway. Substantial pool present. Low flow at time of survey in 2011. Substrate comprised small cobbles, gravel and sand. Bank height approx. 2.5 m above channel. Thin riparian zone with moderate shade cover. Vehicle / cattle crossing point evident. Cattle access evident.
Macroinvertebrate Signal score	Riffle – 5.25
Approx. channel size	7 m (riffle) to 14 m (pool)
Mean depth	0.2 m (riffle), uncertain depth of pool – likely to retain water for extended periods
De1 pool – February 2017	
	

De3 – Lower Deep Creek	
Site coordinates	-22.66108, 149.67363
Description	Adjacent to northeast corner of MLs. Low flow at time of survey. Evidence of recent flooding – debris noted approx. 6-8 m above channel. Steep incised banks 8 m above water level. Substrate comprised largely gravel and sand. Well vegetated riparian zone at all levels. Rubber Vine (*Cryptostegia grandiflora*) dominant in some areas. Channel well shaded. Abundant woody debris observed in channel. Cattle access evident despite presence of exclusion fencing.
Macroinvertebrate Signal score	Riffle – 5.71
Approx. channel size	1.8 m (riffle) to 10 m (pool)
Mean depth	0.3 m (riffle), uncertain depth of pool – likely to retain water for extended periods
De3 riffle site – June 2011	
	

De4 – Lower Deep Creek	
Site coordinates	-22.664023, 149.672344
Description	Located approximately 700 m upstream of De3. No flow observed. Steep incised banks, 8 m above water level on west side. Substrate comprised largely gravel and sand. Well vegetated riparian zone at all levels (Rubber Vine dominant on lower east bank). Channel well shaded. Woody debris observed in channel. No obvious cattle access evident but evidence of pig presence observed.
Macroinvertebrate Signal score	
Approx. channel size	8 m (pool)
Mean depth	uncertain depth of pool – likely to retain water for extended periods
De4 pool – February 2017	
	

St1 – Upper Styx River	
Site coordinates	-22.64, 149.6624
Description	Just downstream of merge of Deep Creek and Tooloombah Creek. Low flow at time of survey. Evidence of recent flooding – debris noted approx. 6 m above channel. Shallow banks 5-7 m above water level. Substrate comprised largely gravel and sand. Very disturbed riparian zone with few tall trees and weed species common (Rubber Vine dominant in some areas). Poor channel shading. Aquatic vegetation present.
Macroinvertebrate Signal score	Riffle – 3.65
Approx. channel size	5 m (run) to 40 m (pool)
Mean depth	0.3 m (riffle area in Tooloombah Creek), main channel uncertain – 0.6 m at edge
St1 pool site – June 2011	
	

St1b – Styx River	
Site coordinates	-22.6232, 149.65187
Description	Located upstream of bridge on Ogmore Connection Road. Substrate dominated by silt / clay. Riparian zone shows evident of infrequent tidal inundation (marine couch present close to channel). Clearing evident with few tall trees present and weed species common. No channel shading. Aquatic vegetation present. Cattle access evident.
Macroinvertebrate Signal score	Riffle – 3.5
Approx. channel size	6 m to 12 m (pool)
Mean depth	Up to 2.5 m in main channel

St2 – Lower Styx River	
Site coordinates	-22.62018, 149.64848
Description	Located downstream of bridge on Ogmore Connection Road. Right bank heavily incised (6 m above channel), left bank floodplain less than 3 m above channel. Substrate dominated by silt / clay. Regular tidal inundation of site and few tall trees present as a result. Weed species common [heavy cover of Noogoora Burr (*Xanthium occidentale*)]. No channel shading. Aquatic vegetation present.
Macroinvertebrate Signal score	Riffle – 3.52
Approx. channel size	4 m to 10 m (pool)
Mean depth	Up to 1.2 m in main channel
St2 pool site – June 2011	
	

To1 – Tooloombah Creek	
Site coordinates	-22.68923, 149.62985
Description	Located adjacent to bridge over highway (downstream). Moderate flow at time of survey. Evidence of recent flooding – debris noted approx. 6 m above channel. North bank steep (>15 m above channel), gentle slope on south bank. Rocky creek with areas of substrate dominated by bedrock, as well as cobbles / gravel / sand. Well vegetated riparian zone. Channel moderately shaded. Evidence of cattle activity recorded at site.
Macroinvertebrate Signal score	Riffle – 5.77
Approx. channel size	5 m (riffle) to 17 m (pool)
Mean depth	0.3 m (riffle) to >1.5 m (pool)
To1 pool site (upstream of bridge) – June 2011	**To1 pool site (at bridge) – February 2017**
	

To2 – Tooloombah Creek downstream	
Site coordinates	-22.68083, 149.6535
Description	Located adjacent to western boundary of MLs. Moderate flow at time of 2011 survey. North bank relatively steep (7 m above channel), gentle slope on south bank. Substrate dominated cobbles / gravel / sand with large rocks sometimes present. Well vegetated riparian zone in good condition although occurrences of Rubber Vine present. Evidence of cattle activity recorded at site. Channel moderately shaded.
Macroinvertebrate Signal score	Riffle – 5.37
Approx. pool size	2.5 m (riffle) to 35 m (pool)
Mean pool depth	0.3 m (riffle), uncertain depth of pool – likely to retain water for extended periods, creek may be permanent some years
To2 riffle site – June 2011	**To2 pool site – February 2017**
	

<table>
<tr><th colspan="2">Gr1 - Granite Creek</th></tr>
<tr><td>Site coordinates</td><td>-22.60893, 149.54475</td></tr>
<tr><td>Description</td><td>Located downstream of highway and 13 km northwest of MLs. Moderate flow at time of survey. Series of large pools joined by riffle areas. Evidence of recent flooding – debris noted approx. 3 m above channel. Banks gently sloped, north bank approx. 5 m above channel. Substrate dominated by cobbles / gravel / sand. Riparian zone disturbed and substantially narrowed in sections. Weeds common. Channel poorly shaded. Aquatic vegetation present.</td></tr>
<tr><td>Macroinvertebrate Signal score</td><td>Riffle – 6.06</td></tr>
<tr><td>Approx. pool size</td><td>3 m (riffle) to 25 - 45 m (pool)</td></tr>
<tr><td>Mean pool depth</td><td>0.3 m (riffle), 3.8 m in deep section of pool – likely to retain water for extended periods</td></tr>
<tr><td>Gr1 riffle site – 5 June 2011</td><td>Gr1 pool site – 5 June 2011</td></tr>
<tr><td></td><td></td></tr>
</table>

16.12.6.1 Targeted GDE Sampling

A number of targeted onsite measurements and sampling methods were carried out on vegetation communities (including MNES habitat) potentially impacted by drawdown of groundwater in order to ascertain their potential use of groundwater. These included leaf water potential (LWP) measurements, stable isotope analysis and soil coring to root depth. This was carried out as part of wider investigations of the occurrence of groundwater dependent ecosystems in the area. The sampling protocols for these methods are summarised below (refer Section 5.2 of Appendix A6 for further detail) and sampling locations are identified across the wider area in Figure 16-100 and in detail in Figure 16-131.

Leaf Water Potential Measurement

For plants to transpire they must maintain a LWP that is more negative than the soil water potential (SWP). A dry soil will have a highly negative SWP and a plant must be able to regulate their stomatal conductance and lower their LWP to be more negative than the SWP to extract water. By contrast, a moist soil or one that is maintained in moist state by shallow groundwater will not require plants to lower their LWP excessively to extract water. Thus, measuring LWP and SWP concurrently provides an indication of where in the soil profile plants are drawing their water from and it also provides an indication as to whether plants have access to groundwater (at the water table, SWP approaches zero).

LWP measurements were carried out in August 2018 during dry conditions with only 28 mm of rainfall recorded at St Lawrence (38 km north of the Project) from May onwards (BoM 2018). This was considered suitable for conducting measurements of LWP as trees would be most likely to access groundwater (if necessary) at this time given the dry ground conditions. Signs of leaf stress at this time would indicate that species are potentially not tapped into groundwater.

Leaf water potential was measured pre-dawn using a Plant Water Potential Gauge. Leaves were collected from the highest accessible part of the tree using an extension pole and attached lopper head. A suitable leaf is selected and the petiole (leaf stem) is cut and placed in the pressure chamber with the cut stem protruding from the chamber at atmospheric pressure. The vessel is sealed around the petiole and pressure applied via an external gas cylinder. The protruding stem is observed and pressure readings recorded at the first point that water is noted to be exuded by the leaf. The positive pressure applied to the leaf at this point is measured as the 'LWP'.

Soil samples were collected for measuring soil water potential during the same soil coring sample process described for the soil pore water stable isotope analysis below. Soil moisture potential was measured onsite using a portable Dew Point PotentiaMeter. A 7 ml soil sample collected from each core is inserted in the potentiometer and analysed for between 10 – 15 minutes.

Stable Isotope Analysis – Soil Water

The overarching aim of stable isotope analysis in this context is to determine the degree to which trees utilise groundwater on either a permanent or seasonal basis. It will be applied only at those sites which are specifically located to investigate the interactions between tree roots and groundwater. Trees may utilise water from a range of sources including the phreatic zone, the vadose zone and surface water and the stable isotopes of water, oxygen 18 (18O) and deuterium (2H) may be a useful tool to help define the predominant source of water used by terrestrial vegetation. The method relies on a comparison between the stable isotope ratios of water contained in plant xylem (from a twig or xylem core) with concentrations in the various sources of water including potential artesian water sources, and shallow soil moisture. Knowing the isotopic composition of these sources and plant water can assist in conceptualising plant water uptake.

Soil sampling for soil pore water was undertaken at regular intervals along a retrieved soil core at each site to capture signatures for possible isotopic end points (ground water and surface water) and a range of potential plant moisture sources within from the upper soil surface to the top of the phreatic (aquifer) zone. Soil was sampled at the following intervals:

- Initial soil sample taken within the top 10 cm of soil profile;
- Subsequent soil samples taken at 0.5 m intervals down borehole to the top of the phreatic zone; and
- Additional soil samples taken where a noted change in soil texture is observed within soil core (e.g. change from clay to sandy clay / loam soil).

A minimum 200ml equivalent of soil was collected for each sample to be analysed. Samples were immediately sealed, labelled for identification and kept on ice /frozen until despatched for laboratory analysis.

Xylem water for stable isotopes was sampled by collecting twigs from the outer branches of mature trees that were the subject of the assessment at each site. Up to four twig samples were collected from the outer branches of four of the subject trees at each site. Collected branches contained some stem diameters of at least 10 mm. Stems were cut into maximum 5 cm lengths and the bark stripped. Stems were sealed in wide mouth sample containers with leakproof polypropylene closure labelled for identification and kept on ice /frozen until despatched for laboratory analysis.

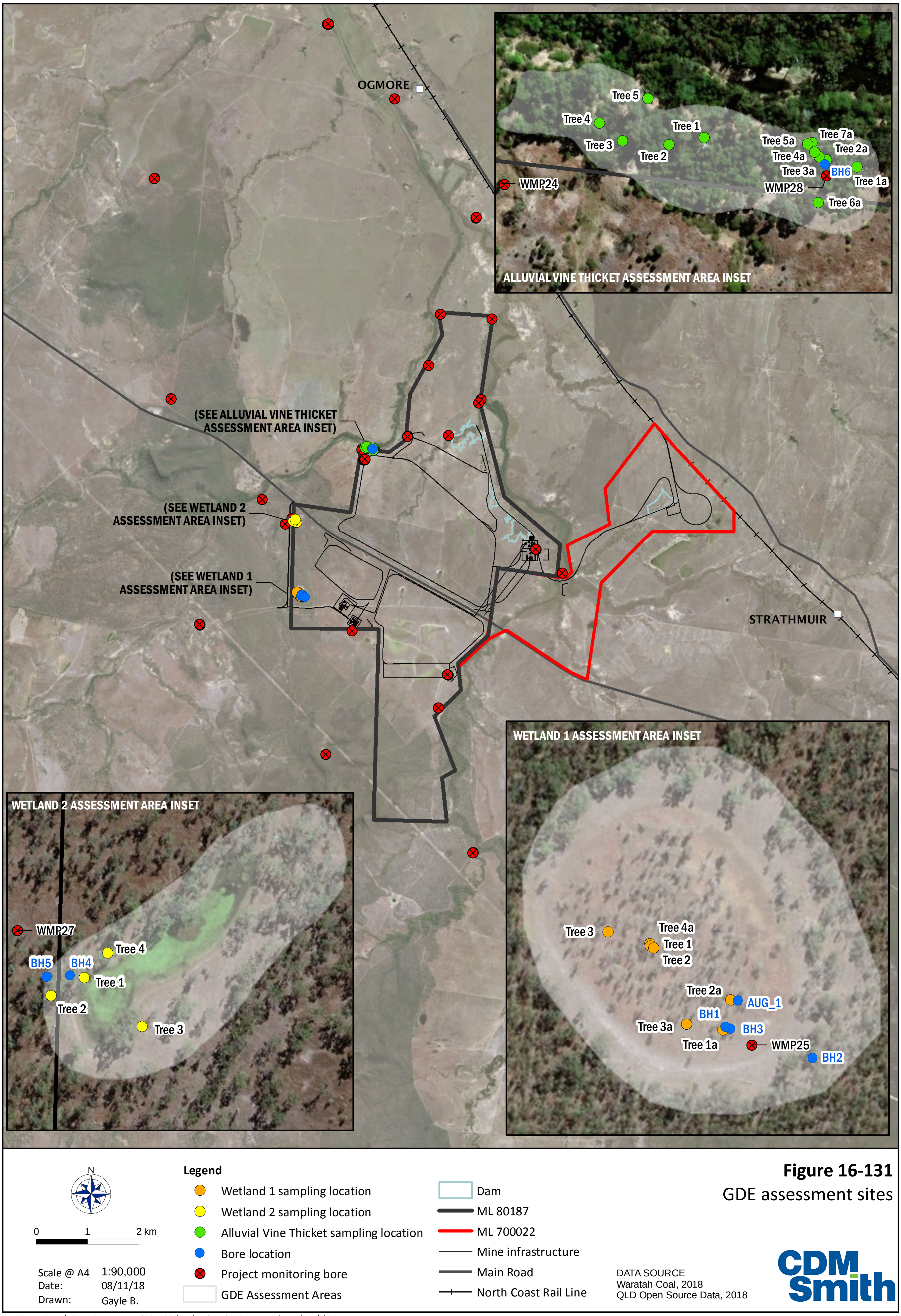
All stable isotope analyses were carried out by the Australian National University Stable Isotope Laboratory.

Stable Isotope Analysis – Surface/Groundwater Interactions

To better understand the relationship between the surface water and groundwater, the stable isotopes of water (2H and 18O) and radon isotope (222Rn) were analysed from water samples collected from the site. The stable isotopes of water can be used to discriminate between different sources of water. The method relies on the distinct isotopic compositions which can arise as a result of isotopic fractionation caused mainly by transportation processes (i.e. mixing) and phase transitions (i.e. evaporation) through the atmosphere, lithosphere and biosphere (Barnes and Allison, 1988).

Six grab water samples were collected from Tooloombah Creek in-stream pools (two sampling points each from three pools within the creek) and another three from Deep Creek in-stream pools (a sampling point from three pools within the creek) between 16th and 18th July 2018. Groundwater samples were collected from six monitoring wells that are close to the surface water sampling points, using a low-flow groundwater sampling pump.

Water samples were analysed by Environmental Isotopes (contracted via Australian Laboratory Services, ALS). The hydrogen and oxygen isotope ratios were measured using a Wavelength Scanned-Cavity Ring-down Spectrometer (Picarro L2120) based on Munksgaard et al. (2011).



Scale @ A4 1:90,000
Date: 08/11/18
Drawn: Gayle B.

Figure 16-131
GDE assessment sites

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018

CDM Smith

BRUGGEMANNGD B:\1000111_Styx_SEIS_post-submission\GIS\DATA\MXD\TEMP\1000111 GDE_working.mxd 11/8/2018

16.12.7 Survey Effort for EPBC Listed Fauna Species

State and Commonwealth survey guidelines have been designed for a number of EPBC listed fauna species that are predicted to occur in the Project area. There are no specific guidelines available for surveying EPBC listed flora species or TECs. EPBC survey guidelines are not mandatory, but provide a guide to the best methods to assess the presence or absence of a particular species or taxa, based on the best available knowledge up to that time (DSEWPaC 2011a). These guidelines were considered during the design and conduct of the fauna surveys undertaken for this Project.

Surveys undertaken as part of the Project were also tailored to site specific conditions, including those relating to habitat quality, distribution and abundance, as well as access, weather, and time constraints to maximise the detection of species that have the potential to occur within survey sites. As such, the fauna surveys undertaken as part of the Project provide a robust and tailored survey of fauna species present within the Project area.Table 16-102 summarises the survey effort for those species considered to have potential habitat in the area compared to the generic EPBC non-mandatory guidelines. The table does not include survey methods for recently listed fauna species for which there are no survey guidelines such as Greater Glider (*Petauroides volans*) and Ghost Bat (*Macroderma gigas*).

The survey effort described below has been further enhanced by subsequent site visits required for water quality sampling (surface and groundwater) in May, August, September and November 2017 and January 2018. These visits included the presence of a qualified ecologist and included searches for raptors and their nests, limited timed bird surveys, spotlighting searches, turtle trap setting in Deep and Tooloombah Creeks, and incidental recording of fauna throughout.

Table 16-102 Survey effort relative to guidelines

Central Queensland Coal field survey effort	Survey Guidelines
Brigalow reptiles – predicted species in Project area: Yakka Skink; Ornamental Snake, Dunmall's Snake and Collared Delma.	Draft referral guidelines for the nationally listed Brigalow Belt reptiles (DSEWPaC 2011a)
Diurnal active habitat searches – including searches for burrows, under leaf litter and logs, rocks, cave and crevices. Approximately 42 hours (hr) of searches over approximately 42 ha were conducted over Project area over a total of 20 days. Spotlighting - approximately 54 person hours conducted over survey periods. Also surveying driving tracks at night and throughout study area where appropriate habitat factors occurred. Pitfall / funnel trapping - no pitfall trapping was possible in March 2011 due to wet conditions. Trapping carried out at eight sites comprising 32 trap nights (four sites each in 2011 and 2017). Elliott trapping carried out at eight sites comprising 640 trap nights (March and September 2011), and four sites comprising 300 trap nights (refer Appendix A9d for separate species results for each survey).	Diurnal active habitat searches- suitable for all predicted species. 1.5 hr per hectare of habitat of average complexity over a minimum of three days. Searches for burrow systems and defecation sites for Yakka Skink. Spotlighting - suitable for predicted species. Targeting wetter areas and surrounds on warm nights. Opportunistic searches - 1.5 hr per hectare of habitat of average complexity over a minimum of three nights. Suitable for Ornamental Snake. Particularly following heavy rainfall events. Pitfall / funnel and Elliott trapping - Suitable for Ornamental Snake. Six 20 litre (l) buckets with funnel trap at each end along a 30 m drift fence Elliott trapping around potential burrow systems for Yakka Skink. Two replicates per habitat type over four days / nights.
Reptiles – predicted species in Project area: Fitzroy River Turtle and Southern Snapping Turtle	Survey guidelines for Australia's threatened reptiles (DSEWPaC 2011b).
Turtle trapping in 2017 only (February, August and September), visual surveys, limited hand trapping carried out in 2011 aquatic ecology survey. Stream habitat assessed for suitability of species presence.	Snorkelling surveys in riffle zones of appropriate waterways. Seine netting. Turtle trapping with meat baits.

Central Queensland Coal field survey effort	Survey Guidelines
Birds – predicted species in Project area: Red Goshawk, Squatter Pigeon, Star Finch (eastern), Black-throated Finch (southern), Australian Painted Snipe and Black-breasted Button-quail	Survey guidelines for Australia's threatened birds (DEWHA 2010a)
Timed bird surveys (20 min) comprising random meander transect within 2 ha site – 115 surveys (approximately 38.5 hrs) carried out over Project area and surrounding areas including dams and wetland areas. This does not include incidental recordings (including raptor sightings) carried out during extensive travel across the site and surrounds. Opportunistic vehicle-based surveys undertaken throughout Project area and surrounds (up to a 10 km radius of the Project area). Based on 2 hrs per day travelling between survey sites (fauna, flora and water quality sampling) over 30 days (60 hrs). Additional raptor / nest searches in riparian and adjacent habitat in conjunction with habitat suitability assessments, water quality sampling along Deep Creek and Tooloombah Creek and opportunistically throughout all survey periods including May, August, September and November 2017, and January 2018. Opportunistic surveys carried out wherever appropriate habitat occurred. Approximately 4.5 hrs of call playback during spotlighting.	Area searches of suitable habitat. Suitable for: Australian Painted Snipe (10 hr over three days), Star Finch (15 hr over five days), Black-breasted Button-quail and Squatter Pigeon (15 hr over three days), Black-throated Finch (10 hr over two days) and Red Goshawk (10 days for a total of 80 hr). Targeted watches of waterholes during dry season. Suitable for Star Finch (10 hr over four days) and Black-throated Finch (6 hr over two days). Flushing surveys for Squatter Pigeon. 10 hr over three days Targeted stationary observation in potential foraging habitat (farm dams). Suitable for Australian Painted Snipe (10 hr over three days).
Mammals – predicted species in Project area: Northern Quoll	Survey guidelines for Australia's threatened mammals (DSEWPaC 2011c)
No potential Northern Quoll denning or preferred habitat lies within the Project's disturbance footprint. Trapping carried out at eight sites comprising 640 trap nights (March and September 2011), and four sites comprising 300 trap nights (refer Appendix A9d for separate species results for each survey). Camera traps set at eight sites (March and September 2011) comprising a total of 110 camera trap nights, and four sites (February 2017) comprising 20 trap nights. Traps subsequently set in 10 locations within preferred rocky habitat from September to December comprising 400 trap nights (refer Appendix 9d for separate species results for each survey). Diurnal active habitat searches – including searches for burrows, under leaf litter and logs, rocks, cave and crevices. Approximately 42 hours of searches over approximately 42 ha were conducted over Project area over a total of 20 days.	Northern Quoll: Cage / Elliott trapping in rocky denning habitat from May-August. Other methods: daytime searches for potentially suitable habitat (extensive rocky areas with permanent water) and latrine sites; baited sand traps; hair tubes; remote cameras and spotlighting.
Mammals – predicted species in Project area: South-eastern Long-eared Bat, Large-eared Pied Bat and Grey-headed Flying-fox.	Survey guidelines for Australia's threatened bats (DEWHA 2010b)

Central Queensland Coal field survey effort	Survey Guidelines
Anabat surveys carried out over 17 nights throughout Project area. Grey-headed Flying-fox - opportunistic searches for camps and flying fox individuals while spotlighting.	South-eastern Long-eared Bat: preliminary Anabat detection. Harp trapping or mist netting in suitable habitat (less than 50 ha in size) - 20 trap nights over a minimum of five days. Large-eared Pied Bat: Anabat detectors set for 16 nights over a minimum of four days. Harp trapping or mist netting (less than 50 ha in size) – 16 trap nights over a minimum of four days. Grey-headed Flying-fox: Desktop research on existing / historic flying-fox camps, searches for camps and flying fox individuals while spotlighting.
Mammals – predicted species in Project area: Koala	EPBC Act referral guidelines for the vulnerable Koala (DotE 2014)
Opportunistic searches for individuals and signs of activity (tree scratches and scats) in eucalypt woodland habitat with a focus on riparian areas where they occurred. Spotlighting surveys.	Several methods recommended (but not prescribed due to habitat flexibility) including: transect searches, spotlighting, remote cameras, trained ‘koala’ dogs and searches for koala signs (such as tree scratches, scats).

16.12.8 Threatened Species Occurrence Assessment

Following the site surveys all flora and fauna species predicted as being potentially present from the desktop research were categorised as to their likelihood of occurrence in the Project area and surrounds. Four categories were used to classify the likelihood of a threatened fauna or flora species being present. Categories were defined as:

- Known (confirmed during field assessments);
- Likely (known distribution, records within or around the Project area, and suitable habitat observed during field assessments);
- Potential (known distribution, limited records of the species occurring in the wider area and possibility of suitable habitat occurring); and
- Unlikely (no suitable habitat or not known to occur within the local region).

The presence or potential presence of species, and species habitat was used to inform assessment of the potential risk of impacts from the Project on identified ecological values. Only species considered as ‘known’ or ‘likely to occur’ are considered for analysis of the potential for significant residual impacts from Project activities.

16.13 MNES Results

16.13.1 Desktop Results - Great Barrier Reef World Heritage Area OUVs

This section provides a stand-alone assessment of the Outstanding Universal Values (OUV) of the GBRWHA and how they relate to the extant values of the waters downstream of the Project in the Broad Sound area. Several of these values overlap with other MNES detailed in the following sections including migratory shorebirds and large marine fauna. Nevertheless, these values are also presented here in order to define the localised OUVs of the GBRWHA for impact assessment.

The Project is located approximately 8 km from the boundary of the GBRWHA. The Great Barrier Reef (GBR) covers an area of 348,000 km^2 extending along much of the Queensland coast from

10°40'S (Cape York Peninsula) south to 24°30'S (north of Bundaberg). It extends up 250 km offshore encompassing the continental shelf and oceanic waters. The GBR encompasses over 900 islands and approximately 2,500 individual reefs. The latitudinal length of the reef, the depth range across the shelf and diversity of marine habitats combine with a very diverse marine fauna making the GBR 'one of the richest and most complex natural ecosystems on earth' (UNESCO 2017). The GBR was inscribed on the World Heritage List in 1981 being recognised for all four of the available 'natural' selection criteria:

- (vii) contain superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance;
- (viii) be outstanding examples representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features;
- (ix) be outstanding examples representing significant on-going ecological and biological processes in the evolution and development of terrestrial, fresh water, coastal and marine ecosystems and communities of plants and animals; and
- (x) contain the most important and significant natural habitats for in-situ conservation of biological diversity, including those containing threatened species of Outstanding Universal Value from the point of view of science or conservation.

In addition to meeting the selection criteria, for a 'natural' property to be considered as of OUV and World Heritage listing it must meet the conditions of integrity. An assessment of 'integrity' examines the extent to which the property:

- Includes all elements necessary to express its OUV;
- Is of adequate size to ensure the complete representation of the features and processes that convey the property's significance; and
- Suffers from adverse effects of development and / or neglect.

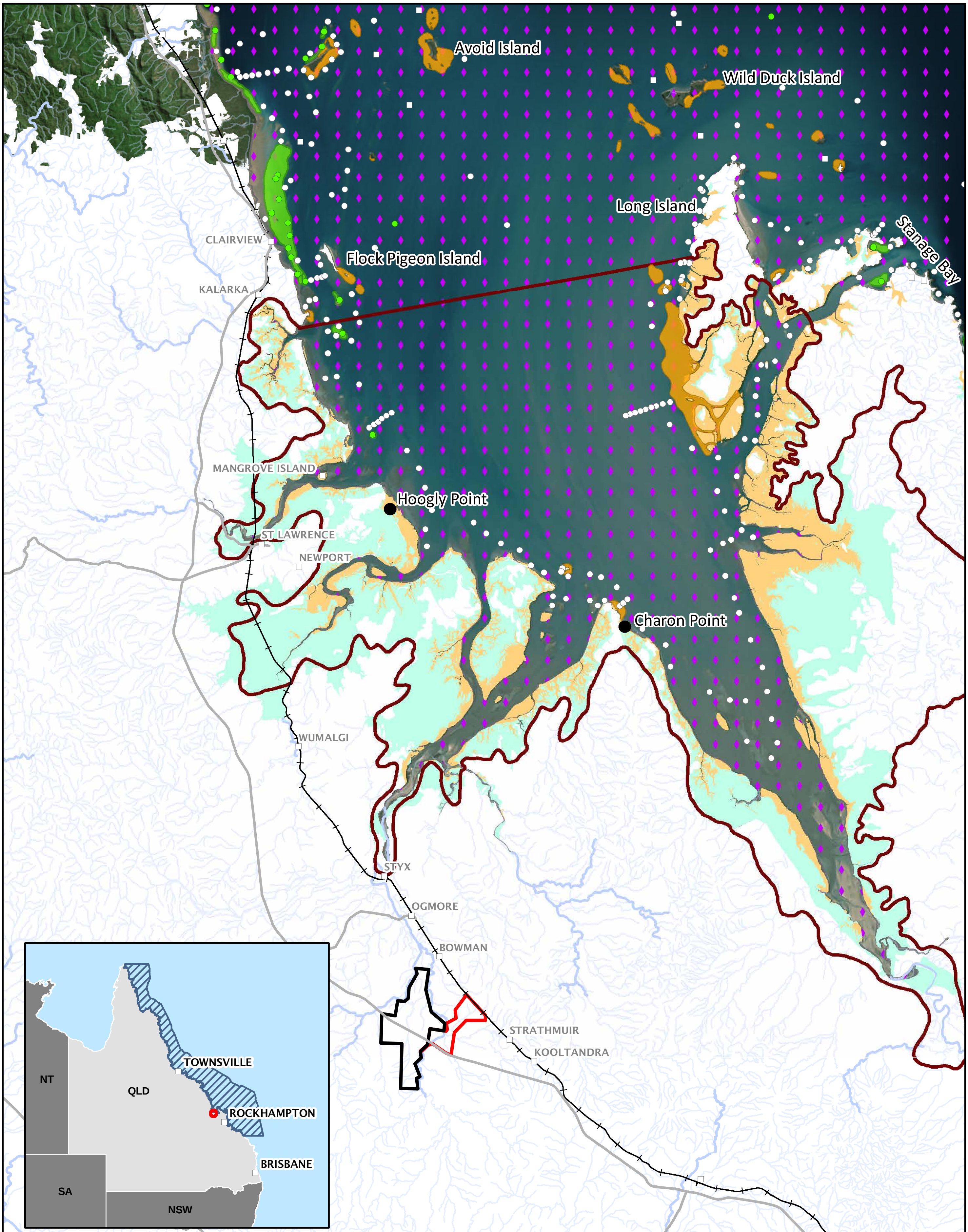
16.13.1.1 Outstanding Universal Values

One of the challenges in assessing the impacts of the Project on the GBRWHA is understanding how the iconic GBRWHA OUVs are expressed locally at Broad Sound. The process is difficult and subject to interpretation; for example, while marine turtle species may be present in Broad Sound, the numbers are very low when compared to important breeding areas within the GBR. Hard corals are present; however, they are not a distinguishing feature of the Broad Sound environment. The combination of the local tidal regime and turbidity levels has a negative effect on many potential GBRWHA OUVs within the local area including coral reef formations and seagrass extent. This has implications on the presence and diversity of marine fauna associated with these habitats. While most of Broad Sound does not contain recognised outstanding natural values, it does contribute to the OUV of the overall GBRWHA.

Broad Sound is in a remote location and there is limited ecological survey and monitoring data available from the area. Data which is relevant to OUVs of the GBR including MNES marine species is outlined in Table 16-146 and described in detail (where possible) in the following sections. For the purpose of clarity, where Broad Sound is referred to in the following text, this refers to the area encompassed by the DIWA boundary as depicted in Figure 16-132.

Table 16-103 World Heritage Values of the GBRWHA and Broad Sound

Criteria	OUV Components of the GBR	Attributes of Broad Sound
Criterion vii Contains superlative natural phenomena or areas of exceptional natural beauty and aesthetic importance	▪ Scenic vistas (above and below water) ▪ Aerial panorama of seascapes ▪ Reef structures, spectacular coral diversity and reef fish diversity ▪ Whitsunday Islands, Hinchinbrook Island and Channel, and Cod Hole, Lizard Island ▪ Seabird and marine turtle nesting colonies ▪ Migrating whales	▪ Scenic vistas ▪ Shorebirds and sea birds
Criterion viii An outstanding example representing major stages of earth's history, including the record of life, significant on-going geological processes in the development of landforms, or significant geomorphic or physiographic features	▪ Geomorphological evolution including reef development ▪ Sea level change and island development ▪ In-shore fringing reefs, mid-shelf reefs and outer reefs	▪ Mangroves ▪ In-shore fringing coral Reefs ▪ Continental islands
Criterion ix An outstanding example representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals	▪ Ecological physical processes and connectivity ▪ Formation of reefs, sand banks and coral cays ▪ Hard corals and *Halimeda* algae ▪ Marine taxa diversity ▪ Island plant colonisation processes ▪ Aboriginal and Torres Strait Islander history and sea culture	▪ Mangroves and saltmarsh communities ▪ Coral reefs ▪ Shorebirds
Criterion x Contains the most important and significant natural habitat for in-situ conservation of biological diversity, including those containing threated species of outstanding universal value from the point of view of science or conservation	▪ Coral diversity ▪ Important inter-reefal areas ▪ Dugong ▪ Whales and dolphins ▪ Marine turtles (including Raine Island) ▪ Seabird breeding sites ▪ Island flora	▪ Shorebirds ▪ Marine turtles ▪ Diversity of species ▪ Mangroves ▪ Dolphins
Criterion – Integrity of the GBRWHA	▪ Unparalleled size and current good state of conservation across the property ▪ Resilience ▪ Intactness ▪ Management and protection.	▪ Intactness ▪ Management and protection



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Date: 25/01/18
Drawn: Parnwell, J

Legend

ML 700022
ML 80187
Great Barrier Reef World Heritage Area boundary
Broad Sound DIWA Wetland
Mapped reef areas

Remnant Vegetation (DNRM)

Saltmarsh
Mangroves

Seagrass presence/absence (AIMS, 2016)

Survey point - absent
Survey point - present
Seagrass meadow composite

Figure 16-132

Great Barrier Reef World Heritage Area boundary and features

DATA SOURCE
QLD Spatial Catalogue (QSpatial), 2017

CDM Smith

PARNWELLJA \\brbsvr1\PRO\Project\BES150160.03-Styx Coal Project 5 mtpa EIS Preparation\CADD GIS\GIS\DATA\MXD\Chapter 16\BES150160.03-003 R5 GBR Marine Park.mxd 25/01/2018

16.13.1.2 Broad Sound

Broad Sound lies north of the Project and encompasses the GBRWHA waters pertinent to the Project. The area is a protected Fish Habitat Area and is listed in the Directory of Important Wetlands in Australia (DIWA). The southern boundary of the designated wetland lies close to the boundary of the WHA area but also encompasses coastal marine plains beyond the low water mark (Figure 16-132). The lower Styx River forms part of the catchment of the wetland. It is noted as "A good example of a marine and estuarine wetland complex within a large sheltered embayment adjacent to a broad coastal plain" (DotEE 2017). The Broad Sound wetland encompasses an area of approximately 2,100 km^2 comprising a complex aggregation of tidal marine and estuarine wetlands. There are also small areas of beach habitat, and brackish and freshwater coastal swamps and lagoons. These have been formed in a sheltered embayment and have a very large tidal range of approximately 9 m.

The Broad Sound wetland area includes the Torilla Plain, a large treeless marine plain to the east of the Project area formed on the western side of the Torilla Peninsula. In this area wetlands occur as numerous interconnected pools and channels which may merge into much larger waterbodies in the wet season.

Broad Sound as a geographical entity refers to the large triangular estuary on the western side of the Torilla Peninsula (directly east of the mouth of the Styx River). The extreme tidal range and generally shallow depth in the wider Broad Sound area has a natural impact on water quality in the area. Constant high turbidity is caused by tidal resuspension of sediments largely due to the currents caused by the ingoing and outgoing tides. Nutrient and chlorophyll concentrations are generally low in this area (De'ath and Fabricius 2008). The turbidity plume extends outwards from Broad Sound to local islands in the Capricorn area of the GBR (such as the Percy Islands group located 110 km north-east of Stanage Bay) (Kleypas 1996).

Several ephemeral drainage lines empty into Broad Sound including Herbert Creek (associated with the Torilla Plain), Saint Lawrence and Waverley Creeks, and the Styx River (associated with the Project area). Flooding within the Styx basin is seasonal and is often associated with a cyclonic event. The Styx River is a relatively small, ungauged catchment and there are no gauges on any of the waterways associated with Broad Sound. As a result, there is no history of flood heights or frequency and no local tidal data. On-site observations indicate the upstream extent of irregular (peak) tidal inundation along the Styx River, as evidenced by the presence of scattered patches of Marine Couch (*Sporobolus virginicus*) on lower banks, occurs downstream of the confluence of Deep Creek and Tooloombah Creek (upstream of the boundary of the Broad Sound DIWA or GBRWHA).

Representative creek bed elevation at this location is approximately 5.5 m AHD. At the Bruce Highway Bridge over Deep Creek, the representative creek bed elevation is approximately 25 m AHD, almost 20 m higher than the peak tidal level. Whilst a storm surge creates tidal inundation (i.e. the storm tide) that travels further inland than regular tides, it would be highly unlikely that cyclonic conditions could create a surge of the magnitude required to reach the Project.

Storm surges are a condition associated with cyclonic weather whereby tidal levels are much higher than normal due to the piling up effect of wind upon the ocean. Little information is available about the potential magnitude of storm surges in the Styx River as there is no local tidal data or river height data from which surge data can be inferred.

16.13.1.3 Scenic Vistas

Broad Sound is the largest shallow, macro-tidal bay on Australia's east coast. The area has a remote and undeveloped character, with mangroves, saltmarshes and sand / mud flats around the shoreline providing habitat for migratory shorebird populations. Mangrove communities provide an example of exceptional natural beauty. The high tidal range creates extensive intertidal areas exposed at low tide. Broad Sound encompasses continental islands on its' northeast boundary including Long Island and smaller islands associated with the Broad Sound Islands National Park (refer Figure 16-133). Broad Sound supports a wide array of fauna and plant life and has values of scenic natural beauty.

16.13.1.4 Mangroves and Saltmarsh Communities

Mangroves are recognised as contributing to the OUVs of the GBRWHA (Whiteway et al. 2013). Mangrove shorelines have unique sedimentary facies that can preserve past sea level and environmental conditions. Mangrove deposits are distinctive and where exposed can be used to identify areas that have experienced shoreline erosion and coastal retreat. Mangrove habitats are important ecologically as nurseries for many fish species including threatened species and protect shorelines from erosion. The mangrove communities of the GBR are amongst the richest in the world, with 37 species recorded (being 54% of the world species diversity). Given this richness and combined with their protected status, the GBR mangroves are of exceptional value (Lucas et al. 1997).

Saltpans and saltmarsh communities occupy 372 km^2 of the Broad Sound wetland area. Current vegetation mapping indicates large areas of saltpans and mudflats with saltmarsh species along the Styx River beginning approximately 14 km downstream (or 10.5 km directly north) of the Project boundary (Figure 16-132). These become extensive further downstream extending 5 km to 6 km inland on the northern bank of the river as the channel splits around Rosewood Island.

Mangroves occupy 216 km^2 within the Broad Sound DIWA wetland boundary. In some areas these form bands over 1 km wide, largely in the western section of the wetland (Torilla Peninsula) but also in the lower reaches of the Styx River around Rosewood Island (Figure 16-132). Mangrove communities begin to occur approximately 21 km downstream or 15 km north of the Project. There are no specific references to the mangrove species occurring in Broad Sound. Based on vegetation mapping dominant species are expected to be Grey Mangrove (*Avicennia marina*), Rhizophora and Bruguiera species, Spurred Mangrove (*Ceriops tagal*) and Black Mangrove (*Aegiceras conrniculatum*). Mangrove communities occur along the banks of the Styx River beginning 20 km downstream (or 15 km directly north) of the Project boundary becoming more extensive near Rosewood Island. The extent of mangroves and saltmarsh within the wetland area did not decline between 2001 and 2013 (EHP 2017a).

Broad Sound (with Shoalwater Bay) is considered one of the five main centres within the GBR for mangrove and saltmarsh communities. These are critical habitats for important juvenile marine species such as Barramundi (*Lates calcarifer*), mullet and peneid prawns. In the past, there has been extensive construction of ponded pastures in the Broad Sound area. Bund walls have been constructed to convert saltmarsh into ponded pasture creating additional temporary and brackish wetlands, thereby restricting movements of juvenile fish into these areas (Goudkamp and Chin 2006).

16.13.1.5 Coral Reefs

Mapping for the GBRMPA area indicates small fringing reefs occur within Broad Sound on Turtle Island and Charon Point approximately 35 km north-northeast of the Project boundary. A larger reef area occurs on the southwest edge of Long Island (52 km northeast), a continental island adjacent to the west of the Torilla Peninsula (Figure 16-132). Several small reefs also occur in the Clairview area to the north of Broad Sound (approximately 55 km north of the Project). There is no information available on the status or quality of these reef areas.

The structure of coral reefs in the area surrounding Broad Sound (including offshore islands such as Peak Island) has been surveyed in the past to examine the impact of the large tidal range and naturally turbid conditions on local reef development. Coral richness in the area is lower than in adjacent regions (De'ath and Fabricius 2008). High turbidity inhibits photosynthesis in symbiotic algae (Thompson et al. 2014) and low tides that allow for extended exposure at low tides are not suitable for most coral species (Kleypas 1996). Kleypas (1996) examined reef systems surrounding the Broad Sound area, including the Percy Islands and Duke Island (90 km and 120 km north-east of the Project respectively). The study found that reefs within or close to Broad Sound were thinner, in shallower waters and comprised species associated with deeper waters. The effects of elevated turbidity in and surrounding Broad Sound included:

- Decreasing hard coral colony size associated with distance to Broad Sound;
- Decreasing diversity of both soft and hard corals;
- Shifting coral morphology; and
- Lack of reef building (or framework) species (Kleypas 1996).

Changes in surface water hydrology, sedimentation of waterways and accidental release of pollutants have the potential to impact on corals. However, impacts to OUV attributes of Broad Sound relating to coral reefs are unlikely given their distance from the Project area.

16.13.1.6 Seagrass

Seagrass mapping data from the past 30 years has been collated across the GBR area (Carter et al. 2016). The only mapped seagrass beds known in the Broad Sound DIWA area are small patches located in the north-east corner of the wetland. There are no seagrass beds mapped near the Styx River estuary or surrounds. Extensive seagrass beds occur to the northwest in the Clairview area (approximately 53 km north of the Project) and in Shoalwater Bay, including small patches near the islands off Stanage Bay approximately 70 km north-east of the Project (Figure 16-132).

The presence of seagrasses depends on a number of factors including water salinity and temperature, substrate, adequate periods of immersion and sufficient light penetration (Hemminga and Duarte 2000). They are most often present in shallow waters with low nutrient concentrations and high light penetration (Choice et al. 2014). Turbid sediment-laden waters are unsuitable as the murky waters hinder photosynthesis in seagrass. Elevated nutrient levels may increase chlorophyll levels in the water column causing shading of seagrass (Choice et al. 2014). Exposure of seagrasses at low tides may be detrimental through processes such as thermal stress (Campbell et al. 2006), dessication (Bjork et al. 1999), or high doses of irradiance or ultra violet light (Figueroa et al. 2002).

It appears the extreme tidal range in Broad Sound may influence the lack of seagrass present due to high turbidity levels and prolonged exposure of tidal flats during low tides.

16.13.1.7 Large Marine Mammals

The seagrass beds to the northwest of Broad Sound (around the township of Clairview) support populations of Dugong (*Dugong dugon*). There is a Dugong Protection Area (DPA) (administered under the *Great Barrier Reef Marine Park Regulations 1983*) extending from Carmilla Creek south to Clairview Bluff approximately 55 km north of the Project). A second DPA occurs in the Shoalwater Bay area to the north-west of the Project. Shoalwater Bay DPA is considered the most important Dugong site in the southern area of the GBRMP. Sightings of Dugong are rare in most of Broad Sound. In a review of Dugong sighting data by Marsh and Penrose (2001) there are no reported sightings in the Broad Sound area. More recently extensive aerial transect surveys for Dugong and marine turtles which included Broad Sound, recorded no individuals in the Sound itself. The nearest reported sightings were individuals in the Clairview and Stanage Bay areas (Sobtzick et al. 2017). Given the lack of seagrass in most of Broad Sound it is unlikely the area downstream of the Project provides suitable habitat value for the species.

Humpback Whale (*Megaptera novaehollandiae*) is listed as Vulnerable and Migratory under the EPBC Act. The species is well known to occur in the waters off Shoalwater Bay (although not in the bay itself). There is no indication the species uses the waters of Broad Sound for resting or feeding and it is likely the tidal regime and associated turbid waters are unsuitable for the species.

Other protected marine species recorded from the region include inshore dolphin species including Australian Hump-back Dolphin (*Sousa sahulensis*) and Australian Snubfin Dolphin (*Orcaella brevirostris*), both of which are listed as Migratory marine species under the EPBC Act. Past surveys indicate that both species occur in the Shoalwater Bay area although Australian Snubfin Dolphin occurs in low numbers compared to further south in the Fitzroy River estuary (Cagnazzi 2010, Cagnazzi et al. 2013). During boat-based surveys of Broad Sound carried out over two weeks in 2013 low numbers of both species were detected (seven separate pods detected including two pods of Australian Snubfin Dolphins). All records were located north of the Styx River. Both species were detected in the channel on the western side of Rosewood Island (CCP 2013). There are several (ALA) database records of Australian Snubfin Dolphin (only) in the wider area to the north of Broad Sound (Figure 16-133). Given the shallow nature of the Styx River, particularly at low tides, suitable habitat for these species in the river is not expected to extend upstream beyond Rosewood Island.

16.13.1.8 Marine Turtles

Marine turtles occur in the Broad Sound area and surrounds. There are large nesting aggregations of Flatback Turtles (*Natator depressus*) at Wild Duck Island (74 km north north-east of the Project) and Avoid Island (75 km north of the Project). The species nests in lower numbers on many of the islands in the local region and selected mainland beaches (Limpus et al. 2002). Targeted nesting surveys in the region indicate the nearest nest sites for this species were the Clairview area (55 km north including mainland beach sites and nearby Flock Pigeon Island), north-east side of Long Island (67 km north north-east), and in the Stanage Bay area (70 km north-east including mainland sites and Quail Island) (Limpus et al. 2002). There are many ALA database records in the wider area and islands but no records within the Broad Sound area itself (Figure 16-133).

Green Turtle (*Chelonia mydas*) has been recorded nesting on several offshore islands in the region including the Percy Islands group (120 km north-east), Curlew Island (116 km north) and islands and mainland beaches in Shoalwater Bay (68 km north-east). Records from the ALA database show several records of Green Turtle in Broad Sound including the Styx River estuary, however these are all attributable to a single radio-tracked individual released by the Cairns turtle rehabilitation and reef HQ facility in 2010 (Figure 16-133). The Shoalwater Bay sites are the nearest known nesting sites to the Project (66 km north-east) (Limpus et al. 2002). Hawksbill Turtle (*Eretmochelys* *imbricata*) is also known to nest in low numbers in the Percy Islands group (Limpus et al. 2002). Loggerhead Turtle (*Caretta caretta*) have been reported as foraging in the waters of Shoalwater Bay.

Extensive aerial transect surveys for marine turtles which included Broad Sound recorded one individual in the Broad Sound DIWA area (on the south-west side of Long Island). Individuals were recorded north of Broad Sound adjacent to the north-west side of Long Island and in the Clairview area. Much higher densities were recorded in Shoalwater Bay (Sobtzick et al. 2016). Green Turtle is known to forage on seagrasses which do not occur in the majority of Broad Sound. The lack of marine turtle observations in the area may be an indicator that the tidal regime in Broad Sound provides low habitat value for marine turtles in general. Given the shallow nature of the river (particularly at low tides) and the lack of suitable instream habitat for marine turtle species in the river, it is not expected that marine turtles occur upstream in the Styx River estuary much further than Rosewood Island.

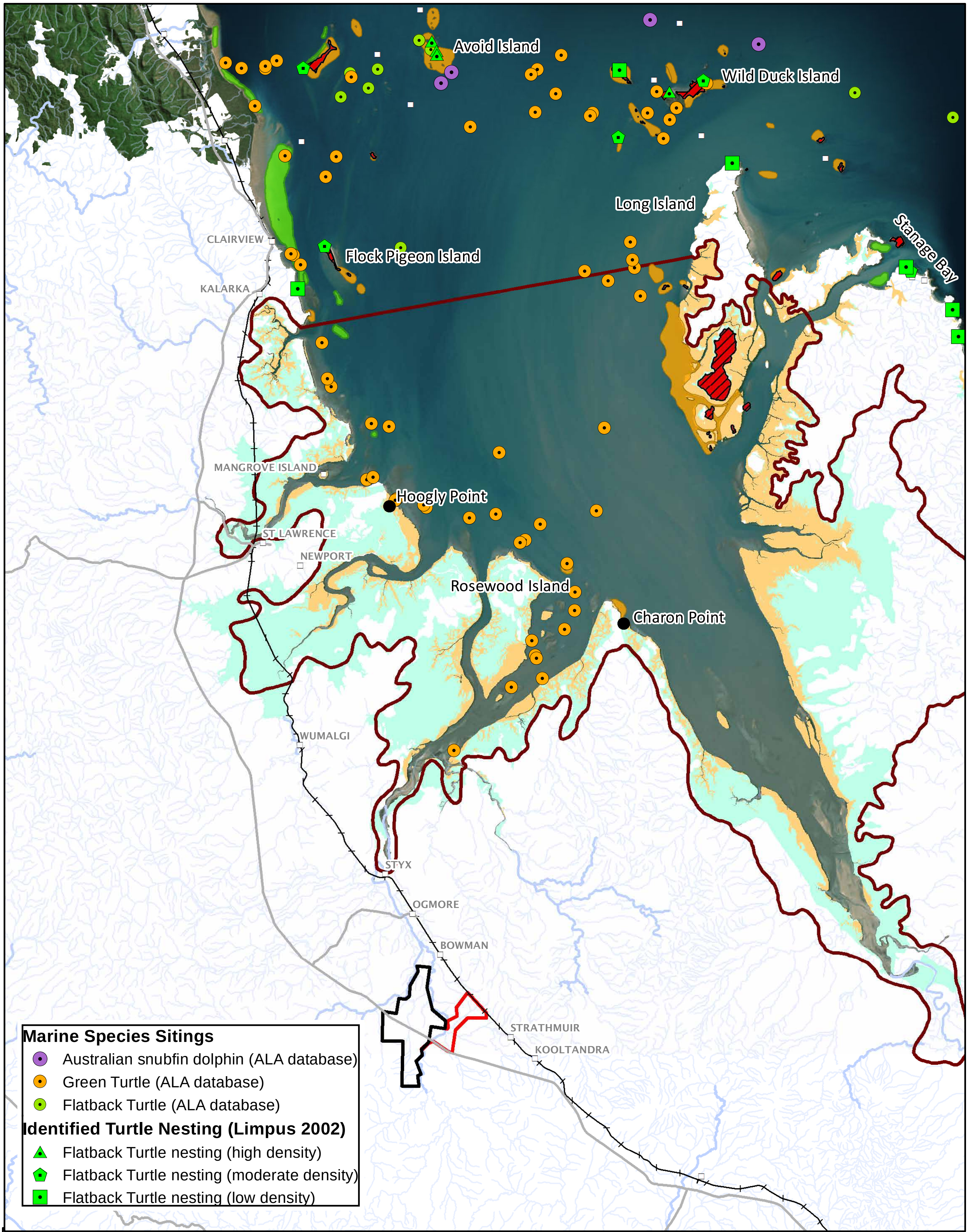
16.13.1.9 Shorebirds and Seabirds

Broad Sound comprises wetland habitats including seagrass beds, lower intertidal and supratidal mudflats, and mangroves. Brackish and freshwater swamps and lagoons occur in adjacent upland areas. The wetland is noted as providing significant habitat for waterbirds including substantial aggregations of a range of migratory shorebirds listed under the EPBC Act (DotEE 2017). Shoalwater Bay and Broad Sound are noted as sites of international importance (based on survey data from 1995) for the following migratory shorebirds; Bar-tailed Godwit (*Limosa lapponica*), Whimbrel (*Numenius phaeopus*), Eastern Curlew (*Numenius madagascariensis*), Terek Sandpiper (*Xenus cinereus*), Grey-tailed Tattler (*Tringa brevipes*) and Great Knot (*Calidris tenuirostris*). The intertidal flats of Broad Sound were found to support fewer shorebirds than Shoalwater Bay excepting large numbers of Great Knot (Driscoll 1996).

Surveys of waterbirds in Broad Sound have recorded 66 species, 21 of them breeding, in the eastern wetlands (Torilla Plains) in 2003 and 88 species, 25 of them breeding, mainly in the western wetlands (Styx River and adjacent plains) in 2006/2007 (Birdlife International 2017). Surveys in Broad Sound carried out by Roger Jaensch in 2008 and 2009 recorded nationally important numbers of Eastern Curlew, Great Knot, Red Knot (*Calidris canutus*), Red-necked Stints (*Calidris ruficollis*), Sharp-tailed Sandpipers (*Calidris acuminata*) and Curlew Sandpipers (*Tringa stagnatilis*) at several wader sites including Charon Point (32 km north-east of the Project) and Hoogly Point (35 km north) (Jaensch 2009). Six high-tide roosts were documented over four survey periods on the west side of Broad Sound comprising up to 3,500 migratory shorebirds (in one survey period) using the areas roost habitat and shallowly-inundated saltpans. Subsequent surveys at three of the roost sites have been carried out sporadically by Birdlife Capricornia (Figure 16-133). Surveys have recorded nationally important numbers of similar species to those recorded in 2008 and 2009. In general, Eastern Curlew appears to be present in substantial numbers across Broad Sound. Large numbers have been counted consistently at the Hoogly Point roost across several survey years including internationally significant numbers (505 individuals) counted in September 2013 (Figure 16-134) (refer Section 16.11.6 and Appendix 9c – Ecological Desktop Search Results for further detail on shorebird surveys).

Seabirds are generally considered those birds that forage in open waters such as some tern species, shearwaters, and noddys. These species generally nest on island habitats in the GBR with the majority of seabird nesting occurring on remote coral cays (Hulsman et al. 1997). The southern GBR supports significant seabird colonies on an estimated 22 islands. Coral cays in the Capricorn-Bunker group maintain large numbers of Wedge-tailed Shearwater (*Ardenna pacifica*) and Black Noddy (*Anous minutus*) which comprise approximately 30% and 50% of the global populations of these species (Turner et al. 2006). These islands are located well offshore from Gladstone and are located 250 km east of the Project.

Seabird species in the vicinity of Broad Sound are restricted to inshore and coastal foraging species. There is a known breeding colony of Australian Pelican (*Pelecanus conspicullatus*) in Shoalwater Bay on Akens Island and Pelican Rocks (68 km north-east). This is the only breeding site within the GBR south of Cape York Peninsula (Walker et al. 1993). Little Tern (*Sternula albifrons*) nests on sandy beach areas and is known to have 'primary' nesting sites in Shoalwater Bay with minor nesting also occurring in Broad Sound (FBA 2015). It is noted Little Tern was not recorded during shorebird surveys of western Broad Sound in 2008 / 2009 or in subsequent years.



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Scale @ A4 1:410,000
Date: 09/05/18
Drawn: Parnwell, J

Legend

ML 80187
ML 700022
Broad Sound DIWA Wetland
Mapped reef areas
Broad Sound Islands National Park

Remnant Vegetation (DNRME)

Saltmarsh
Mangroves
Seagrass meadow composite

Figure 16-133
Marine fauna database records and turtle nesting in wider area

DATA SOURCE
QLD Spatial Catalogue (QSpatial), 2017

CDM Smith

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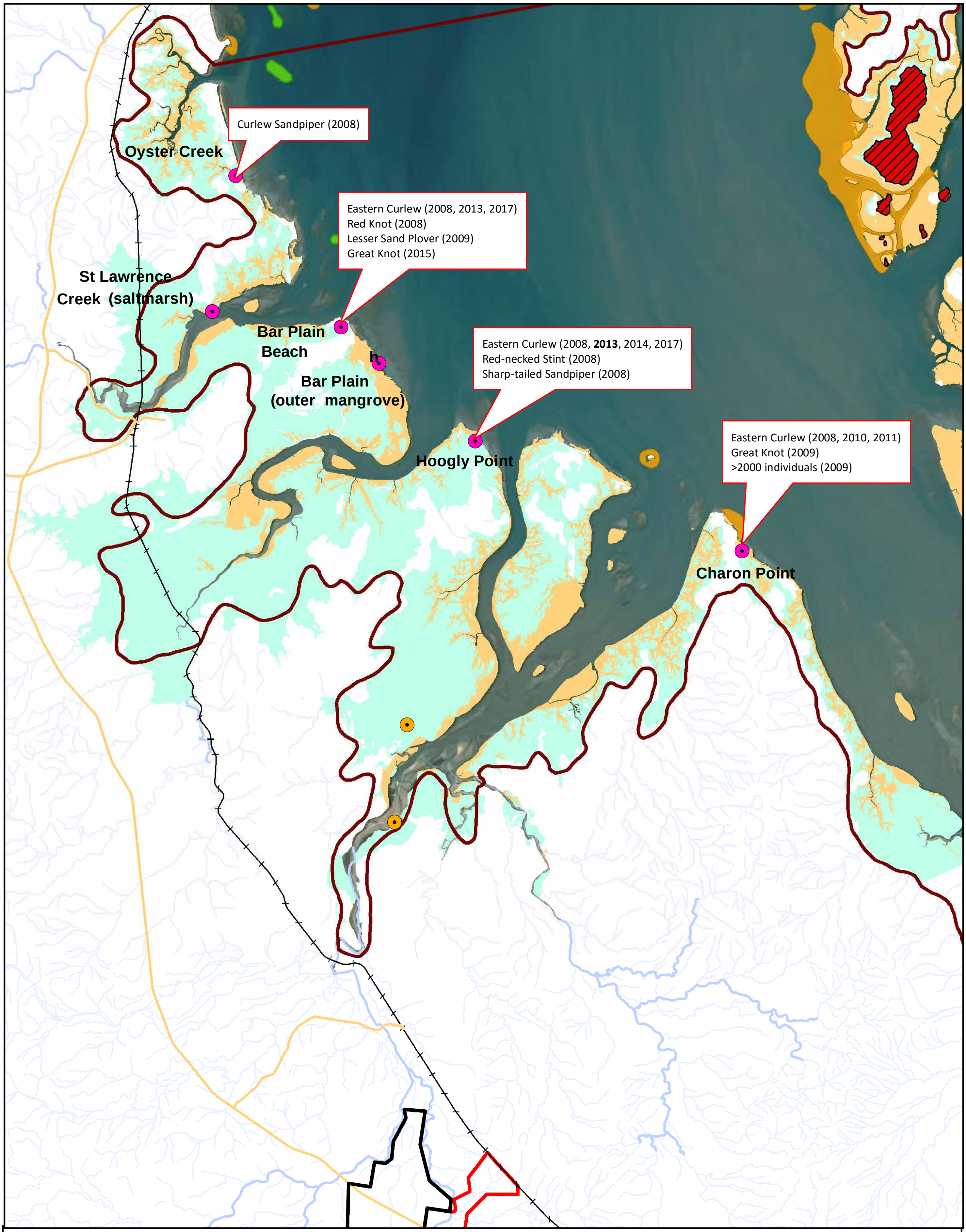

Legend

- Eastern curlew (2011)
- Wader roost
- ML 80187
- ML 700022
- Main road
- Broad Sound DIWA Wetland
- Mapped reef areas
- Broad Sound Islands National Park

Remnant Vegetation (DNRM)

- Saltmarsh
- Mangroves
- Seagrass meadow composite

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Scale @ A4 1:250,000
Date: 02/05/18
Drawn: Parnwell, J

Figure 16-134

Broad Sound shorebird survey locations and significant count data (Jaensch 2009 and Birdlfe Capricornia 2018)

DATA SOURCE
QLD Spatial Catalogue (QSpatial), 2017
(Jaensch 2009 and Birdlife Capricornia 2008)

CDM Smith

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16.13.1.10 Intactness

Surface water inflows from the lower catchment of the Styx River have been substantially altered in the past through the extensive vegetation clearance activities throughout the catchment and establishment of numerous artificial berm structures to create ponded pasture for cattle grazing. The downstream waters of the Styx River and Broad Sound are naturally turbid due to the resuspension of sediments caused by the large tidal range in the sound. These conditions appear to have limited the range of marine habitats supporting threatened or migratory marine fauna associated with the OUVs of the GBR that are present in Broad Sound (downstream of the Project). The impact of the tidal range on turbidity limits the extent and diversity of coral reefs associated with islands of the GBR as they extend outward locally from Broad Sound (Kleypas 1996). There appears to be little seagrass known in the immediate vicinity of the sound itself i.e. downstream of the Styx River. Downstream habitat associated with the GBR OUVs includes extensive areas of mangroves and saltmarsh which support migratory shorebird species. The extent of these communities does not appear to have declined between 2001 and 2013 (EHP 2017a).

16.13.1.11 Management and Protection

The Great Barrier Reef Marine Park Authority is the managing authority for the GBRWHA.

The Reef 2050 Long-term Sustainability Plan is the overarching framework for protecting and managing the GBR until 2050. Improving water quality is one of the key themes of the plan and it incorporates the goals and targets of the Reef 2050 Water Quality Improvement Plan which focuses on reducing the impacts of diffuse source pollution on the reef.

The draft Reef 2050 Water Quality Improvement Plan 2017-2022 guides how industry, government and the community will work together to improve the quality of water flowing to the GBR. It addresses all land-based sources of water pollution including run-off from urban, industrial and public lands; while recognising that the majority of pollution comes from agricultural activities. Water quality targets have been set for the catchments adjacent to the GBR, based on modelling and other scientific information. The Styx Catchment water quality targets

The Great Barrier Reef Report Cards detail progress towards reef water quality targets. The Report Cards outline results from the Paddock to Reef Integrated Monitoring, Modelling and Reporting Program.

The *Great Barrier Reef Outlook Report 2014* (GBRMPA 2015) is the latest report produced by GBRMPA as an assessment of the performance of management measures implemented to protect the OUVs of the GBR. Outlook reports are produced every five years and provide key information into any changes required in management approaches and consideration of broader issues by governments.

The report covers the current condition of a broad range of factors associated with the GBR including:

- Habitats (such as mangroves, saltmarsh, reefs, seagrass etc);
- Species and populations including terrestrial and marine flora and fauna;
- Ecosystem health including physical, chemical and ecological processes; and
- Heritage and commercial use values.

Given the size and diversity of the GBR it is not possible or necessary to summarise the findings of the report in this document. There is very little information in the report specific to the area downstream of the proposed Project i.e. Broad Sound. As noted above the main GBR habitats closest to the Project are saltmarsh and mangrove communities. Minor coastal / island reef habitats also occur. The following points summarise the status of these attributes as outlined in the report and specific to the area of concern (including information from the Fitzroy and Whitsunday coastal zones):

- Broad Sound is specifically mentioned within the report as providing important habitat for shorebirds;
- Mangrove forests in the GBR region are relatively stable and extent is being maintained;
- There has been a decline in coral cover and evidence of changes in species composition, particularly in inshore reefs. This is a result of declining water quality (including higher nutrients and increased turbidity) and its impacts on sensitive coral species, thereby reducing coral diversity in these habitats. Flooding from the Fitzroy River in 2011 (resulting from Cyclone Yasi) caused large declines in shallow-water soft corals with impacts extending (to a lesser extent) into deeper waters inshore of Great Keppel Island;
- Sediment loads entering the GBR lagoon are estimated as twice as high as pre-European settlement. It is; however, estimated there has been an 11% reduction in sediment loads from 2009 to 2013 due to changes in management practices. The GBR waters associated with the Project area are mapped as experiencing moderate exposure suspended solids from 2007 to 2011; and
- Similarly, nutrient inflows to the GBR are considered close to twice as high as pre-European settlement. Management practices are estimated to have reduced nutrient inflows by 16% from 2009 to 2013. The GBR waters associated with the Project area are mapped as experiencing high exposure to dissolved inorganic nitrogen from 2007 to 2011.

The Paddock to Reef Integrated Monitoring, Modelling and Reporting Program (Paddock to Reef program) is a collaboration involving governments, industry bodies, regional natural resource management bodies, landholders and research organisations.

The Fitzroy Water Quality Improvement Plan (FWQIP) (FBA 2015) was developed to improve water quality in the Fitzroy Basin to protect the GBR. The FWQIP covers the Fitzroy Basin and coastal catchments including the Styx River. The plan sets water quality targets for the region, identifies priority areas to undertake works and recommends management actions to improve water quality (FBA 2015).

Water borne pollutant modelling – Styx and Fitzroy Basins

Water borne pollutant inputs to the GBR lagoon (and hence Broad Sound) from land uses in the Styx Basin have been modelled as part of reporting for the wider Fitzroy Basin on the reduction of pollutant loads in the GBR catchment through improved land management practices (Dougall et al. 2014). The modelling for the Styx Basin is based on generalised data from across the catchment coupled with land use cover estimates, as there are no stream gauges in the Styx catchment to provide flow or water quality data.

A summary of results pertinent to the Styx Basin compared to the much larger Fitzroy Basin as reported in the 2013 assessment is provided in Table 16-104. It's important to note the modelled area includes minor drainages to the north which do not feed into the Styx River catchment. The modelling indicated the Styx Basin exhibits pollutant loads per basin area slightly above that exhibited by the Fitzroy Basin.

Table 16-104 Landuse and pollutant run-off data for the Styx and Fitzroy Basins (Dougall et al. 2014)

Basin statistics	Styx Basin			Fitzroy Basin		
Total area	3,013 km^2			142,552 km^2		
Agricultural lands (includes grazing)	2,352 km^2			109,482 km^2		
	Estimated pollutant loads					
	Pre development	Post development	Anthropogenic sourced	Pre development	Post development	Anthropogenic sourced
Suspended solids (total) (kt/year)	28	68	40	440	1,740	1,300
Total Nitrogen (t/year)	119	154	35	2,768	3,688	921
Total Phosphorus (t/year)	21	38	17	414	983	569
Herbicides (kg/year)	N/A	22	22	N/A	521	521

16.13.1.12 2017 Scientific Consensus Statement

The recently released *2017 Scientific Consensus Statement* (SoQ 2017) (the 'statement') provides a comprehensive review on water quality impacts to the GBR associated with catchment land use which is an update of a 2013 review. The statement makes the following points:

- The current poor state of marine and coastal ecosystems, particularly marine habitats on the inner shelf, is largely the result of declining water quality associated with land-based run-off;
- Agricultural activity in the GBR catchment is the main source of primary pollutants (fine sediments, pesticides and nutrients) entering the GBR;
- Regionally the Wet Tropics, the Burdekin and Fitzroy areas contribute the majority of pollutant loads to the GBR;
- Catchments dominated by sugarcane growing contribute the largest inorganic nitrogen and pesticide loads, whereas grazing areas contribute the largest sediment and particulate loads. Management of land cover has been found to be effective at reducing erosion (and thereby mobilised sediments) in grazing areas, although gully and bank erosion remain a major problem; and
- Run-off impacts during major flood events affects key ecosystems such as seagrass and coral communities. In the southern GBR this has been especially apparent in the Fitzroy and Burdekin catchments in recent years (2010 -2011). Nevertheless, subsequent periods of low rainfall (and thereby low run-off) have allowed inshore seagrass and coral communities to recover although they remain in poor to moderate condition.

The Styx Basin (3,013 km^2) comprises 2% of the overall Fitzroy catchment area which is naturally dominated by the Fitzroy Basin (142,552 km^2). Modelling of sediment and pollutant loads from the Fitzroy catchment show that although loads of some pollutants contributed by the Styx catchment have effectively doubled since settlement of the area, these are much less (by more than a factor of ten) than contributions from the Fitzroy catchment (Dougall et al. 2014). The statement identifies priority catchments for water quality improvements based on pollutant exposure and the risk to coastal and marine ecosystems. The Styx catchment has been identified as low priority for sediment and particulate nutrients and minimal priority for dissolved inorganic nitrogen.

16.13.2 Desktop Results - National Heritage Places

The National Heritage list includes natural, historic and Indigenous places considered to be of outstanding national heritage value to the Australian nation. The GBR was placed on the National Heritage List in May 2007 in accordance with the provisions of item 1A of Schedule 3 of the Commonwealth's *Environment and Heritage Legislation Amendment Act (No.1) 2003*.

It was determined by the Minister of the then Department of Environment and Water Resources the GBR should be included on the National Heritage List as the National Heritage values were demonstrated to be achieved through corresponding Wold Heritage values identified in Section 16.13.1.

The National Heritage criteria for the GBR are listed with corresponding World Heritage listing criteria as follows:

a) The place has outstanding heritage value to the nation because of the place's importance in the course, or pattern, of Australia's natural or cultural history – corresponds to World Heritage criteria (vii), (viii), (ix) and (x);

b) The place has outstanding heritage value to the nation because of the place's possession of uncommon, rare or endangered aspects of Australia's natural or cultural history– corresponds to World Heritage criteria (x);

c) The place has outstanding heritage value to the nation because of the place's potential to yield information that will contribute to an understanding of Australia's natural or cultural history – corresponds to World Heritage criteria (viii), (ix) and (x);

d) The place has outstanding heritage value to the nation because of the place's importance in demonstrating the principal characteristics of
   - A class of Australia's natural or cultural places or
   - A class of Australia's natural or cultural environments
   - Corresponds to World Heritage criteria (viii), (ix) and (x);

e) The place has outstanding heritage value to the nation because of the place's importance in exhibiting particular aesthetic characteristics valued by a community or cultural group – corresponds to World Heritage criteria (vii).

The GBR is also of indigenous cultural importance for Aboriginal and Torres Strait Islanders with over 70 clan groups maintaining links to land and sea. Non-Indigenous heritage values are also represented including lighthouses and historic shipwrecks occurring throughout GBR area. Along with its biological diversity, these represent features of outstanding national heritage value leading to the GBR being registered as a place of National Heritage.

16.13.3 Desktop Results - Threatened Ecological Communities

The Protected Matters Search Tool identified five listed TECs as having potential to occur in the Project area:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) – Endangered;
- Broad leaf tea-tree (*Melaleuca viridiflora*) woodlands in high rainfall coastal north Queensland – Endangered;

- Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions – Endangered;
- Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin – Endangered; and
- Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar Bioregions – Endangered.

Current RE mapping indicates there is 19.8 ha of one RE present within the overall Project area that may be considered a Brigalow TEC (RE11.4.9) (refer Figure 16-129). The extent of REs (as mapped by DNRME) within the Project area, within a 10 km radius of the Project area, and within the Marlborough Plains and Nebo-Connors Ranges subregions are described in Table 16-105. It is important to note the potential extent of TECs outside of the Project area is based on DNRME RE mapping (which has not been ground-truthed) in which the TEC equivalent RE is dominant. Composite REs in which the TEC equivalent RE is not dominant are not included.

Table 16-105 Currently mapped REs within the Project area

TEC	RE code	VM Act status	Total within Project area (ha)	Total within a 10 km radius of Project (ha)	Total within Marlborough Plains subregion (ha)	Total within Nebo-Connors Ranges subregion (ha)
ML80187						
	Non-remnant	-	1,801.6	37,232.3	543,487.3	176,257.7
	11.3.4	Of Concern	9.78	925.5	10,042.1	4,287.6
	11.3.25	Least Concern	16.03	1,332.4	2,955.8	8,981
	11.4.2	Of Concern	174.92	2,058.6	6,121.3	1,822.1
Brigalow	11.4.9	Endangered	12.7	182.7	517.2	129.1
	11.5.8a / 11.7.2	Least Concern	25.38	362.6	1,840	362.6
	11.10.7	Least Concern	29.11	513.5	88.4	513.5
	11.10.7 / 11.10.1	Least Concern	80.58	1,484.2	772.7	711.5
	11.11.15a	Least Concern	125.52	1,090.6	20,698.4	1,949.1
ML700022						
	Non-remnant	-	675.66	37,232.3	543,487.3	176,257.7
	11.3.4	Of Concern	9.64	925.5	100,42.1	4,287.6
	11.3.25	Least Concern	26.04	1,332.4	2,955.8	8,981
	11.4.2	Of Concern	19.74	2,058.6	6121.3	1,822.1
Brigalow	11.4.9	Endangered	7.14	182.7	517.2	129.1
	11.11.1	Least Concern	4.18	2619.5	3,270.6	576.7
	11.11.15	Least Concern	9.72	1,090.6	20,698.4	1,949.1

16.13.4 Desktop Results - Threatened and Migratory Terrestrial Species

Database searches identified 15 flora and 29 terrestrial fauna species listed as threatened (Endangered, Vulnerable or Critically Endangered) and 24 fauna species listed as migratory under the EPBC Act (see Table 16-106). The searches were used to inform the field investigations of species which could potentially occur in the Project area.

Table 16-106 Predicted EPBC Act listed species

Scientific name	Common name	EPBC Status	Data source	
			WN	PM
Plants				
Capparis thozetiana		V	X	X
Corymbia xanthope	Glen Geddes Bloodwood	V	X	X
Cycas megacarpa		E	X	X
Cycas ophiolitica	Marlborough Blue	E	X	X
Dichanthium setosum	Bluegrass	V		X
Hakea trineura	Three-veined Hakea	V	X	X
Eucalyptus raveretiana	Black Ironbox	V	X	
Marsdenia brevifolia		V	X	X
Neoroepera buxifolia		V	X	X
Olearia macdonnellensis		V	X	
Omphalea celata		V		X
Phaius australis	Lesser Swamp-orchid	E	X	X
Pimelea leptospermoides		V	X	X
Pultenaea setulose		V	X	X
Samadera bidwillii	Quassia	E	X	X
Reptiles				
Elseya albagula	Southern Snapping Turtle	CE	X	X
Rheodytes leukops	Fitzroy Turtle	V	X	X
Delma torquata	Collared Delma	V		X
Egernia rugosa	Yakka Skink	V		X
Denisonia maculata	Ornamental Snake	V		X
Furina dunmalli	Dunmall's Snake	V		X
Birds				
Erythrotriorchis radiatus	Red Goshawk	V	X	X
Turnix melanogaster	Black-breasted Button-quail	V	X	X
Charadrius leschenaultii	Greater Sand Plover	V,M	X	
Charadrius mongolus	Lesser Sand Plover	E,M	X	
Rostratula australis	Australian Painted Snipe	E,M	X	X
Calidris ferruginea	Curlew Sandpiper	CE,M	X	X
Calidris canutus	Red Knot	E,M	X	
Calidris tenuirostris	Great Knot	CE,M	X	X
Limosa lapponica baueri	Bar-tailed Godwit (baueri)	V,M	X	X
Limosa lapponica menzbieri	Bar-tailed Godwit (menzbieri)	CE,M		X
Numenius madagascariensis	Eastern Curlew	CE,M	X	X
Geophaps scripta scripta	Squatter Pigeon - southern subspecies	V	X	X
Epthianura crocea macgregori	Yellow Chat (Dawson)	CE,M	X	X
Poephila cincta cincta	Black-throated Finch (southern)	E		X
Neochmia ruficaunda ruficauda	Star Finch	E		X
Mammals				
Dasyurus hallucatus	Northern Quoll	E		X
Phascolarctos cinereus	Koala	V	X	X
Petauroides volans	Greater Glider	V	X	X
Pteropus poliocephalus	Grey-headed Flying-fox	V		X
Macroderma gigas	Ghost Bat	V		X
Chalinolobus dwyeri	Large-eared Pied Bat	V		X
Nyctophilus corbeni	South-eastern Long-eared Bat	V		X
Xeromys myoides	Water Mouse	V		X

Scientific name	Common name	EPBC Status	Data source	
			WN	PM
Migratory bird species				
Hirundapus caudacutus	White-throated Needletail	M		X
Apus pacificus	Fork-tailed Swift	M	M	X
Pandion cristatus	Eastern Osprey	M		X
Plegadis falcinellus	Glossy Ibis	M	X	
Pluvialis squatorola	Grey Plover	M		
Gallinago hardwickii	Latham's Snipe	M	X	X
Calidris acuminate	Sharp-tailed Sandpiper	M		
Calidris ruficollis	Red-necked Stint	M	X	
Numenius phaeopus	Whimbrel	M		X
Tringa brevipes	Grey-tailed Tattler	M		
Tringa nebularia	Common Greenshank	M	X	
Tringa stagnatilis	Marsh Sandpiper	M	X	
Xenus cinereus	Terek Sandpiper	M	X	
Gelochelidon nilotica	Gull-billed Tern	M	X	
Hydroprogne caspia	Caspian Tern	M	X	
Sterna albifrons	Little Tern	M		X
Thalasseus bergii	Crested Tern	M	X	
Cuculus optatus	Oriental Cuckoo	M		X
Monarcha melanopsis	Black-faced Monarch	M	X	X
Symposiachrus trivirgatus	Spectacled Monarch	M	X	X
Myiagra cyanoleuca	Satin Flycatcher	M		X
Rhipidura rufifrons	Rufous Fantail	M	X	X
Motacilla flava	Yellow Wagtail	M		X

1: Status: Ex = Extinct; E = Endangered; CE = Critically Endangered; V = Vulnerable; M = Migratory; 2: Database source: WN = Wildlife online (accessed from EHP 2016); PM = EPBC Protected Matters online search tool.

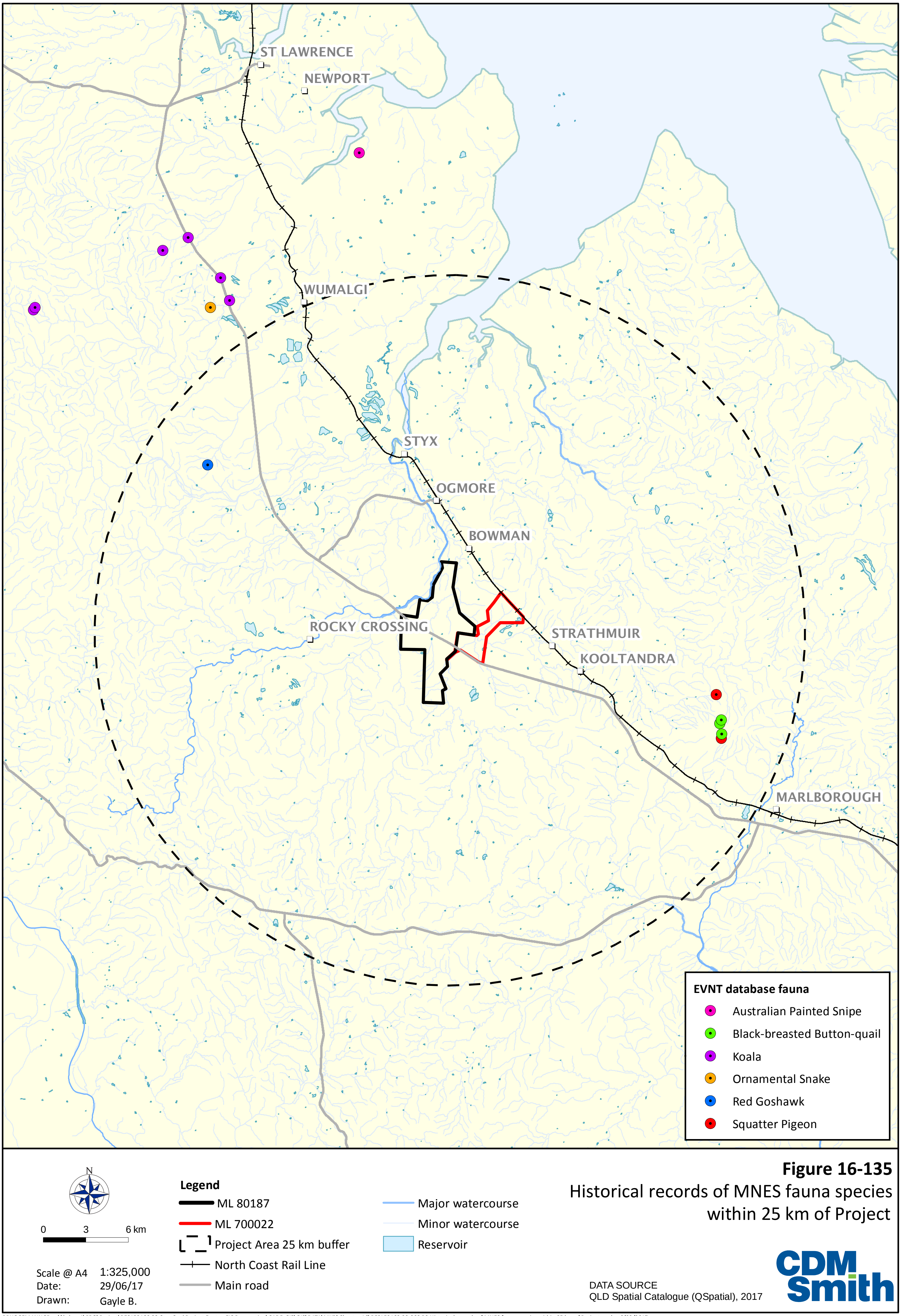
A historical account of the presence of conservation significant fauna species within the wider area surrounding the Project was conducted with the use of the ALA and DES Species Profile Search databases. Records for this region were mapped to assess the historical occurrence of conservation significant species listed under the EPBC Act within the Project area and surrounding region (see Figure 16-135).

There are several records of threatened fauna species in the wider area surrounding the Project area. Five fauna species listed as EVNT were recorded on the DES or ALA database within a 25 km buffered radius of the Project area including:

- One old record (1905) of Red Goshawk located 17 km northwest of the MLs;
- Two records of Squatter Pigeon (southern) located approximately 18 km east of the Project area;
- Three 1996 records of Black-breasted Button-quail located 18 km east of the Project area located on the edge of hilly country;
- A single record of Ornamental Snake 24 km northwest of the ML; and
- A single record of Koala 24 km northwest of the ML. There are five additional records of Koala between 25 and 33 km to the northwest in the same general area (Figure 16-135).

There is also a single record of Australian Painted Snipe 30 km to the north of the ML. Two aquatic species have records occurring 31 km to the southwest and southeast: Southern Snapping Turtle and Fitzroy Turtle (Figure 16-135).

The databases searches also identified a number of other threatened (13 species) or migratory fauna species (nine species) as potentially occurring in the Project area (refer Appendix A9c – Ecological Desktop Search Results). These species are considered in the following sections as their habitat requirements are estuarine / marine or they are pelagic (offshore) bird species. The Project area does not encompass any estuarine / marine habitat.



Scale @ A4 1:325,000
Date: 29/06/17
Drawn: Gayle B.

Figure 16-135
Historical records of MNES fauna species within 25 km of Project

DATA SOURCE
QLD Spatial Catalogue (QSpatial), 2017

CDM Smith

16.13.5 Desktop Results - Large Marine Fauna

The EIS did not include an assessment of threatened or migratory fauna species associated with marine environments as identified in the EPBC Online Protected Matters search results. The Project is located upstream of and some distance away from marine habitat that potentially supports marine species. An assessment of the potential occurrence of identified marine species in the area of the Styx River and Broad Sound located downstream of the Project has been provided as per requests from DotEE (Table 16-107). This assessment is based on desktop information. Further species information and an assessment of impacts from the Project activities are provided for those species considered as 'likely' or 'known' to occur in the area.

The results of the assessment indicate the following species are considered as likely to occur in marine habitat downstream of the Project:

- Estuarine Crocodile (*Crocodylus porosus*) (Migratory);
- Green Turtle (*Chelonia mydas*) (Vulnerable, Migratory);
- Flatback Turtle (*Natator depressus*) (Vulnerable, Migratory);
- Australian Snubfin Dolphin (*Orcaella heinsohni*) (Migratory); and
- Australian Hump-backed Dolphin (*Sousa sahulensis*) (Migratory).

Excepting Estuarine Crocodile, these species are not expected to occur close to the Project due to the very low water levels in the Styx River during the low tidal phase and the general lack of suitable foraging habitat present. The nearest suitable marine habitat is likely to be in the vicinity of Rosewood Island adjacent to the mouth of the Styx River which is located 23 km north of the Project area.

Estuarine Crocodile is anecdotally considered to occur, in a large waterhole located downstream of the confluence of Deep Creek and Tooloombah Creek (2.2 km north of the Project boundary). The species has not been observed at this site or waterbodies in Deep Creek and Tooloombah Creek during monthly water quality sampling carried out since March 2017, or during ecological investigations associated with the Project.

A further four species are considered to have some potential to occur in the downstream Broad Sound area, but not within the Project area due to the absence of any suitable habitat: Loggerhead Turtle (*Caretta caretta*), Hawksbill Turtle (*Eretmochelys imbricata*), Olive Ridley Turtle (*Lepidochelys olivacea*), and Reef Manta Ray (*Manta alfredi*). Those species considered as 'likely' to occur are subject to a significant impact assessment under the Matters of National Environmental Significance Significant Impact Guidelines 1.1 (DotE 2013).

Table 16-107 Likelihood of occurrence of EPBC Act listed marine fauna species in habitat downstream of the Project area

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence	
			Styx River estuary	Wider Broad Sound area
Threatened Species				
Loggerhead Turtle *Caretta caretta*	E,M	In Australia, the Loggerhead Turtle occurs in the waters of coral and rocky reefs, seagrass beds and muddy bays throughout eastern, northern and western Australia (Limpus et al. 1992). Nesting is concentrated in southern Queensland and from Shark Bay to the North West Cape in Western Australia, foraging areas are more widely distributed. Occurs over a wide range of habitats in tidal and sub-tidal waters including reefs, seagrass and soft-bottomed sand or mud. Loggerhead Turtles specialise in foraging for slow-moving shelled invertebrates including gastropods, bivalves and some crab taxa. Nesting females feed close to nesting beaches. Hatchlings disperse to pelagic waters, then returning to inshore waters at an estimated age of 13 years (Limpus 2008a).	**Unlikely.** No suitable habitat likely to be present due to shallow waters.	**Low potential.** Single ALA database record from the broader region located 107 km east of the Project in the Port Clinton area. Targeted nesting surveys in the region found low level nesting activity (1 – 10 females per year) on the Percy Islands (approx. 120 km north-east of the Project) and Bushy Island (offshore from Mackay). Aerial surveys for large marine turtles in the broader region (including Broad Sound) in 2016 recorded only one marine turtle (species not identified) within the Broad Sound DIWA area (Sobtzick et al. 2016). Potentially occurs in the wider Broad Sound area but habitat downstream of the Project is likely to be less suitable for this species.
Green Turtle *Chelonia mydas*	V,M	Adult green turtles eat seagrasses, a wide range of algae, as well as mangrove fruits. They will occasionally eat other items such as jellyfish and sponges (Read and Limpus, 2002; Arthur et al., 2007). They occur on reefs, seagrass meadows and algal mats on sand or mud substrates (Limpus 2008b). This is a widespread species. Major nesting rookeries in the southern GBR occur in the Capricorn-Bunker group of islands, with minor nesting areas on several other islands as well as the mainland coast.	**Known**. There are several ALA records within the Styx River estuary. However, these are all attributable to a single radio-tracked individual released by the Cairns turtle rehabilitation and reef HQ facility in 2010. There is no suitable seagrass foraging habitat in the estuary. This is a widespread and common species that may transiently occur during foraging movements.	**Known**. There are many ALA records in the wider Broad Sound area (Figure 16-133). Low-level nesting has been recorded on several offshore islands in the wider region including the Percy Islands group, Curlew Island and islands and mainland beaches in Shoalwater Bay. The Shoalwater Bay sites are the nearest known nesting sites to the Project (66 km north-east) (Limpus et al. 2002). Aerial surveys for large marine turtles in the region (including Broad Sound) in 2016 recorded only one marine turtle (species not identified) within the Broad Sound DIWA area (Sobtzick et al. 2017). There is little suitable mapped seagrass habitat located within the Broad Sound DIWA area and none downstream of the Project (i.e. Styx River estuary). Nevertheless, this is a widespread and relatively common species and is considered likely to occur at times.

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence	
			Styx River estuary	Wider Broad Sound area
Leatherback Turtle *Dermochelys coriacea*	E, M	Leatherback Turtles feed in pelagic waters on soft-bodied organisms such as squid and jellyfish. They occur in both oceanic waters and over the Australian continental shelf. There are no major nest sites in Australia. Scattered minor nesting has been recorded along the Northern Territory coast and southern Queensland / New South Wales (Limpus 2009a).	**Unlikely.** A single ALA database record (1985) from the Mackay region. Circumstances of record are not given. Given the species occurs in open waters the area of Broad Sound downstream of the Project does not constitute habitat for this species.	
Hawksbill Turtle *Eretmochelys imbricata*	V, M	Hawksbill turtles are generally associated with reef habitats (tidal and sub-tidal). Nesting in Queensland occurs on northern Cape York Peninsula. They have been recorded as far south as northern New South Wales. They feed principally on various species of sponge, but they may also feed on algae, soft corals and macro-zooplankton such as jellyfish and comb-jellies (Limpus 2009b).	**Unlikely.** No suitable habitat present.	**Potential.** Three ALA database records – one of indeterminate origin from Mackay, and two records (1985 and 2010) offshore of Yeppoon. The nearest sizeable reef habitat to the Project is located on the western side of Long Island (approx. 53 km north, refer Figure 16-133). Aerial surveys for large marine turtles in the broader region (including Broad Sound) in 2016 recorded only one marine turtle (species not identified) within the Broad Sound DIWA area (Sobtzick et al. 2016). There is a low potential for the species to occur in the area based on the limited habitat available.
Olive Ridley Turtle *Lepidochelys olivacea*	E, M	It is likely that Australia has the largest remaining breeding population of Olive Ridley Turtles in the southeast Asia–western Pacific region (Limpus, 2008c). Nesting occurs in the Northern Territory and the western coast of Cape York Peninsula. There are no nesting records from the east coast of Queensland. The species feeds on gastropods and crabs. It prefers soft-bottomed habitats in shallow waters as far south as south-east Queensland. It rarely occurs in seagrass or coral reef habitats. Trawl fishery data indicates the species occurs largely from 6 to 35 m depth in the GBR region (Limpus 2008c).	**Unlikely.** No suitable habitat likely to be present due to shallow waters.	**Potential.** There are no ALA database records from the wider Broad Sound region. Aerial surveys for large marine turtles in the broader region (including Broad Sound) in 2016 recorded only one marine turtle (species not identified) within the Broad Sound DIWA area (Sobtzick et al. 2016). Although there are no records for this species in the wider area, there is potential habitat in the Broad Sound area downstream of the Styx River estuary.

<table>
<tr><th rowspan="2">Species name</th><th rowspan="2">EPBC Act status</th><th rowspan="2">Habitat preference</th><th colspan="2">Likelihood of occurrence</th></tr>
<tr><th>Styx River estuary</th><th>Wider Broad Sound area</th></tr>
<tr><td>Flatback Turtle
Natator depressus</td><td>V,M</td><td>Flatback Turtle is the only marine turtle species that is endemic to the Australian continental shelf and only nests in Australia. Species feeds on soft-bodied invertebrates such as jellyfish, soft corals and sea pens. It prefers soft-bottomed habitats in shallow waters and rarely occurs in seagrass or coral reef habitats. Trawl fishery data indicates the species occurs largely from 6 to 35 m depth in the GBR region (Limpus 2007).</td><td>Low Potential. There are no ALA records within or close to the Styx River estuary. The species forages in shallow waters and is known to occur in the wider area. The lower estuary around Rosewood Island may provide transient suitable foraging habitat during the high tide cycle.</td><td>Likely. There are many ALA records in the wider area including records to the north of the Broad Sound DIWA area and Stanage Bay (Figure 16-133). However there are no records in the DIWA area itself. There is a major nesting rookery at Wild Duck Island (74 km north north-east of the Project) and Avoid Island (75 km north of the Project) (Figure 16-133). The species nests at low levels on several islands and mainland beaches in the surrounding region. Targeted nesting surveys in the region indicate the nearest nest sites for this species were the Clairview area (55 km north including mainland beach sites and nearby Flock Pigeon Island), north-east side of Long Island (67 km north north-east), and in the Stanage Bay area (70 km north-east including mainland sites and Quail Island) (Limpus et al. 2002). Aerial surveys for large marine turtles in the region (including Broad Sound) in 2016 recorded only one marine turtle (species not identified) within the Broad Sound DIWA area (Sobtzick et al. 2016). Although there are no records for this species in Broad Sound itself area, there is potential habitat in the Broad Sound area downstream of the Styx River estuary. Given the species nearby occurrence it is considered likely to occur.</td></tr>
<tr><td>White-bellied Storm-petrel
Fregetta grallaria grallaria</td><td>V</td><td rowspan="3">These are all pelagic bird species that forage in offshore open waters and nest on remote offshore islands. In Australia the White-bellied Storm-petrel and Kermadec Petrel breed in the Lord Howe Island group. Kermadec Petrel also breeds on Phillip Island (offshore from Norfolk Island). Southern Giant Petrel breeds in Antarctica and sub-Antarctic islands and occurs mainly over the Southern Ocean but also ventures into subtropical waters. Campbell Albatross does not breed in Australian waters and is most reported in open</td><td colspan="2" rowspan="3">Unlikely. Two ALA records for Southern Giant Petrel of uncertain provenance off Yeppoon approximately 120 km southeast of the Project area. No other database records from the broader region for the other species. The waters of Broad Sound downstream of the Project are very unlikely to provide suitable foraging habitat for these species.</td></tr>
<tr><td>Southern Giant Petrel
Macronectes giganteus</td><td>E, M</td></tr>
<tr><td>Kermadec Petrel
Pterodroma neglecta neglecta</td><td>V</td></tr>
</table>

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence	
			Styx River estuary	Wider Broad Sound area
Campbell Albatross *Thalassarche impavida*	V,M	waters of the continental shelf off Tasmania, Victoria and New South Wales (DotEE 2018).		
Blue Whale *Balaenoptera musculus*	E,M	Blue Whale sightings are widespread around the continental shelf of Australia although much of this area is likely to be used for migratory movements and incidental foraging. The only known areas of significance in Australian waters are feeding areas around the southern continental shelf, notably the Perth Canyon, off Western Australia, and the Bonney Upwelling and adjacent upwelling areas of South Australia and Victoria (DotEE 2018).	**Unlikely.** Four ALA databse records from the surrounding region including offshore of Yeppoon approximately 140 km east of the Project area (record described as sighted 'off Maryborough'). Two of these are strandings: one recorded in the Shoalwater Bay area in 1928; and another at Saint Lawrence in 1994 (DoD 2009). The species likely occurs offshore of the local mainland at times but the shallow waters of Broad Sound downstream of the Project are not suitable for the species.	
Humpback Whale *Megaptera novaeangliae*	V	Large baleen whale species are well known for winter migrations along the east and west coast of Australia where the species breeds. Feeding largely occurs in Antarctic waters during the southern hemisphere summer. Migratory habitat off the Australian coast is usually within 20 km of the mainland and less than 200 m deep. Core areas off Queensland include resting areas off Moreton Bay and Hervey Bay and calving habitat in the Whitsunday Islands area.	**Unlikely.** Many database records in the wider area offshore from Shoalwater Bay and local offshore islands. No records in Broad Sound downstream of the Project. The shallow marine habitat located downstream of the Project is very unlikely to represent suitable resting or calving habitat for this species.	
Green Sawfish *Pristis zijsron*	V,M	The Green Sawfish has a preference for sand and mud flats outside of river mouths (Peverell 2005) and frequently utilises very shallow water. It was previously recorded as far south as Jervis Bay in New South Wales, but is now considered to reach as far south as the Whitsunday Islands (DotEE 2018) area to the north of the Project area.	**Unlikely.** There are no database records in the wider region and no recent records south of Port Douglas in north Queensland. The Project area is located south of the species likely current distribution.	

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence	
			Styx River estuary	Wider Broad Sound area
Migratory Fauna				
Estuarine Crocodile *Crocodylus porosus*	M	The estuarine crocodile inhabits coastal and inland waterways from Gladstone to Cape York and through the Gulf of Carpentaria to the Queensland/ Northern Territory boarder (Read et al. 2004) with the majority of the population occurring in tidally influenced areas (Fukuda et al. 2007). The habitat of the estuarine crocodile includes marine habitats such as mangroves, but they also commonly occur in freshwater habitats such as rivers, lakes and swamps.	**Potential.** There are no database records from the wider area. The nearest ALA database records are from the Fitzroy River approximately 50 km south of the Project. During the June 2011 survey evidence of the presence of estuarine crocodiles was observed at two Styx River sites and at one site on Deep Creek. Anecdotal evidence collected at the time suggested crocodiles have occurred in Deep Creek, Granite Creek as well as the Styx River. No evidence of crocodile presence was observed at any of the aquatic ecology sampling sites in February 2017 or any water sampling sites (May 2017 to April 2018) and in general habitat conditions appeared less suitable for the species i.e. isolated pools largely with steep banks. However, anecdotal evidence collected in May 2017 suggested an individual had been observed at a large pool in the Styx River directly downstream of the confluence of Tooloombah and Deep Creeks. This site has been subject to monthly surface water sampling events and no signs of crocodile presence has been observed.	**Likely.** No ALA database records from wider area. Species known to occur in low numbers in the Shoalwater Bay area (DoD 2009).
Flesh-footed Shearwater *Ardenna carneipes*	M	Pelagic bird species that forage in offshore open waters and nest on remote offshore islands. On the east coast of Australia, the species is known breed on Lord Howe Island and has been recorded on Norfolk Island (DotEE 2018).	**Unlikely.** There are no database records in the wider region. The waters of Broad Sound are very unlikely to provide suitable foraging habitat for this species.	

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence	
			Styx River estuary	Wider Broad Sound area
Dugong *Dugong dugon*	M	Dugong is widespread across northern Australia, and specialises in feeding on seagrasses in shallow inshore areas. There are several concentrations of Dugong along the eastern Queensland coast. The Shoalwater Bay area is considered the most important site south of Cooktown due to the large population and controls on impacts due to the presence of the Shoalwater Bay Training Area (DoD 2009). Other areas supporting the species includes Moreton Bay, Hervey Bay, Port Curtis, Cleveland Bay, Upstart Bay, and Hinchinbrook Island. Movements appear highly idiosyncratic with variations of less than 15 km up to 560 km recorded during monitoring of individuals (DotEE 2018).	**Unlikely.** Database records from the wider region are restricted to the Shoalwater Bay area 65 km east of the Project area. There is a Dugong Protection Area associated with extensive seagrass beds extending from Carmilla Creek south to Clairview Bluff (approximately 55 km north of the Project). Seagrass mapping data (Carter et al. 2016) indicates no mapped seagrass beds known in the Broad Sound DIWA area downstream of the Project. Extensive seagrass beds occur to the northwest in the Clairview area and in Shoalwater Bay, including small patches near the islands off Stanage Bay Seagrasses require suitable light conditions and appropriate nutrient levels. It is likely the extreme tidal range in Broad Sound influences the lack of seagrass likely due to high turbidity levels and prolonged exposure of tidal flats during low tides. Sightings of Dugong are rare in the majority of Broad Sound. In a review of Dugong sighting data by Marsh and Penrose (2001) there are no reported sightings in the Broad Sound area downstream of the Project. More recently extensive aerial transect surveys for Dugong and marine turtles which included Broad Sound recorded no individuals in the sound itself. The nearest reported sightings were individuals in the Clairview and Stanage Bay areas (Sobtzick et al. 2017). Given the lack of seagrass in the majority of the Broad Sound DIWA it is unlikely the area downstream of the Project provides suitable habitat value for the species.	
Australian Snubfin Dolphin *Orcaella heinsohni*	M	The species habitat preference in the Keppel Bay area is shallow waters ranging from 2 to 15 m depth (Cagnazzi et al. 2013). Populations occur sporadically along the Queensland coast through to northern Western Australia.	**Likely.** Species recorded during targeted survey in 2013 in channel on west side of Rosewood Island which is connected to the Styx River (CCP 2013). Suitable habitat very likely to be limited to this area of the Styx River due to shallow waters and tidal range.	**Likely.** Several ALA database records in wider area including in the Shoalwater Bay area and offshore islands north of Stanage Bay. Also known to occur in the waters of Shoalwater Bay (DoD 2009). Abundant suitable shallow inshore habitat likely to occur in Broad Sound.
Australian Humpback Dolphin *Sousa sahulensis*	M	Species occurs as local populations along the Queensland coast that are small in number and discrete in geographic range (Hale et al. 2000). Habitat preference is for shallow turbid estuarine and coastal waters (Lin et al. 2013) and in particular shallow channels.	**Likely.** Species recorded during targeted survey in 2013 in channel on west side of Rosewood Island which is connected to the Styx River (CCP 2013). Suitable habitat likely to be limited to this area of the Styx River due to shallow waters and tidal range.	**Likely.** No ALA database records in wider area with nearest being the Whitsunday region 250 km to the north. Known to occur in the waters of Shoalwater Bay (DoD 2009). Species recorded during targeted survey in 2013 along coast north of the Styx River (CCP 2013). Abundant suitable shallow inshore habitat likely to occur in Broad Sound.

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence	
			Styx River estuary	Wider Broad Sound area
Killer Whale *Orcinus orca*	M	Killer Whales are recorded off all Australian states although they are more common in the cooler waters of the southern states as well as Antarctic and sub-Antarctic waters. Preferred habitat for the species is difficult to define given its widespread distribution and ability to inhabit all parts of the oceans. In Australia they are generally seen on the continental shelf and edge, particularly where seal colonies occur. Feeding is varied and dependent on local conditions. In Australia they are known to feed on a range of marine mammal species (including larger whale species) as well as smaller marine fauna including fish and cephalopods.	**Unlikely.** No database records from the wider region. The shallow marine habitat in Broad Sound downstream of the Project is very unlikely to represent suitable habitat for this species.	
Bryde's Whale *Balaenoptera edeni*	M	Rarely recorded species that may occur off all Australian states where it prefers waters above 16°C in temperature. Specific identification in the field may be difficult due to confusion with Sei Whales (*B. borealis*). There are two forms of Bryde's whale: the coastal form of Bryde's Whale is smaller and appears to be limited to the 200 m depth isobar, moving along the coast in response to availability of suitable prey. The offshore form is found in deeper water (500 m to 1000 m). Unlike other baleen whales the species is known to feed all year round. There are no specific feeding or breeding grounds known in Australia. The species is considered to be pelagic (i.e. occurs in open waters) (DotEE 2018).	**Unlikely.** No database records from region and the marine habitat located downstream of the Project does not represent suitable habitat for this species.	
Porbeagle *Lamna nasus*	M	The species occurs in temperate, arctic and subantarctic waters and is known from southern Queensland through to south-west Western Australia. Porbeagle generally occurs in open water off the continental shelf (DotEE 2018).	**Unlikely.** No database records from region and the marine habitat located downstream of the Project does not represent suitable habitat for this species.	

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence	
			Styx River estuary	Wider Broad Sound area
Reef Manta Ray *Manta alfredi*	M	The Reef Manta Ray is commonly sighted inshore, around coral reefs and rocky reefs in coastal areas (Marshall et al. 2011) and within areas of upwelling which provide nutrient rich waters supporting high plankton abundance. The species predictably aggregates to particular locations such as Lady Elliot Island, North Stradbroke Island and Byron Bay in eastern Australia, for which they display a high degree of site fidelity (Couturier et al. 2011). Aggregation sites are strongly believed to represent critical habitats for this species.	**Unlikely.** No suitable habitat present.	**Low potential.** No database records from region. Suitable reef habitat located in the wider Broad Sound area (downstream of the Project) is limited and likely restricted to the inshore islands located adjacent to the Torilla Peninsula.
Giant Manta Ray *Manta birostris*	M	The giant manta ray lives mostly in the open ocean, traveling with the currents and migrating to areas where upwellings of nutrient-rich water increase prey concentrations.	**Unlikely.** No database records from region and the marine habitat located downstream of the Project does not represent suitable habitat for this species.	

16.13.5.1 Threatened marine species likely to occur in Styx River / Broad Sound

The following section provides life cycle descriptions and habitat preferences of the threatened marine species considered likely to occur within the Project area. Both species are also listed as Migratory under the EPBC Act. The information provided is based on the available desktop information.

Green Turtle (Vulnerable)

There are seven widely separated breeding aggregations of Green Turtles that are considered separate stocks: southern GBR, Coral Sea, northern GBR, Gulf of Carpentaria, Ashmore Reefs, Scott Reef and the Northwest Shelf (Dutton et al., 2002). The important nesting locations for the southern GBR stock are the islands of the Capricorn-Bunker Group. Lesser nesting aggregations occur on Bushy Island, Bell Cay, Lady Elliott Island and coastal mainland north of Bundaberg (Limpus, 2008b). It's noted low-density nesting may occur on most beaches within the southern GBR zone. Nesting females remain in marine habitat local to rookeries during the breeding season (known as 'internesting' habitat).

Green Turtles in the southern GBR nest from mid-October to early April with a peak in late December / early January. Nest temperatures impact the sex ratio of turtle hatchlings with warmer temperatures producing females. This temperature differs between breeding areas. At Heron Island a temperature of 27.6°C is estimated to be the point at which 50/50 sex ratio in hatchlings is produced. Beaches at the Heron Island rookery are likely to be biased towards females (Limpus et al. 1984; Limpus 2008b). Hatchlings emerge from December through to May.

Adult Green Turtles are largely herbivorous, eating seagrass, algae, and mangrove fruits, although they will occasionally eat other items such as jellyfish and sponges (Brand-Gardner et al., 1999; Read and Limpus, 2002; Arthur et al., 2007). Feeding occurs in a variety of habitats including reef systems (coral and rocky), seagrass meadows and algal mats on sand or mud (Limpus 2008b).

The *Recovery Plan for Marine Turtles in Australia* (CoA 2017b) identifies nesting habitat considered 'critical to the survival of the species' including a 20 km 'internesting' buffer (occurring from October to April) around these sites. These areas have been identified as 'biologically important areas' (BIAs). The nearest BIA to the Project area for Green Turtles is Bushy Island (part of the South Cumberland group of islands) which is located approximately 180 km north of the Project area off the coast of Mackay.

Flatback Turtle (Vulnerable)

Flatback Turtles are the commonest nesting species in the marine area surrounding Broad Sound. The species nests only in Australia. There are four genetic stocks of flatback turtles in Australia: Queensland east coast, Torres Strait/Gulf of Carpentaria, Northern Territory and Western Australia (Limpus 2007). The foraging range of the east coast population lies largely within the GBRWHA. While nesting occurs at a large number of beach locations, some key rookeries have been identified. In the southern GBR region significant rookeries are known from Curtis Island, Wild Duck Island, Avoid Island, Peak Island and to a lesser extent mainland nesting occurs at Mon Repos (Limpus 2007). Minor nesting also occurs on a number of other continental islands and mainland sites along the east coast of Queensland to the north of Bundaberg.

Flatback Turtles in the area nest from late spring to early summer with a peak in late November through to early December. Wild Duck and Peak Islands support the largest rookeries in Australia

(Limpus 2007). At Mon Repos a temperature of 29.3°C is considered the point at which 50/50 sex ratio in hatchlings is produced.

Flatback Turtle has a preference for shallow, soft-bottomed sea bed habitats away from reefs. The Flatback Turtle is carnivorous and mostly feeds on epibenthic invertebrates including sea cucumbers, sea pens, jellyfish and soft corals.

The *Recovery Plan for Marine Turtles in Australia* (CoA 2017b) identifies nesting habitat considered 'critical to the survival of the species' including a 60 km 'internesting' buffer (occurring from October to March) around these sites. These areas have been identified as BIAs. The nearest BIAs to the Project area for Flatback Turtles includes Wild Duck Island (located 74 km to the north-east of the Project site) and the islands located within Broad Sound Islands National Park. This includes a number of islands scattered across a wide area to the north of Broad Sound and Shoalwater Bay. The nearest of these islands is located at the southern end of Long Island and is approximately 50 km north-east of the Project boundary. It is noted that aerial photography indicates that mangroves surround these islands completely, rendering them unsuitable for use as nesting sites.

16.13.5.2 Migratory marine species likely to occur in Styx River / Broad Sound

Estuarine Crocodile

Not observed during any surveys but there is anecdotal evidence of the species presence in the Styx River including just downstream of the junction of Tooloombah and Deep Creeks. The large waterhole in this area has been subject to monthly water quality sampling (May 2017 to April 2018) and has been inspected for the presence of crocodile during these events. No evidence of the species presence has been observed during any Project related surveys (ecological or water quality sampling) in the wider area. Also 'evidence of the presence of estuarine crocodiles' was observed at site De2 during aquatic ecology surveys in June 2011.

Estuarine Crocodile is widespread throughout northern Australia and its range includes all of the Gulf of Carpentaria and the Queensland east coast south to the latitude of approximately Gladstone. Their habitat includes marine habitats such as mangroves, but they also commonly occur in freshwater habitats such as rivers, lakes and swamps. Crocodiles have wide and varied diets which differ between habitats. Prey size increases with the size of the crocodile, with the diet of juveniles consisting of smaller prey such as insects, crustaceans and occasionally small mammals such as rats. Larger crocodiles feed on fish, crabs, turtles, birds and mammals including large prey items such as wallabies, pigs, water buffalo, cattle and horses.

Australian Snubfin Dolphin

The preferred habitat of Australian snubfin dolphins can vary regionally. The largest recorded population of Australian snubfin dolphin is in Blue Mud Bay (Northern Territory), estimated at approximately 1,000 individuals with the dolphins preferring water depths between 2.5 and 18 m (Freeland and Bayliss 1989). Parra (2006) identified that in Cleveland Bay (Townsville) the preferred habitat was shallower water (1 to 5 m) in the vicinity of seagrass beds, whereas Cagnazzi et al. (2013) found that in Keppel Bay (located at the mouth of the Fitzroy River), Australian Snubfin Dolphins used depths ranging from 2 to 15 m.

Australian Snubfin Dolphins show a larger dietary breadth than humpback dolphins, feeding on both fish and cephalopods (Parra & Jedensjö 2009). Like the Indo-Pacific humpback dolphins, coastal development is considered a threat to the species, but it persists in areas with such developments (as occurs in Cleveland Bay) (Parra 2006). This species exhibits site fidelity and long-term associations between individuals. There is no reliable information on calving season.

Australian Humpback Dolphin

Australian Humpback Dolphins occur in the coastal waters of Australia from approximately the Queensland / New South Wales border to Ningaloo Reef (Western Australia). The Australian Humpback Dolphin has local populations along the Queensland coast that are small in number and discrete in geographic range (Hale *et al*., 2000). The species prefers shallow turbid estuarine and coastal waters (Parra 2006; Lin *et al*., 2013) and in particular shallow channels (2 to 5 m) (Hale *et al.,* 1998), although they do range over a much larger depth range (approximately 20 m). At Port Curtis (Gladstone) they have been observed in waters from 5 m to 15 m depth (Cagnazzi 2010; Cagnazzi et al. 2013). They occur in various habitats such as reefs, seagrass meadows, mangroves and modified habitats such as dredged channels (Parra and Cagnazzi 2016).

They principally consume various species of coastal benthic and pelagic fish (Parra and Jedensjö, 2009). Calves may be born throughout the year, but spring and summer peaks are reported for many parts of their range (Jefferson and Karczmarski, 2001).

16.13.6 Desktop Results – Migratory Shorebird and Shorebird Habitat

DotEE sought further information regarding a number of wader and shorebird species recorded in Project-associated surveys in 2011 and listed as threatened and / or Migratory under the EPBC Act (refer Section 16.13.9 and 16.13.10). Five species listed as Migratory were identified during the 2011 / 2012 surveys: Eastern Curlew; Whimbrel; Bar-tailed Godwit (baueri); Caspian Tern (*Hydroprogne caspia*); and Gull-billed Tern (*Gelochelidon nilotica*). Eastern Curlew and Bar-tailed Godwit (baueri) are also listed as threatened under the EPBC Act (refer Table 16-115). The 2011 / 2012 surveys covered a much larger area than required for the current Project layout. Very little information regarding the locations of these records was provided in the reports on the 2011 /2012 surveys excepting site information for Eastern Curlew. The Project area does not encompass habitat, or is located close to habitat, for shorebird species. The nearest record for Eastern Curlew from the 2011 / 2012 surveys is over 14 km north of the Project area and located on estuarine flats associated with the Styx River (refer Figure 16-134).

Nevertheless, there is potential habitat for shorebird species downstream of the Project. The following section provides an assessment of the known habitat values for migratory shorebirds in the western Broad Sound area.

There is limited information available on the distribution of migratory wader species in the wider Broad Sound area likely due to the general inaccessibility of the region. In order to inform an impact assessment on potential wader habitat downstream of the Project the following provides a more detailed overview of knowledge of Migratory species in the region than provided in the original EIS.

The Broad Sound wetland is noted as providing significant habitat for waterbirds including substantial aggregations of a range of migratory shorebirds listed under the EPBC Act (DotEE 2017). Shoalwater Bay and Broad Sound are noted as sites of international importance (based on survey data from 1995) for the following migratory shorebirds; Bar-tailed Godwit (*Limosa lapponica*), Whimbrel, Eastern Curlew, Terek Sandpiper, Grey-tailed Tattler (*Tringa brevipes*) and Great Knot. The intertidal flats of Broad Sound were found to support fewer shorebirds than Shoalwater Bay excepting large numbers of Great Knot (Driscoll 1996; Jaensch 2009).

Surveys of waterbirds in Broad Sound have recorded 66 species, 21 of them breeding, in the eastern wetlands (Torilla Plains) in 2003, and 88 species, 25 of them breeding, mainly in the western wetlands (Styx River and adjacent plains) in 2006/2007 (Birdlife International 2017).

16.13.6.1 Migratory Shorebirds – Important Habitat

As defined in the EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species (the Guidelines) (CoA 2017c) an area may be classified as an 'important habitat' for a migratory shorebird species if the area is recognised as nationally or internationally important. The criteria used to identify these areas is that adopted under the Ramsar Convention on Wetlands.

A wetland habitat should be considered 'internationally important' if it regularly supports:

- 1% of the individuals in a population of one species or subspecies of waterbird; or
- A total abundance of at least 20,000 waterbirds.

An area may be considered 'nationally important habitat' for migratory shorebirds if it regularly supports:

- 0.1% of the flyway population of a single species of migratory shorebird; or
- 2000 migratory shorebirds; or
- 15 migratory shorebird species.

Estimates of populations of the 37 migratory shorebirds listed under the EPBC Act that use the east-Australian flyway have recently been revised (refer Hansen et al. 2016) and are used for the assessment of the following survey data from the Broad Sound region.

16.13.6.2 Broad Sound Survey Data

Detailed shorebird counts were carried out in western Broad Sound, supervised by Roger Jaensch (with volunteers on behalf of Wetlands International) in late 2008 and early 2009 for the Fitzroy Basin Association (Jaensch 2009). Six high-tide roosts were documented including census surveys from September 2008 to March 2009. Roosts sites extended north from Charon Point (32 km north-east of the Project) to Oyster Creek (south of Clairview and approximately 48 km north of the Project area) (refer Figure 16-134). Between one to three counts were carried out at each site dependent on access conditions during each survey period. Three surveys were able to be carried out at four of the sites. Additional surveys were carried out at a single brackish foraging area that was inundated at the time.

The surveys recorded 14 migratory shorebird species across the six sites. This included nationally important numbers at individual roost sites of Great Knot, Red Knot, Lesser Sand Plover, Red-necked Stint, Sharp-tailed Sandpiper, Curlew Sandpiper and Eastern Curlew (Table 16-108). When considering all sites combined western Broad Sound also supported nationally important numbers of Bar-tailed Godwit and Whimbrel (both during the November 2008 survey). All four surveys recorded greater than 2,000 migratory shorebirds across the region. The Charon Point roost site alone supported more than 2,000 shorebirds during the February and March 2009 surveys.

The 2008 / 2009 count data indicates the western Broad Sound region provides 'important habitat' for migratory shorebirds in general (i.e. greater than 2,000 individuals across all counts) as well as at times supporting nationally important numbers (0.1% of the flyway population estimate) of a number of species. The roost at Charon Point may be considered as 'important habitat' by itself given more than 2,000 individuals were counted at the site on two occasions, as well as the presence of nationally important numbers of Eastern Curlew and Great Knot.

Table 16-108 Migratory shorebird data - nationally important count species (Jaensch 2009)

Survey period	Site	Species	Count	Flyway estimate – 0.1%	Flyway estimate – 1%
September 2008	Charon Point	Eastern Curlew	92	35	350
	Hoogly Point	Eastern Curlew	50	35	350
	Bar Plains Point	Eastern Curlew	68	35	350
		Red Knot	350	110	1,100
	Oyster Creek	Curlew Sandpiper	120	90	900
November 2008	Hoogly Point	Eastern Curlew	50	35	350
		Red-necked Stint	802	475	4,750
		Sharp-tailed Sandpiper	95	85	850
February 2009	Charon Point	Great Knot	2,300	425	4,250
	Bar Plains Point	Lesser Sand Plover	240	180	1,800
March 2009	Charon Point	Great Knot	2,200	425	4,250

Following the 2008 / 2009 surveys Birdlife Capricornia have carried out annual surveys at three of the Broad Sound wader roost locations (Charon Point, Hoogly Point and Bar Plains Point) (refer Figure 16-134) where weather conditions allowed site access. Surveys were restricted to the early part of the migration season (September or October) due to poor wet season conditions in the early part of the year restricting site access, particularly to Charon Point. Table 16-109 provides the more substantial count data gathered from the last three years of data collected at each site (refer Appendix A9h – Broad Sound – Shorebird Survey Count Data for full data table).

The low numbers of birds recorded early in the season at Charon Point resulted in surveys at this roost being discontinued, although nationally important numbers of Eastern Curlew were recorded in 2010 and 2011. In general, Eastern Curlew appears to be present in substantial numbers across the area. Large numbers have been counted consistently at the Hoogly Point roost across several survey years including internationally significant numbers (505 individuals) counted in September 2013. Bar Plains Point also supports nationally significant numbers of Eastern Curlew and Great Knot at times.

The Birdlife Capricornia surveys also recorded both Gull-billed Tern and Caspian Tern at all three sites. These species do not have population estimates as associated with the migratory wader species. Both species are for the most part resident within Australia.

Table 16-109 Broad Sound migratory shorebird data 2010 - 2017 (Birdlife Capricornia 2018)

Survey period	Site	Species	Count	Flyway estimate – 0.1%	Flyway estimate – 1%
September 2010	Charon Point	Eastern Curlew	50	35	350
September 2011	Charon Point	Eastern Curlew	60	35	350
September / October 2013	Hoogly Point	Eastern Curlew	505	35	350
		Red-necked Stint	290	475	4,750
		Whimbrel	35	65	650
	Bar Plains Point	Eastern Curlew	94	35	350
		Red-necked Stint	280	475	4,750
		Sharp-tailed Sandpiper	75	85	850
October 2014	Hoogly Point	Eastern Curlew	251	35	350
		Red-necked Stint	171	475	1,800
		Whimbrel	45	65	650
October 2015	Bar Plains Point	Great Knot	464	425	4,250
September / October 2017	Bar Plains Point	Eastern Curlew	62	35	350
	Hoogly Point	Eastern Curlew	231	35	350
		Red-necked Stint	155	475	4,750

Although patchy, the existing recent survey data indicates roost sites in western Broad Sound provide 'important habitat' for migratory waders as defined under the Guidelines including the following:

- Charon Point provides nationally important habitat for Eastern Curlew and in some years may be an important staging point for Great Knot on their return migration passage to the northern hemisphere in late summer. At these times Charon Point alone may support nationally important numbers of migratory waders (>2,000 individuals). The Charon Point roost is located to the south of the mouth of the Styx River estuary and is 33 km north-north-east of the Project boundary;
- Other wader roost sites in western Broad Sound also support nationally important numbers of wader species at times, in particular Eastern Curlew. Hoogly Point on one recorded occasion has supported internationally significant numbers of Eastern Curlew. Hoogly Point and Bar Plains Point roost sites are 33 km north and 40 km north of the Project boundary respectively; and
- The evidence suggests that when summarised collectively the wader habitat across western Broad Sound is likely to consistently support nationally important numbers of migratory waders (>2,000 individuals), and nationally important numbers of migratory wader species including Eastern Curlew, Great Knot, Red-necked Stint, Whimbrel, and Sharp-tailed Sandpiper.

16.13.6.3 Likelihood of Occurrence

The EIS did not include an assessment of threatened or migratory shorebird species associated with estuarine / marine environments as identified in the database results. The Project is located upstream of and some distance away from marine habitat that potentially supports these species. An assessment of the potential occurrence of identified migratory shorebird species in the area of the Styx River downstream of the Northern Rail Line bridge (approximately 10 km downstream of the Project boundary) and Broad Sound has been provided as per requests from DotEE (Table 16-110). Estuarine habitat to the south of the rail crossing is not considered suitable for these species. Project observations of the Styx River downstream of the rail bridge indicate a largely sandy substrate at this point, which appears (via analysis of aerial imagery) likely to continue further downstream in the estuary.

This assessment is based on desktop information. Further species information and an assessment of impacts from the Project activities are provided for those species considered as 'likely' or 'known' to occur in the area. The results of the assessment in Table 16-110 indicate that 12 species are considered as likely or known to occur in estuarine habitat associated with the Styx River downstream of the Project, and 16 species are likely or known to occur in the wider Broad Sound area.

Table 16-110 Likelihood of occurrence of EPBC Act listed migratory shorebird species in habitat downstream of the Project area

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence	
			Styx River estuary	Wider Broad Sound area
Threatened / Migratory Species				
Greater Sand Plover *Charadrius leschenaultia* Lesser Sand Plover *Charadrius mongolus*	V, M E, M	These are shorebird species that occur on intertidal habitats in sheltered coastal areas. Both species prefer sandy habitats for foraging although Lesser Sand Plover is more likely to forage on muddier substrates as well (Menkhorst et al. 2017).	**Likely.** Sandy substrate in the Styx River downstream of the rail bridge may be utilised by these species for foraging.	**Known.** Both species have been recorded at roost sites in western Broad Sound in recent years (refer Appendix A9h). Lesser Sand Plover has been recorded in 'nationally important' numbers on at least one occasion (Table 16-108).
Red Knot *Calidris canutus* Great Knot *Calidris tenuirostris*	E, M CE, M	Shorebird species that occur on intertidal habitats in sheltered coastal areas. Prefer areas of extensive tidal flats. Gregarious species which often occur together in large numbers at roost sites (Menkhorst et al. 2017).	**Potential.** Sandy substrate in the Styx River downstream of the rail bridge is less suitable for these species. Both species generally prefer coastal habitat. Habitat around Rosewood Island is likely to be more suitable.	Known. Both species have been recorded at roost sites in western Broad Sound in recent years. Red Knot has been recorded in 'nationally important' numbers on at least one occasion. Great Knot may regularly use the area in large numbers (Table 16-108 and Table 16-109).
Eastern Curlew *Numenius madagascariensis*	CE, M	Mainly forages on intertidal mudflats and sandflats and occasionally ocean beaches. Roosts on sandy spits and islets, in mangroves and saltmarsh, and along high water mark on beaches (Higgins and Davies 1996).	**Known**. Both species recorded foraging on mudflats adjacent to the Styx River approximately 14 km north of the Project area in February 2012. Eastern Curlew also observed on associated estuarine plains 16 km north in September 2011 of the Project area during fauna surveys.	Known. Recent survey records show this species regularly occurs at roost sites in western Broad Sound and in nationally important numbers. On one occasion recorded in internationally important numbers at a single roost site (Table 16-108 and Table 16-109).
Bar-tailed Godwit (baueri) *Limosa lapponica baueri*	V, M	Mainly occurs in coastal habitats such as tidal flats, estuaries, lagoons, bays and harbours. Sometimes occurs on brackish wetlands, saline flats or sewage farms located near coast (Higgins and Davies 1996). May occur on larger waterbodies in inland areas.		**Known**. Recent survey records show this species occurs regularly at roost sites in western Broad Sound (Appendix A9h).
Western Alaskan Bar-tailed Godwit *Limosa lapponica menzbieri*	CE, M	Subspecies migrates from breeding grounds in North America. Same habitat as Bar-tailed Godwit (baueri) (which migrates from Siberian region). In Australia, this subspecies occurs in north western Australia.	**Unlikely.** No database records. EPBC Online search only. Species does not occur in this region of Australia	
Curlew Sandpiper *Calidris ferruginea*	CE, M	Generally found on wetland habitat along the coast including tidal flats, salt pans and sewage ponds. They also occur on nearby coastal freshwater / brackish wetlands and less commonly on inland wetlands (Pizzey and Knight 2012).	**Potential.** Sandy substrate in the Styx River downstream of the rail bridge is less suitable for these species. Both species generally prefer coastal habitat. Habitat around Rosewood Island is likely to be more suitable.	**Known**. Recent survey records show this species irregularly occurs at roost sites in western Broad Sound (Appendix A9h). On one occasion recorded in 'nationally important' numbers at a roost site (Table 16-108).

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence: Styx River estuary	Likelihood of occurrence: Wider Broad Sound area
Migratory Species				
Latham's Snipe *Gallinago hardwickii*	M	Occurs on swamp and marsh margins and in wet pasture (Pringle 1987).	**Known from Project site.** Refer Section 16.13.10.2	
Whimbrel *Numenius phaeopus*	M	Occurs on coastal mudflats, coral cays, estuaries, sewage ponds and sometimes flooded grasslands or paddocks. Roosts in mangroves (Pizzey and Knight 2012).	**Known.** Recorded foraging on mudflats adjacent to the Styx River approximately 14 km north of the Project area in February 2012.	**Known.** Recorded regularly at roost sites in western Broad Sound in recent years (refer Appendix A9h).
Grey Plover *Pluvialis squatorola* Terek Sandpiper *Xenus cinereus* Grey-tailed Tattler *Tringa brevipes*	M	Shorebird species that occur on intertidal habitats in sheltered coastal areas. Prefer areas of extensive tidal flats. Gregarious with other species at roost sites. Terek Sandpiper known to sometimes roost in mangroves (Menkhorst et al. 2017).	**Potential.** Sandy substrate in the Styx River downstream of the rail bridge is less suitable for these species. Grey Plover and Grey-tailed Tattler generally prefer coastal habitat. Terek Sandpiper may occur along estuaries. Habitat around Rosewood Island is likely to be more suitable.	**Known.** Recent survey records show all three species irregularly occur at roost sites in western Broad Sound and generally in low numbers (Appendix A9h).
Sharp-tailed Sandpiper *Calidris acuminata*	M	These species are generally found on wetland habitat along the coast including tidal flats, salt pans and sewage ponds. They also occur on nearby coastal freshwater / brackish wetlands, saltmarsh and less commonly on inland wetlands (Pizzey and Knight 2012).	**Likely.** Sandy substrate in the Styx River downstream of the rail bridge is less suitable for these species. However, extensive tracts of saltmarsh and brackish wetlands associated with the river will provide good foraging habitat for these species.	Known. Recorded irregularly at roost sites in western Broad Sound in recent years (refer Appendix A9h). Recorded in 'nationally important' numbers on at least one occasion (Table 16-108).
Common Greenshank *Tringa nebularia*				**Known.** Recorded irregularly at roost sites in western Broad Sound in recent years (refer Appendix A9h).
Red-necked Stint *Calidris ruficollis*				Known. Recorded regularly at roost sites in western Broad Sound in recent years (refer Appendix A9h). Recorded in 'nationally important' numbers on at least one occasion (Table 16-108).
Marsh Sandpiper *Tringa stagnatilis*				**Likely.** No records from recent surveys but likely to occur at times.
Gull-billed Tern *Gelochelidon nilotica*	M	Generally coastal habitats but may occur well inland. As well as wetlands can be found on grasslands, crops and ploughed fields where it forages for insects.	**Likely.** Species may forage along the Styx River.	**Known**. Recorded regularly at roost sites, sometimes in large numbers, in western Broad Sound in recent years (refer Appendix A9h).

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence	
			Styx River estuary	Wider Broad Sound area
Caspian Tern *Hydroprogne caspia*	M	Mostly coastal habitats but also large inland terrestrial wetlands including lakes, reservoirs and large rivers (Higgins and Davies 1996).	**Likely.** Species may forage along the Styx River. Recorded during Project surveys in February 2012. Location unknown but likely to be along Styx River.	**Known**. Recorded regularly in low numbers at roost sites in western Broad Sound in recent years (refer Appendix A9h).
Crested Tern *Thalasseus bergii*	M	Largely coastal species that may also occur on tidal rivers and larger (Pizzey and Knight 2012).	**Likely.** Species may forage along the Styx River.	**Known.** Recorded on a single occasion at a roost site in western Broad Sound in 2008 (refer Appendix A9h).
Little Tern *Sternula albifrons*	M	Coastal species that also occurs on shallow coastal areas and sometimes adjacent waterbodies such as brackish lakes, salt fields and sewage ponds (Menkhorst et al. 2017).	**Unlikely.** Habitat along the Styx River is generally unsuitable for this species. Recorded during Project surveys in September 2011. Location unknown but likely to be along Styx River.	**Potential.** Several database records located on Turtle Island in Broad Sound area. Suitable habitat may be present for this species but no records of the species during recent surveys.

16.13.6.4 Threatened / Migratory Shorebird Species Known or Likely to Occur

The following section provides brief descriptions of the habitat preferences for the migratory shorebird species considered likely or known to occur downstream of the Project area. Migratory routes for the species are described in the text.

Greater Sand Plover (Critically Endangered, Migratory)

Greater Sand Plovers prefer sandy substrates inhabiting beaches and dunes, tidal flats, sandy spits, reefs, saltmarsh and sometimes paddocks, predominantly along the coastal zone (Marchant and Higgins 1993; Pizzey and Knight 2012). They are gregarious feeders (often in large flocks) on tidal flats, predominantly foraging for molluscs, crustaceans, worms and insects (Marchant and Higgins 1993). It occurs patchily along much of the Australian coastline with larger numbers found at northern sites. Greater Sand Plover roosts on beaches at high tides, usually with other wader species. The species is more tolerant of hot dry sand than other waders (Menkhorst et al. 2017).

The species breeds from Turkey to southern Siberia. Individuals that visit Australia generally take a more westerly route than other waders with most recorded on passage at south-east Asian sites including the Philippines, Malaysia, and Indonesia (DotEE 2018). It is an early migrant with large numbers appearing in northern Australia throughout August. Return migrations start in early March (Menkhorst et al. 2017).

Lesser Sand Plover (Vulnerable, Migratory)

Lesser Sand Plover occurs in similar habitats to Greater Sand Plover but can tolerate muddier substrates (Menkhorst et al. 2017). They feed predominantly on molluscs, crustaceans, worms and insects (Marchant and Higgins 1993). Like the above species it occurs patchily along much of the Australian coastline although it is more common along the eastern Australian coastline. Lesser Sand Plover also roosts in similar habitats as Greater Sand Plover and often flocks with that species (Menkhorst et al. 2017).

The species breeds in central and north-east Siberia (Menkhorst et al. 2017). The bulk of Australian migrants travel through the Sea of Okhotsk (between the Kamchatka Peninsula and the east coast of Russia) and through coastal China in July and September, then occurring in Indonesia in August to November. This species begins appearing in northern Australia from August / September. Maximum numbers occur at sites around December. Southern individuals begin moving to northern Australian sites around February with return migrations generally occur from April / May (DotEE 2018).

Grey Plover (Migratory)

Largest coastal plover species that generally occurs as solitary individuals or small flocks. Tends to dissociate from other waders during foraging (Pizzey and Knight 2012). Large numbers may occur at some communal roost sites where the species join other large wader species (Menkhorst et al. 2017). The species is exclusively coastal preferring sheltered embayments with large tidal flats. As with the other plover species they forage predominantly on molluscs, crustaceans, polychaete worms and insects (Marchant and Higgins 1993). They occur along much of the Australian coast with larger numbers occurring along the south and west coasts, particularly at sites in South Australia (DotEE 2018).

The species breeds in northern Siberia (Menkhorst et al. 2017). The bulk of Australian migrants leave from mid-August to mid-September travelling across a wide front through the Sea of Okhotsk and then sites in south-east Asia including Mongolia, Korea, Philippines and Japan. Individuals have been recorded in Indonesia in September and October (DotEE 2018). This species begins appearing in northern Australia from August to early September. Many individuals then move to southern Australia in October, often over land rather than along the coast. Birds may start to return north from March to May. It appears many birds overwinter in Australia, particularly first year sub-adults (DotEE 2018).

Bar-tailed Godwit (baueri) (Vulnerable, Migratory)

Large bulky wader with long slightly upturned bill that occurs, usually in large numbers (sometimes 1,000s), on extensive tidal flats. Smaller groups, often of younger birds, may be found at other coastal habitats. May use inland habitat during migration. Forages in shallow water along the tide edge. Roosts at wet sites (sand or mud) in association with other species including knots. May occur around the entire coast of Australia where suitable habitat occurs (Menkhorst et al. 2017).

Bar-tailed Godwit (bauera) breeds in north-east Siberia and north-west Alaska. Birds migrating from Siberia move through the Yellow Sea. Alaskan birds migrate through south-west Alaska and then fly directly to the non-breeding grounds, (some without stopping) in New Zealand before moving to Australia. Birds leave for the northern breeding grounds by April. Many immature birds overwinter in Australia for their first two or three years (TSSC 2016).

Eastern Curlew (Critically Endangered, Migratory)

Eastern Curlew is the largest shorebird species and has a distinctive long curved bill. It occurs on sheltered coasts, especially estuaries, harbours and coastal lagoons, and are often recorded in saltmarsh and on mudflats within mangroves. They mainly forage on intertidal mudflats and sandflats and occasionally ocean beaches, and roost on sandy spits and islets, in mangroves and saltmarsh, and along high water mark on beaches (Higgins and Davies 1996). The species is usually located while feeding individually or in small groups. Eastern Curlew tends to forage for larger prey such as crabs and ghost shrimp (Menkhorst et al. 2017). However, large numbers may congregate at high tide roosts (Lane 1987) located in open settings such as saltmarsh flats and beaches. Wary species which can be disturbed easily compared to other waders (Menkhorst et al. 2017). Within Australia the species occur in suitable habitat on all coasts (Higgins and Davies 1996).

The Eastern Curlew breeds in eastern Siberia during the northern hemisphere summer. Adults vacate breeding areas around June and migrate through Asia on their way to Australia and New Zealand. They arrive in north-eastern Australia as early as late July, but most arrive in eastern Australia by late August and September. By October, birds have moved as far south as Victoria and Tasmania (Ueta et al. 2002). Birds begin to depart to return to breeding grounds around March and April (Lane 1987). Sub-adults do not migrate north until 2-4 years old so a substantial percentage of the population remains in Australia during winter (Menkhorst et al. 2017).

Whimbrel (Migratory)

Whimbrel is similar to the previous species (being in the same genus – *Numenius*) but smaller and with a much shorter bill. The species is almost exclusively coastal preferring areas of extensive tidal flats with mangroves. Solitary and quite territorial when foraging unlike other waders. At high tide may roost in flocks with other waders (often Eastern Curlew) but is also well known to roost in mangroves or other prominent locations. Widespread along coastal Australia but more common in north where preferred habitat occurs (Menkhorst et al 2017).

Whimbrel breeds at widespread locations in the Arctic and sub-Arctic northern hemisphere. Australian individuals largely originate from eastern Siberia. Breeding grounds are left in July, with migrations through south-east Asia including Korea, Japan, China and the Philippines. They arrive in northern and eastern Australia from August to October. Birds begin to depart to return to breeding grounds from February onwards with an influx of southern birds reaching Queensland in early March to April (DotEE 2017). Similar to Eastern Curlew sub-adults do not migrate north until 2-3 years and a substantial percentage of the population overwinters in Australia (Menkhorst et al. 2017).

Terek Sandpiper (Migratory)

Small to medium sized wader with distinctive upturned longish bill and orange legs. Terek Sandpiper occurs along the coast preferring to forage on exposed seagrass flats or tidal mudflats close to mangroves. It is very active when foraging, mainly for insects, molluscs and crustaceans. Roosts in large mixed flocks of shorebirds at normal roost sites but also utilises mangrove branches or exposed rocky areas (often with Grey-tailed Tattler) (Geering et al. 2008). The species may occur at scattered sites along the entire mainland coast but is much more common in the north and east.

Grey-tailed Tattler breeds along the shores of freshwater lakes and larger rivers from Siberia to north-east Europe (Geering et al. 2008). For those populations migrating to Australia the migration path is focused along the east coast of Asia. Populations occurring in the east and west of Australia appear to be from different populations (Fry 1990). They migrate through northern Asian sites from mid-July onwards arriving in eastern Australia in August to September with a second wave in recorded in November. Birds are recorded leaving the summer foraging grounds in March / April (Marchant & Higgins 1993).

Grey-tailed Tattler (Migratory)

Grey-tailed Tattler is an exclusively coastal wader species preferring areas with extensive tidal mudflats, and sometimes reefs or rock platforms. It feeds on insects, polychaete worms, molluscs, crustaceans and sometimes fish. Tends to forage in small flocks. Roosts in large mixed flocks of shorebirds at normal roost sites but also utilises mangrove branches or exposed rocky areas including artificial structures such as piers of breakwaters (Geering et al. 2008). The species occurs along the entire mainland coast but is more common in the north.

The species breeds in north-east Siberia along stony riverbeds. The species migration path is focused on the east coast of Asia although the south-west Pacific Ocean is also used. They are recorded moving through Korea and north-east China from July onwards, with some birds remaining at the northern breeding sites as late as October. They are commonly recorded in the Philippines and New Guinea during migration. They generally arrive in Australia by late August and leave around early to mid-April (Higgins & Davies 1996).

Common Greenshank (Migratory)

Tall, elegant wader species found in variety of wetlands from sheltered saline coastal waters to freshwater wetlands with associated extensive mudflats. They generally occur in wetlands on or close to the coast but they are also known to occur on inland wetlands (Menkhorst et al. 2017). It feeds on aquatic insects, molluscs and crustaceans and has been recorded catching larger prey such as fish, frogs, lizards and rodents (Higgins & Davies 1996). Generally solitary when feeding. Roosts in small flocks, often standing in shallow water and usually separate from or on the edge of other groups of waders (Geering et al. 2008). The species occurs along the entire mainland coast as well as inland sites.

Common Greenshank breeds in southern Siberia, migrating south across a wide front from as early as July. The species migrates both overland or along coasts and as such may be seen throughout Asia. At least 30% of the flyway population migrates through the Yellow Sea region. It may be seen in various place in south-east Asia from August to September. It arrives in Australia, largely in the west but also via the Torres Strait, from August onwards. From there birds filter to southern and eastern sites until around November. Birds depart for summer breeding grounds from March, but predominantly in April (DotEE 2018).

Marsh Sandpiper (Migratory)

The Marsh Sandpiper is found mainly in freshwater or brackish wetlands, including lakes, rivers, ponds and swamps, and occurs far inland such as parts of central Australia. They sometimes occur on tidal wetlands, particularly in the north during the incoming migration period. The species is generally solitary or occurs in small parties, sometimes with other species of wader. It feeds on aquatic insects, molluscs and crustaceans. Roosts in mixed flocks, especially Common Greenshank (Pringle 1987; Menkhorst et al. 2017). Occurs throughout coastal Australia extending inland in the east and north.

Marsh Sandpipers breed in temperate Eurasia and the majority of individuals spend the northern hemisphere winter in Africa. Breeding grounds are left from early July through to September, with migrations passing through much of south-east Asia. They arrive in northern Australia from September with birds arriving in the south as late as December. Birds begin to depart to return to breeding grounds from March / April onwards with temporary influxes of southern birds reaching east coast locations (DotEE 2018). Some birds overwinter from India east to Australia.

Great Knot (Critically Endangered, Migratory)

Great Knot is a robustly built medium sized wader coastal wader species that is restricted to areas with extensive tidal mudflats. It is a specialist feeder on bivalves often foraging along the tide edge. Tends to roost in large flocks, often with other shorebirds (particularly Red Knot and godwits) on open areas (such as beaches) with a damp substrate (Menkhorst et al. 2017). The species occurs sporadically along the entire Australian coast but is more common in the north.

The species breeds in alpine areas of north-east Siberia. The majority of the population migrates to Australia (Geering et al. 2008). The species migration path is focused along the east coast of Asia. They are commonly recorded moving through Korea in August and September and are recorded in small numbers in parts of China and Hong Kong. They arrive in northern Australia from late August where feeding occurs. Numbers at the northern sites decline in November to December as birds then fly to southern sites. Birds depart southern sites to return to breeding grounds from February to April onwards with temporary influxes of southern birds reaching east coast locations. Some birds overwinter in Australia particularly at sites in the north-west (DotEE 2018).

Red Knot (Endangered, Migratory)

Similar to but smaller than Great Knot. The species has similar ecological requirements but appears to prefer firmer (sandier) substrates for foraging. Again, it is a specialist feeder on bivalves often foraging along the tide edge. As noted above roosts with Great Knot and godwits. Will feed at roost sites if water is present . It occurs along the entire Australian coast and is more common in the south than the more numerous Great Knot (Geering et al. 2008; Menkhorst et al 2017).

Red Knot breeds in the polar deserts of the entire Arctic circle including Russia, North America and Greenland and various islands. Subspecies that migrate to Australia mostly breed in north-east Siberia and the New Siberian Islands. It is thought the species first gathers on the south-east Russian coast (from June to September) before flying direct to northern Australia, stopping off at various sites along the east Asian coast. They arrive in northern Australia by late August and early September with some individuals arriving as late as November. Most birds likely remain close to their arrival destination with some moving directly to southern sites. Birds leave for breeding grounds from March to April (DotEE 2018).

Red-necked Stint (Migratory)

Small common wader that is usually coastal but may also be found a long way inland. Abundant on extensive tidal flats but also occurs on beaches (particularly where wrack accumulates) and shallow brackish / freshwater wetlands with exposed mud or sand for foraging and without dense vegetation (Menkhorst et al. 2017). It forages for small invertebrate prey. Forms large flocks of 100s or sometimes 1000s and will roost in a variety of habitats including sheltered beaches, saltmarsh, spits, raised banks and sometimes on exposed reef / shoal areas (Higgins and Davies 1996). The species may be found around the entire coastline as well as inland. Approximately 80% of the world population is thought to migrate to Australia in the non-breeding season (DotEE 2018).

Red-necked Stint breeds on Arctic tundra from northern Siberia to west Alaska. Migration may occur in a 'stepped' manner with failed breeders leaving in June, females in mid-July, males in early August and juveniles in mid-August. Some birds may migrate overland and others migrate along the east Asian coast. Large numbers are recorded migrating through Korea, Japan and Taiwan from August to October. They arrive in northern Australia mostly from September onwards, although some arrive earlier. Birds may arrive in southern Australia not long after this (two weeks). Birds leave for the breeding grounds mostly in late March to April. Some birds in their first year overwinter in Australia (Higgins and Davies 1996).

Sharp-tailed Sandpiper (Migratory)

The Sharp-tailed Sandpiper is one of the more common sandpiper species to visit Australia. It occurs in a wide variety of habitats, both saline and freshwater, including reefs, estuaries, mangroves, beaches, marshes, lagoons, flooded pasture and sewage ponds. It often associates with other species of wader and feeds mainly on aquatic insects, polychaete worms, molluscs and crustaceans (Pringle 1987). May occur throughout Australia (including far inland) although many inland records are likely to be birds on the southward migration (DotEE 2018).

Sharp-tailed Sandpipers breed in arctic Siberia from June to August and spend the Northern Hemisphere winter in Indonesia, New Guinea, the western Pacific and Australia, with small numbers occurring in Europe and western North America (Pringle 1987). The majority of the population migrates to Australia. Breeding grounds are left from late June - early July through to September, with migrations passing through China, eastern Mongolia, Korea, Japan south through south-east Asia. They arrive in northern Australia from mid-August, with the majority of birds dispersing to the south-east of the country. Sharp-tailed Sandpiper is one of the first waders to leave Australia departing to return to breeding grounds by April (DotEE 2018).

Curlew Sandpiper (Critically Endangered, Migratory)

Curlew Sandpiper is a small wader with distinctive long downward curved bill. Largely occurs on extensive tidal flats but also uses freshwater and brackish wetlands. It is usually found in flocks and readily associates with other waders. Commonly forages in shallow water feeding on a variety of invertebrates and also seeds. Roosts on beaches, spits, banks, associated with coastal habitats or wetlands. May continue to feed at high tide (Geering et al. 2008). May be found around the entire Australian coastline as well as inland sites. Was formerly common but has declined sharply in recent decades (Menkhorst et al. 2017).

Breeds in Arctic Siberia. Birds leave for the southern hemisphere in a staged manner with males leaving in early July, followed by females (July to early August) and juveniles (August). Those migrating to Australia cross Russia reaching coastal Asia from August onwards across a broad front from China to India. They reach northern Australia in late August / early September, subsequently migrating further south (mostly to the south-east) and arriving in late August to September. The return migration begins in March and occurs across a wide front in Australia including overland. Younger birds may overwinter in Australia (Higgins and Davies 1996).

Caspian Tern (Migratory)

Large tern with distinctive red bill. Caspian Tern inhabits sheltered coastal embayments but also forages in open wetlands far inland, including lakes, dams and rivers, preferring wetlands with clear water over turbid or muddy waters (Higgins and Davies 1996). Caspian Tern is widely distributed at scattered sites across North America, Europe, Africa, Asia and Australasia. In Australia the species In Australia, widespread on coast and eastern interior. Mainly nests on offshore coastal islands as solitary pairs or small colonies. The species tends to be resident or partly dispersive within Australia (Menkhorst et al. 2017).

Gull-billed Tern (Migratory)

Large tern with thick black bill. Gull-billed Tern inhabits a range of areas including shallow coastal environments (such as beaches and mudflats) lakes, dams, salt lakes, sewage farms, floodwaters, , irrigated crops and sometimes grasslands. Rarely seen in offshore waters. The species is widespread in Australia although is more common in the north. Individuals tend to migrate to the north of the continent during the Australian winter. The species tends to be resident or partly dispersive within Australia. Usually nests in colonies located on high ground in large inland lakes / wetlands. (Menkhorst et al. 2017).

The Asian subspecies of Gull-billed Tern (*G. n. affinis*) is a regular visitor to coastal northern Australia (Menkhorst et al. 2017).

Crested Tern (Migratory)

Common large tern with variably yellow bill (dependent on location). Crested Tern generally inhabits coastal waters but also forages in offshore waters. It roosts on sandy beaches, rocky areas and man-made structures. It nests in colonies on sparsely vegetated sandy or rocky islands. The species occurs around the entire coast of Australia as well as being widespread in the Pacific and Indian Oceans (Menkhorst et al. 2017).

16.13.7 Field Results: Overview

The biological character of the Project area is representative of that of the surrounding region which remains largely cleared for cattle grazing in lower-lying lands with small areas of cropping. Remnant vegetation in the south and west of the MLs remain connected to a substantial tract of vegetation that also comprises Tooloombah Creek Conservation Park (1 km west of the western boundary). The topography is relatively flat across much of the MLs. Vegetation in the south is connected to higher altitude rocky tabletop that intersects the far south of the MLs.

The haul road crosses Deep and Barrack Creeks and then traverses a gradual rise to the TLF area. The soils in the Project area comprise a mix of dark clay soils mainly north of the Bruce Highway, and rocky or coarse volcanic soils in the south of the MLs. Much of the area immediately surrounding the Project area to the east and north has been impacted to some degree by cattle grazing activity (such as tree clearing or thinning).

Land cleared for cattle grazing dominates the MLs, haul road and TLF areas. The MLs has been substantially cleared with 78% of the Project area mapped as non-remnant vegetation. The land on which the haul road and TLF are proposed also comprise land currently used for cattle grazing with the only remnant vegetation associated with the haul road crossing point on Deep Creek and Barrack Creek.

The major remnant habitat type remaining within the mine ML is grassy woodlands dominated by Poplar Box (*Eucalyptus populnea*), Poplar Gum and / or Narrow-leaf Ironbark. These communities occur in the south and west of the MLs. Riparian corridors along the creek lines and adjacent forests feature a relatively closed canopy with Forest Red Gum as the dominant canopy species.

Vegetation mapping of the Central Queensland Coal mine area was carried out by Oberonia Botanical Services in 2011 and resulted in changes to the extent of several vegetation communities from the original certified DNRME mapping. The only vegetation community representing a TEC is a small portion of SEVT vegetation on the eastern boundary of the ML. Ground-truthing identified areas mapped as Brigalow (RE 11.4.9) were occupied by eucalypt woodland / open forest communities.

Ground-truthing surveys in February 2017 identified a single small patch (0.6 ha) of Brigalow is located within the eastern portion of the MLs. There are also narrow patches of SEVT associated with the riparian vegetation along Tooloombah Creek although these largely lie outside of the MLs. Table 16-112 provides a description of the (non-TEC) vegetation communities ground-truthed as present to provide context for the Project areas ecological values.

In general, weed species were abundant within the ML including several Weeds of National Significance (WONS) and weeds listed under the Queensland *Biosecurity Act 2014* (see Table 16-111) and particularly along Deep Creek and Tooloombah Creek. The ground layer of cleared areas within the northern section of the mine ML is dominated by the introduced Buffel Grass (*Cenchrus ciliaris*) where cracking clays occur. Bellyache Bush occurs patchily occurs along the margins of both creeks. Rubber Vine and Lantana is common along both creeks (sometimes forming dense infestations) and occurs along the minor drainage located within the ML to the north of the Bruce Highway. Lantana occurs in varying density throughout much of the remnant vegetation in the area, and in non-remnant areas located near creek lines. Olive Hymenachne (*Hymenachne amplexicaulis*) is a semi-aquatic species and was recorded in isolated waterholes in February 2017. The species was observed to have increased in extent substantially in January 2018, when the species was observed in several dams / wetlands.

Table 16-111 Declared weed species identified within Project area

Species name	Common name	Biosecurity Act category	Weeds of National Significance	2011 surveys	2017 surveys
Aristolochia elegans	Dutchman's Pipe	Category 3	No	X	
Bryophyllum delagoense	Mother-of millions	Category 3	No	X	X
Cryptostegia grandiflora	Rubber-vine	Category 3	Yes	X	X
Harrisia martinii	Harrisia Cactus	Category 3	No	X	
Hymenachne amplexicaulis	Olive Hymenachne	Category 3	Yes	X	X
Jatropha gossypifolia	Bellyache Bush	Category 3	Yes	X	X
Lantana camara	Lantana	Category 3	Yes	X	X
Opuntia stricta *Opuntia tomentosa*	Prickly Pear species	Category 3	Yes	X	X X
Parthenium hysterophorus	Parthenium	Category 3	Yes	X	X
Sporobolus fertilis	Giant Paramatta Grass	Category 3	No	X	

Table 16-112 Representative vegetation sampling descriptions (non-TEC)

RE 11.3.4	
Forest Red Gum (*Eucalyptus tereticornis*) woodland on alluvial plains	
VM Act status: Of Concern	**EP Act Biodiversity status: Of Concern**
Description of community onsite	**Site cover: ML700022 – 11.6 ha**
This community occurs in patches across the eastern portion of the ML where it is associated with the alluvial plains adjacent to Deep Creek. This community occurs on shallow black self-mulching clays. This vegetation community is characterised by a canopy of Forest Red Gum, Poplar Gum with Carbeen (*Corymbia tessellaris*). An understorey is often present and comprised of species such as Swamp Mahogany (*Lophostemon suaveolens*) and Red Ash. The lower shrub layer tends to be dominated by Lantana, although native species present include Coffee Bush (*Breynia oblongifolia*) and Boonaree (*Alectryon diversifolius*). The ground layer tends to be dense and dominated by grasses such as *Bothriochloa* spp., Kangaroo Grass (*Themeda triandra*) and Black Spear Grass (*Heteropogon contortus*). This community is in a variable condition with evidence of past tree clearing or thinning for cattle grazing purposes particularly in the southern portion of the ML. An understorey of Lantana is common throughout. No Endangered, Vulnerable and Near Threatened (EVNT) flora species were observed or expected.	
RE 11.3.25	
Forest Red Gum (*Eucalyptus tereticornis*) woodland fringing drainage lines	
VM Act status: Least Concern	**EP Act Biodiversity status: Of Concern**
Description of community onsite	**Site cover: ML80178 - 26.2 ha, ML700022 – 18.9**
Occurs along riparian areas of drainage lines. including a tributary of Deep Creek which crosses the ML north of the Bruce Highway. Restricted to the immediate bed and banks of watercourses this woodland community is dominated by Forest Red Gum and Weeping Tea Tree (*Melaleuca leucadendra*). Along Deep and Tooloombah Creeks a mid-dense lower tree and upper shrub layer is characterised by River She-oak (*Casuarina cunninghamiana*), Weeping Bottlebrush (*Melaleuca viminalis*) as well as White Cedar (*Melia azedarach*) and Red Ash. Tooloombah Creek and sections of Deep Creek feature a range of dry rainforest species along the banks. Lantana is a common and often dense understorey species. Within the ML the sub-canopy of this community includes Carbeen, Brigalow and Northern Swamp Mahogany (*L. grandiflorus*). The lower shrub layer includes *Hibiscus heterophyllus, Capparis loranthifolia,* Wilga (*Geijera parviflora*), Sandpaper Fig, Currant Bush and Lantana. Within the ML this habitat is restricted to a narrow strip in poor condition heavily impacted by past clearing of adjacent communities. Cattle are largely excluded from Deep and Tooloombah Creeks and this community is in good condition (although suffering extensive weed invasion). No EVNT flora species observed or expected.	 **Community along Barrack Creek**  **Community along drainage line in north of ML**

RE 11.3.27	
Freshwater wetlands	
VM Act status: Least Concern	**EP Act Biodiversity status: Of Concern**
Description of community onsite	**Site cover: ML80178 - 3.4 ha**
Occurs as four discrete patches, two small wetlands close to the Bruce Highway in the western portion of the ML, and two ephemeral wetlands located in depressions in the east of the ML. This community is characterised by open water with a variety of floating and aquatic emergent plants including sedges, lotus species, Swamp Lily and Water Snowflake. The wetland is surrounded by a narrow strip of Forest Red Gum. Olive Hymenachne Olive Hymenachne observed on at least one wetland and likely to be present ythroughout. Cattle disturbance observed. No EVNT flora species were observed or are expected.	 **Mapped VM Act wetland on west side of ML**  **Ephemeral wetland depression on east side of ML**
11.3.35	
***Eucalyptus platyphylla*, *Corymbia clarksoniana* woodland on alluvial plains**	
VM Act status: Least Concern	**EP Act Biodiversity status: Least Concern**
Description of community onsite	**Site cover: ML80178 - 28.7 ha**
Occurs on an upper alluvial terraces associated with Deep Creek to the north and south of the Bruce Highway. Dominated by Poplar Gum, *Corymbia clarksoniana* with scattered Carbeen. A sparse shrub layer includes Red Ash, Turkey Bush (*Grewia retusifolia*), Coffee Bush and *Acacia salicina.* Lantana is sparsely present as an understorey species. A relatively dense ground layer includes native grass species including *Cymbopogon refractus*, *Eriachne glabrata*, *Leptochloa decipiens.* This community is heavily impacted by cattle grazing. No EVNT flora species observed.	

<table>
<tr><td colspan="2">RE 11.4.2</td></tr>
<tr><td colspan="2">Eucalyptus spp. and/or Corymbia spp. grassy or shrubby woodland on Cainozoic clay plains</td></tr>
<tr><td>VM Act status: Of Concern</td><td>EP Act Biodiversity status: Of Concern</td></tr>
<tr><td>Description of community onsite</td><td>Site cover: ML80178 - 206.9 ha, ML700022 – 40.4 ha</td></tr>
<tr><td>Dominant remnant community remaining on the plains within the ML, mainly north of the Bruce Highway but also occurs in the south on the lower slopes of the hills.

Dominated by Polar Box and Narrow-leaved Ironbark as well as Poplar Gum, Pink Bloodwood (Corymbia intermedia) and Carbeen. The relatively open canopy of this community is evident over the sparse shrub layer and grassy understorey. Shrub species include Currant Bush, Wilga, Boonaree and Turkey Bush (Grewia retusifolia). Where it borders regrowing Brigalow communities species such as Brigalow and Belah (Casuarina cristata) occur. Ground layer tends to be characterised by grasses such Kangaroo grass, Black Spear Grass, Eragrostis spp. and Bothriochloa spp.

No EVNT flora species were observed and none are expected.</td><td></td></tr>
<tr><td colspan="2">RE 11.3.12</td></tr>
<tr><td colspan="2">Melaleuca viridiflora woodland on alluvial plains</td></tr>
<tr><td>VM Act status: Least Concern</td><td>EP Act Biodiversity status: No Concern at Present</td></tr>
<tr><td>Description of community onsite</td><td>Site cover: ML80178 - 4.16 ha</td></tr>
<tr><td>Occurs as an isolated area in a natural depression in the western portion of the site north of Mt Bison Road. Water present during 2011 surveys. No water present in February 2017 (depicted) but filled in April 2017.

This community is characterised by a central patch of Broad-leaved Paperbark with a variety of sedges and a sparse cover of hydrophytes (including Ottelia ovalifolia) present in 2011 and 2018. Dry margins of wetland with sparse to dense cover of low sedges and forbs. Surrounded by mixed eucalypt woodland (RE11.4.2 and 11.5.8a).

Impacted by cattle grazing. Cattle observed to be present in community throughout 2017 and 2018 surveys. Feral Pigs also observed to be present. No EVNT flora species were observed or are expected.</td><td></td></tr>
</table>

RE 11.5.8a	
***Eucalyptus platyphylla*, *Corymbia intermedia* woodland on Cainozoic sand plains / remnant surfaces**	
VM Act status: Least Concern	**EP Act Biodiversity status: No Concern at Present**
Description of community onsite	**Site cover: ML80178 - 33.4 ha**
This community occurs as extensive remnants along the western boundary of the ML (south of the Bruce Highway) on colluvial and residual deposits. Characterised by emergent eucalypts such as Pink Bloodwood and Queensland Peppermint, as well as Poplar Gum and Ghost Gum. The sparse to mid-dense lower tree layer is a mix of co-dominant species including: Red Ash, Quinine Bush (*Petalostigma pubescens*) and a variety of *Acacia* spp. Shrubs include *Canthium buxifolium*, Orange Box Thorn (*Denhamia celastroides*) and scattered Lantana. Species common in the ground layer include Black Spear Grass, *Aristida* spp., *Bothriochloa* spp. and Kangaroo grass. Cattle present in this habitat during February 2017 survey. Some limited impacts from tree thinning evident. No EVNT flora species were observed or expected.	

RE 11.10.3	
***Acacia shirleyi* open forest on coarse-grained sedimentary rocks - crests and scarps**	
VM Act status: Least Concern	**EP Act Biodiversity status: No Concern at Present**
Description of community onsite	**Site cover: ML80178 - 36.6 ha**
Restricted to rocky elevated habitat in the southeast corner of the ML. The mid-dense canopy layer is dominated by Lancewood (*Acacia shirleyi*) with emergent Pink Bloodwood. There is a lower tree layer including Quinine Bush, *Canthium buxifolium* and *Melaleuca nervosa.* Lower shrub and ground layers are often sparse on the rocky substrate. Shrubs include Medicine Bush (*Pogonolobus reticulatus*) and Bitterbark (*Alstonia constricta*). Grasses present include perennial species such as Wiry Panic (*Entolasia stricta*), *Eragrostis elongatus* and *Bothriochloa pertusa*. This community is in good condition and is likely less attractive to cattle for browsing, impacts due to grazing are limited. No EVNT flora species were observed. May provide habitat for *Cycas ophiolitica* (EPBC Act and NC Act – Endangered) and *Lissanthe brevistyla* (NC Act – Vulnerable).	

<table>
<tr><td colspan="2">RE 11.10.7</td></tr>
<tr><td colspan="2">Eucalyptus crebra woodland on coarse-grained sedimentary rocks</td></tr>
<tr><td>VM Act status: Least Concern</td><td>EP Act Biodiversity status: No Concern at Present</td></tr>
<tr><td>Description of community onsite</td><td>Site cover: ML80178 - 76.4 ha</td></tr>
<tr><td>Restricted to lower slopes of elevated habitat in the southeast of the ML.

The canopy is dominated by Poplar Gum and Clarkson's Bloodwood (Corymbia clarksonia). A shrub layer ranges from mid-dense to sparse and is characterised by the presence of Red Ash, Quinine Bush, Acacia longispicata and Red Kamala (Mallotus philippensis). Lantana is dominant in the lower shrub layer and often in high density.

This community has been variably impacted by cattle grazing with some evidence of previous tree clearing (few mature trees present).

No EVNT flora species were observed and none are expected.</td><td></td></tr>
<tr><td colspan="2">RE 11.11.1</td></tr>
<tr><td colspan="2">Eucalyptus crebra +/- Acacia rhodoxylon woodland on old sedimentary rocks</td></tr>
<tr><td>VM Act status: Least Concern</td><td>EP Act Biodiversity status: No Concern at Present</td></tr>
<tr><td>Description of community onsite</td><td>Site cover: ML 700022 – 5.1 ha</td></tr>
<tr><td colspan="2">This community occurs along the western boundary of the haul road/TLF ML as derived from vegetation mapping carried out in 2011 and 2012.

The ecologically dominant layer is characterised by Narrow-leaved Ironbark and/or Silver-leaved Ironbark (E. melanophloia) over a well-developed understorey of Rosewood (Acacia rhodoxylon). A shrub layer is often present and may include Hibiscus divaricatus, Erythroxylon sp., Yellow-berry Bush (Maytenus cunninghamii), and Currant Bush. The ground layer is typically dense and characterised by various grass species.

No EVNT flora species are expected.</td></tr>
<tr><td colspan="2">RE 11.11.15a</td></tr>
<tr><td colspan="2">Eucalyptus crebra woodland on deformed and metamorphosed sediments and interbedded volcanics</td></tr>
<tr><td>VM Act status: Least Concern</td><td>EP Act Biodiversity status: No Concern at Present</td></tr>
<tr><td>Description of community onsite</td><td>Site cover: ML80178 - 88.3 ha, ML 700022 – 10.7 ha</td></tr>
<tr><td>This community occurs along the western boundary of the haul road/TLF ML as derived from vegetation mapping carried out in 2011 and 2012.

This woodland community is dominated by a mixture of Poplar Gum and Narrow-leaved Ironbark with a range of less dominant eucalypts including Carbeen and Ghost Gum. The lower tree and shrub layers tend to be sparse including Red Ash, Broad-leaved Paperbark, Beefwood (Grevillea striata) and Quinine Bush. Lantana is also present in scattered and sparse patches. Ground cover comprises a mix of native grass species including Black Spear Grass, Bothriochloa spp., Kangaroo Grass and Panicum spp.

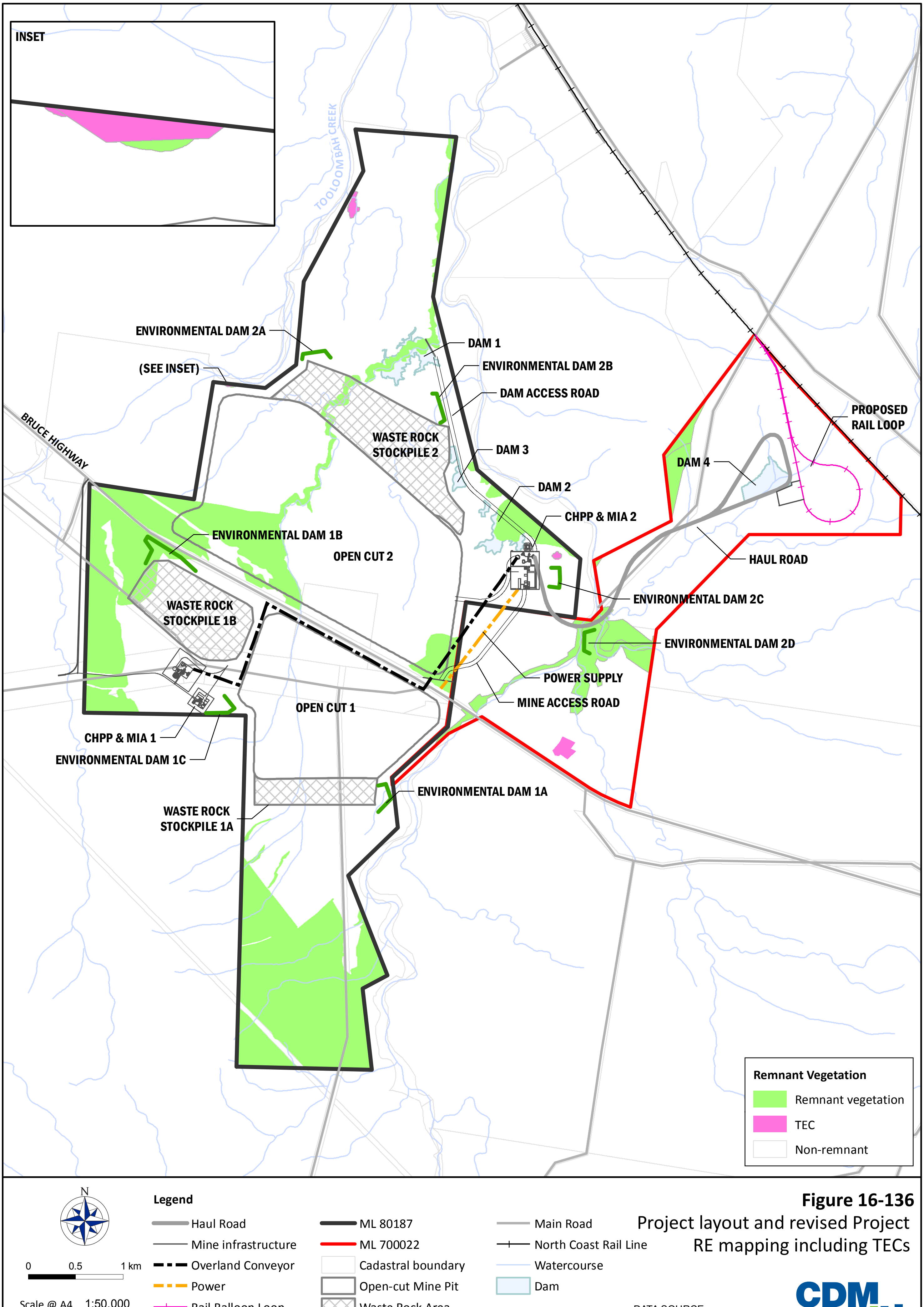
No EVNT flora species are expected.</td><td></td></tr>
</table>

16.13.8 Field Results: Threatened Ecological Communities

Field surveys confirmed that two EPBC-listed TECs are associated with two REs occurring within the Project area. Current DNRME vegetation mapping is not always accurate in predicting the appropriate RE on the ground, including TECs. Field inspections indicated the current mapping of the extent of the Brigalow TEC (RE 11.4.9) is inaccurate with only a small patch extant outside of the currently mapped area. Proposed revised mapping of REs (including TECs) within the transport corridor is shown on Figure 16-136. A summary of the TECs located in the Project area is provided in Table 16-113. A detailed discussion of the presence / likelihood of TECs within the Project area is then provided.

Table 16-113 TEC vegetation communities located within Project area

RE 11.3.11	
Semi-evergreen vine thicket on alluvial plains	
VM Act status: Endangered	**EP Act Biodiversity status: Endangered**
Description of community onsite	**Site cover: ML80178 - 2.2 ha**
This community occurs as two patches on the edge of the western boundary of the ML (north of the highway) and is associated with alluvial terraces along Tooloombah Creek where several patches occur in the localised area (within 200 m of the ML boundary) (refer Figure 16-136). This vegetation community is characterised by a relatively low canopy (7 – 10 m) comprising a variety of species including Python Tree (*Gossia bidwillii*), Red Kamala, Peanut Tree (*Sterculia quadrifida*), White Cedar, Tuckeroo (*Cupaniopsis anacardioides*) among other taxa. Forest Red Gum and Carbeen occur as occasional emergents. A varied understorey with abundant vines is present and comprised of species such as Chain Fruit (*Alyxia ruscifolia*), Queensland Ebony (*Diospyros geminata*), Sandpaper Fig, Broad-leaved Cherry (*Exocarpos latifolius*), and Velvet Mock-orange (*Notelaea microcarpa*) and Currant Bush. This community is in a reasonable condition given evidence of past tree clearing for cattle grazing purposes. Rubber Vine is commonly present on the edge of this community. No EVNT flora species were observed or expected.	
RE 11.4.9	
Brigalow (*Acacia harpophylla*) shrubby woodland on Cainozoic clay plains	
VM Act status: Endangered	**EP Act Biodiversity status: Endangered**
Description of community onsite	**Site cover: ML80178 - 0.54 ha, ML 700022 – 3.37 ha**
This community occurs as an isolated remnant patch within the eastern portion of the ML. Much of the ML north of the Bruce Highway comprises dark cracking clays with extensive low regrowth of this community. A larger patch is located to the east of Deep Creek in the southern portion of the TLF ML (refer Figure 16-136). This community is characterised by an open forest canopy of Brigalow with occasional Poplar Box. Upper and lower shrub layers are mid-dense comprising False Sandalwood (*Eremophila mitchellii*), Currant Bush, Boonaree and Queensland Ebony (*Disospyros humilis*). The ground layer tends to be dominated by introduced pasture grasses. This community is heavily impacted by cattle grazing. No EVNT flora species observed.	



Scale @ A4 1:50,000
Date: 21/11/18
Drawn: Gayle B.

Figure 16-136
Project layout and revised Project RE mapping including TECs

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018

CDM Smith

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 General Arrangement and field RE__16-39.mxd 11/21/2018

16.13.8.1 Brigalow (*Acacia harpophylla* dominant and codominant)

Brigalow communities are listed as endangered under the EPBC Act. In the past, this community has been subject to extensive vegetation clearing for agriculture and grazing activities. This has reduced much of the former extent of this community to isolated, small fragments. Vegetation communities potentially containing Brigalow TECs within and around the Project area are mapped as: RE 11.4.9 – Brigalow shrubby woodland on Cainozoic plains.

The site survey in February 2017 indicated 0.54 ha of this community occurs in a single patch of remnant vegetation within the mine area (ML 80187). The flora surveys carried out in 2011 indicate the presence of a 3.37 ha patch of Brigalow (RE 11.4.9) within ML 700022, located adjacent to the north of the Bruce Highway and to the east of Deep Creek.

The criteria specify that a Brigalow ecological community can be excluded from the list of Brigalow communities if it meets any one of the following three criteria:

- Vegetation has been comprehensively cleared (not thinned) within the past 15 years;
- Exotic perennial plants have more than 50% cover; assessed in a minimum area of 0.5 ha (100 m by 50 m); and
- Individual patches of Brigalow are smaller than 0.5 ha.

Observational data obtained from the 2017 and 2018 field assessments indicate that the area containing Brigalow RE within the Project area shows obvious signs of cattle disturbance but is generally in good condition and is confirmed as meeting the threshold conditions for a Brigalow TEC. The extent of this RE across the Project area includes at 0.54 ha within ML80187, and 3.37 ha within ML700022. Isolated patches also occur outside the Project MLs, particularly to the northeast (Figure 16-136).

Brigalow Regrowth

Further requests have been made by DotEE since submission of the EIS for information regarding areas containing regrowth Brigalow located within ML 80187. An assessment of the community was carried out using the criteria outlined in Butler (2007), historical aerial imagery, site observations (January 2017) and advice from the previous landowner.

Regrowth Brigalow does not occur in the cleared habitat to the south of the Bruce Highway where remaining vegetation is restricted to scattered individuals of Poplar Box (*E. populnea*). High resolution aerial imagery of the site from 2004 (Figure 16-137) was obtained from DNRME and compared to the latest site imagery available online (Figure 16-138). The 2004 imagery shows two areas where regrowth Brigalow occurred in relatively continuous patches as identified in Figure 16-137. The remainder of the property was cleared and devoid of vegetation excepting scattered trees. Later imagery (2012 and 2016) of these areas shows these areas as having been heavily impacted sometime after the 2004 imagery (Table 16-114).

These sites were inspected in January 2018. Brigalow was found to be the dominant canopy tree in these areas. For the most part the Brigalow present was between 3 m to 5 m in height (Plate 16-12) indicating a relatively young age given the seasonal coastal rainfall available in this area. Communications were established with the former landowner who owned the property until 2006. He informed CDM Smith that these areas had been 'pulled' (i.e. cleared using a heavy chain dragged between two bulldozers) as was most of the country on that side of the highway to 'tidy up' the property prior to selling in 2006 (pers. comm. John McCartney, February 2018). As such, these areas, as well as the remainder of the property to the north of the highway have been comprehensively cleared within the past 15 years and do not fit the criteria for inclusion as the Brigalow TEC.

Plate 16-12 Brigalow regrowth in west area (January 2018)

16.13.8.2 Broad Leaf Tea-tree (*Melaleuca viridiflora*) Woodlands in High Rainfall Coastal North Queensland

Broad Leaf Tea-tree woodlands in high rainfall coastal north Queensland are listed as endangered under the EPBC Act. This community is characterised by a dominant canopy of Broad Leaf Tea-tree restricted to the Wet Tropics and Central Mackay Coast bioregions in Queensland.

There are no corresponding vegetation communities recorded in the Project area which is also located outside the range of this community.

16.13.8.3 Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregion

The Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions are listed as endangered under the EPBC Act. This ecological community is characterised by grassy woodlands with a dominant canopy of Coolibah (*E. coolabah*) and / or Black Box (*E. largiflorens*). This is a floodplain ecological community located within the upper reaches of the Murray-Darling Basin and the southern Fitzroy basin. The Project area is located outside of this range.

No vegetation communities corresponding to this TEC were recorded onsite during ground-truthing surveys.

N

0 0.5 1 km

Legend

ML 80187

North Coast Rail Line

Main road

Figure 16-137

Aerial imagery of northern section of Project area

June 2004

Scale @ A4 1:35,000

Date: 01/02/18

Drawn: Parnwell J.

DATA SOURCE
QLD Spatial Catalogue (QSpatial), 2017

CDM Smith

PARNWELLJA \\brbsvr1\PRO\Project\BES150160.03-Styx Coal Project 5 mtpa EIS Preparation\CADD GIS\GIS\DATA\MXD\Chapter 16\BES150160.03-018 R1 Brigalow_Tif.mxd 1/02/2018

N

0 0.5 1 km

Legend

ML 80187

North Coast Rail Line

Main road

Scale @ A4 1:35,000
Date: 01/02/18
Drawn: Parnwell J.

Figure 16-138

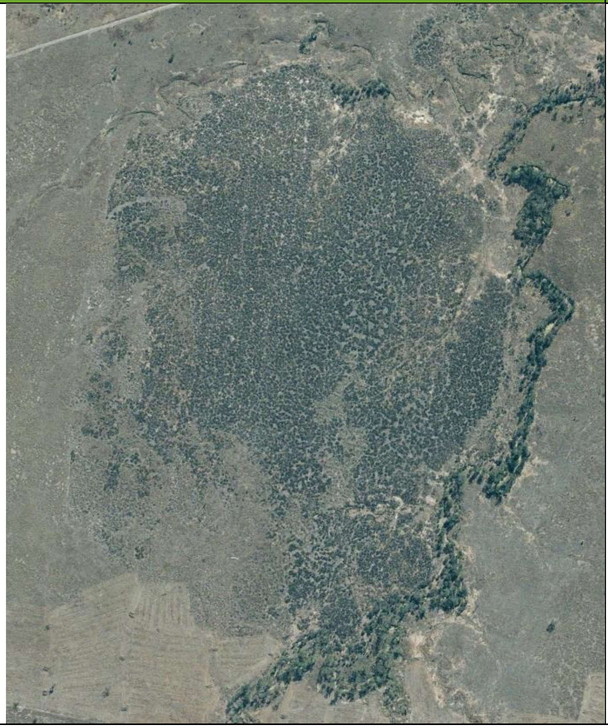
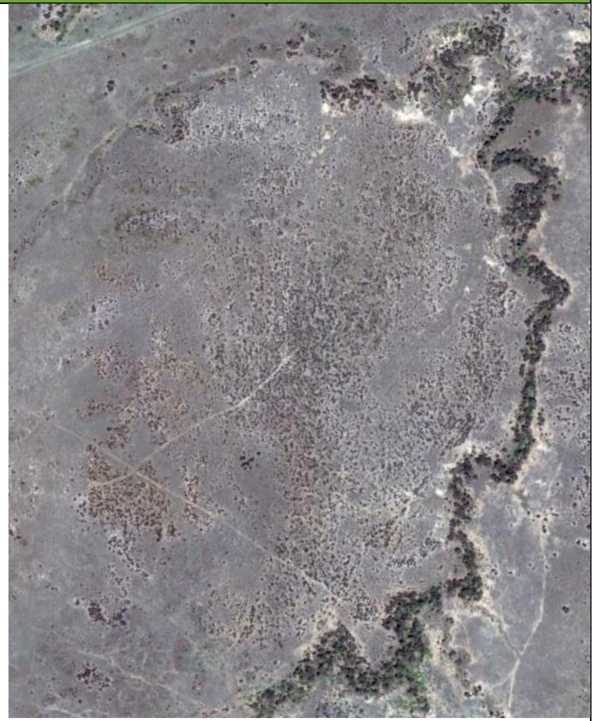
Aerial imagery of northern section of Project area
March 2016

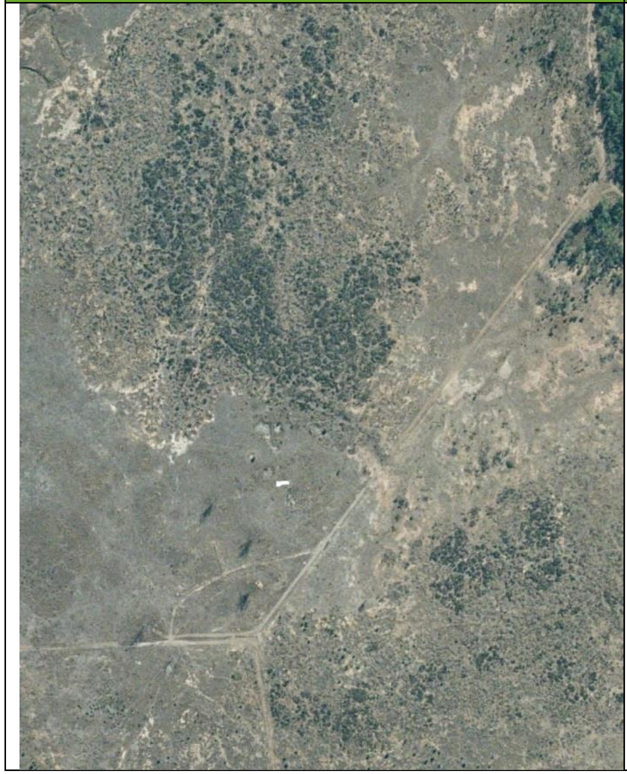
DATA SOURCE
QLD Spatial Catalogue (QSpatial), 2017

CDM Smith

PARNWELLJA \\brbsvr1\PRO\Project\BES150160.03-Styx Coal Project 5 mtpa EIS Preparation\CADD GIS\GIS\DATA\MXD\Chapter 16\BES150160.03-018 R1 Brigalow_noTif.mxd 1/02/2018

Table 16-114 Brigalow regrowth areas - comparative aerial imagery

Aerial photograph regrowth – west area June 2004	Aerial photograph regrowth – west area October 2012	Aerial photograph regrowth – west area March 2016
		

Aerial photograph regrowth – west area June 2004	Aerial photograph regrowth – west area October 2012	Aerial photograph regrowth – west area March 2016
		

16.13.8.4 Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy Basin

Natural Grasslands of the Queensland central highlands and the northern Fitzroy Basin (referred to as 'Natural Grassland' below) are listed as endangered under the EPBC Act. Recognised threats for this community include degradation from agricultural activities, clearing for mining and infrastructure and introduced pests and weeds. The potential for this TEC to occur within the Project area was considered in consultation with the Commonwealth listing advice for this TEC (TSSC 2008a).

In tropical areas 'Natural Grasslands' feature 'indicator' grasses including *Dichanthium* and *Aristida* species. The grasslands in the Project area are the result of previous clearing activities and are dominated by introduced species.

There are no areas of this TEC within the Project area.

16.13.8.5 Semi-evergreen vine thicket of the Brigalow Belt (North and South) and Nandewar Bioregions

Semi-evergreen vine thicket of the Brigalow Belt (north and south) and Nandewar Bioregions are listed as endangered under the EPBC Act. Current threats include a high level of fragmentation of remaining SEVT, inappropriate fire regimes, introduced weeds and cattle grazing. Vegetation communities potentially containing SEVT TECs within and around the Project area are mapped as RE 11.3.11 – SEVT and semi-deciduous notophyll rainforest on Cainozoic alluvial plains.

There are no criteria for excluding patches of this community from being considered a TEC as long as the requirements defined within the VM Act are met for a vegetation patch to be classed as remnant vegetation in Queensland. Current mapping does not indicate the presence of SEVT in the Project area or local surrounds. Site surveys indicates the edge of a 2.9 ha patch of SEVT adjacent to Tooloombah Creek is intersected by the ML boundary, with 0.4 ha lying within the mine ML. Four more patches of this TEC covering approximately 19 ha in total, occur along the creek, although outside of the ML (see Figure 16-136).

During on-site activities in September 2017 a minor discrepancy was identified in the vegetation mapping within ML 80187 as described in the EIS. A small patch of vegetation covering approximately 2.5 ha in the north of the ML associated with an incised gully line (Plate 16-13; Figure 16-136) was previously described as Forest Red Gum open forest (RE11.3.25) due to its connection to riparian vegetation associated with Tooloombah Creek. However, no specific flora survey plot had been conducted in or near this patch of vegetation at this time due to previous restrictions on site access. Site observations reveal a species composition and vegetation structure consistent with that of a SEVT community (RE11.3.11).

Plate 16-13 SEVT-lined gully (January 2018)

16.13.8.6 Summary of TEC Surveys

Detailed investigations undertaken as part of the flora and fauna surveys within the Project area identified 3.91 ha of potential Brigalow TEC associated with RE 11.4.9 in two patches within the MLs, and potential for 2.2 ha of SEVT TEC associated with 11.3.11 within ML80187. No other TECs were recorded within the Project area during field assessments.

16.13.9 Field Results: Threatened Terrestrial Species

16.13.9.1 Overview

Fifteen flora species and 29 fauna species listed under the EPBC Act have the potential to occur within the Project area and surrounds based on the results of the desktop EPBC Protected Matters Search Tool and database searches. Onsite surveys and habitat suitability assessments confirmed the presence of Squatter Pigeon, Greater Glider and Koala within the MLs (see Figure 16-142). Ornamental Snake is considered as being likely to occur. Threatened species that are known or likely to occur are referred to in more detail in the following sections. A further eight species are considered as having some potential to occur in the Project area based on available habitat (see Table 16-115).

16.13.9.2 Southern Snapping Turtle

In the EIS chapter Southern Snapping Turtle (*Elseya albagula*) (Critically Endangered under the EPBC Act) was listed as having been recorded close to site (refer Section 16.11.4.2 of Chapter 16 – MNES of the EIS). This was based on a recorded capture of the species in Deep Creek during aquatic ecology surveys in June 2011. This was despite the species not being known to occur in the Styx River catchment and the presence of unsuitable habitat (i.e. the species prefers flowing waters whereas the catchment streams are largely ephemeral).

CDM Smith requested the photo records of the captured individual (as noted in the report) from the original survey by ALS Water Resources Group. The photos were located and passed on to CDM Smith and an expert from DES with experience of freshwater turtle species (Dr. Col Limpus) for verification (refer Plate 16-14 and Plate 16-15). The photos depicted a juvenile Saw-shelled Turtle (*Wollumbinia latisternum*). As such, Southern Snapping Turtle is no longer considered as 'occurring' or 'likely to occur' in or near the Project area (refer Table 16-115) and therefore, no longer considered to be impacted by the Project's activities.

Plate 16-14 Saw-shelled turtle - plastron (ALS Water Sciences 2011)

Plate 16-15 Saw-shelled turtle (ALS Water Sciences 2011)

16.13.9.3 Red Goshawk

DotEE submitted a request for further discussion regarding the potential occurrence of Red Goshawk (*Erythrotriorchis radiatus*) in the Project area or surrounds. The following provides more discussion on the species requirements and known occurrence of the species in the wider area.

Ecological Requirements

The Red Goshawk occurs in a variety of woodland or forest types, most frequently in riverine forests. They generally do not occur in dense forests such as rainforest or wet sclerophyll forests. Red Goshawk prefer areas with a patchwork or mosaic of woodland / forest types and the presence of water considered to be an important factor (Debus and Czechura 1988). Red Goshawks found in the south of their range (such as the Project area) are largely known to occur in rugged terrain, although some individuals may spend the winter in adjacent coastal lowlands where suitable habitat occurs (DERM 2012).

This is a secretive and somewhat skulking raptor which primarily hunts larger forest birds, often dominated by parrot species (DotEE 2018). It often flies below the canopy. When not hunting it may perch under cover for extended periods. Soaring or higher flying behaviour appears uncommon but has been seen to occur in the late morning (Debus and Czechura 1988).

The Red Goshawk nests in large trees, frequently the tallest (emergent) in a stand, and mostly within 1 km of permanent water (Debus and Czechura 1988; Czechura et al. 2009). Limited studies have recorded that male Red Goshawks in the non-breeding season move up to 7 km from the nest site hunting within an estimated home range of up to 200 km^2. During the breeding season females were recorded moving up to 5 km in all directions from the nest site with an estimated home range of 120 km^2. Breeding pairs will use the same nesting area year after year, often using the same nest site (Aumann and Baker-Gabb 1991).

Species Occurrence in the Wider Area

The nearest known ALA record (1999) to the Project area is 17 km north-west of the Project area. Figure 16-139 depicts the known records from the wider area (post 1950 records only) surrounding the Project. There have been no records of the species in the wider area since 2001. *The new atlas of Australian birds* (Barrett et al. 2003) outlines bird records from systematic surveys carried out across Australia from 1998 to 2002. There is a single 'opportunistic' record located nearby to the north of the Project in the Saint Lawrence area (no exact location data provided) and only one other record in south-east Queensland that is south of Cape York Peninsula.

The E-Bird Australia website provides a central database for amateur and professional birders to submit bird species lists and records from Australia. The nearest records to the Project area are located 440 km south-east at Hervey Bay (2005 record). The closest records to the north are several records from the Mission Beach area (640 km north-west of the Project) (eBird 2018). This species is noteworthy and attracts the attention of birdwatchers who will travel large distances to see known individuals or nest sites. Despite this there are no known sites in central or south-east Queensland.

Survey Intensity

CDM Smith has undertaken bird surveys and nest searches throughout 2017 and January 2018 as part of targeted ecology surveys and in conjunction with water quality sampling along Deep Creek and Tooloombah Creek. The Commonwealth's *Survey guidelines for Australia's threatened birds* (DEWHA 2010a) recommends 80 hours of area searches over ten days to locate nest sites (including by use of vehicle). CDM Smith's overall survey effort is considered to have exceeded the guideline survey effort comprising the following:

- Timed bird surveys (20 min) comprising 115 surveys (approximately 38.5 hours) carried out over the Project area and surrounding areas including dams, wetland areas and creek lines;
- Opportunistic vehicle-based surveys undertaken throughout Project area and surrounds (up to a 10 km radius of the Project area). Based on two hours per day travelling between survey sites (fauna, flora and water quality sampling) over 30 days (approximately 60 hours in total); and
- Raptor nest searches were carried out in riparian and adjacent habitat in conjunction with, locations for habitat suitability assessments, water quality sampling along Deep Creek and Tooloombah Creek, and opportunistically during driving across the wider area throughout the surveys.

The species was not observed despite the overall survey effort. The only active raptor nest observed was that of a Brown Falcon (*Falco berigora*) located in open grazing lands north of the Bruce Highway. No raptor nest sites were observed in the vicinity of the major creek lines in the area.

Habitat Availability

The Project area is predominantly cleared. Suitable nesting habitat is likely to be restricted to Forest Red Gum communities (RE 11.3.25 and RE11.3.4) which comprises emergent tall eucalypts along, or adjacent to creek lines (refer Figure 16-140). However, much of this habitat, particularly north of the Bruce Highway which bisects the mine area, occurs as narrow lines of riparian vegetation surrounded by cleared habitat. Given the species prefers continuous forest it is considered unlikely the species would utilise these areas for nesting.

More suitable habitat occurs to the south of the mine area where foraging habitat, which may be considered as virtually all woodlands, and open forest containing forest birds in the area, is contiguous with riparian vegetation. The species has large home range requirements. The patchy nature of the remnant vegetation in the area immediately surrounding the Project (Figure 16-140) appears less suitable for the occurrence of the species compared to the continuous forests located in the ranges to the west.

Species Potential to Occur

Given the lack of any recent records of the species in the region, the lack of any record of the species in the area despite abundant survey effort for the Project over a substantial period of time, and the habitat availability associated with the Project, the species is considered as 'potentially occurring' as per the previous assessment in the MNES chapter of the EIS. Significant impact assessments have been restricted to species which are 'known' or 'likely to occur' and as such no assessment has been carried out.

16.13.9.4 Collared Delma

DotEE submitted a request for further discussion regarding the potential occurrence of Collared Delma (*Delma torquata*) in the Project area or surrounds. The following provides more discussion on the species requirements and known occurrence of the species in the wider area.

Ecological Requirements

The Collared Delma is a small, secretive legless lizard (Pygopodidae) that shelters in soil cracks, leaf litter and under rocks in open eucalypt forest with a shrub and tussock grass understorey. It is found at sporadic sites in south-east Queensland and surrounding sites in the Brigalow Belt. The habitats the species is found in are largely associated with rocky areas featuring exposed rocks or abundant surface rocks for cover. Nevertheless sites in the west of its distribution comprise River Red Gum or Brigalow with no obvious rocky habitat present (Wilson 2015). Sites in the eastern part of its range are associated with rock outcrops on ridges and slopes (Brigalow Belt Reptiles Workshop 2010).

The species is known to occur in the following land zones:

- Land zone 3 – alluvium (river and creek flats);
- Land zone 9 – undulating country on fine-grained sedimentary rocks; and
- Land zone 10 – sandstone ranges (Brigalow Belt Reptiles Workshop 2010).

Collared Delma is very secretive, is difficult to survey and its habits are little known. Essential habitat factors for the species presence appears to be abundant groundcover including rocks, logs, bark and / or a well-developed litter layer (Brigalow Belt Reptiles Workshop 2010). Surveys for the species provide a low return of observations (DotEE 2018). The species is known to be active by day and feeds on invertebrates. Small cockroaches appear to be a common prey item and individuals have been found within underground termite colonies (Davidson 1993; Porter 1998). Eggs are laid in December and hatch in February / March (Peck & Hobson 2007).

Species Occurrence in the Wider Area

The nearest known ALA database records to the Project area are 145 km to the south-east at Ulam (1974) (south of Rockhampton) and 130 km south-west from the Blackdown Tableland National Park (1997). Figure 16-139 depicts these records in relation to the Project area. There are no records to the west of the Project. Mapping of the species potential occurrence by ALA and on the DotEE SPRAT database indicates the Project area is on the northern edge of its potential range being mapped as 'species or species habitat may occur' (DotEE 2018).

Habitat Availability and Survey Intensity

There is suitable habitat for Collared Delma in the southern extent of the ML including two REs on land zone 10: RE 11.10.3 and 11.10.7 (Figure 16-141). Visual observations indicated extensive patches comprising loose surface rock and scattered outcrops occurring in this area. Surface rock does not occur extensively elsewhere on the site. The majority of the remainder of the Project area (Land zone 4) is either cleared of vegetation or does not have suitable habitat factors (i.e. lack of rock, woody debris or well developed leaf litter).

The species may be grazing-sensitive, as all Brigalow Belt records are from ungrazed or rarely grazed areas (DERM unpubl. Data in DSEWPaC 2011b). The Project area has been subject to cattle grazing throughout the ML throughout the period CDM Smith has been carrying out on-site activities through 2017 and 2018.

During the September 2011 fauna surveys, trap sites (including pitfall trapping and herpetofauna searches) were established at four sites in the Project area or nearby surrounds. One of these sites was located in habitat on land zone 10 adjacent to the southern portion of the mine ML (refer Figure 16-130). Trap sites established by CDM Smith in February 2018 also included pitfall / funnel trapping and herpetofauna searches. Again, one of these sites was located in the south of the Project area in remnant habitat on land zone 10 (refer Figure 16-130). The remainder of trap sites from both surveys were located in remnant habitat on land zone 5 and land zone 3.

Recommended survey methods under Commonwealth guidelines for the species comprises herpetofauna habitat searches and the use of tile grids (SEWPaC 2011a). Pitfall trapping has been found to provide limited results (SEWPaC 2011b). Trapping in south-east Queensland captured individuals in October to February. Herpetofauna searches located individuals throughout the year (SEWPaC 2011b). The overall Project survey effort comprises the following:

- Diurnal active habitat searches – including searches for burrows, under leaf litter and logs, rocks, cave and crevices. Approximately 42 hours of searches over approximately 42 ha were conducted over Project area over a total of 20 days; and
- Pitfall / funnel trapping - no pitfall trapping was possible in March 2011 due to wet conditions. Trapping carried out at eight sites comprising 32 trap nights (four sites each in September 2011 and February 2017).

The species has not been recorded. Of the Pygopodids only Brigalow Scaly-foot (*Paradelma orientalis*) has been identified in the area from Project surveys.

Species Potential to Occur

Given the lack of any record of the species ever occurring in the area, the lack of Project survey records of the species in the area, and the habitat availability associated with the Project, the species is considered as 'potentially occurring.' Significant impact assessments have been restricted to species which are 'known' or 'likely to occur' and as such no assessment has been carried out. Suitable habitat occurs in the southern section of the ML where intact canopy vegetation on land zone 10 (with patchily abundant cover of surface rocks) occurs (refer Table 16-112). It is noted the Project footprint does not encompass or otherwise impact habitat on land zone 10. Waste Rock Stockpile 1a is the nearest Project component and is located approximately 500 m to the north of potential habitat in the south of the ML (refer Figure 16-141). Habitat in the remainder of the ML is lowland (on land zone 4), heavily impacted by clearing, has little fallen timber and little to no cover of surface rocks. Despite the fact there are no records in the near vicinity of the Project, and the habitat is largely unsuitable, the species has been elevated to 'potential to occur' in the SEIS (from unlikely in the EIS) due to the intact canopy vegetation on land zone 10 in the southern section of the ML. However, it is not considered necessary to carry out a significant impact assessment which are based on 'likely' or 'known' species, due to the lack of suitable habitat impacted by the Project and distance from the nearest known records of the species occurrence.

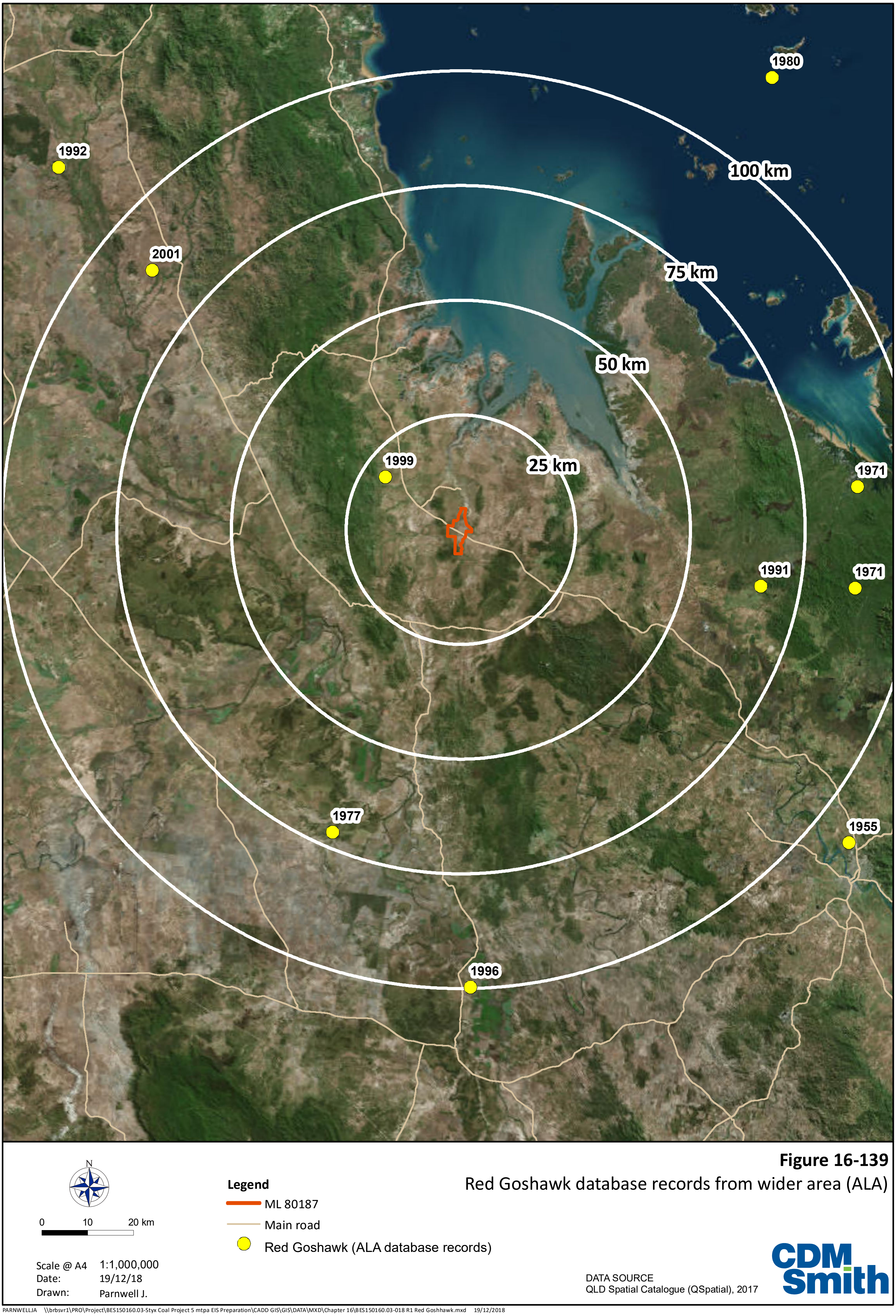


Figure 16-139

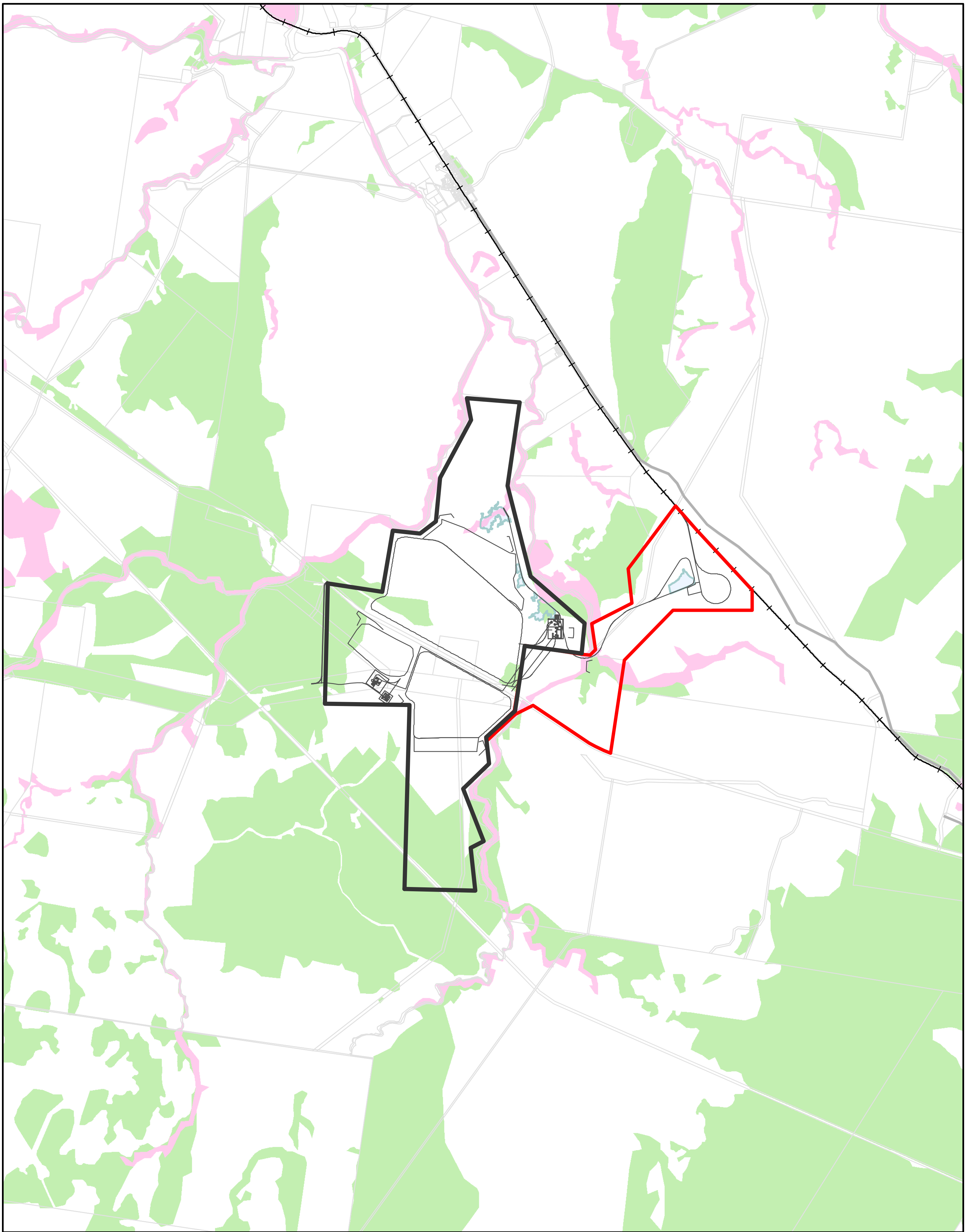
Red Goshawk database records from wider area (ALA)

Scale @ A4 1:1,000,000
Date: 19/12/18
Drawn: Parnwell J.

DATA SOURCE
QLD Spatial Catalogue (QSpatial), 2017

CDM Smith

PARNWELLJA \\brbsvr1\PRO\Project\BES150160.03-Styx Coal Project 5 mtpa EIS Preparation\CADD GIS\GIS\DATA\MXD\Chapter 16\BES150160.03-018 R1 Red Goshhawk.mxd 19/12/2018



N

0 1 2 km

Scale @ A4 1:100,000
Date: 18/12/18
Drawn: Jess P.

Legend

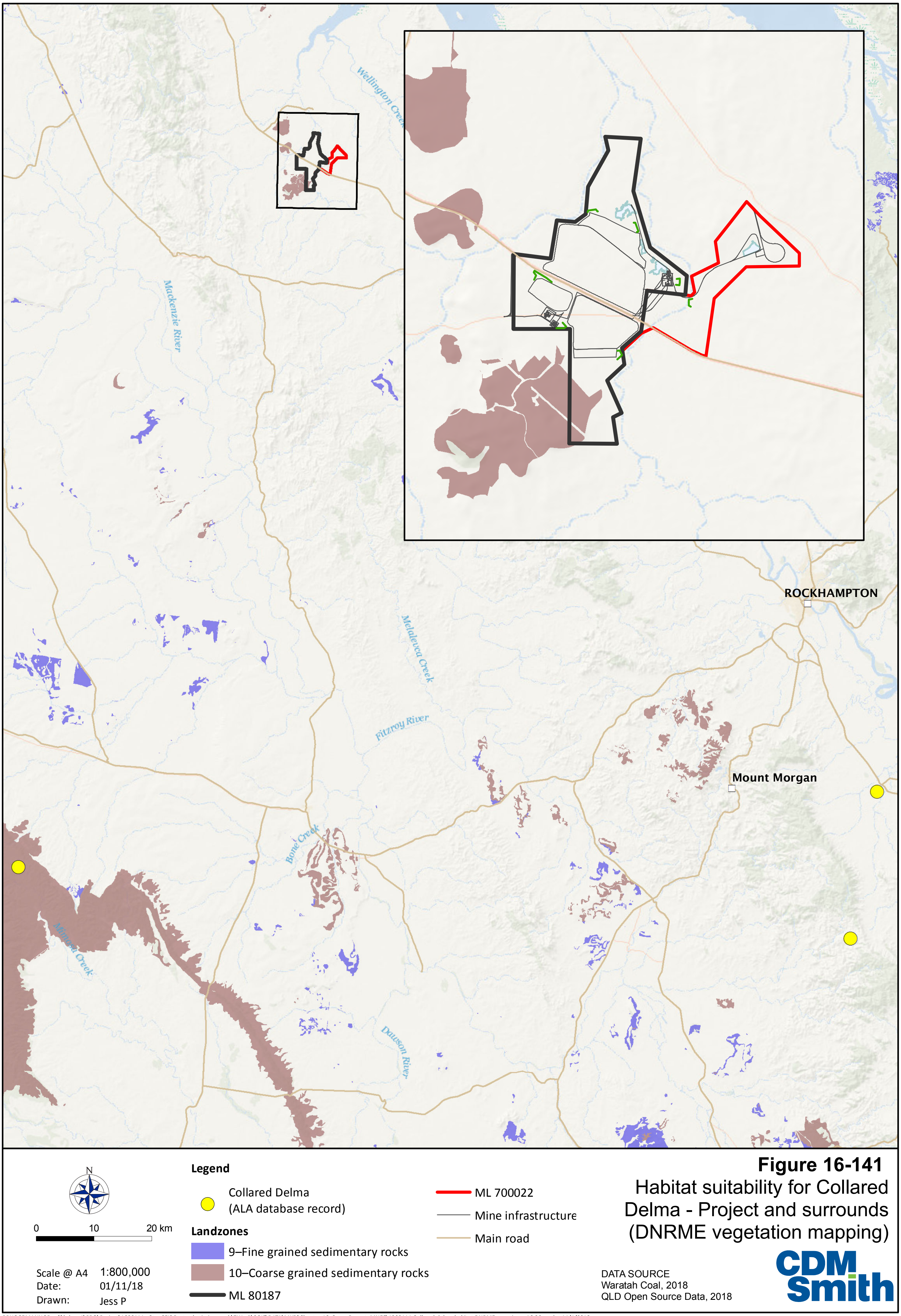
- Potential foraging habitat
- Potential nesting habitat
- ML 80187
- ML 700022
- Mine infrastructure
- Cadastral boundary
- Main Road
- North Coast Rail Line
- Dam

Figure 16-140
Habitat suitability for Red Goshawk – Project and surrounds (DNRME vegetation mapping)

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
QLD Department of Environment and Heritage Protection, 2016

CDM Smith

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 Red GoshhawkHabitat__16-37.mxd 12/18/2018



Scale @ A4 1:800,000
Date: 01/11/18
Drawn: Jess P

Figure 16-141
Habitat suitability for Collared Delma - Project and surrounds (DNRME vegetation mapping)

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 Collared delma habitat DNRME mapping__16-39.mxd 11/1/2018

Table 16-115 Likelihood of occurrence of EPBC Act listed threatened terrestrial species

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence in the Project area
Plants			
Capparis thozetiana	V	Spiny shrub endemic to central Queensland in the Marlborough–Rockhampton region where it is confined to serpentinite hills and adjacent undulating colluvial aprons. The species grows on mostly shallow skeletal serpentinitic soils in woodland communities dominated by *Eucalyptus fibrosa* and *Corymbia xanthope*.	**Unlikely.** No suitable habitat (serpentine landscapes) observed within the Project area. 20 Wildlife online database records from wider area.
Glen Geddes Bloodwood *Corymbia xanthope*	V	Occurs in woodlands with *E. fibrosa* on ridges or hill slopes on serpentinite geology with sandy soils. This community is recognised as a distinct regional ecosystem (RE 11.11.7 *E. fibrosa* subsp. *fibrosa*, *C. xanthope* woodland on serpentinite).	**Unlikely.** No suitable habitat (serpentine landscapes) observed within the Project area. 16 Wildlife online database records from wider area.
Cycas megacarpa	E	Trunked cycad grows to 5m tall. Is endemic to southeast Queensland from Bouldercombe in the north, to near Woolooga in the south, in woodland or open woodland dominated by eucalypts, usually on rocky substrate.	**Unlikely.** Two Wildlife online database records from wider area to the south. Species is not known to occur this far north.
Marlborough Blue *Cycas ophiolitica*	E	Occurs from Marlborough in the north, to the Fitzroy River near Rockhampton in the south, in woodland or open woodland dominated by eucalypts, often on serpentinite substrates. Plants occur along hilly outcrops and in lower regions near creek systems.	**Unlikely.** No suitable habitat occurs and no cycads recorded. 23 Wildlife online database records from wider area.
Bluegrass *Dichanthium setosum*	V	Associated with heavy basaltic black soils and stony red-brown hard setting loams with clay subsoil. Found in moderately disturbed areas such as cleared woodlands, grassy roadside remnants, grazed land and highly disturbed pastures.	**Unlikely.** No suitable habitat in Project area. No database records. EPBC Online search only.
Black Ironbox *Eucalyptus raveretiana*	V	Grows along watercourses on alluvial flats or open woodland. Associated with RE 11.3.25a and occasionally 11.3.11 (DotEE 2018).	**Unlikely**. Single Wildlife online database record from wider area (25 km to south of ML). Suitable habitat within ML (RE11.3.25) is heavily degraded. Better habitat occurs along Deep Creek, however no individuals have been recorded for this species within the region and not recorded during site surveys.
Hakea trineura	V	Occurs on serpentinite-derived so mostly on gravelly ridges and slopes, often with *E. fibrosa* and *C. xanthope* woodland over hummock grassland on hills.	**Unlikely.** No suitable habitat (serpentine landscapes) observed within the Project area. 13 Wildlife online database records from wider area.

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence in the Project area
Marsdenia brevifolia	V	Erect or loosely scrambling sub-shrub up to 1 m tall. Plants occurring north of Rockhampton grow on serpentine rock outcrops or on black crumbly soils derived from serpentine in woodland dominated by *C. xanthope* and *E. fibrosa*. Despite this close association with serpentine, the species is not a serpentine endemic. Also grows in woodland on granite soils dominated by *E. granitica*, *C. leichhardtii* and *E. acmenoides*.	**Unlikely.** No suitable habitat (serpentine landscapes) observed within the Project area. 17 Wildlife online database records from wider area.
Neoroepera buxifolia	V	Shrub or small tree growing to 6 m high. Known from two small areas between Marlborough and Yaamba, and between Rockhampton and Yeppoon, in Queensland. This species occurs along creek banks or in creek beds on serpentinite soils (Batianoff et al., 2000) in riparian vine thicket, vine forest, *Melaleuca* or eucalypt woodland or open forest with rainforest species in the understorey.	**Unlikely.** No suitable habitat (serpentine landscapes) observed within the Project area. 26 Wildlife online database records from wider area.
Olearia macdonnellensis	V	Viscid aromatic shrub to 1.2 m high. Occurs in eucalypt open forest in the Marlborough region of central Queensland, all records are from rocky serpentinite hills and ridges. Associated vegetation / species includes open forests of *C. xanthope* and *E. fibrosa*.	**Unlikely.** No suitable habitat (serpentine landscapes) observed within the Project area. Six Wildlife online database records from wider area.
Omphalea celata	V	Known from three rocky sites in central east Queensland occurring in SEVT. Locations are Hazlewood Gorge, near Eungella; Gloucester Island, near Bowen; and Cooper Creek in the Homevale Station area, northwest of Nebo (TSSC 2008b).	**Unlikely.** Well outside of known range of species. No database records. EPBC Online search only.
Lesser Swamp Orchid *Phaius australis*	E	Commonly associated with coastal wet heath / sedgeland wetlands swampy grassland or swampy forest and often where Broad-leaved Paperbark (*M. quinquinervia*) or Swamp Mahogany (*E. robusta*) is found (Sparshott and Bostock, 1993). It is restricted to the swamp-forest margins, where it occurs in swamp sclerophyll forest, swampy rainforest, or fringing open forest. Mostly found in southeast Queensland and further south. Isolated population in Byfield National Park.	**Unlikely.** No suitable habitat in Project area. No database records. EPBC Online search only.

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence in the Project area
Pimelea leptospermoides	V	A shrub growing to 1 m high. Occurs from near Marlborough to Rockhampton in Queensland. Found in most serpentine soil vegetation communities, but not in riverine forest. Notably on black clays on stony hillsides and sandy clay in *E. fibrosa* and *C. xanthope* open woodland. Also, tall open forest, open forest and low open forest, all with a grassy and / or heathy understorey, and in woodland with a *M. bracteata* subcanopy layer where prolonged flooding occurs.	**Unlikely.** No suitable habitat (serpentine landscapes) observed within the Project area. 44 Wildlife online database records from wider area.
Pultenaea setulose	V	An erect shrub growing on serpentine substrates in *E. fibrosa* and / or *C. xanthope* woodlands or open forests on ridges, hills and slopes.	**Unlikely.** No suitable habitat (serpentine landscapes) observed within the Project area. 11 Wildlife online database records from wider area.
Quassia *Samadera bidwillii*	V	Occurs in lowland rainforests or rainforest margins. Also found in other forest types, such as open forest and woodland. Usually found in areas adjacent to both temporary and permanent watercourses up to 510 m altitude. Commonly associated trees in open forest and woodlands include *C. citriodora, E. propinqua, E. acmenoides, E. tereticornis, C. intermedia, E. siderophloia, E. moluccana, E. cloeziana* and *E. fibrosa*.	**Unlikely.** No suitable species associations observed within the Project area. Two Wildlife online database records from wider area.
Reptiles			
Southern Snapping Turtle *Elseya albagula*	CE	Occurs in Fitzroy, Mary and Burnett Rivers and associated drainages in southern coastal Queensland. Prefers flowing, clear well-oxygenated waters. Occurs in lower densities in rivers with intermittent flows (TSSC 2014).	**Unlikely.** Styx River catchment is separated from the Fitzroy Basin. Two Wildlife Online records from wider area are located over 30 km south on Marlborough Creek and the Mackenzie River both of which are part of the Fitzroy Basin. Creek lines in the Styx River basin are largely ephemeral with only sporadic flow events following heavy rainfall. The species was incorrectly identified as occurring during aquatic ecology surveys throughout the wider area in 2011.
Fitzroy Turtle *Rheodytes leukops*	V	Fitzroy Turtle is restricted to the rivers of the Fitzroy Basin. It prefers large pools and connecting flowing riffle habitats with clear water. It generally does not move far within its home range. It is known to feed on aquatic insect larvae, freshwater sponges and Ribbonweed (*Valisneria* spp.) (Tucker et al. 2001).	**Unlikely.** Uncertain whether species occurs in Styx catchment which is separated from the Fitzroy Basin. Five Wildlife Online records from wider area, all located in the Fitzroy Basin. Nearest records are located over 70 km south of the Project and associated with Marlborough Creek (part of the Fitzroy Basin).
Collared Delma *Delma torquata*	V	Occurs in soil cracks on heavy stoney soils west of Brisbane. Also recorded from Blackdown Tablelands west of Rockhampton. Known from REs on land zones 3, 9 and 10 including 11.3.2, 11.9.10, 11.10.1 and 11.10.4 (DotEE 2018).	**Potential.** No database records from wider area. EPBC Online search only. Nearest records from south of Rockhampton (approx. 145 km southeast of the Project) and Blackdown Tablelands (130 km south-west). Project area lies on the extreme northern edge of range where mapped as 'species or species habitat may occur' (DotEE 2018). Vegetation on land zone 10 occurs in the southern portion of the site.

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence in the Project area
Yakka Skink *Egernia rugosa*	V	Occurs in dry forests, woodlands and rocky areas (usually on well drained, coarse gritty soils) including Poplar Box on alluvial soils, low ridges, Callitris on sands, Belah (Ehmann 1992; Cogger 2000; Drury 2001; Wilson 2015). Also occur in highly degraded sites and where there are log piles and rabbit warrens (EPA 2003).	**Potential.** Sparse large woody debris is present in wooded habitat in the south of the ML and in habitat adjacent to Deep Creek near Site 4 (2017). No database records in near vicinity. Nearest record in Blackwater region approximately 100 km southwest of Project. EPBC online search only.
Ornamental Snake *Denisonia maculata*	V	Occurs in low-lying areas with deep-cracking clay soils that are subject to seasonal flooding, and adjacent areas of clay and sandy loams. The species is a frog predator found in woodlands and shrublands, such as Brigalow, and in riverine habitats, and lives in soil cracks and under fallen timber (Ehmann 1992; Wilson 2015). Potential habitat is associated with REs 11.3.3, 11.4.3, 11.4.6, 11.4.8, 11.4.9 and 11.5.16 or where they occurred before clearing. (DSEWPaC 2011b).	**Likely.** Species has not been recorded within ML despite extensive targeted searches throughout 2017. Recorded on three occasions during the 2011 / 2012 fauna surveys. All recorded in areas associated with remnant RE 11.4.9 outside of the current Project area: two records 3.5 km west and one record 5.8 km north-west of the ML. No Wildlife Online records from the wider area. A single ALA record located approximately 24 km north of the Project area. Soils in the Project area are generally suitable and gilgai habitat is widespread in the ML north of the Bruce Highway.
Dunmall's Snake *Furina dunmalli*	V	Rarely encountered. Occurs in a variety of habitats including forests to woodlands on sandy soils, cracking soils with Brigalow scrub, and dry vine scrub. Occurs in the Brigalow Belt in southeast inland Queensland.	**Potential.** No database records from wider area. EPBC Online search only. Species is on the northern edge of its range in this area. Nearest record to Project is from Mt Archer, Rockhampton and species previously recorded from Yeppoon (DotEE 2018). Most northerly record is from Clermont area over 400 km west of the Project. Suitable cracking clay substrate occurs in Project area although vegetation mostly cleared in this habitat.
Birds			
Squatter Pigeon (southern) *Geophaps scripta scripta*	V	Dry grassy eucalypt woodlands and open forests, also *Callitris* and *Acacia* woodlands. Most birds live in sandy sites near permanent water (Frith 1982; Blakers et al. 1984; and Crome and Shields 1992). Often around cattle yards and other disturbed areas.	**Known.** Species observed on all surveys including within the ML. Species is relatively common in the wider area and there are 23 Wildlife Online database records.
Red Goshawk *Erythrotriorchis radiatus*	V	Endemic to northern and eastern Australia in coastal and subcoastal areas with large home ranges of up to 200km^2. Occurs in woodlands and forests and prefers mosaic habitats that hold a large population of birds and permanent water. Riparian areas are heavily favoured (Marchant and Higgins 1993).	**Potential.** One Wildlife Online database record (1999) from wider search area. Preferred riverine nesting habitat adjacent to Project area although local landscape is heavily cleared. Southern extent of ML remains well vegetated. Species may utilise Project area for foraging should it occur in the area.
Australian Painted Snipe *Rostratula australis*	E	Terrestrial shallow wetlands, ephemeral and permanent, usually freshwater but occasionally brackish. They also use inundated grasslands, saltmarsh, dams, rice crops, sewage farms and bore drains (Marchant and Higgins 1993).	**Potential.** May be occasional visitor to dams in the Project area. Prefers shallow wetlands with adjacent vegetative cover for shelter. Very uncommon species that occurs erratically over eastern and northern Australia. Three database records from wider region recorded on wetlands to the north of Project area associated with the Broad Sound region (including St Lawrence wetlands) where the species is known to occur.

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence in the Project area
Black-breasted Button-quail *Turnix melanogaster*	V	Cryptic species that occurs in dry rainforest and vine-thickets with abundant leaf-litter. They have also been recorded in Brigalow, Belah and Bottle-tree scrubs, and in eucalypt forests with a dense understorey including Lantana (Marchant and Higgins 1993).	**Unlikely.** Three database records located 18 km east of Project area. No potential habitat within ML. Very marginal habitat along Tooloombah Creek where understorey of vine thicket occurs in a narrow band along steep creek bank. No evidence of presence (i.e. platelets) was observed during surveys.
Yellow Chat (Dawson) *Epthianura crocea macgregori*	CE	Occurs on marine plain wetlands in the Fitzroy River Delta, Torilla Plains and Curtis Island in central Queensland (Houston et al. 2004; Jaensch et al. 2004). Requires grassland, dense beds of rush or sedge, bare mud and / or shallow water, and patches of Samphire (Houston et al. 2004).	**Unlikely.** 50 Wildlife Online database records from wider area. These records are likely to be associated with the extensive Torilla Plains located approximately 40 km east of the Project area. There is no suitable marine habitat in or near the Project area. Targeted surveys in 2011/2012 located in potential habitat to the north of the Project did not record the species.
Black-throated Finch (southern) *Poephila cincta cincta*	E	Occurs in grassy open woodlands near water. Prefers areas of intact woodlands with a variety of native grasses for year round feeding. Nests in large trees, sometimes in tree hollows and arboreal termite nests.	**Unlikely.** Suitable grassy woodland habitat exists however, Project area is south of the species current known range. No database records. EPBC online search only.
Star Finch *Neochmia ruficaunda ruficauda*	E	Occurs mainly in dense, damp grasslands bordering wetlands and watercourses, as well as open grassy woodlands near permanent water. Forages for seeds in tall native grasses (Higgins et al. 2006).	**Unlikely.** Although once widespread this species is now very rare. Project area is south of the species current known range. No database records. EPBC online search only.
Mammals			
Northern Quoll *Dasyurus hallucatus*	E	Formerly occurred in a variety of habitats across northern Australia and Queensland. Now most common in rocky eucalypt woodland and open forest within 200 km of the coast (Menkhorst and Knight 2004).	**Potential.** No Wildlife Online or ALA database records from the search area (EPBC Online Search only). Nearest records are 65 km west in the Middlemount area (1969 record) and in Stanage Bay 110 km and 130 km to the northeast (1929 record and 1990 record). The nearest recent records are in Homevale National Park (2011 records) 170 km to the northwest and the Mt Morgan area (2000 record) 120 km to the southeast. Habitat within the mine area is mostly cleared and unsuitable for the species. The south-west corner of the ML may provide suitable habitat where a rocky jump-up occurs providing potential den habitat in the form of rock crevices on crest of jump-up. Species requires access to permanent freshwater and none is nearby (nearest waterhole of any permanence approximately 1.5 km away). This area occupies approximately 25 ha within the ML boundary and adjoins a large area of contiguous woodlands that remain tenuously connected to more suitable habitat to the west (rocky ranges). Remote camera traps (baited) were located in this area from September to December 2017 (total of 400 trap nights) (refer Figure 16-130) with no records of the species occurrence.

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence in the Project area
Koala *Phascolarctos cinereus*	V	Feed almost entirely on eucalypts (Martin et al. 2008); most likely in riverine and riparian habitats.	**Known.** Scats recorded in both 2011 surveys. Species recorded on five occasions within ML in 2017 including Poplar Box (*Eucalyptus populnea*) woodland (RE11.4.2) (February and September surveys), Poplar Gum (*Eucalyptus platyphylla*) woodland (RE11.5.8a) (November survey) and on camera in Lancewood (*Acacia shirleyi*) woodland (October 2017) and Narrow-leaf Ironbark (*E. crebra*) woodland (RE 11.10.7). Forest Red Gum along creeks likely the most favoured habitat for this species although species evidently occurs in low population density throughout the area. Eleven Wildlife Online record from wider area.
Greater Glider *Petauroides volans*	V	May occur in a range of eucalypt dominated habitats from coastal areas to ranges. Needs large hollow-bearing trees for daytime roosting. Favours habitats with a diversity of eucalypt species (Kavanagh 1984).	**Known.** Two individuals recorded in woodland habitat (RE11.11.15a) in south of ML in February 2017. Individuals recorded in riparian habitat (RE11.3.25) along Deep Creek south of the highway in November 2017 and June 2018. Also noted in February 2012 survey but no location provided. No database records from wider area. EPBC Online search only. Nearest records from mainland adjacent to Shoalwater Bay. Suitable habitat in southern and eastern extent of ML where continuous forest with large hollows remain.
Grey-headed Flying-fox *Pteropus poliocephalus*	V	Nomadic species that generally roosts at sites near water and within 50 km of the coast, generally with rainforest, paperbark or casuarina species (Eby and Roberts, 2012). Generally, occurs further south but regular roost site found near Finch Hatton (Eungella area) in recent years (Roberts et al. 2008).	**Potential.** No database records from the wider area. Little Red and Black Flying-fox have been recorded during the 2011/2012 surveys. Little Red and Black Flying-foxwere observed roosting seasonally at a large colony site in the township of Marlborough 50 km southeast of the Project. Surveys of the colony have not identified Grey-headed Flying-fox. There are no roost sites where the species is known to occur in the region surrounding the Project. Current DotEE (2017) data on monitored flying-fox roosts indicates that Finch Hatton (200 km north of the Project) is the nearest roost regularly utilised by the species. They have been recorded using a roost at Middlemount (96 km west of the Project) in 2014 but not during subsequent surveys. To the south the species has been recorded at roost sites in the Bundaberg area (approximately 350 km south of the Project). There is a low potential for the species to forage in the Project area during eucalypt flowering periods given the Project area lies in the northern extent of its accepted range. There is potential roost habitat adjacent to the Project area along Tooloombah Creek and Deep Creek although no camp sites were observed or are known from the wider area.

Species name	EPBC Act status	Habitat preference	Likelihood of occurrence in the Project area
Ghost Bat *Macroderma gigas*	V	One of the largest microbat species in the world. Roosts in shallow caves, abandoned mines and rock piles. Australia's only carnivorous bat (Churchill 2008).	**Potential.** No database records from wider area. EPBC Online search only. Well known maternity colony known to occur at Mt Etna caves approximately 90 km southeast of Project area. No suitable habitat observed within mine disturbance area but jump-up at southern extent of ML may provide suitable rocky crevices for roosting.
Large-eared Pied Bat *Chalinolobus dwyeri*	V	Species has been recorded roosting in disused mine tunnels, rock overhangs, caves and Fairy Martin (*Petrochelidon ariel*) nests (Eyre et al. 1997; Thompson 2002). Appears to be closely associated with the presence of sandstone escarpment country for roost sites.	**Potential.** No database records from search area. EPBC Online search only. ALA records from the 1990s to the east of the Project area associated with the mainland adjacent to Shoalwater Bay. No suitable habitat observed within mine disturbance area but jump-up at southern extent of ML may provide suitable rocky crevices for roosting.
South-eastern Long-eared Bat *Nyctophilus corbeni*	V	Occurs in a variety of dry forest habitats including River Red Gum, open woodland, mallee, brigalow and other arid and semi-arid habitats. It roosts in tree hollows or under bark (NSW NPWS 2003). Surveys suggest the species requires large tracts of forest to occur (Turbill et al. 2008).	**Unlikely.** While there is suitable habitat for this species, the Project area is located substantially north of its current known distribution. There are no database records from the area for this species. There are 596 records of this species in the ALA database and the nearest record is approximately 400 km south of the Project area in the Expedition Range. The nearest records from the DES species database comes from the same area and is likely to be the same record. EPBC Online search only.
Water Mouse *Xeromys myoides*	V	Occurs in mangroves, saltmarsh, sedged lakes near foredunes and coastal freshwater swamps. Requires relatively large areas of intertidal flats over which to forage (Gynther and Janetzki 2008).	**Unlikely.** No database records from wider area. No suitable habitat within or near Project area. EPBC Online search only.

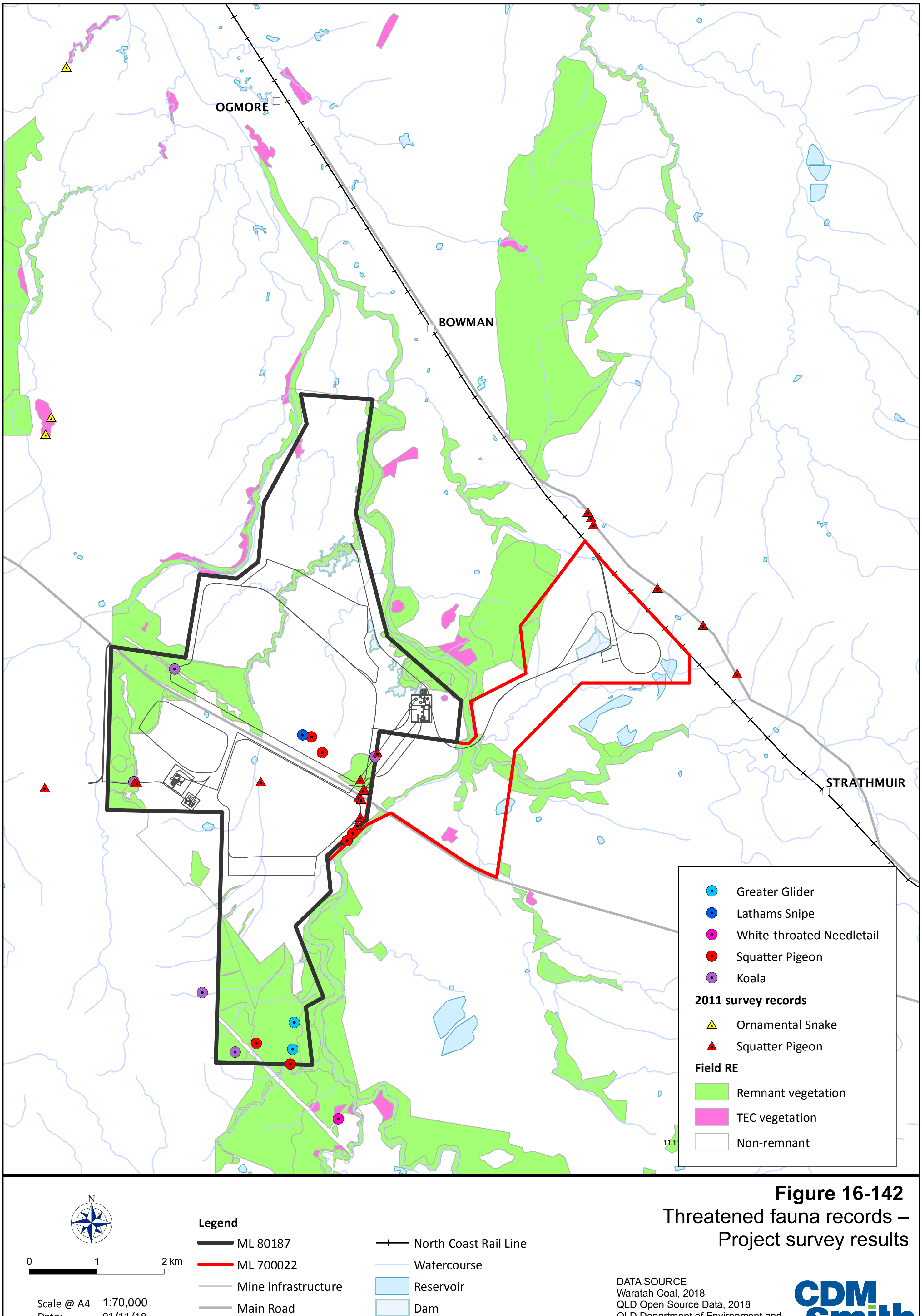


Figure 16-142
Threatened fauna records – Project survey results

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
QLD Department of Environment and Heritage Protection, 2016

CDM Smith

16.13.9.5 Threatened Fauna Species Information

This section outlines the known ecological requirements, distribution and potential threats of those EPBC Act-listed species that are known or likely to occur within or near the Project area.

Squatter Pigeon (southern) – Vulnerable (known to occur)

Plate 16-16 Squatter Pigeon recorded during Project surveys (March 2011)

Ecology and habitat: The Squatter Pigeon is largely terrestrial, foraging and breeding on the ground. The southern subspecies occurs mainly in dry grassy eucalypt woodlands and open forests (Frith, 1982; Crome and Shields, 1992). It also inhabits *Callitris* and *Acacia* woodlands and was reported from open plains in its historical southern range (Frith, 1982). Most birds live in sandy sites near permanent water (Blakers et al. 1984; Reis 2012). Squatter Pigeons dust-bathe and are often encountered on dirt tracks and in areas of bare soil denuded of ground cover by livestock (Frith, 1982; Higgins and Davies, 1996). They are usually encountered as pairs, family groups or small flocks (Reis 2012). Although they remain common in heavily grazed country in tropical Queensland they are typically more common in un-grazed land (Woinarski and Ash 2002; Reis 2012). These birds mainly feed on seeds, although insects are a seasonally important part of the diet (Reis 2012).

Distribution and breeding: This species was historically found from Cape York Peninsula in Queensland south to the Dubbo region in New South Wales (NSW). There have been no official records in NSW since the 1970s and the species has declined greatly in southern Queensland (Higgins and Davies 1996; NSW NPWS 2003). Over its current range the species persists at numerous sites and no recent declines have been observed (Garnett et al. 2011).

Breeding in southern Queensland is known throughout the year but does appear to be greatly influenced by rainfall (Reis 2012). The nest is a shallow depression on the ground lined with grass and often sheltered by a log or tussock grass (Frith 1982; Higgins and Davies 1996).

The total population size is estimated at 40,000 breeding birds and is thought to occur as a single interbreeding population. This estimate; however, is considered to be of low reliability.

The subspecies range occurs north to Townsville and west to Charleville. Important populations of the Squatter Pigeon have been identified as those isolated and sparsely distributed sub-populations that occur south of the Carnarvon Ranges in central and southern Queensland including;

- Populations occurring in the Condamine River catchment and Darling Downs of southern Queensland;
- Populations occurring in the Warwick-Inglewood-Texas region of southern Queensland; and
- Any population that may potentially occur in NSW (Squatter Pigeon Workshop 2011).

North of the Carnarvon Ranges the species remains common and is considered to be distributed as a single, continuous (that is inter-breeding) sub-population (DotEE 2018).

Threats: Much of the original habitat in Queensland has been replaced with pasture for livestock (Higgins and Davies 1996). Threats to existing populations include clearing and fragmentation of habitat, overgrazing by livestock and feral herbivores, trampling of nests by livestock and feral animals, predation by cats and foxes, and illegal shooting (NSW NPWS 2003).

Field survey results: Recorded during every site survey and throughout ML and surrounds, although mostly south of Bruce Highway (Figure 16-142, Plate 16-16). Although there appears abundant suitable habitat within the ML it is noted the species was encountered in the same locations during successive survey periods in 2017 and 2018. The species was mainly observed in pairs or as individuals but groups of up to six individuals recorded. The species is not associated with particular REs and was often recorded in cleared habitat.

Greater Glider – Vulnerable (known to occur)

Plate 16-17 Greater Glider (Source: Brett Taylor 2017)

Ecology and habitat: Greater Gliders (Plate 16-17) are typically found in mature eucalypt forests and woodlands with a variety of eucalypt species and a high density of large tree hollows (van der Ree et al. 2004). The diet is largely composed of eucalypt leaves and sometimes flowers. Large hollows in old trees are favoured as shelter sites during the daytime (Goldingay 2012). Sites with a high abundance of suitable hollows appear to support higher populations. The species uses relatively small home ranges of 1 ha – 4 ha in more productive forests (Gibbons and Lindenmayer 2002), but up to 16 ha in more open and dry habitats (Smith et al. 2007).

Distribution and breeding: The species occurs across eastern Australia in a broad swathe of territory associated with the Great Dividing Range. It is known to occur from north Queensland (Atherton Tablelands) to central Victoria.

Females breed in their second year giving birth to a single young each year (March to June). Their low birth rate may cause isolated populations in small forest fragments to be vulnerable to extinction (van der Ree et al. 2004).

Threats: Greater Glider is thought to be particularly sensitive to forest clearing / logging and forest fragmentation. They appear to have a poor dispersal ability being relatively restricted to intact forests / woodlands. They are thought to be susceptible to major disturbances such as frequent or intense fires (TSSC 2016). Climate modelling suggests the species may be threatened by potentially increased temperatures associated with climate change, particularly populations in north Queensland (Kearney et al. 2010).

Field survey results: Two individuals were recorded during spotlighting surveys of the site in February 2017. The individuals were recorded in the continuous tracts of eucalypt woodland that characterise the southern portion of ML 80187 and well to the south of the closest disturbance area. Another individual was observed in riparian Forest Red Gum on Deep Creek in December 2017 which remains connected to the woodlands further south. Two individuals were recorded in the same area in June 2018 (see Figure 16-142). There are no database records of the species occurrence from the wider area surrounding the Project. Suitable habitat within or near the Project is likely to be restricted to this area due to the extensive clearing carried out elsewhere.

Koala (combined populations of Qld, NSW and ACT) – Vulnerable (known to occur)

Plate 16-18 Koala recorded on remote camera in south of ML (November 2017)

Ecology and habitat: Koalas have a distinct association with eucalypt woodland and forest habitat types containing suitable food trees (Hume and Esson, 1993; Moore and Foley, 2000; and Martin et al. 2008). They are not necessarily restricted to bushland or remnant areas and are known to exist and breed within farmland and the urban environment (Dique et al. 2004). Similarly, movement is not confined to vegetated corridors, as they also move across cleared rural land and through suburbs (Martin et al. 2008). They use a variety of trees, including many non-eucalypts, for feeding, shelter and breeding purposes (Dique et al. 2004; and Martin et al. 2008).

They are known to have localised preferences throughout their range, selecting some tree species over others (Pahl and Hume 1990). They are also known to favour individual trees and this has been suggested to be a response to a variety of factors including; high leaf moisture content, high leaf nitrogen content (which is often related to low fibre content making leaves more palatable) and low levels of chemicals compounds which are expressed by eucalypts to resist herbivory (Pahl and Hume 1990; Hume and Esson 1993; and Moore and Foley 2000).

Distribution and breeding: Koalas occur throughout northeast, central and southeast Queensland, extending south through Victoria into South Australia and Kangaroo Island. Breeding occurs in spring / summer when males become territorial, attacking and fighting rivals and using loud bellows to advertise their presence (Martin et al. 2008). Young permanently leave the females pouch after seven months, but continue to ride on the mothers back until 12 months and the beginning of a new breeding season. After this time, adolescent females may remain in the natal habitat, but males generally disperse to new territories between one to three years of age (Dique et al. 2003; and Martin et al. 2008).

Threats: Current threats to Koalas include habitat destruction and fragmentation, bushfire and disease. Populations around urban / populated areas are also at increased risk of mortality due to dog attack and road strike (Maxwell et al. 1996).

Field survey results: The species was observed in Poplar Box remnant woodland within ML 80187 during spotlighting for the February and September 2017 and June 2018 site surveys and in Poplar Gum woodland in November 2017. Two individuals recorded on remote camera in the south of the ML (Plate 16-18), but outside of the proposed disturbance areas (Figure 16-142).

The central eastern and western portion of the ML is dominated by tracts of Poplar Box (RE 11.4.2) which is considered a secondary forage tree. Forest Red Gums are considered primary feed trees (Australian Koala Foundation 2015) and occur in narrow bands along creek lines including the drainage line that crosses the ML north of the Bruce Highway. The Forest Red Gum habitat in the local area (RE 11.3.4 and 11.3.25) is likely to be the most favoured habitat for this species.

Ornamental Snake – Vulnerable (likely to occur)

Plate 16-19 Ornamental Snake recorded during Project surveys (March 2011)

Ecology and habitat: Ornamental Snake occurs in low-lying areas with deep-cracking clay soils that are subject to seasonal flooding, and adjacent areas of clay and sandy loams. The species is found in woodlands and shrublands in Brigalow, Gidgee (*Acacia cambagei*), Blackwood (*A. argyrodendron*) or Coolabah-dominated vegetation communities associated with moist areas, particularly gilgaied landscapes. It also occurs in modified grassland associated with gilgais, and lake margins and wetlands (Melzer 2012). The species has been recorded in the following REs none of which occur in the Project area: 11.4.6, 11.4.8, 11.4.9 and 11.3.3 (DotEE 2018).

Ornamental Snake shelters in soil cracks and under fallen timber. It is a nocturnal species and feeds almost entirely on frogs, though lizards may very occasionally be eaten (Ehmann 1992; Wilson 2015). They are known to congregate around waterholes and temporary pools where frogs are abundant. They are most likely to be encountered following heavy summer rains (Melzer 2012). Gilgais are a known important habitat for the species and the presence of remnant vegetation is not required for the species to occur (DSEWPaC 2011a).

Distribution and breeding: The species occurs in the eastern half of the central and northern Brigalow Belt, mainly in the Fitzroy and Burdekin Basins. High population densities are known from the Isaac River (Dysart, Moranbah and Nebo) and Dawson River catchments (Melzer 2012).

Threats: Threats to Ornamental Snake include: habitat clearing and fragmentation; altered water quality and hydrology affecting gilgai and wetland habitat; habitat degradation by cattle and exotic weed species, predation by feral species; and consuming Cane Toads (*Rhinella marina*). The species is generally not found in areas with high numbers of Cane Toads (Melzer 2012).

Field survey results: Two individuals were recorded in remnant Brigalow habitat 3 km west of the northern boundary of the ML in September 2011. One individual was recorded in Brigalow habitat along a minor drainage line approximately 5.8 km northwest of the northern boundary of the ML in March 2011 (Figure 16-142; Plate 16-19).

There are suitable cracking clay soils within the ML north of the Bruce Highway where regrowth Brigalow occurs including extensive gilgai formations. No individuals were observed within the ML during the Project surveys despite targeted surveys (trapping, habitat searches and spotlighting) within this area in February 2012, and February, July and November 2017.

16.13.10 Field Results: Migratory Bird Species - Terrestrial

16.13.10.1 Overview

A total of 24 species listed as Migratory under the EPBC Act were predicted to occur in the Project area through the EPBC Protected Matters search and database searches (see Table 16-116). During field assessments five species were recorded within the Project area:

- Latham's Snipe;
- Oriental Cuckoo;
- Fork-tailed Swift;
- White-throated Needletail; and
- Rufous Fantail.

Glossy Ibis is listed as Migratory and was recorded in estuarine / wetland habitat north of the current Project area during the 2011/2012 surveys. This species is considered as 'likely to occur' within the ML given the habitat occurring in the Project area and local surrounds.

A further four listed migratory species are considered to have some potential to occur sporadically within the Project area (Table 16-116).

Table 16-116 Likelihood of occurrence of EPBC Act listed Migratory terrestrial bird species

Species name	EPBC Act Status	Habitat preference	Likelihood of occurrence in the Project area
Migratory shorebirds			
Latham's Snipe *Gallinago hardwickii*	M	Occurs on swamp and marsh margins and in wet pasture (Pringle 1987).	**Known.** Up to 15 individuals observed at farm dam within the proposed mine area in February 2017. Single Wildlife Online record.
Other migratory bird species			
Eastern Osprey *Pandion cristatus*	M	Mainly coastal habitats but can occur on inland rivers and lakes (Debus 2012).	**Potential.** Suitable habitat adjacent to Project area along Tooloombah Creek and Deep Creek. No database records. EPBC Online search only.
Glossy Ibis *Plegadis falcinellus*	M	Terrestrial wetlands, preferring inland freshwater wetlands with abundant aquatic flora (Pringle 1985; and Marchant and Higgins 1990).	**Likely.** Recorded in 2011 northwest of the ML on estuarine sedge swamp. Seasonal wetlands and shallow dams in the Project area provide ephemeral habitat for this species. Single Wildlife online database record.
Oriental Cuckoo *Cuculus optatus*	M	Rainforest, vine thickets, wet sclerophyll forest and open forest and woodland (Higgins 1999).	**Known.** Recorded on March 2011 survey although sighting location unknown. May be occasional visitor to denser woodlands (such as riverine and adjacent woodland) in the Project area.
White-throated Needletail *Hirundapus caudacutus*	M	Aerial non-breeding summer visitors that may occur over any habitat type, including cleared land and infrastructure.	**Known**. Recorded during the November 2017 survey in the south of the ML. Wide ranging aerial species which migrates from the northern hemisphere to eastern Australia. May occur over the Study area in the summer months. No database records from wider area. EPBC Online search only.
Fork-tailed Swift *Apus pacificus*			**Known.** Recorded during the September 2011 survey although well to the northwest of the ML. Wide ranging aerial species which migrates from the northern hemisphere to Australia. May be occasional aerial visitor to the Project area in the summer months. Single Wildlife Online record from wider area.
Spectacled Monarch *Symposiachrus trivirgatus* Black-faced Monarch *Monarcha melanopsis*	M	Both species generally occur in dense vegetation such as rainforests, wet sclerophyll forests and other dense vegetation such as mangroves. Sporadically occurs in drier sclerophyll forests, woodlands, parks and gardens (Higgins et al. 2006).	**Potential.** There are limited WildNet database records for these species from the wider area. In general, the habitat in the Project area is open, dry and unsuitable. More suitable (dense) habitat occurs along the adjacent creek lines. Species may utilise the Project area during autumn / spring migrations.

Species name	EPBC Act Status	Habitat preference	Likelihood of occurrence in the Project area
Satin Flycatcher *Myiagra cyanoleuca*	M	Satin Flycatchers are mostly found in eucalypt forest, favouring wet forests, moist gullies and watercourses (Higgins et al. 2006).	**Potential.** This species may occasionally utilise the Study area during autumn / spring migrations. No database records. EPBC online search only.
Rufous Fantail *Rhipidura rufifrons*	M	Generally occur in dense vegetation, mainly in rainforests, but also in wet sclerophyll forests and other dense vegetation such as mangroves, drier sclerophyll forests, woodlands, parks and gardens (Higgins et al. 2006).	**Known.** Recorded on March 2011 survey although sighting location unknown. May occur throughout the Project area including regrowth Brigalow. Six database records from wider area. More likely in denser woodlands such as riverine and adjacent woodland.
Yellow Wagtail *Motacilla flava*	M	Sporadic visitor to coastal areas. Prefers short grass or bare ground close to swamps, sewage ponds and saltmarsh. May occur on airfields, playing fields or town lawns (Pizzey and Knight 2012).	**Unlikely.** No database records. EPBC online search only. Very occasional visitor to Queensland.

16.13.10.2 Migratory Species Known or Predicted as Likely to Occur

The following sections provide descriptions of the habitat preferences of the migratory species that were observed during field assessments or are considered likely to occur within the Project area. All were found in low numbers and, given the relatively small areas of preferred habitat present, it is considered unlikely the Project area supports significant populations of any of the species referred to below. It is unlikely that the Project area provides locally or regionally important habitat for these species.

Most of these species are dispersive or seasonal migrants that move location as conditions for foraging and / or breeding become suitable. There are no distinct migratory routes for these species at or near the Project area. As such, no maps of migration routes are presented. Migratory routes for those species that move seasonally are described in the text.

Glossy Ibis

Recorded in the wider area to the north of the Project on a brackish swamp associated with the Styx River marine plains during the September 2011 survey. The Project area is likely to provide suitable habitat, particularly following heavy rainfall.

The Glossy Ibis is a widespread species, occurring throughout the northern hemisphere and over much of Australia. This species breeds in dense colonies, often with other species of ibis and waterbirds (Marchant and Higgins 1990). Outside of the breeding season, the species is nomadic, seeking suitable foraging areas. It feeds on aquatic invertebrates and occurs in terrestrial wetlands, preferring inland freshwater wetlands with abundant aquatic flora (Pringle 1985; and Marchant and Higgins 1990). Core breeding habitat for the species is within the Murray-Darling Basin (NSW and Victoria), the Macquarie Marshes in NSW and in southern Queensland.

Latham's Snipe

This migratory shorebird species was recorded at a single farm dam on Mamelon Station in February 2017. Several visits to the site were made to ascertain the number of individuals present. Up to 15 individuals were recorded.

Latham's Snipe is a secretive species that occurs in swamp and marsh margins and in wet pasture, feeding mainly on earthworms and insect larvae (Pringle 1987). Latham's Snipe breeds mainly in Japan, arriving in northeast Queensland during the northern winter and then moving south through the coastal / sub-coastal areas of south east Queensland into much of eastern Australia during spring / summer (Pringle 1987; and Pizzey and Knight 2012). The species does not breed in Australia. It has been recorded in Australia from the Cape York Peninsula through South Australia. The species may occur around shallow wetlands and farm dams in the Project area.

Fifteen individuals are an unusually high number for this species on a relatively small site (approximately 0.6 ha in extent). The species was not recorded elsewhere within the Project area during the February 2017 survey (or other Project related surveys) and no other migratory shorebird / wader species was recorded within or near the ML. The Commonwealth's *Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DotE 2015a) treats Latham's Snipe differently to the other migratory shorebirds listed under the EPBC Act due to the different habitats and behaviour of the species. The Guideline states that important habitat for the species may be identified where:

- Areas have previously been identified as internationally important for the species; and
- Areas that support at least 18 individuals of the species (DotE 2015a).

Six important sites have been identified in Australia located in Victoria (five sites) and Tasmania (one site) (DotEE 2018). Therefore, the Project is not considered as 'important habitat' for Latham's Snipe.

Oriental Cuckoo

A single record of this species 1.3 km east of the ML during the March 2011 survey.

Oriental Cuckoo breeds in China, Japan and Mongolia in the northern summer. It migrates south to the Australasian region. It is widespread but sparsely recorded across eastern Queensland in the summer months (September to May). The species may occur in a wide range of habitats including relatively cleared areas such as leafy trees in paddocks (Pizzey and Knight 2012).

White-throated Needletail and Fork-tailed Swift

Fork-tailed Swift was recorded during 2011 and 2012 surveys of the wider area. White-throated Needletail recorded near the southern boundary of the mine ML in November 2017.

The White-throated Needletails and Fork-tailed Swift are widespread over eastern and south eastern Australia during the warmer months. Both species breed in eastern Asia and spend the non-breeding season mainly in Australia, and occasionally in New Guinea and New Zealand (Blakers et al. 1984; and Higgins 1999). White-throated Needletail arrives in eastern Australia in late October moving south along both sides of the Great Dividing Range as far south as Tasmania. Fork-tailed Swift also arrives in October but may occur throughout Australia (Higgins 1999). Both are aerial foraging species and can occur over most habitats including heavily disturbed areas. They are commonly associated with storm fronts. White-throated Needletail is likely to be more commonly observed in the Project area.

Rufous Fantail

A single record of this species during March 2011 survey. Most suitable habitat for this occurs along Deep Creek and Tooloombah Creek.

Rufous Fantails occur in moist habitats, including closed forest s, coastal scrubs, mangroves and along watercourses and gullies, and urban / rural areas during mid-year migration (Pizzey and

Knight 2012; Higgins et al. 2006). They predominantly feed on small insects within the understorey (Higgins et al. 2006). The species occurs across Northern Australia from the Kimberley to Cape York and down the entire eastern coast (Pizzey and Knight 2012). The eastern races migrate to the north in early autumn and return in early spring to breed (Pizzey and Knight 2012; Higgins et al. 2006).

16.13.10.3 Migratory Bird Habitat

Several man-made farm dams / wetlands of varying size occur within the Project area or immediate surrounds. The only site within the Project area, on which migratory waterbirds were recorded, is a pair of dams located within the north of the Central Queensland Coal mine area which was the location of several Latham's Snipe in February 2017. Observations in February 2017 showed water remaining in these sites despite the very dry conditions at the time. These dams may provide relatively permanent habitat for these species, although similar wetland habitat is abundant across the wider area.

As defined under the Significant Impact Guidelines 1.1 (DotE 2013), an area may be classified as an 'important habitat' for a migratory species if the area contains:

- Habitat used by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;
- Habitat that is of critical importance to the species at particular life-cycle stages;
- Habitat utilised by a migratory species that is at the limit of the species range; and / or
- Habitat where the species is declining.

It is considered unlikely the area can be considered as 'important habitat' because:

- The species were observed in low numbers and there is no evidence suggesting the region supports an ecologically significant proportion of the populations of any of these species;
- Given the widespread distribution of all of the species observed and the lack of observed breeding / nesting within the Project area, there is no evidence to suggest the habitat is of critical importance at particular life-stages for these species; and
- The Project area is not at the limit of any of the species range or is it known to be habitat where any of the species is declining.

In addition, the Project area is unlikely to serve as a significant 'staging' site (resting place and feeding ground) for migratory shorebirds travelling via the East Asian Australasian Flyway.

16.13.11 Summary of MNES Baseline

Based on a review of existing records, habitat preferences, and field survey of habitats, ecological communities, and species, the following MNES are known or are considered likely to occur within or near the Project area:

- Threatened Ecological Community:
  - Brigalow (Endangered) (known)
  - SEVT (Endangered) (known)
- Threatened Species:
  - Squatter Pigeon (southern) (Vulnerable) (known)

  - Ornamental Snake (Vulnerable) (likely)
  - Greater Glider (Vulnerable) (known)
  - Koala (Qld, NSW and ACT populations) (Vulnerable) (known)
- Migratory Species:
  - Glossy Ibis (likely)
  - Latham's Snipe (known)
  - Oriental Cuckoo (known)
  - White-throated Needletail (known)
  - Fork-tailed Swift (known)
  - Rufous Fantail (known)
- Threatened and Migratory large marine fauna (downstream of Project):
  - Green Turtle (Vulnerable, Migratory) (likely)
  - Flatback Turtle (Vulnerable, Migratory) (likely)
  - Australian Humpback Dolphin (Migratory) (likely)
  - Australian Snubfin Dolphin (Migratory) (likely)
  - Estuarine Crocodile (likely)

An assessment of the potential impacts associated with the Project on these communities and species is provided in Section 16.14.

16.14 Potential Impacts to MNES

The Project has the potential to impact MNES, including threatened fauna, vegetation communities and other ecological values within the Project area and surrounds. These include:

- TECs;
- Populations of threatened and migratory fauna;
- Habitat for threatened and migratory fauna; and
- Downstream ecological values impacting:
  - Great Barrier Reef World Heritage Area
  - National Heritage Places – Great Barrier Reef
  - Great Barrier Reef Marine Park.

Throughout the construction, operation and decommissioning phases, the Project has the potential to impact on MNES values through the following activities:

- Removal of remnant vegetation for mine infrastructure (CHPP / MIA areas), waste rock stockpile areas, dams, open cut pits, TLF and site access and haul roads;
- Topsoil stripping;
- Construction of above ground buildings and facilities;
- Day and night time operation of coal mining activities;
- Stockpiling and transportation of the coal resource; and
- General transportation movements.

Considering key threats faced by the relevant MNES and the location of potential habitat within the Project area in relation to Project activities, potential impacts relating to the TECs found within and around the Project area include: habitat clearance and degradation, changes in surface water quality and hydrology, groundwater changes, dust, weeds, and fire. These are described in further detail below.

16.14.1 Vegetation Clearance and Habitat for MNES Fauna

16.14.1.1 Threatened Ecological Communities

Clearance of remnant habitat will necessarily occur during the construction phase of the Project. The layout of the Project has changed since the publishing of the EIS and has deliberately avoided or minimised some impacts to MNES during refinement of the design of the mine and infrastructure footprint. The overall footprint of the Project is 1,124.8 ha. Under the current Project footprint an approximate total of 108.22 ha of remnant habitat is predicted to be cleared within the mine and associated infrastructure areas, haul road and TLF over the lifespan of the Project. Direct clearing of TECs (SEVT or Brigalow) has been eliminated. Remnant habitat to be impacted will be largely woodland dominated by Poplar Box and Narrow-leaf Ironbark (RE 11.4.2) or Forest Red Gum (RE 11.3.25).

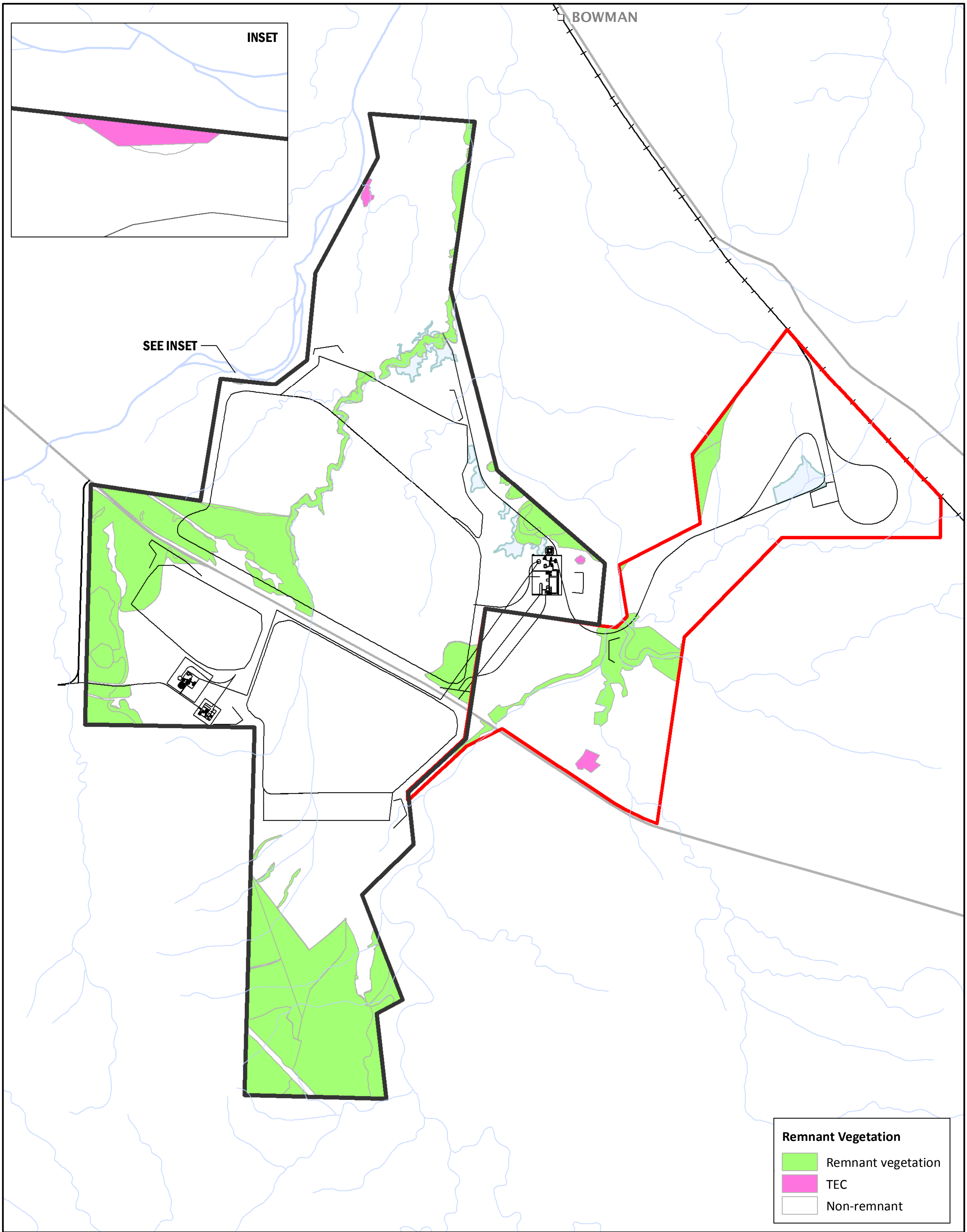
The vegetation communities and associated MNES values predicted to be impacted by clearing are described in Table 16-117 and depicted in Figure 16-143.

16.14.1.2 Habitat for MNES Fauna

Under the current Project footprint an approximate total of 108.22 ha of remnant habitat is predicted to be cleared within the mine and associated infrastructure areas, haul road and TLF over the lifespan of the Project. The majority of remnant habitat to be impacted will be open woodland dominated by Poplar Box and Narrow-leaf Ironbark (RE 11.4.2) or Forest Red Gum (RE 11.3.25). The ground-truthed vegetation communities and associated MNES values predicted to be impacted by clearing are described in Table 16-117.

This does not include vegetation communities outside the western boundary of the mine ML through which the new access road for Mount Bison Road and the CHPP / MIA 1 areas will traverse (Figure 16-143). The vegetation in this area has not been subject to ground-truthing. The proposed access road occupies 4.4 ha of lands in the following Queensland (DNRME) mapped REs: 11.4.2 (1.8 ha); and RE 11.5.8a/ 11.7.2 (2.6 ha).

Much of the mine area footprint has been cleared for cattle grazing. The remainder is dominated by grassy woodlands. Most of the haul road and the entirety of the TLF is also cleared of remnant vegetation.



N

0 0.5 1 km

Scale @ A4 1:50,000
Date: 01/11/18
Drawn: J Parnwell

Legend

- ML 80187
- ML 700022
- Mine infrastructure
- Main Road
- North Coast Rail Line
- Major watercourse
- Minor watercourse
- Dam

Figure 16-143

Revised Project RE mapping and corresponding TECs from field verification

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
QLD Department of Environment and Heritage Protection, 2016

CDM Smith

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 Mine layout & REs__16-34.mxd 11/1/2018

Table 16-117 Predicted impact on extant vegetation communities and potential MNES habitat

RE	Brief description	MNES habitat	Original impact area (EIS) (ha)	Impact area revised (SEIS) (ha)	Total within a 10 km radius of Project (ha)	Total within Marlborough Plains subregion (ha)
11.3.4	Forest Red Gum woodland on alluvial soils	Koala – Forest Red Gum is a known preferred forage tree species – core foraging habitat Greater Glider – may provide hollow-bearing habitat where it occurs next to continuous woodlands in the south of the mine ML	7.92	0.6	925.5	10,042.1
11.3.11	SEVT on alluvial soils	SEVT TEC	0.4	0	5.22	112.9
11.3.25	Forest Red Gum riparian woodland	Koala – Forest Red Gum is a known preferred forage tree species – core foraging habitat Greater Glider – provides hollow-bearing habitat where it occurs connected to continuous woodlands in the south of the mine ML Ornamental Snake – may provide habitat where it occurs within the ML adjacent to cleared / regrowth Brigalow habitat	28.1	21.27	1,332.4	2,955.8
11.3.27b	Wetlands with fringing Forest Red Gums	Koala – core foraging habitat available in surrounding trees (Forest Red Gum)	-	2.2		575.8
11.3.35	Poplar Gum /	Koala – secondary foraging habitat Squatter Pigeon – species may forage in this habitat.	-	1.4		98.8
11.4.2	Poplar Box / Narrow-leaf Ironbark woodland on Cainozoic clay plains	Koala – Foraging habitat as Poplar Box considered feed species Squatter Pigeon observed in this habitat	94.84	82.75	2058.6	6,121.3
11.4.9	Brigalow shrubby woodland on Cainozoic clay plains	Brigalow TEC Ornamental Snake – species recorded in this community outside of the Project area	0.2	0	182.7	517.2

RE	Brief description	MNES habitat	Original impact area (EIS) (ha)	Impact area revised (SEIS) (ha)	Total within a 10 km radius of Project (ha)	Total within Marlborough Plains subregion (ha)
11.10.7	Narrow-leaf Ironbark woodland on metamorphosed sediments	Koala – Narrow-leaf Ironbark considered supplementary feed species during drought Greater Glider - likely to utilise habitat where recorded in adjacent RE11.11.15a	6.84	0	513.5	88.4
11.11.15a	Narrow-leaf Ironbark on metamorphosed sediments	Koala –Narrow-leaf Ironbark considered supplementary feed species during drought Greater Glider observed in this habitat Squatter Pigeon observed in this habitat	0.11	0	1,090.6	20,698.4
Non remnant	Lands cleared for cattle grazing	Squatter Pigeon - observed in this habitat (excluding areas of regrowth Brigalow on gilgais north of Bruce Highway) Ornamental Snake – provides habitat where gilgais / regrowth Brigalow habitat observed	753 275	508 353	37,232.3	543,487.3
Total remnant vegetation area			**138.41**	**108.22**		

Squatter Pigeon

Squatter Pigeon was recorded within or near the Central Queensland Coal mine area during most surveys for the Project. Within the mine ML the species was recorded in Poplar Box woodland (RE 11.4.2), Poplar Gum woodland (RE11.5.8a), as well as Narrow-leaf Ironbark woodland in the south of the ML (RE 11.11.15a) but was more commonly observed in non-remnant habitat close to remnant or regrowth vegetation and permanent water sources (farm dams) (Figure 16-144).

This is a widely distributed species that occurs in grassy woodlands with a preference for sandy areas near permanent water. Breeding habitat for the species is said to be stony rises occurring on sandy or gravelly soils, within 1 km of a permanent waterbody (Squatter Pigeon Workshop, 2011) or on well-draining, sandy or loamy soils on low, gently sloping flat to undulating plains and foothills, e.g. Land Zone 5 and Land Zone 7 (Squatter Pigeon Workshop, 2011). Therefore breeding habitat is likely to be restricted to the southern portion of the mine ML where stony rises / hills occur, or in the west of the ML where land zone 5 occurs. Likely preferred breeding habitat is shown on Figure 16-144 and occurs outside the Project footprint.

Natural foraging habitat for the Squatter Pigeon (southern) is any remnant or regrowth open-forest to sparse, open-woodland or scrub dominated by *Eucalyptus*, *Corymbia*, *Acacia* or *Callitris* species, on sandy or gravelly soils, within 3 km of a suitable, permanent or seasonal waterbody (Squatter Pigeon Workshop 2011). The species is known to occur within 3 km of waterbodies and may utilise heavily modified habitats (including cleared areas) in order to access water, dispersal purposes, dust bathing and foraging for grass seed; however it is unlikely to move far from woodland trees (remnant or regrowth) to avoid predation by other bird species. Due to this broad habitat preference for open areas, there are no recommended REs in which this species may be found. Where non-alluvial clay soils (land zone 4) occur, the species is less likely to be present unless the ground cover has been thinned to suitable levels (Squatter Pigeon Workshop 2011; DotEE 2018). There have been no sightings of the species in habitat associated with regrowth Brigalow (on land zone 4) to the north of the Bruce Highway (refer Figure 16-144).

There are a number of farm dams and levees present on the property. Therefore, given the 'broad' habitat preferences described above, the species may potentially forage throughout the mine area when conditions are suitable (water and grass seed are present). Although, it is noted, despite repeated site visits throughout 2017 / 2018, the species was only observed in selected areas close to or within remnant vegetation, often repeatedly (across site visits), reflecting the species sedentary habits and a relatively limited home range for local individuals. Although there are substantial non-remnant grasslands in the Project area footprint it appears likely the species uses a limited subsection of the overall habitat present (favouring areas close to remnant or regrowth vegetation and permanent water sources).

Squatter Pigeon was not detected within the transport corridor but was recorded to the north of the TLF area during 2011 surveys. Clearing of remnant vegetation for the mine component predicted to impact this species will be focussed on RE 11.4.2 (82.75 ha), which may be considered potential foraging habitat only. The Project will also impact 508 ha of non-remnant grasslands with some potential as sub-optimal foraging habitat located largely south of the Bruce Highway (Figure 16-144). As noted in Table 16-117 there is abundant similar cleared non-remnant habitat located within 10 km of the Project – 37,230 ha. The impacted area represents 1.99% of this locally available area.

Greater Glider

Greater Glider was recorded in tall Narrow-leaf Ironbark woodland (RE 11.11.15a) in the south of the ML (February 2017) and in tall riparian trees on Deep Creek (RE 11.3.25) to the south of the highway. It was also recorded in the area in February 2012 although the location was not provided. The species prefers extensive tracts of woodlands with large tree hollows. The most likely habitat for the species within or near the Project is the woodlands in the southern portion of the mine ML which remains connected to extensive vegetation to the south and west and to riparian vegetation along Deep Creek which likely retains abundant large hollows in Forest Red Gums (Figure 16-145). The haul road impacts riparian habitat along Deep Creek to a minor degree (0.33 ha) although the species has not been detected north of the highway. Habitat north of the highway is fragmented or reduced to narrow riparian strips. It is uncertain how well connected this area is to the more suitable habitat in the south, given the presence of the highway and the narrow riparian habitat present in that area.

Koala

Koala (single individuals) was observed in February, September and November 2017, and June 2018 during spotlighting surveys (all within the ML boundary). Koala was also recorded in October and November 2017 on the southern boundary of the ML by remote camera (refer Figure 16-146 for locations). A road-killed individual was observed approximately 10 km east of the Project area during the February 2017 survey. Signs of Koala presence (scratches and scats) were noted during the 2011 surveys to the west of the southern portion of the ML. The mine ML comprises tracts of remnant woodlands largely comprising forage tree species (Poplar Box in RE 11.4.2) and supplementary forage species (Narrow-leaf Ironbark in RE 11.4.2, 11.10.7 and 11.11.15a). The mine ML contains a degraded and narrow linear remnant of riparian forest containing Forest Red Gum, considered a preferred forage tree species in RE 11.3.25. This habitat also occurs in better condition along both Deep Creek and Tooloombah Creek which lie adjacent to the ML boundary. A section of this habitat is impacted by the haul road crossing on Deep Creek. The mine ML also contains small patches of RE 11.3.4 adjacent to the riparian community along Deep Creek on the eastern boundary. This community also contains Forest Red Gum as well as a variety of other eucalypt species. The projected clearing of these communities required for the Project are shown in Figure 16-146 and presented in Table 16-117. Total clearing of remnant vegetation for the mine component predicted to impact this species will be 108.22 ha.

Ornamental Snake

Survey records from 2011 indicate the Ornamental Snake occurs in the wider area surrounding the Project area where it was recorded in Brigalow woodland (RE 11.4.9). No individuals of Ornamental Snake were recorded within the mine ML during targeted surveys conducted for the Project. Suitable habitat for this species may occur where alluvial cracking clays and gilgai depressions occur to the north of the Bruce Highway. This habitat has been heavily impacted by clearing but there are substantial areas of patchy to sparse Brigalow regrowth. The species does not necessarily require the presence of woody vegetation to occur and is known to occur in cleared lands where gilgais occur. Based on an analysis of aerial imagery as well as on-site observations of habitat conditions there is considered approximately 647 ha of this non-remnant habitat which may be suitable for Ornamental Snake to the north of the Bruce Highway (Figure 16-145). A degraded strip of riparian vegetation along a creek line that passes through this area may also provide shelter and foraging habitat. Nevertheless, the species does not require overhead vegetation to occur. No habitat for Ornamental Snake was identified within the area of the haul road and TLF.

Clearing of remnant vegetation for the mine component predicted to impact this species will be focussed on RE 11.3.25 where it occurs adjacent to gilgais on cracking clays (20.9 ha). The Project will also impact approximately 353 ha of non-remnant grasslands / regrowth on clay soils with potential as habitat located north of the Bruce Highway (Figure 16-145). As noted in Table 16-117 there is abundant similar cleared non-remnant habitat located within 10 km of the Project.

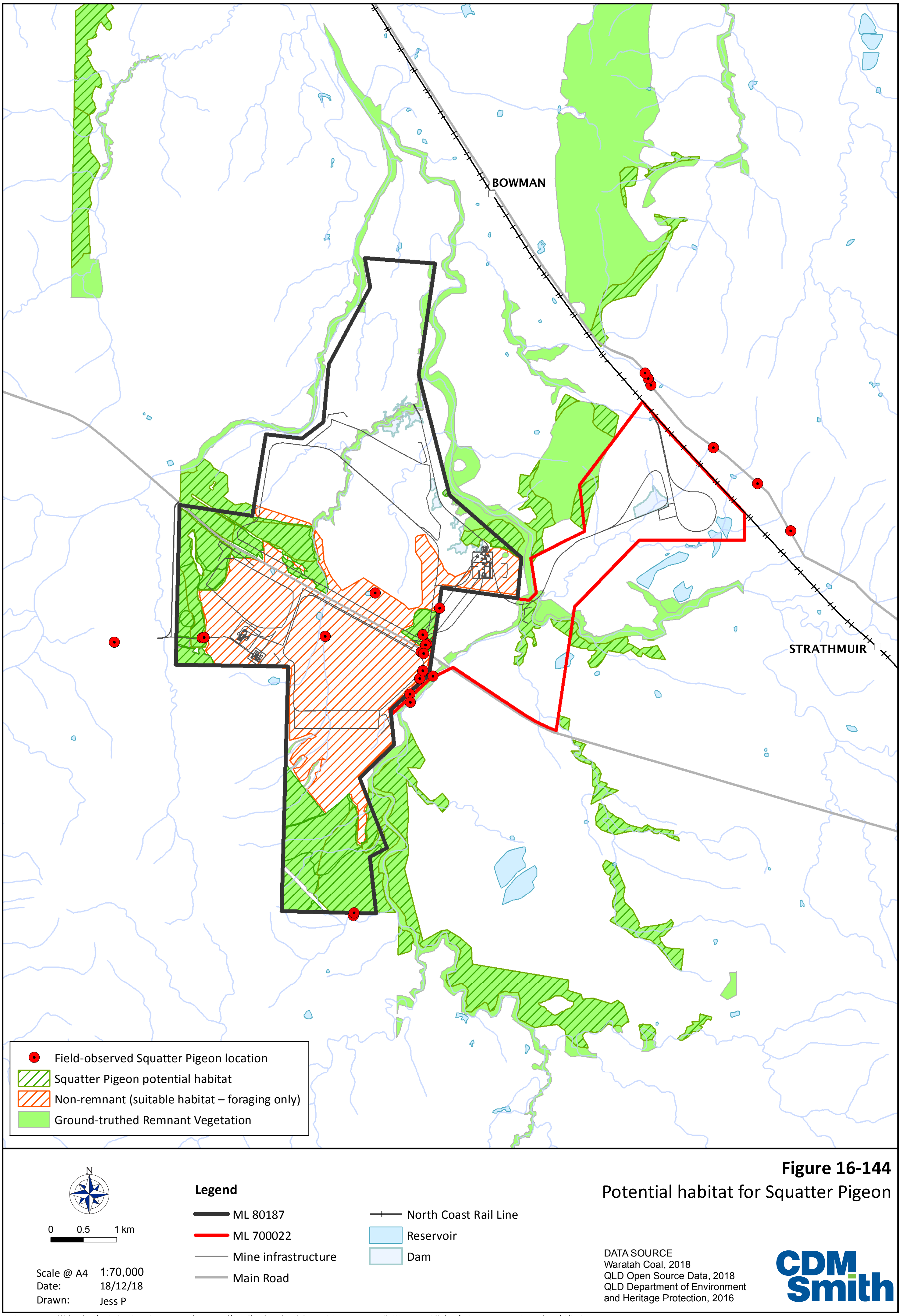
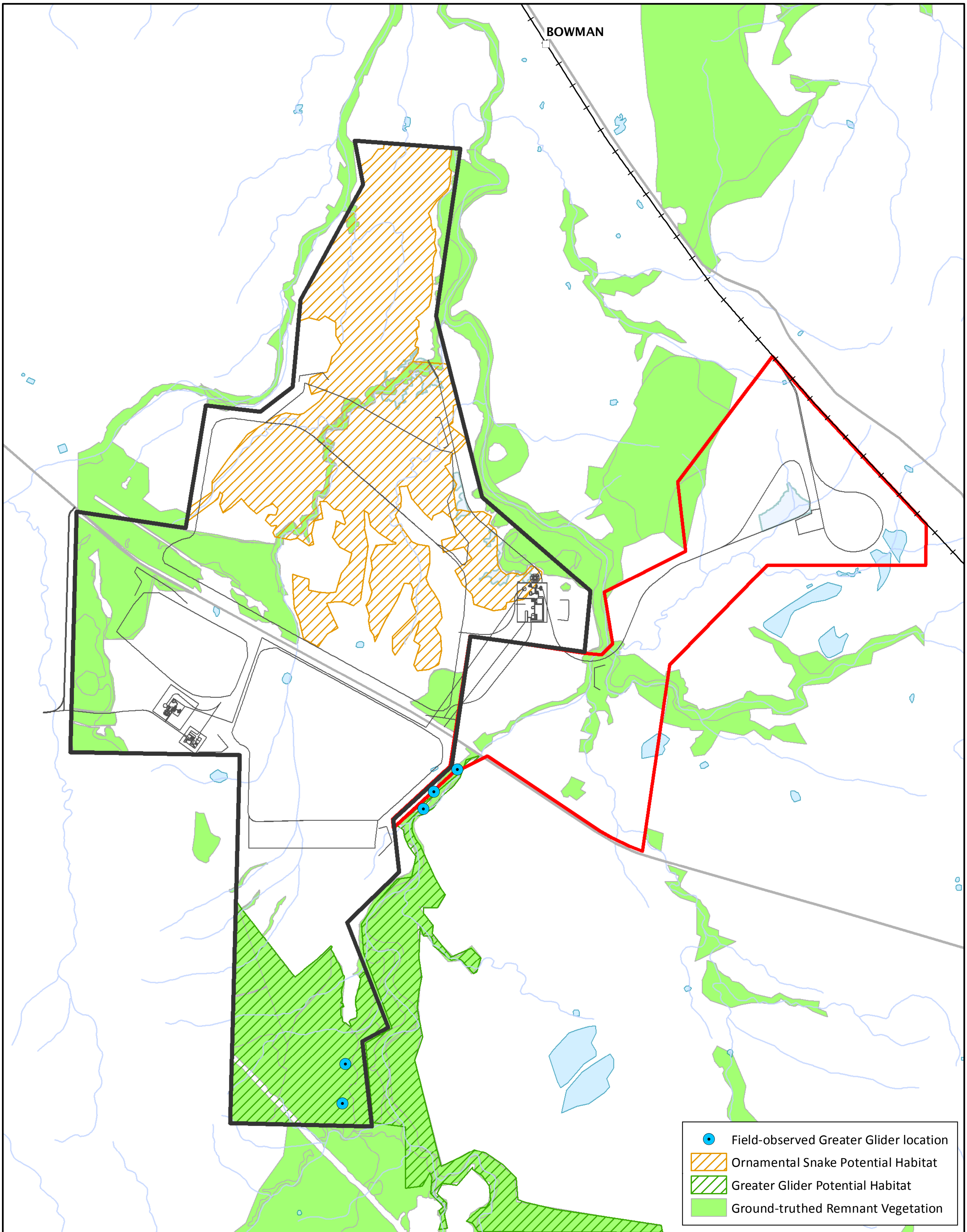


Figure 16-144

Potential habitat for Squatter Pigeon

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 Potential habitat for Squatter Pigeon__16-40.mxd 12/18/2018



N

0 0.5 1 km

Scale @ A4 1:50,000
Date: 21/11/18
Drawn: Jess P

Legend

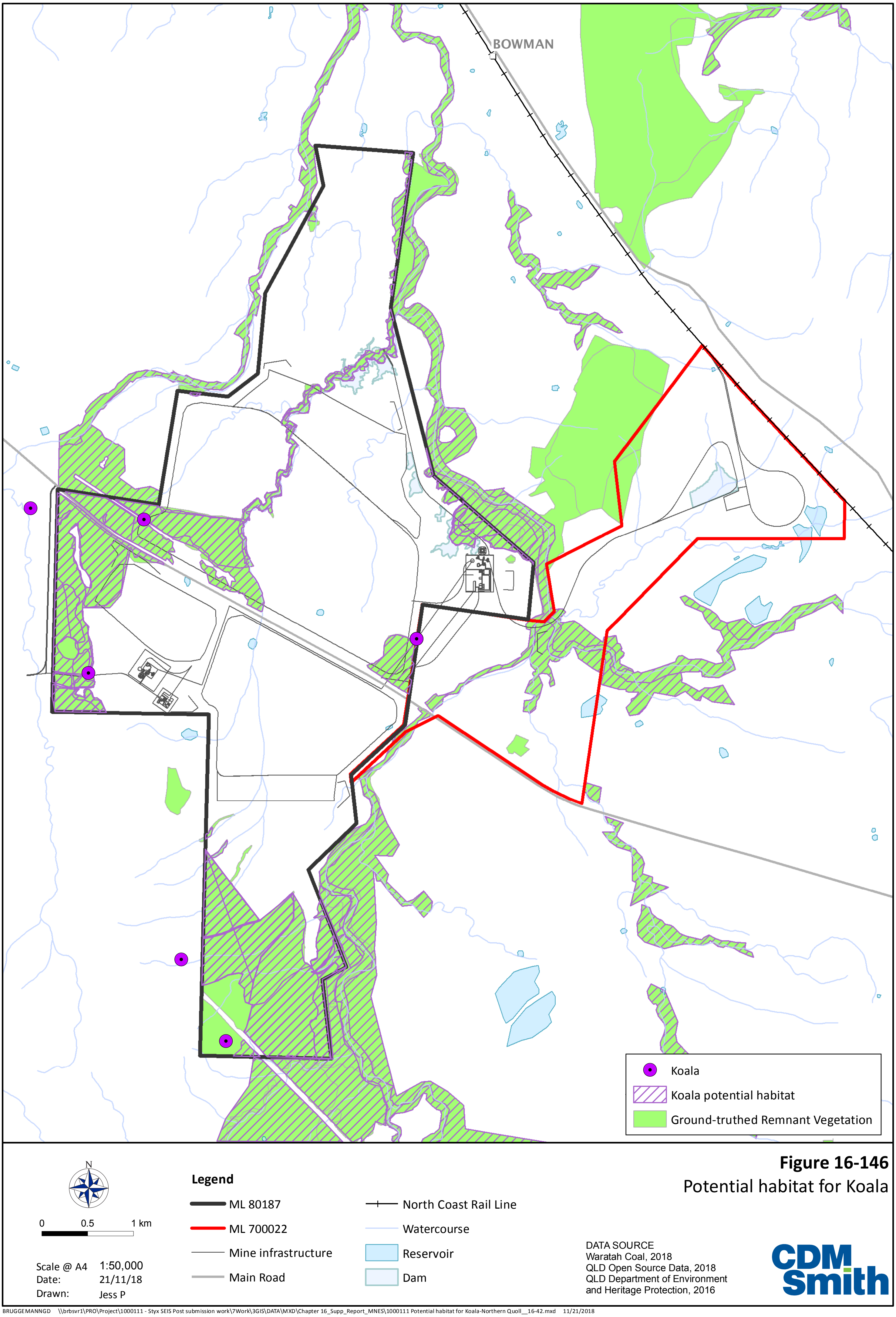
ML 80187
ML 700022
Mine infrastructure
Main Road
North Coast Rail Line
Watercourse
Reservoir
Dam

Figure 16-145
Potential habitat for Greater Glider and Ornamental Snake

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
QLD Department of Environment and Heritage Protection, 2016

CDM Smith

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 Potential habitat for greater glider & ornamental snake__16-41.mxd 11/21/2018



Scale @ A4 1:50,000
Date: 21/11/18
Drawn: Jess P

Figure 16-146
Potential habitat for Koala

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
QLD Department of Environment and Heritage Protection, 2016

CDM Smith

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 Potential habitat for Koala-Northern Quoll__16-42.mxd 11/21/2018

16.14.2 Fauna Mortality and Injury

Direct mortality to MNES fauna may occur during tree clearing and during the construction phase of the Project and collision with increased vehicular activity during all Project phases. Mortality from tree clearing has potential to impact Koala and Greater Glider. Clearing and earthworks in cracking clay / gilgai habitat north of the highway has potential to impact Ornamental Snake should it occur in the area. Squatter Pigeon is not expected to be directly impacted during clearing activity.

Increased traffic within the Central Queensland Coal mine area may impact Squatter Pigeon, Ornamental Snake (should it occur in this area) and Koala. A focus point for potential collisions may be the haul road crossing of the Deep Creek riparian corridor and adjacent alluvial habitat which provides the most suitable habitat for Koala. Increased traffic in the wider region resulting from workers accessing the Project may pose an increased risk to the regional population of Koalas, although the additional traffic generated by the Project would be negligible relative to existing traffic movements already occurring on the Bruce Highway which bisects the mine ML.

Fauna may potentially also become exposed to mortality risk if using the operational site as shelter, although the CHPP / MIA areas are located well away from vegetated habitat. The TLF is also located entirely within cleared habitat and well away from potential habitat for koala.

No impacts are expected once the decommissioning phase has been completed and no further Project related traffic occurs within the Project area.

16.14.3 Change in Surface Water Quality and Hydrology

The Project will involve the construction of structures and diversion systems which will modify surface water flows, and potentially surface water quality. The potential impacts of these may manifest mainly during the construction and operation phase of the Project.

The main construction activities that could impact on surface water quality values include:

- Excavations and earthmoving including topsoil and mine spoil removal and stockpiling, for the construction of open cut mine pits and mine infrastructure including site access roads, environmental dams, the haul road and TLF. This may potentially lead to erosion and sedimentation, deterioration of water quality, and changes to water flows; and
- The use of fuels and chemicals for vehicles and construction equipment, potentially resulting in water contamination because of spills, leaks, or other uncontrolled releases.

Operational impacts are in relation to:

- Altered catchment conditions on the hydrology of waterways and drainage lines due to open cut mine pit excavations and associated redirection of minor waterways, buildings and infrastructure and water harvesting (dams); and
- Stormwater runoff, erosion and contaminants from Project infrastructure including the TLF, waste rock stockpile areas and MIA / CHPP areas.

The Project activities that may impact surface water quality and hydrology are described in detail in Section 16.10.6. Changes in water flows and quality in water bodies have the potential to affect aquatic values associated with MNES on or adjacent to the site and associated with downstream estuarine / marine waters. The impacts on these values are considered to be minor given the management and mitigation measures discussed in detail in Sections 16.10.5, 16.10.7, and summarised in Section 16.15.

Given there is very little TEC vegetation in the Project area or surrounds, it is considered unlikely that changes to water quality and hydrology in this component of the Project area would be to the extent that they would affect vegetation, including any vegetation in TECs. Most of the Project lies within the catchment of Deep Creek. This could potentially affect aquatic MNES downstream of the Project area (Estuarine Crocodile). Squatter Pigeon occurs in the area and is reliant on permanent water sources, and therefore may also be impacted by changes to surface water quality.

Downstream MNES values potentially impacted also includes the waters and coastal habitats of the Styx River and Broad Sound which support GBRWHA OUVs. This includes coastal saltmarsh and mangrove communities which provide extensive potential habitat for Migratory shorebirds and potential habitat for MNES marine fauna species.

An assessment of potential impacts on the water quality and habitat values of Broad Sound from the existing (or baseline) water quality in the tributaries (as recorded during Project assessments) discharging into the Styx River and Broad Sound was not undertaken. A risk assessment was carried out and it was considered the risk of downstream impacts resulting from the Project with mitigation actions applied was very unlikely. It is also noted a suitable baseline water quality data set for the marine / estuarine waters of Broad Sound, on which to base an impact assessment does not appear to exist.

Broad Sound likely experiences a complex and broad range of water quality influences reflecting varying inputs from fresh and marine waters. Current widespread clearing of vegetation in low-lying areas for agriculture / cattle grazing leads to increased erosion, mobilisation of sediments and nutrients entering Broad Sound. Extensive construction of low embankments to create ponded pasture throughout the Broad Sound area have altered freshwater inputs from the catchment (Holmes et al. 2013).

Water borne pollutant inputs to the GBR lagoon (and hence Broad Sound) from land uses in the Styx Basin have been modelled as part of reporting for the wider Fitzroy Basin on the reduction of pollutant loads in the GBR catchment through improved land management practices (Dougall et al. 2014). The modelling for the Styx Basin is based on generalised data from across the catchment coupled with land use cover estimates, as there are no stream gauges in the Styx catchment to provide flow or water quality data.

A summary of results pertinent to the Styx Basin compared to the much larger Fitzroy Basin as reported in the 2013 assessment is provided in Table 16-104. It's important to note the modelled area includes minor drainages to the north which do not feed into the Styx River catchment. The modelling indicated the Styx Basin exhibits pollutant loads per basin area slightly above that exhibited by the Fitzroy Basin.

Potential water quality impacts to Broad Sound as a result of Project activities, are likely to be limited to mobilisation of sediments and associated nutrients as discussed in the following sections. Any potential impacts are expected to be mitigated through project controls, and eliminated once the decommissioning and rehabilitation phase has been completed.

16.14.3.1 Hydrology

Most of the catchment for Deep Creek and Tooloombah Creek lies upstream of the Project. Modelling of local flood levels in Deep Creek and Tooloombah Creek because of a reduction in catchment size due to Project activities shows only a very minor reduction in peak flows (refer Section 16.10.3 and 16.10.6.4). A number of Project dams will be constructed including a raw water dam (Dam 1) and environmental dams to contain rainfall run-off from Project infrastructure. The dam specifications are described in Section 16.7.3.7 and 16.10.4.6.

The biggest impact with regards to flood flow magnitude is at the Deep Creek Bridge location where several localised catchments are diverted into Deep Creek compared to the undeveloped case. These diversions are unlikely to impact the hydraulic performance of the bridge structure as the peak of the diverted flow is calculated to arrive prior to the main flood peak. This occurs due to the small size of the diverted catchments in comparison to the relatively large catchment upstream of the bridge.

The isolation of the open pits from the available floodplain has an impact on the peak flood depths within Tooloombah and Deep Creek. As the developed case assumes a 19 year planned mining scenario - flow within the tributaries located within Open Cut 1 and Open Cut 2 are completely cut-off in the model. This leads to lower depths and velocities within tributaries located downstream of the pits. The downstream end of the 2nd order minor tributary that runs through Open Pit 1 and Open Cut 2 now reports to Dam 1, bunding water below 36.4 m AHD into the local contours of the area.

This results in a decrease in the peak depths within Deep Creek and Tooloombah Creek by 0.07 m and 0.03 m, respectively. The decrease is considered minor and will unlikely affect the aquatic ecology. A concurrent minor decrease to the magnitude to peak flows is considered unlikely to impact on aquatic habitat values, particularly as peak flows only occur for a short duration of time.

A 700 ML raw water dam (Dam 1) is proposed to be built across a second order watercourse to the north of mining activities to supply potable water for the life of the Project. As the upstream catchments will be removed due to Project construction, treated water is to be pumped to the dam by pumping water from stormwater run-off collected from environmental dams associated with run-off from Project infrastructure.

Watercourse and creek crossing structures may cause an increase in runoff velocity due to construction of culverts and conveyance features that eliminate natural features such as meanders and increase in slope. However, with appropriately designed stormwater and crossing structures this is unlikely to cause more than localised and very minor changes to surface hydrology.

Given the minor changes described above no significant impacts to MNES or downstream OUVs of the GBRWHA are considered likely because of Project-associated changes to hydrological regimes in the area.

16.14.3.2 Sedimentation of Waterways

During construction and operation sediment can be mobilised and transported by surface water during rainfall events ultimately discharging into drainage lines which can result in negative impacts on water quality and aquatic habitats. Specifically, increased suspended sediments can reduce light penetration, decreasing photosynthesis of aquatic flora and decrease dissolved oxygen. This can impact values associated with the GBRWHA including marine taxa such as seagrass and algae beds, and corals. It's noted the extent of seagrass and coral habitats immediately downstream of the Project are very limited.

If stormwater runoff is not adequately contained, particularly during the construction of the mine infrastructure components, there is potential for sedimentation and contamination to adversely impact the surface water receiving environments. Erosion and sedimentation during the operation phases is most likely to occur from stormwater runoff from the coal stockpiles, CHPP / MIA areas and ongoing minor earthworks associated with the maintenance of roads and dams. Impacts to Tooloombah Creek are less likely, as this catchment is isolated from the majority of the Project infrastructure components. Environmental Dam 1b (associated with Waste Rock Stockpile 1b) and environmental Dam 2a (associated with Waste Rock Stockpile 2) both drain towards Tooloombah Creek.

This may impact downstream refugial pools in Deep Creek and Tooloombah Creek, although for the most part the Project area drains towards Deep Creek. These creeks in turn drain into the Styx River which ultimately drains into Broad Sound and hence the GBR area. Suspended sediments from runoff will likely contain elevated nitrogen and phosphorus levels due to the agricultural activities within the surrounding landscape. Background surface water quality levels of nitrogen and phosphorus in both Tooloombah Creek and (moreso) Deep Creek were regularly recorded to be above local water quality objectives for the catchment (refer Section 16.10.2.3). Increased nutrients can promote algal growth and in extreme cases result in blooms and surface water deoxygenation within low flow situations. It is noted these nutrient inputs (and any associated aquatic impacts) will continue to occur should the Project not go ahead. Should the Project go ahead this will reduce the local footprint for rainfall run-off and associated sediments entering the creek.

Baseline water quality monitoring results indicated that existing waterways generally have low to moderate turbidity and suspended sediment loads during flow periods (such as sampled in June 2011 and May 2017). During dry periods when the waterways are reduced to isolated pools high levels of turbidity and suspended sediment loads were recorded consistently in the Deep Creek sites.

An assessment of the existing sediment loads on Mamelon property has been carried out under differing stocking regimes (refer Section 16.9.3). The results of the assessment show that for the areas assessed within ML 80187 the estimated annual sediment generation potential ranges between 777 to 3,653 t/ha (dependent on cattle stocking regime). Soil loss estimate calculations undertaken for the site indicate a maximum soil loss of 217 tonnes per hectare per year, assuming no erosion and sediment controls are implemented as part of Project activities. With the installation, operation and maintenance of sediment basins to capture mobilised sediment across the site, at least 90% of sediments would be captured and retained (refer Section 16.9.4.4). In addition, Central Queensland Coal proposes to remove cattle from the majority of the property surrounding the Project and manage revegetation in cleared areas as part of the Project's environmental offsets management activities. In the long term this will represent a significant reduction in downstream sedimentation emanating from the property compared with the current grazing regime.

Excessive sedimentation can impact downstream shorebird habitat through structural changes to foraging habitat or by carrying excess nutrients (TSSC 2016). Shorebird species largely employ specialised feeding techniques and are therefore vulnerable to minor changes to prey sources and foraging habitat. Nutrient enrichment of marine waters may promote blooms of algae, phytoplankton or cyanobacterium, which can significantly affect the local invertebrate community, with consequent deleterious effects on foraging shorebirds (Estrella 2011).

Poor water quality can negatively impact the health of inshore dolphin species and their habitat (GBRMPA 2012). Studies on stranded inshore dolphins have implicated urban sewage and stormwater run-off in a number of deaths (e.g's Parsons and Jefferson 2000; Bowater et al. 2003). Similarly, poor water quality may impact marine turtles and their habitat (GBRMPA 2014). It is noted there is no evidence of seagrass habitat (habitat for Green Turtle) occurring in the area of Broad Sound downstream of the Styx River. Poor water quality is associated with increased disease risk in marine turtles in areas near dense human populations, agricultural run-off, polluted coastal areas, and biotoxin producing algae (Aguirre & Lutz 2004; Norton & Walsh 2012).

The waters of Broad Sound are shallow and subject to a large tidal regime with resulting naturally high turbidity levels. The currents associated with the tides already leads to constant resuspension of sediment in the water column. The turbidity plume extends outwards from Broad Sound to local islands in the Capricorn area of the GBR (Kleypas 1996). When combined with the extreme tidal range (potentially leaving prolonged exposure of the substrate during low tides) there are few marine habitats supporting MNES marine fauna and GBR OUVs directly downstream of the Project (such as coral reefs and seagrass meadows) (refer Figure 16-132).

Downstream mangrove communities entrain suspended sediments contributing to the extension of existing mud banks (Furukawa 1996) in the area. The release of suspended sediments may have some potential to extend mangrove habitat thereby potentially creating more breeding habitat for fish species and / or encroaching on foraging habitat for threatened migratory shorebirds, although this effect may be subdued by the large tidal regime in the area. As described previously a number of water diversions and environmental dams will be constructed as part of the Project layout minimising entrained sediments (associated with the Project) entering the creek lines during heavy rainfall events. In addition the Project has committed to the removal of cattle from much of the property (as part of environmental offset management) and allow vegetation regeneration in cleared areas. As a result, current levels of sediment and associated nutrient loss from the property would be expected to decrease over time.

Several Project components, including the site access road and haul road, will traverse a number of drainage features. At these crossings impacts may include riparian vegetation clearing, direct deformation of the bed and banks, and alteration of hydrological flows. Consequential impacts may include decreased instream and riparian habitat, and vegetation removal and earthworks leading to increased erosion and sediment entering downstream waterways. The haul road crosses Deep Creek and Barrack Creek. There are no large waterholes at these crossing points which will require direct disturbance during construction. As a result, no direct impact to terrestrial MNES habitat is considered likely.

16.14.3.3 Accidental Release of Pollutants

Changes to surface water quality may occur due to contaminated rainfall runoff from the haul road, waste rock stockpile areas, coal stockpiles, coal conveyor and other infrastructure elements such as environmental dams. Coal mine water collected in dewatering and sediment dams may contain a range of pollutants (depending on the source material) such as hydrocarbons and heavy metals. Other potential chemical contaminants from Project activities may include: aqueous waste streams including oily waste water (from heavy equipment cleaning); contaminated runoff from chemical storage areas; potentially contaminated drainage from fuel oil storage areas; and general washdown water.

Contaminated runoff has the potential to impact potential habitat for Estuarine Crocodile should waterholes on Deep Creek, Tooloombah Creek and the upper Styx River be impacted. Unmitigated contaminated runoff has the potential to affect water quality entering the Styx River and Broad Sound, temporarily impacting localised GBR OUVs. Impacts include the degradation of stream habitat quality near the Project and to a much lesser likelihood, adversely impact downstream estuarine / marine waters and habitats (such as saltmarsh, mangroves and mudflats) associated with GBR OUVs in the Broad Sound area. In the extreme case this may cause mortality to MNES fauna (migratory shorebirds and large marine fauna).

During operations, Deep Creek and Tooloombah Creek are not anticipated to be directly impacted by surface water runoff from Project facilities (such as the CHPP / MIA areas) as runoff will be captured in a number of environmental dams for re-use or treatment. Cattle will be excluded from the majority of the property and riparian vegetation will be allowed to regenerate. This will create a vegetated buffer to the creeks reducing sediment and nutrient inputs from the property. Together with Project erosion and sediment controls detailed in Section 16.9.4.3 and 16.9.4.4 and outlined in 16.15.3.2 it is predicted there will be minimal (if any) impact on surface water runoff, and in the long-term water quality of runoff may improve due to improved land management practises (refer Section 16.9.4.2).

Deep Creek which is located approximately 250 m from the eastern edge of the Open Cut 1 pit area and 500 m from the south-eastern corner of Open Cut 2. Other potential sources of pollutants include the MIA / CHPP 2 areas which are located approximately 250 m and 500 m from Deep Creek respectively. Surface water run-off from the TLF facility will be diverted into environmental dams for remediation before discharge into Barrack Creek. All discharges of mine-associated water will be strictly controlled under water quality conditions set by DES and will be designed to have no, or a negligible impact on adjacent and downstream waters.

The Waste Rock Stockpile 1a and 1b, and Waste Rock Stockpile 2 cover 35.6 ha, 83.2 ha, and 124.5 ha respectively. Waste Rock Stockpile 1a is located relatively close to Deep Creek. The boundary of Waste Rock Stockpile 2 is located close to both Deep Creek and Tooloombah Creek. These areas thereby have potential to release contaminated run-off into the creeks, if engineering controls are not put in place.

A number of analyses were carried out of the potential for the waste rock and coal rejects produced by the Project to release contaminants. The results include the following:

- A low risk of acid generation with more than 98% of samples analysed considered as 'non-acid forming';
- Leachate from waste rock and coal reject materials may contain elevated concentrations of dissolved arsenic, molybdenum, selenium and vanadium when compared to potential water quality monitoring criteria. Metal / metalloid concentrations in water extracts (RGS 2012) were generally consistent across composition samples and therefore likely consistent with existing concentrations within the regional geology and associated aquifer. The waste rock was classified as acid consuming and likely to remain pH neutral to alkaline following excavation. Therefore, dissolution of heavy metals in an acidic environment is unlikely; and
- Waste rock and potential coal reject samples were alkaline and moderately saline, while sodicity was very high. Strongly sodic materials are likely to have structural stability problems related to potential dispersion.

The waste rock is expected to have a low capacity to be potentially acid forming and moderate saline drainage potential. The waste rock has potential to be highly sodic. There is some potential for leachate from extracted waste rock and fine rejects to enter local waterways and degrade water quality. Rainfall on the stockpile areas are unlikely to cause any significant mobilisation of contaminants within the solid reject material given the geochemistry of rejects.

Rainfall run-off from both stockpile areas will be captured in specific environmental dams to avoid contaminated water draining into the adjacent creeks. The location of the waste rock environmental dams are shown in Figure 16-143. The dams will be built to hold a 4.9% AEP standard flood level capacity (with a spillway rating of 0.2% AEP) and are considered sufficient to meet the requirements for the potential flood events over the life of the Project.

The proposed detailed design of the water storages and other water infrastructure components associated with the Project is described in Section 16.7.3.7 and 16.10.4.6.

16.14.4 Change in Groundwater

Modelling of the potential drawdown effect of the open cut mine operations has been updated based on the collection of further groundwater data since the EIS. This includes the establishment and sampling of 16 Project monitoring bores installed from September 2017 to March 2018. A further 30 Project monitoring bores have been installed in September and October 2018. These have been specifically located to provide greater coverage around the Project (for groundwater heads and quality), especially near to watercourses to assess potential for groundwater and surface water interactions and vertical hydraulic gradients between shallow and deeper hydrostratigraphy. There is now greater confidence in the modelling results as described in Section 16.11.3 and in detail in the Groundwater Technical Report (Appendix A6).

The Project area is dominated by shallow alluvial aquifers which are intersected by deeply incised ephemeral creeks. Recharge to this system is from direct rainfall, leakage from the creeks during surface flow events and from the underlying units. Surface pools exist within the streambeds of Tooloombah Creek and Deep Creek. The pools in Tooloombah Creek and in the lower reaches of Deep Creek are likely to be groundwater fed (i.e. Type 2 GDEs) during extended dry periods (refer Section 16.11.2.1). A review of groundwater bore information and groundwater dependent ecosystems in the Project area indicates the water table reaches the rooting depth of riparian vegetation along Tooloombah Creek and Deep Creek (RE 11.3.25) and the alluvial community adjacent to Deep Creek (RE 11.3.4) although there is a lack of understanding around the groundwater environmental requirements of these communities. Elsewhere (i.e. away from watercourse), the water table is deeper, generally >10 mbgl and it is unlikely that groundwater forms a large proportion of terrestrial GDEs water requirements, if at all.

The Project area is characterised by local to intermediate groundwater flow systems (i.e. the distance between recharge and discharge zones ranges between less than a few kilometres up to between 10 and 20 km). Groundwater flow analysis shows that, prior to mining, groundwater discharges locally to the major tributaries of Styx River (Tooloombah and Deep Creeks), as well as Styx River itself and the Broad Sound estuary, as well as having deeper discharge through to the coast. Where the water table is close to surface (generally within a few metres), which will be typical along the riparian zone of most stream reaches in the mid to lower catchments of Tooloombah and Deep Creeks, Styx River and the Broad Sound estuary, significant amounts of groundwater will be lost via evapotranspiration either directly from the water table or from plant transpiration.

The Project has potential to impact groundwater values through the following:

- Impacts to groundwater quantity;
- Impacts to groundwater quality;
- Impacts to surface water and groundwater interaction; and
- Physical disruption of aquifers.

These impacts are described in detail in Section 16.11.3. The overall impacts associated with the Project relate to groundwater drawdown impacts and their potential impact on waterholes along Deep Creek and Tooloombah Creek, adjacent riparian vegetation that may provide preferred habitat for Koala, and local alluvial habitat which provides preferred habitat for Koala. Figure 16-147 depicts the maximum impact of groundwater drawdown predicted to be 10 years after the cessation of mining.

The predicted 0.1 m drawdown contour does not extend past the lower reaches of either Tooloombah or Deep Creeks. As such there are expected to be no impacts to values associated with the GBRWHA values from offsite processes such as acid sulfate soil or salwater intrusion (refer Section 16.11.3.6).

The following sections provide a summary of predicted impacts to GDEs and associated MNES values from the impacts of groundwater drawdown. These impacts are described in detail in Section 16.11.3.6.

16.14.4.1 Impacts to Type 1 GDEs

Groundwater drawdown has potential to impact on the vertical extent of stygofauna habitat. A maximum drawdown of around 13 m is predicted at the location of the bore (STX 093) where stygofauna have been identified (Figure 16-147) between 2036 and 10 years following the end of mining. The predicted rate of drawdown at this location is around 1.5 m/yr. Water is not suddenly removed, allowing stygofauna to move deeper the alluvium water column.

At this location the alluvial aquifer is estimated to have a saturated thickness of around 15 m, corresponding to an approximate maximum 90% loss of vertical habitat for stygofauna. Although, streamflow recharge can be expected to mitigate this loss of habitat to some extent. Full recovery of the water table to pre-mining condition is predicted to occur by around 50 years after mine closure, with a 50% recovery occurring approximately 15 years after closure.

Stygofauna at this site are therefore likely to undergo a substantial decrease in localised habitat availability and may no longer occur in the area. However, it is considered extremely unlikely that the stygofauna taxon found at the bore (unknown taxa of water mite – Acari) will be restricted to this area or the local catchment. Therefore, no stygofaunal species is restricted to the potential impact area. On the other hand, a sample that does not contain taxa does not necessarily indicate complete absence in that aquifer setting.

Other locations where stygofauna were detected are located over 5 km north of the nearest modelled groundwater drawdown contour (Figure 16-147) and are not likely to be impacted.

16.14.4.2 Impacts to Type 2 GDEs

Groundwater drawdown has potential to impact on baseflow rates (flux) to streams and, consequently, aquatic ecosystem function. Predicted water table contours during mining show groundwater flow is diverted to the mine pit (due to dewatering / depressurisation) impacting the mid-catchment of Tooloombah and Deep Creeks (refer Figure 16-106 to Figure 16-109; and Figure 3-19 to Figure 3-25 of Appendix A6 – Groundwater Technical Report).

Shallow surface pools exist within streambeds of Tooloombah Creek and Deep Creek which are groundwater fed (i.e. Type 2 GDEs) during dry periods. The sources of groundwater supporting the Type 2 GDEs in the catchment include stream losses from surface flow events, discharge from the alluvial aquifer and / or interception of the shallow water table by deep streambeds. Along the length of Tooloombah Creek, Styx River and the lower reach of Deep Creek, the Type 2 GDEs are likely to be supplied by discharge from local groundwater flow systems, and the connection to groundwater is likely to be permanent. In the mid to upper reaches of Deep Creek, the water table is relatively flat, and the connection of Type 2 GDEs to groundwater is likely to be ephemeral, dependent on the magnitude of the rise and fall of groundwater levels in response to recharge events.

All watercourses are likely to experience losing conditions during and following high surface flow periods, when the deep-water column within the streams (>5 metres) will recharge the adjacent Quaternary sediment aquifer. As the surface flow recedes, gaining conditions can return where bank storage drains back to the stream, a local groundwater flow system drives flow to the stream, or where shallow water tables are intersected by the streambed. A decline in groundwater levels (e.g. from prolonged periods of dry weather with little to no surface flow events, or from drawdown caused by mine dewatering) may result in a reduction in the volume of discharge (baseflow and evapotranspiration) and may potentially cause disconnection of the Type 2 GDEs from groundwater (and consequently, an adverse impact on aquatic ecosystem function).

Numerical groundwater modelling predicts 0.5 m to 5 m drawdown along the mid-reach of Tooloombah Creek and 1 to 7.5 m drawdown along the mid-reach of Deep Creek until around 50 years post-mining. Although, the maximum predicted drawdown occurs at around 10 years after the cessation of mining (Figure 16-147) with recovery toward pre-mining levels commencing from approximately 25 years post-mining. Predictions indicate that a baseflow reduction (potentially >30%) will occur along the mid-lower reaches of Tooloombah Creek (i.e. downstream of the Bruce Highway) and tributaries during mining. Conditions will return to pre-mining levels after closure with approximately 50% recovery by around 65 years after mine closure, and the remaining 50% occurring within another 20 years. No drawdown or baseflow reduction is predicted along lower reaches of Tooloombah and Deep Creeks (immediately upstream of their confluence), or Styx River and Broad Sound estuary.

Groundwater baseflow reduction will occur along the entire reach of Deep Creek and tributaries with the following predicted effects:

- Less than 10% reduction for the upper reach (i.e. upstream of the confluence of Deep Creek and Barrack Creek; refer Figure 16-147) with a slow return to pre-mining levels within around 75 years after closure;
- Upwards of 40% reduction for the middle reach (i.e. between the confluence of Deep Creek and Barrack Creek and the confluence with the tributary that runs through ML 80187 and is impacted by Dam 1; refer Figure 16-147) with a slow return to pre-mining levels after closure (~25% recovery by around 60 years after closure, and the remaining ~75% occurring within another 20 years or so); and
- Less than 10% reduction for the lower reach (from the confluence with the tributary downstream to the confluence of Deep and Tooloombah Creeks; refer Figure 16-147) with flux slowly returning to background within around 75 years after closure.

A low threat of adverse effects are expected along stream reaches supporting permanent pools within the predicted 0.1 m to 0.5 m drawdown contour, while more than 1 m drawdown is expected to cause a moderate to high threat. Based on this classification, mining effects are expected to pose a low threat of adverse impact to 3.4 km of Tooloombah Creek and 3.3 km of Deep Creek, while a moderate to high threat is expected at 2.4 km of Tooloombah Creek and 3.9 km of Deep Creek (Figure 16-147). This is an overestimate of the extent of potential impact area given permanent pools do not occur along the entire length of creek bed.

16.14.4.3 Impacts to Type 3 GDEs

Type 3 GDEs (including RE 11.3.25 and RE 11.3.4) occur along the riparian zones and adjacent alluvial flats of Tooloombah Creek and Deep Creek. These GDEs are regarded as habitat for an MNES species: Koala. Two wetland areas mapped as Type 3 GDEs (Figure 16-101) are not considered connected to groundwater and therefore will not be impacted by groundwater drawdown (refer Section 16.11.2.1).

The water requirements of these vegetation communities may include multiple sources of water including soil water stores, seasonal soil water from surface water flow and groundwater. The proportion of water use from each source making up the water requirements will influence the vegetation community's resistance to changes in groundwater. For example, if the predominant source of water use is soil water, then changes to groundwater may be less likely to adversely impact the vegetation community.

The water requirements of GDEs relevant to the Project area is uncertain. It is; however, assumed that vegetation communities along riparian areas, where the depth to groundwater varies from around 10 mbgl along creek banks to 0 mbgl (i.e. at ground surface) within creek beds, are likely to utilise groundwater during dry periods when the soil water reservoir becomes depleted (i.e. seasonally). In terrestrial areas (i.e. away from riparian zones), the depth to groundwater is typically between 10 and 20 mbgl or deeper. Although these observations do not preclude deep-rooted plant species from potentially using underlying groundwater, it is likely that groundwater is only a small component of water use during extended periods of limited soil water availability (i.e. droughts).

A decline in groundwater levels may result in a reduction in the volume of water available to Type 3 GDEs for transpiration and consequently, an adverse impact on riparian and terrestrial ecosystem function. Between 0.1m and 5 m drawdown is predicted beneath riparian GDEs (RE 11.3.25) along Tooloombah Creek. Between 0.1 and 7.5 m drawdown is predicted beneath riparian GDEs (RE 11.3.25) along the majority of Deep Creek. Although only a small section of Deep Creek to the south of the Bruce Highway is predicted to be impacted beyond the 5 m drawdown contour (refer inset Figure 16-147). Between 0.1 m and slightly more than 2 m drawdown is predicted beneath terrestrial Forest Red Gum woodlands on alluvial plains (RE 11.3.4) associated with Deep Creek.

No drawdown is predicted along the lower reaches of Tooloombah and Deep Creeks (immediately upstream of their confluence), or the Styx River and Broad Sound estuary. Less than 1 m of drawdown is predicted on the western side of Tooloombah Creek excepting a small area to the north of open cut pit 2. The eastern side of Deep Creek experiences drawdown of between 0.5 m and 3.5 m along two stretches of the creek to the west of the pits and north-west of open cut pit 2. This impact extends approximately 800 m east of the creek at its maximum extent (Figure 16-147).

Given the limited understanding of the temporal nature of the use of groundwater for Type 3 GDEs relevant to the Project, the impacts have been considered based only on whether or not groundwater is available for use (i.e. the time of exposure to direct effects has not been taken into account) (refer Section 16.11.3.2 for further information). Drawdown of between 0.1 m and 1 m in riparian areas is considered to cause a low threat of adverse impacts to Type 3 GDEs while more than 1 m of drawdown is considered a moderate to high threat. Based on this classification and ground-truthed vegetation mapping, mining effects are predicted to pose a low level threat to an area of 40.3 ha of vegetation communities along Tooloombah Creek and 62.4 ha along Deep Creek. A moderate to high threat is predicted in vegetation communities encompassing 8.3 ha along Tooloombah Creek and 34.2 ha along Deep Creek.

In terrestrial areas (i.e RE 11.3.4 located where the water table is less than 10 mbgl), a low to moderate threat is considered to occur if drawdown is between 0.1 m and 5 m while a high level of threat is considered if drawdown exceeds 5 m. Ground-truthed vegetation mapping indicates there 14.25 ha of this community within the 0.1 m to 5 m groundwater drawdown contour. There are no occurrences of this community where the drawdown exceeds 5 m. These potential impacts are summarised in Table 16-118.

Table 16-118 Extent of potential threat on identified Type 3 GDEs from predicted groundwater drawdown

Threat level	Riparian vegetation (RE11.3.25)	Terrestrial vegetation (RE 11.3.4) where water table < 10 mbgl	Terrestrial vegetation (RE 11.3.4) where water table > 10 mbgl
Low to moderate	*Drawdown < 1 m* – Tooloombah Creek – 40.3 ha Deep Creek – 62.4 ha	*Drawdown < 5 m* – 14.25 ha	*Drawdown 5 m to 10 m* – 0 ha
Moderate to high	*Drawdown > 1m* - Tooloombah Creek – 8.3 ha Deep Creek – 34.2 ha	*Drawdown > 5 m* - 0 ha	*Drawdown > 10 m* - 0 ha

The rate at which draw down occurs is expected to influence the extent of adverse impacts. It is expected that a slow rate of draw down will result in a lesser impact as it is expected that root systems will, in part and over time, adjust to the lower water table. Conversely, a sharp and severe reduction in groundwater levels would be expected to result in a greater adverse impact.

16.14.4.4 Potential Impact on Threatened Ecological Communities

Brigalow (*Acacia harpophylla* dominant and co-dominant)

Vegetation communities comprising the Brigalow TEC on the site (RE11.4.9) occupy shrink-swell dark clays (vertosols) with well-developed gilgai microtopography in the upper soil profile (0.6 m to the surface) where the bulk of nutrient recycling occurs. The subsoil components are however typically strongly cohesive clays with high levels of salinity, sodicity, acidity and phytotoxic concentrations of chloride which may reduce the effective rooting depth in these soils (Dang et al. 2008; Grant 2012).

Johnson et al. (2016) describe brigalow as 'a clonal species with stems arising from horizontal roots which draw resources from a substantial area around the plant'. The concentration of the Brigalow root mass in the upper soil profile enables the species to sucker profusely from horizontal roots after physical disturbance, and also limits the capacity for other woody species to compete for moisture and nutrients. Brigalow's shallow rooting habitat is evident with the tendency of mature trees to topple as a result of churning in the upper soil profile with fallen trees universally exposing a well-developed lateral root system with little evidence for development of deeper tap roots.

With consideration given to the physical and chemical limitations of soils associated with Brigalow and the shallow rooted nature of the Brigalow tree itself, it is unlikely that Brigalow vegetation communities can be considered as a GDE and therefore, is unlikely to be subject to impacts from groundwater drawdown.

Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar Bioregions

There are several patches of SEVT in or adjacent to the Project area associated with Tooloombah Creek. These patches (mapped as RE 11.3.11) occur on an alluvial bench formed from fine silty sand that is elevated well above the flood channel of Tooloombah Creek.

Pre-dawn leaf water potential (LWP) measurements were undertaken on four species of canopy tree from within SEVT located within the mine ML during very dry conditions in August 2018 (refer Section 16.9.9.1). The measurements indicated all trees are under significant water stress with all measurements at or below the standard wilting point for crops (-217 psi) with the largest of the trees measured, an emergent Narrow-leaved Bottle Tree (*Brachychiton rupestris*) demonstrating a measured LWP of 812 psi (approximately four times below standard wilting point). Despite the obvious water stress, all plants were observed to be physically healthy with dense, green canopy foliage demonstrating an ability to withstand drought conditions.

The significant water stress that was evident in this habitat is a clear indication that constituent SEVT trees are not utilising groundwater even in the driest seasonal periods, and that a dependence on groundwater is not necessary for habitat survival and persistence. This accords with the findings of Yates et al. (1988), Unwin and Kreidemann (1990) and Bowman (2000) that rainforest trees have capacity to withstand considerable drought stress. As such, it is considered unlikely that the SEVT community associated with the Project area and surrounds can be considered as a GDE and therefore, is unlikely to be subject to impacts from groundwater drawdown.

16.14.4.5 Summary – Impacts to MNES Values

Groundwater drawdown may result in long-term (up to 50 years post-mining) impacts to the following MNES:

- Riparian and alluvial Forest Red Gum communities in these same areas may suffer adverse impacts in the long-term if groundwater levels decline below the necessary rooting depth required for tree species within this community. These habitats provide foraging habitat for Koala (Vulnerable - EPBC Act).

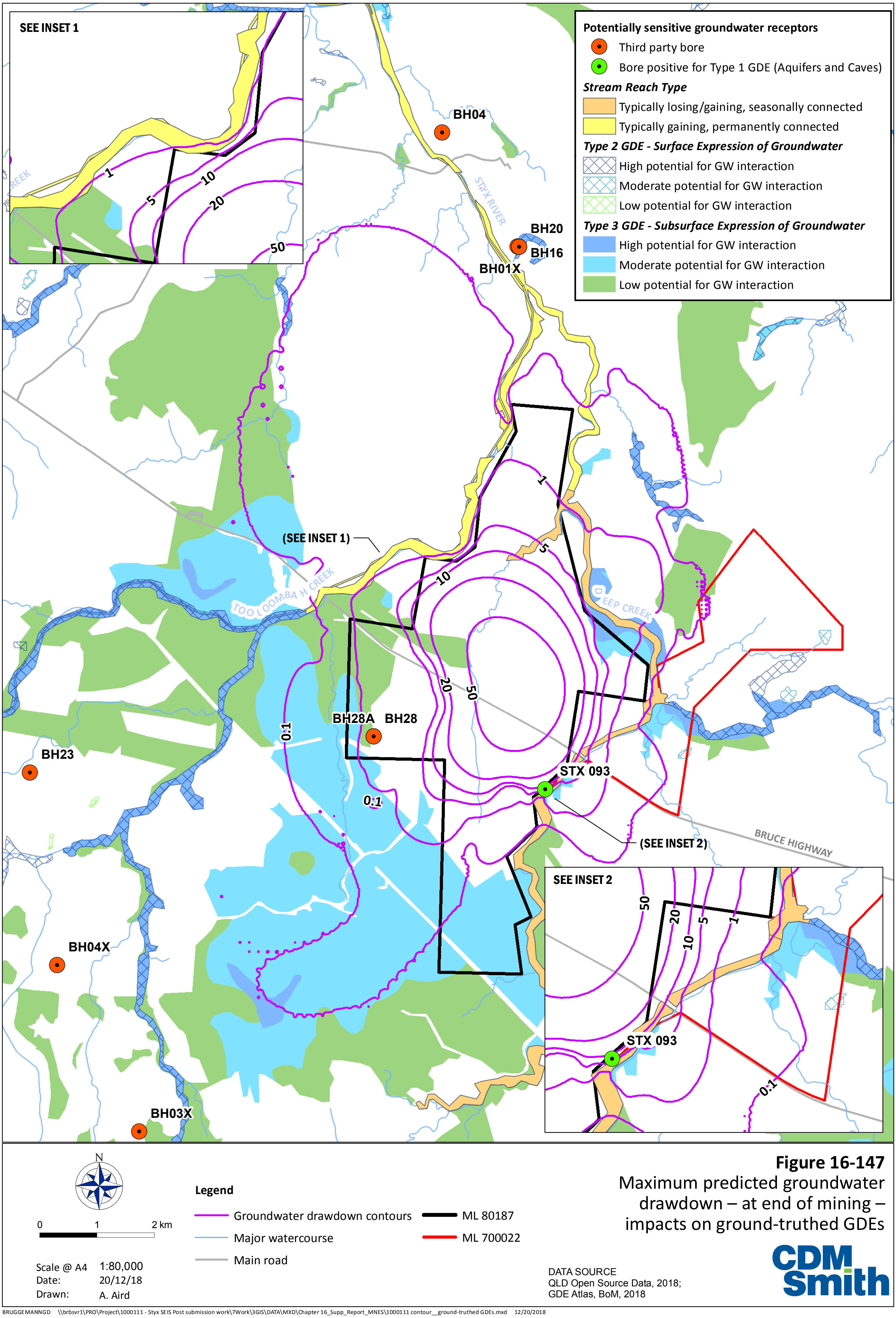


Figure 16-147
Maximum predicted groundwater drawdown – at end of mining – impacts on ground-truthed GDEs

16.14.5 Dust

Increased dust resulting from excavations, topsoil stripping, vehicle movement, open cut mining activities, construction of infrastructure, coal transport (by road and conveyor) and from coal stockpiles has the potential to impact local flora and fauna values within and surrounding the Project area throughout construction and operation.

Coal dust can result in adverse impacts on plant photosynthesis and productivity (Chaston and Doley 2006), changes in soil properties ultimately impacting plant species assemblages' (Farmer 1993; Spencer and Tinnin 1997), and mortality and / or decrease in aquatic health on aquatic communities from the toxicity of poor water quality. Naidoo and Naidoo (2005) found coal dust on mangroves located within 3 km of a coal terminal in South Africa impaired the productivity of two out of four species tested by reducing photosynthetic activity. It is noted only leaves that were 'extensively covered and appeared black' were tested.

The deposition of (unpaved) road dust on nearby freshwater wetlands caused by heavy traffic increases due to energy development projects found minimal impact on water quality or soils (Creuzer et al. 2016). However, the actual impacts on wetlands or wetland vegetation from coal dust deposition, as (opposed to increased atmospheric dust) appear little studied.

The predominant wind directions from the region are as follows: from the north and northeast during spring; north, northeast and southeast during summer; in autumn, the winds are primarily from the southeast; and southerly and southeast winds are more frequent during the winter season. Modelling of potential dust particle deposition resulting from both Project construction and operation activities showed the areas most likely to be impacted were receptor points located to the direct west of the Project (Tooloombah Creek service station) and in the Ogmore area to the north of the Project. However, these impacts were minimal in comparison to the modelled natural background dust concentration and all concentrations were below air quality criteria set by the State under the Environmental Protection (Air) Policy 2008 (refer Chapter 4 – Climate of the SEIS for more information).

As shown on the revised layout for the mine (see Figure 16-143) the coal conveyor is no longer located along Deep Creek, as reported in the EIS. Vegetation along Deep Creek in the vicinity of the Project area has potential to be impacted during construction works for infrastructure (such as access roads), the CHPP / MIA 2 area, the raw water dam (Dam 1) which is located within 500 m of Deep Creek. Operational Project components located close to creek lines includes Open Cut 1 and Overburden Stockpile 1a (200 m to 300 m from Deep Creek), Open Cut 2 (north-west corner adjacent to Tooloombah Creek and south-west corner adjacent to eucalypt woodland), and Overburden Stockpile 2 (approximately 220 m from both Tooloombah and Deep Creeks at the closest points). It is important to note that mining activities in the open cut pits and Stockpile areas will be sequential and will include rehabilitation of mined areas as the Project progresses.

The haul road crosses Deep Creek and Barrack Creek, although there are no large, permanent pools on either creek at, or near, the proposed haul road crossing points. Dust emitted during coal transport may have a minor potential to impact riparian vegetation associated with the creeks where they occur adjacent to the haul road. Refer to Chapter 12 – Air Quality for further information.

Chronic exposure to high and localised concentrations of fine coal particles (as associated with bulk coal marine transport spills) have been found to have lethal effects on coral and impact the growth rates of tropical fish and seagrass (Berry et al. 2016). Coal contains contaminants such as metals and polycyclic aromatic hydrocarbons which may pose a risk to aquatic organisms including marine species. However, recent research indicates the risk of these contaminants leaching into seawater is low (Jaffrennou et al. 2007; Lucas and Planner 2012, Berry et al. 2016). The risks of fine coal particles in water are likely to be physical processes where there is a concentrated point source or plume of particles. This may have effects such as the physical smothering of benthic fauna, and attenuation of light inhibiting algae (Jaffrennou et al. 2007) or seagrass growth.

Marine values associated with the GBRWHA area downstream of the mine area include extensive areas of mudflats, saltmarsh flats and mangroves. These habitats support valuable fish breeding areas as well as resident and migratory shorebirds. Coral communities and seagrass meadows do not occur to any great extent in the vicinity of the Styx River. Broad Sound also provides habitat for large marine fauna listed as MNES (refer Section 16.13.5). Given the distance these habitats are away from the Project area and the relatively minor extent of the modelled impacts it is considered unlikely that coal dust deposition from Project activities will have any more than a very minor impact (if any) on downstream marine habitats, including those associated with the GBRWHA.

16.14.6 Pests and Weeds

Pests and weeds may pose a significant threat to MNES values within and surrounding the Project area, including TECs and habitat for threatened fauna and direct predation. Introduced grasses dominate the ground layer in many areas because of the long grazing history within the Project area. Much of the remaining remnant vegetation habitat already contains a high proportion of introduced grass species and woody weeds (Lantana and Rubber Vine), particularly in the vicinity of creek lines. Olive Hymenachne, has the potential to infest wetland areas and was observed at several wetland / farm dam sites in January 2018. Other problem weed species such as Parthenium, also toxic to cattle, is presently limited in extent to the creek lines and adjacent riparian areas. Any potential introductions of weeds and pests as a result of Project activities (including construction and operational phases), particularly transportation and operation of construction vehicles and equipment, will therefore need to be managed.

No impacts are likely once the decommissioning phase has been completed.

16.14.7 Fire

Fire is a natural part of the Australian landscape, and most vegetation communities are adapted to periodic fires. However, changes in the natural fire regime may result in changes in the species composition and / or structure of the vegetation.

Within the vicinity of mining activities, the majority of remaining remnant vegetation is woodland with a grassy understorey and is subject to cattle grazing, which under normal grazed circumstances would also be relatively resistant to carrying fires. All vegetation along the haul road and the TLF area consists of cleared lands and is grazed apart from habitat on and adjacent to the haul road crossing of Deep Creek and Barrack Creek. A potential hazard exists if grassy woodlands remain ungrazed for some time and develop high fuel loads that could carry fires under dry conditions. Woody weeds such as Lantana, which is common along and close to drainage lines in the area, provide additional risks by increasing potential fire fuel loads in these areas impacting potential Koala habitat. Such fires may also be damaging to Brigalow or SEVT if occurring frequently or at high intensity.

16.14.8 Noise

Noise and vibration levels will remain elevated after construction when mining commences, although these will be more constant and less intermittent. Sources include primarily movements of haulage trucks, operation of coal handling equipment (including conveyors), open cut mine blasting and train loading. Blasting will remain as part of the open cut operations but will be on a very intermittent basis

Understanding of the impacts of noise on fauna is limited. There are no current government policies or guidelines that recommend thresholds or limits in relation to fauna. Noise may adversely affect wildlife by interfering with communication, masking the sound of predators and prey, causing stress or avoidance reactions, and in some cases, may lead to changes in reproductive or nesting behaviour. Excessive noise may lead some species to avoid noisy areas, potentially resulting in the fragmentation of species habitat. Radle (2007) states the consensus that terrestrial fauna will avoid any industrial plant or construction area where noise or vibration presents an annoyance to them. Additionally, many animals react to new noise initially as a potential threat, but quickly 'learn' that the noise is not associated with a threat (Radle 2007). Currently, the Project area would experience noise and vibration levels typical of rural areas, with natural sounds, such as bird calls generating most noise. Farm machinery and rural traffic would cause occasional elevated levels in localised areas.

Construction, operation, and closure of the Project will result in increased noise from traffic, machinery, blasting, piling, and the presence of personnel, primarily in the MIA, open cut mine pits haul road and TLF. If noise or vibration is intermittent, fauna may pause their activities or flee the area. Conventional blast methods and piling employed during construction will create a higher level of intermittent noise and vibration pulses which could potentially disturb fauna. However, blasting and piling would only occur during daylight hours during the construction and operation phase of the Project.

Many fauna species, particularly birds, are likely to become habituated to constant background noise due to routine mining and processing operations. In addition, most noise will attenuate relatively quickly with increasing distance, while the local hilly topography will act as a barrier to noise generated by the mine and associated facilities. Noise modelling (refer Chapter 13 – Noise and Vibration) indicates that operational noise levels below 60 dB are not expected to cause adverse responses in fauna. The relatively low level of impulsive or low frequency noise at a distance from operations is also not likely to impact fauna. The noise and vibration from haul truck movements could potentially produce the most likely occurrence of impact on fauna located near the transport corridor.

The generation of construction and operational noise, within the Central Queensland Coal mine area, will largely be in cleared areas in which Squatter Pigeon and Ornamental Snake may occur. It is likely that individuals that occur on the site will leave the immediate area of noise impact. During operation, the species may become habituated to adjacent habitat following completion of construction disturbance. Other significant fauna habitat nearest to construction and operation noise sources is likely to be adjacent to the Open Cut 2 (south-west corner), Overburden Stockpile 1b and along the haul road where intact vegetation communities provide habitat for Koala. Given Koala occurs in urban habitats it is considered unlikely noise will be a significant impact on this species. With measures to mitigate noise impacts implemented as part of the Project design and management noise is not expected to cause a significant impact to MNES fauna in the area.

16.14.9 Lighting

Artificial lighting from infrastructure and machinery may impact fauna within the Study area during construction and operation. Artificial lighting may have a range of impacts across different groups of taxa and between species within these groups. Rodents may avoid brightly lit areas at night. Frogs and nocturnal reptiles may congregate at artificial lights to feed on insects attracted to light (Perry et al. 2008). Similarly, many microbat species may congregate at artificial lighting (Rich and Longcore 2006), although other species may avoid well-lit areas (Threlfall et al. 2013). Species such as Sugar Glider (*Petaurus breviceps*) have been experimentally shown to reduce foraging time under artificial lighting (Barber-Meyer 2007), although whether this effect occurs in natural situations is unknown. Known impacts on birds include disruption of migratory patterns and choice of nest sites (Longcore and Rich 2004).

There are few if any studies to suggest the fauna inhabiting the woodland around the Project area will be impacted to more than a minor extent. As suggested by the evidence above there will be differing responses between species or taxa group with some responses considered quite benign (e.g. microbats and other taxa attracted to night lighting). Habitat around the Project area is largely cleared or woodland with a limited suite of species present. Significant fauna habitat nearest to the CHPP / MIA 2 area is likely to be Forest Red Gum habitat which may support Koala. This species was also observed onsite in Poplar Box woodland which will remain adjacent to the open cut areas. Non-remnant areas containing regrowth Brigalow and gilgaied habitat surrounding the CHPP / MIA 2, Open Cut 2 and Waste Rock Stockpile 2 may provide habitat for Ornamental Snake. Squatter Pigeon occurs in woodland as well as cleared grassy habitat in the area but it is uncertain what impact lighting will have on this species. Koala may occur, although given the species occurs in suburban habitats Project lighting is not expected to impact this species. With informed lighting design, this habitat will be at a distance where light levels would have attenuated to levels where they are unlikely to be causing a significant impact to fauna.

16.15 Mitigation and Management Measures

Mitigation measures have been developed to minimise impacts associated with construction and operation of the Project. Mitigation strategies have been developed based on the following criteria:

- Avoid potential impacts where possible;
- Minimise the severity and / or duration of the impact; and
- Offset unavoidable impacts.

The recommended mitigation measures to ameliorate potential impacts to MNES associated with the Project are outlined in the following sections.

16.15.1 Vegetation Clearance and Degradation

To minimise the need for clearing, and to mitigate the impacts, the following measures have been incorporated into the environmental management strategy:

- Continuing refinement of the design of the mine and infrastructure design is expected to avoid any direct impact to TECs within the mine footprint;
- To avoid unnecessary vegetation clearing or risk of damaging vegetation, any occurrence of Brigalow or SEVT community within the vicinity of construction works will be fenced off and appropriately marked as a No-Go Zone to site workers;
- Where vegetation clearance is required, then clearance will only take place once a Permit to Clear has been issued by the site environmental officer;
- All clearance will be carried out under ecological supervision;
- Revegetation of any exposed surfaces will be undertaken as soon as practicable, using native species where appropriate;
- All workers will be briefed on the importance of TECs, their location and procedures for working around them, as appropriate; and

- The site will be subject to a progressive rehabilitation program throughout the life of the Project that will seek to reinstate previously occurring vegetation communities present, thereby reinstating TECs and habitat for MNES fauna where present on the site.

16.15.1.1 Mamelon Property – Vegetation Regeneration and Environmental Offsets

Central Queensland Coal owns the Mamelon property, of which the majority of the Project's disturbance footprint occurs. Central Queensland Coal will utilise areas outside of the ML and within Mamelon for land management and environmental offsetting purposes for predicted residual impacts of the Project. Vegetation regeneration and de-stocking of cattle across the majority of the property. Mamelon encompasses a total area of 6,478 ha of which the Project ML covers 2,275 ha. This leaves a total of 4,203 ha remaining outside of the Project boundary with significant portions remaining as remnant vegetation largely subject to cattle grazing impacts.

There are extensive areas of non-remnant lands previously subject to vegetation clearing / management, within and outside the Project ML (1,725 ha and 587 ha respectively). These areas will be managed so as to allow regeneration of the original vegetation communities, thereby extending the availability of MNES vegetation communities and fauna habitat in the area and improving habitat linkages between remnant vegetation patches to the south and north-east of the property.

The northern portion of the Project ML is dominated by cleared habitat or scattered Brigalow regrowth on cracking clay soils. Cleared habitat to the north and east of Overburden Stockpile 2 will be managed and allowed to regenerate tree cover over approximately 180 ha. Similar smaller patches between Deep Creek and Project infrastructure (such as the cleared habitat around CHPP / MIA 2) will also be allowed to regenerate cover. This will have several positive conservation outcomes including:

- Substantial increase in the cover of Brigalow TEC vegetation on the property and in the wider area;
- Substantial increase and improvement of habitat for Ornamental Snake on the property; and
- Improved vegetation connection of Tooloombah Creek to Deep Creek, thereby improving landscape connection to several large habitat patches to the north-east of the property (refer Section for further detail).

Elsewhere, on the property the regeneration of eucalypt vegetation communities will allow for the increase in extent and habitat connectivity of suitable habitat for other MNES fauna known to occur in the area including Squatter Pigeon, Greater Glider and Koala. Portions of the property will also be subject to the Project's Environmental Offsets Plan (refer Section 16.19 and Appendix A18 – Draft Offsets Management Plan). Offset management practises in these areas, in tandem with land management across the rest of the property, will also provide additional ecological benefits by improving the water quality entering the adjacent creek lines (and potentially Styx River and Broad Sound) during heavy rainfall events through reducing nutrient inputs from cattle dung, reducing soil erosion and mobilisation of sediments and increasing vegetation cover on the site.

16.15.2 Mortality and Injury

Workers at the site will be instructed to stop where feasible, when fauna are observed crossing roads and tracks. All clearing works will be supervised by a qualified fauna spotter catcher in all remnant habitat. Speed limits will be in place on all roads throughout the Project area and set at levels which minimise the risk to fauna. All staff / contractors will be educated on the occurrence of

MNES species (such as Koala) and local fauna in the area and encouraged to observe strict speed limits outside of the Project area when travelling to and from the Project, particularly during the night. Signage would be provided in areas of concern. Should a Koala be found in a working area then works will stop and an appropriate handler called in to relocate the animal to a place of safety.

During operations, speed limits will be in place on all roads throughout the Project area.

Appropriate fauna infrastructure such as an underpass / culvert and Koala-proof fencing would be provided along the haul road crossing of the riparian corridor along Deep Creek and Barrack Creek to avoid fauna from venturing onto the road within Koala habitat. This fencing will also function to 'funnel' fauna under the crossing culvert / bridge.

The Project LUMP will include other general measures to mitigate impacts to fauna such as:

- Prior to any vegetation disturbance a trained ecologist or other qualified environmental specialist will be onsite to remove fauna (if required). Hollow-bearing trees will be marked and hollows inspected for the presence of arboreal fauna prior to tree-felling. Construction areas that pose a risk to fauna will be fenced off where practical;
- The Project LUMP will include measures for monitoring and record wildlife road collision incidents throughout construction and operation to help remediate 'high risk' collision areas, potentially involving installation of additional fencing and passages, and set conditions for attending to injured native wildlife;
- Appropriate speed limits will also be in place throughout the site and all contractors will be educated on the risks to local fauna to minimise impacts when driving;
- Fauna infrastructure (such as barriers and underpasses) will be installed along the haul road where it intersects with a potential fauna corridor (Deep Creek / Barrow Creek area) to reduce the likelihood of collision with vehicles. Fauna infrastructure design will be informed by the latest design considerations such as DTMR's Fauna sensitive road design manual Vol 2 (SoQ 2010); and
- To reduce the risk of mortality to native wildlife, no domestic animals will be allowed onsite.

A draft Significant Species Management Plan (SSMP) has been developed (refer Appendix A20). The finalised SSMP will be implemented for MNES fauna species known or likely to occur on the site. The plan identifies potential impacts on these species (including identified habitat) resulting from Project activities throughout the life of the Project (construction, operation and decommissioning). The Plan details specific management measures to mitigate the potential impacts and incorporates adaptive management principles to allow for the adoption of new management measures, where considered necessary, as the Project progresses.

16.15.3 Change in Surface Water Quality and Hydrology

Mitigation measures related to surface water are detailed in Section 16.9.4.4 and 16.10.7. As part of Project mitigations a detailed REMP will be developed and implemented and will include monitoring of surface water quality in key targeted locations throughout the life of the Project including before construction (refer 16.10.7.4 and Figure 16-77). The REMP will be developed in accordance with DES Guidelines and submitted to DES for approval prior to Project construction activity. The REMP will be a 'live' document and will be regularly reviewed and updated throughout the life of the Project. The REMP will be designed to include monitoring measures associated with the GDE monitoring program outlined in the Section 16.15.4.1 and detailed in Section 16.11.4.5.

16.15.3.1 Site Water Management

The management of water (including potential contaminated water storages) associated with the site has been discussed in Section 16.7.3.7, and in detail throughout Section 16.10. Table 16-16 provides an assessment of the necessary storage sizes for the Project environmental dams (also refer Section 16.10.4.6). A WMP will be prepared for the Project which, in conjunction with the REMP, will form the approach to management of onsite water usage and storage. The WMP be developed to minimise the risk of adverse impacts on surface water (and groundwater) systems. The WMP will describe the mine water balance, key water infrastructure (i.e. water storages, pipe network, drainage system), and flood immunity infrastructure.

The redirection of all mine affected run-off and mine affected waters will be made to appropriately managed environmental dams which have been designed to hold a 4.9% AEP standard flood level capacity (with a spillway rating of 0.2% AEP) and are considered sufficient to meet the requirements for the potential flood events over the life of the Project.

In addition, the Project has included the following design elements associated with surface water management as part of the WMP:

- Locate and design roads and other built infrastructure so that minimal run-off to waterways occurs;
- Stormwater flows emanating from upstream of the site will be diverted around Project infrastructure to Tooloombah or Deep Creek ensuring stormwater quality is not affected by Project activities;
- Retention Basins to allow a pre-treatment of mine-affected water and wastewater prior to discharge into the aquatic environment. These dams will collect water from the MIA, CHPP, haul road, waste rock stockpiles, coal stockpiles and the TLF and store contaminated rainfall runoff across the site. This water will be used to supplement the demands for stockpile dust suppression, washdown and CHPP demand. The discharge of mine-affected water and wastewater will be similar to water quality of receiving waters and in accordance with the water quality objectives for the Styx River Basin for lowland waters as set by DES; and
- Discharge (if any) of treated wastewaters to receiving water will occur during wet periods where possible.

The design of the creek crossings along the haul road has been undertaken such that impacts on surface water, both upstream and downstream, have been minimised. The bridge and culvert crossing designs will limit afflux change and will result in no change to downstream flows or direction. As such, it is not anticipated that the transport corridor will have an impact on vegetation communities or downstream MNES habitat (such as for Estuarine Crocodile and GBRWHA waters) because of surface water impacts.

16.15.3.2 Erosion and Sediment Control

A detailed assessment of the erosion and sediment control management approach (including analyses of potential soil loss / erosion hazard specific to the site) for the Project is provided in Section 16.9.4. An ESCP, prepared by a CPESC, will be developed and implemented for the construction and operation phases of the Project. The ESCP will be developed consistent with principles discussed in Best Practice Erosion and Sediment Control (IECA, 2008). The ESCP will be developed and submitted to DES for approval prior to the commencement of construction works.

Areas of disturbed or exposed soil will be managed so that the loss of sediment is reduced including through minimising the area of exposed soil, where possible not exposing soil, and not undertaking clearing or earthworks during rainfall events. Other measures include using a minimum number of heavy equipment and applying a minimum number of passes by heavy equipment to help minimise land disturbance, erosion and dispersion of soils. Sediment control devices will be designed as described in the assessment provided in Section 16.9.4.3 and 16.9.4.4.

The plan will include the following control measures at a minimum (refer Section 16.9.4 for further information):

- Sediment fences will be installed along the down slope sides for any disturbed areas experiencing runoff;
- Sediment basins will be operational during both the construction and ongoing operation of the mine allowing for the capture, treatment and discharge of stormwater generated from the site during rainfall events;
- No surfaces will be left open if they are not being worked on and all areas will have topsoil pulled back over and be suitably compacted once construction work in the area has finished. Grassed areas cleared for construction of any mine-related infrastructure will be re-contoured and landscaped once construction is complete to minimise erosion impacts;
- Site drainage will divert all clean water runoff around disturbed area;
- All vehicle movements will be restricted to stabilised access locations;
- Erosion control devices will be installed in diversion drains;
- Vegetation will be preserved with only the minimum amount of land required to operate the Project cleared at any one time. No Go Zones shall be established prior to clearing / grubbing activities and maintained throughout the life of the Project; and
- Disturbed land will be returned to pre-existing vegetative habitat condition, including cattle grazing, native vegetation or where appropriate farm dams and wetlands.

16.15.3.3 Property Management

The Project is located on the Mamelon property. Mamelon encompasses a total area of 6,478 ha of which the Project footprint covers approximately 1,323 ha. Central Queensland Coal have proposed destocking the majority of the property and restricting cattle access to already cleared habitat in the south-west and south of the property (encompassing approximately 1,000 ha) as part of its environmental offsets management for the Project. The remaining area, including the creek lines which lie adjacent to the mine area, will be managed and allowed to regenerate. This measure will contribute to localised water quality improvements, and contribute to improving the water quality entering Broad Sound and the GBRWHA through the following:

- The long-term restoration of this habitat, and in particular allowing vegetation to regrow along the riparian zones along Deep Creek and Tooloombah Creek (which are presently mostly cleared), will capture / entrain sediment and nutrient run-off from the property;
- The restoration of cleared areas will also reduce soil erosion on cleared areas of the property, thereby reducing the entrainment of sediments entering creek lines during bouts of heavy rainfall; and
- The removal of cattle from much of the property will also remove a source of long-term nutrient input into creek lines following rainfall.

An assessment of the existing sediment loads on Mamelon property has been carried out under differing stocking regimes (refer Section 16.9.3 and Chapter 5 – Land). The results of the assessment show that for the areas assessed within ML 80187 the estimated annual sediment generation potential ranges between 777 to 3,653 t/ha (dependent on cattle stocking regime). Soil loss estimate calculations undertaken for the site indicate a maximum soil loss of 217 tonnes per hectare per year, assuming no erosion and sediment controls are implemented as part of Project activities. With the installation, operation and maintenance of sediment basins, at least 90% of sediments would be captured and retained. With the removal of cattle from much of the property, this represents a significant reduction in downstream sedimentation compared with the current grazing regime.

It is expected that the reduction of mobilised sediments will continue post mining as the intention is to set aside the property for nature conservation and environmental offsetting purposes. A key aspect of the destocking approach will be to allow the vegetation communities within the riparian corridors to regenerate without being subjected to ongoing grazing pressures. As vegetation coverage continues to increase within the riparian corridors and across the property more generally combined with the absence of grazing, the potential for sediments to mobilise reduces and will continue to do so.

16.15.3.4 Chemical Pollutants

The following management measures will be implemented to minimise the risk of pollutants and contaminants entering local water ways:

- The proponent will ensure that that all construction machinery is maintained to minimise the risk of spill or leakage;
- All refuelling facilities and the storage and handling of oil and chemicals will be in appropriately designed sites and will comply with relevant Australian Standards. Procedures will be established so fuel, oil and chemical are stored and handled to Australian Standards 1940 - 'The storage and handling of flammable and combustible liquids'. These materials will be stored within bunded areas with a storage capacity of 100% of the largest vessel and 10% of the second largest vessel. The bunding will have floors and walls that are lined with an impermeable material;
- Appropriate spill control materials including booms and absorbent materials will be onsite and near likely impacted waterways at all times. These will be used for mitigating and managing events where a substance is spilled into the surrounding waters; and
- Wash-down areas for plant and equipment will be clearly marked to prevent contaminated water from leaching into soils or flowing into nearby watercourses.

16.15.3.5 Summary

The following summarises the potential impacts on surface water quality as a result of the Project following application of mitigation measures:

- The Project lies approximately 14 km upstream of the nearest saltmarsh and potential shorebird habitat, at least 21 km upstream of the nearest mangrove habitat, and approximately 30 km upstream of the likely closest habitat suitable for large marine fauna (i.e. deeper channels close to Rosewood Island). The nearest known 'important habitat' (roost sites) for migratory shorebirds are over 40 km downstream of the Project;

- The Project footprint is minor within the overall catchments of Tooloombah Creek and Deep Creek. The hydrological impact of the Project is minimal at worst and will have little conceivable impact on adjacent or downstream aquatic habitat values;
- Background water quality in Broad Sound waters and the Styx River estuary is already considered naturally turbid due to tidal resuspension. Water quality sampling indicates background water quality in Deep Creek and Tooloombah Creek often exceeds local water quality objectives for nutrients (i.e. nitrogen and phosphorus);
- Water releases associated with the Project will be strictly controlled, monitored, and similar to water quality of receiving waters and in accordance with the water quality objectives set by the DES;
- Industry standard mitigation measures will be applied to prevent sediment loss / movement or chemical contaminants released from the site into local waterways and downstream habitats. Vegetation management on the surrounding property will in the long-term reduce sediment loss into local waterways and downstream habitat as experienced under the current cattle grazing regime; and
- Given the Project storage design and ephemeral nature of rainfall and flows in the catchment, uncontrolled releases of potentially contaminated run-off are considered unlikely and restricted to extreme rainfall events.

Given the background water quality in Broad Sound waters and adjacent creek lines it is considered very unlikely that the accidental and transient release of sediments and / or contaminants from Project activities will possibly be of a magnitude or duration that may significantly impact downstream MNES fauna (migratory shorebirds and large marine fauna) or their habitats associated with the GBR OUVs.

16.15.3.6 Reef 2050 Long-term Sustainability Plan

The ToR requests it be demonstrated how the proposed action will provide a net benefit to water quality in the GBRWHA and is consistent with the objectives of the *Reef 2050 Long-term Sustainability Plan* (DotEE 2015) including the following reductions (based on a 2009 baseline) in sediment, nitrogen and pesticide loads in 'priority areas' (refer to Water Quality Targets in the following section).

Surface water quality sampling for the Project (2011 and 2017 / 2018) recorded the following background data from the surface waters adjacent to the Project:

- Turbidity and suspended solids loads were generally low and below water quality objectives set for the Styx River catchment during periods of flow or following recent rains. High levels of turbidity and suspended solids were recorded largely in Deep Creek following extended dry periods and no flow conditions; and
- High levels of total nitrogen, ammonia and phosphorus were recorded (above local water quality objectives) across sites in Deep Creek and the Styx River following extended dry periods and no flow conditions. This effect was less marked in Tooloombah Creek.

It is also known that the waters of Broad Sound are naturally turbid and low in nutrients due to the large tidal range in the area (De'ath and Fabricius 2008).

The Project is in the lower catchments of both Tooloombah Creek and Deep Creek. It is uncertain to what extent the Project area currently contributes to sediment or nutrient loads entering the creeks.

An estimate of the potential current sediment load (under grazing) on the property is provided in Section 16.9.3). It is noted that the entire Project area is subject to cattle grazing (thereby contributing to nutrient and sediment run-off) and comprises areas of dispersive and sodic soils that are prone to erosion (as evident during site inspections). Cattle will be excluded from the majority of the Property and vegetation will be allowed to regenerate in cleared areas, thereby reducing potential nutrient loads and sediment from bank erosion entering local waterholes.

The mitigation measures outlined above in the previous sections and detailed in Section 16.9.4 and 16.10.7 are designed to at a minimum maintain background water quality in the adjacent creek lines. The implementation of a REMP (refer Section 16.10.7.4 and 16.11.4.5) will also provide continuous data on local water quality in the Styx River catchment which was not previously available. The Project site layout and design will necessarily reduce the local catchment impacts through a reduction in catchment area. The removal of cattle and restoration of cleared habitat surrounding the mine will also reduce these impacts. With the reduction in catchment run-off area and proposed mitigation and monitoring measures the Project has the potential to provide a net benefit to water quality in the GBRWHA.

16.15.3.7 Assessment of Project against Reef 2050 Water Quality Targets

An assessment of potential Project impacts against the Reef 2050 Water Quality Targets (WQT) is provided below. The assessment takes into consideration the benefits associated with the installation of specifically designed and engineered erosion and sediment control measures described previously (as detailed in Section 16.9.4), the removal of grazing from the majority of the Mamelon Property, and the anticipated ongoing reduction in sediments reporting to the GBR associated with the change in land use on the property.

Water Quality Target 1

- **At least a 50 per cent reduction in anthropogenic end-of-catchment dissolved inorganic nitrogen loads in priority areas, on the way to achieving up to an 80 per cent reduction in nitrogen by 2025**

  The Fitzroy Basin catchment is not a priority area for nitrogen management as defined in the Reef Water Quality Protection Plan 2013 (State of Queensland 2013) (RWQPP).

  No further assessment against this WQT is required. Nevertheless, dissolved inorganic nitrogen loads are primarily associated with runoff from fertilised agricultural areas. Noting cattle will be removed from the vast majority of the Mamelon property there is an expected, albeit minor at the catchment scale, reduction on inorganic nitrogen loads reporting to the GBR.

- **At least a 20 per cent reduction in anthropogenic end-of-catchment loads of sediment in priority areas, on the way to achieving up to a 50 per cent reduction by 2025**

  The Fitzroy Basin is a priority area for suspended sediment management as defined in the RWQPP. The Project will result in a positive contribution to this target through the anticipated reduction in sediment load reporting to Tooloombah Creek and Deep Creek associated with the cessation of grazing activities and subsequent managed regeneration of native vegetation on the majority of the Mamelon property.

  While it is possible that some localised erosion may occur on site because of construction and operation of the mine it is considered that the potential sediment load contribution would be negligible given the specifically design and engineered erosion protection works that would be established across the Project disturbance areas. The ESCs would reduce the potential for scour and erosion thereby minimising the potential to increase sediment loads.

- **At least a 20 per cent reduction in anthropogenic end-of-catchment loads of particulate nutrients in priority areas**

  The Fitzroy Basin is a priority area for suspended sediment management and the sediment target has been refined to include particulate nutrients (particulate nitrogen and particulate phosphorous) in priority areas (Queensland Government 2015).

  The Project would result in a positive contribution through a reduction in nutrients because of the cessation of grazing activities and subsequent managed regeneration of native vegetation on the majority of the Mamelon Property.

- **At least a 60 per cent reduction in end-of catchment pesticide loads in priority areas**

  The Fitzroy Basin is a priority area for pesticide management as defined in the RWQPP.

  The Project would result in a positive contribution to this target through a reduction in fertilisers associated with the cessation of grazing activities on the vast majority of the Mamelon property. It is anticipated there will be an increase in the use of herbicides on the property to control a range of weeds listed under the Biosecurity Act 2014. Under the present regime there is little effort to control the spread of weeds across the Mamelon property. The Land Use Management Plan will include undertaking weed spraying to control weed species such as Rubber Vine and Parthenium where necessary. The potential increase will be of short duration and spatially limited to the ML and designated offset management areas and is anticipated to result in a negligible increase to the pesticide load reporting from the Fitzroy Catchment to the GBR.

Water Quality Target 2

- **Ninety per cent of sugarcane, horticulture, cropping and grazing lands are managed using best management practice systems (soil, nutrient and pesticides) in priority areas**

  The Project will result in a reduction of grazing lands, either as disturbed land associated within mining activities, or land where cattle have been destocked. The destocked land will positively contribute to achieving WQTs associated with increasing late dry season groundcover and increasing the extent of riparian vegetation.

- **Minimum 70 per cent late dry season groundcover on grazing lands**

  The Project will result in an increase of the extent of late dry season groundcover through the cessation of grazing on the majority of Mamelon property. The destocking of cattle will enable vegetation to regenerate within the areas that will not be disturbed through mining activities.

- **The extent of riparian vegetation is increased**

  The Project will result in an increase of the extent of riparian vegetation through the cessation of grazing on the vast majority of Mamelon property. The destocking of cattle and subsequent Project management of native revegetation will enable vegetation to regenerate within the riparian corridors associated with Deep and Tooloombah Creeks, both of which currently remain as narrow bands of vegetation within heavily cleared lands (as they occur adjacent to the ML). Project revegetation activities will also increase riparian vegetation along several smaller tributaries in the south of the property which are currently cleared.

- **There is no net loss of the extent, and an improvement in the ecological processes and environmental values, of natural wetlands**

  Groundwater drawdown will not impact the mapped wetlands on the property as they do not rely on groundwater (refer Section 16.11.2.1). The Project Water Management System and erosion and sediment control system will ensure that polluted / sediment-laden rainfall run-off from the Project infrastructure does not enter adjacent waterholes in Tooloombah Creek and Deep Creek. Groundwater drawdown may have impacts on waterholes on Tooloombah Creek and Deep Creek located close to the open cut areas. These waterholes will be monitored regularly within the Project Receiving Environment Management Plan for water height / extent. Where water loss is attributed to groundwater drawdown from the Project activities these waterholes will be replenished with treated water of a suitable standard to maintain current environmental values (refer Section 16.11.4.6).

Water Quality Target 3

- **By 2020, Reef-wide and locally relevant WQTs are in place for urban, industrial, aquaculture and port activities and monitoring shows a stable or improving trend**

  The Project will not inhibit the development of reef-wide and locally relevant WQTs for urban, industrial, aquaculture and port activities. The Project alone will not contribute significantly to long-term trends in water quality.

Water Quality Target 4

- **Water quality in the GBR has a stable or positive trend**

  With specifically designed and engineered erosion and sediment controls in place, together with the destocking of cattle and subsequent managed regeneration of native vegetation on the vast majority of Mamelon property, no decline in the water quality of the GBR is expected as a result of the Project. In the long-term the Project may provide a positive improvement (if minor and localised) in the water quality entering the GBR.

Water Quality Target 5

- **Traditional Owners, industry and community are engaged in on-ground water quality improvement and monitoring**

  The Project will not inhibit the engagement of Traditional Owners, industry and community in on-ground water quality improvement and monitoring. Traditional owners have been engaged with the Project through the development of Cultural Heritage Management Plans.

16.15.4 Change in Groundwater

The proposed open-cut mining method will physically disrupt and drain saturated rocks within the subsurface, resulting in groundwater depressurisation and decline of water table elevation surrounding the open-cut pits during mining. Apart from alteration of the volume of coal resource to be extracted, the magnitude and extent of groundwater depressurisation will be controlled by the hydrogeological properties of the surrounding rocks, with no practical measures available to mitigate these effects.

16.15.4.1 Groundwater Monitoring - REMP

A detailed REMP will be established for the Project (refer Section 16.11.4.5 for more detail). This will include continued monitoring of groundwater and landholder monitoring bores established for the Project (refer Figure 16-128) within the likely zone of mine influence. Based on the information collected during the first few years of mining, a need for expansion or rationalisation of the monitoring network may be identified. In the long-term monitoring of these bores will allow for a better understanding of local groundwater conditions and observations regarding actual drawdown caused by mining activity. Data collected from the REMP in the first years of mining will be used to verify the groundwater drawdown model predictions and, if necessary, provide a basis for recalibration of the groundwater model. The REMP will document the proposed groundwater monitoring and evaluation plan, and will include:

- GDE condition monitoring, including:
  - Type 1 GDEs - stygofauna surveys at Project bores
  - Type 2 GDEs – waterhole monitoring and macroinvertebrate surveys in pools on Deep Creek and Tooloombah Creek
  - Type 3 GDES – permanent vegetation monitoring transects;
- Groundwater monitoring, including level gauging, water quality sampling and laboratory testing program;
- Monitoring of mine water dewatering rates/volumes and produced water laboratory testing program;
- Data evaluation criteria;
- Monitoring frequency and reporting; and
- Requirements for revision of the REMP.

Trigger Action Response Plans (TARPS) will form part of the REMP and will outline the actions and responses required, in the event operations have or are likely to result in management objectives and approvals conditions not being achieved. TARPs will identify:

- Further investigations to identify EVs (including MNES) and sensitive receptors that may be impacted and to assess level of impact / threat posed to the sensitive receptors, if pre-determined trigger thresholds are reached;
- Of those mitigation measures identified in the REMP, which are appropriate to manage or remove the specific cause or pathway of the impact / threat and what other mitigation measures may be available to improve outcomes (e.g. new technology);
- Implementation of the mitigation plan(s) deemed most appropriate, including providing notification (where necessary) to relevant authorities and stakeholders;
- Reporting (internal and external) to summarise monitoring results, investigation findings and mitigation approaches, with follow up information provided to relevant authorities and stakeholders; and
- Review and update of the REMP to ensure adequate monitoring of detected impacts and mitigation efforts is incorporated, and to re-assess appropriateness of mitigation measures outlined in the plan (i.e. to ensure the mitigation measures will appropriately address the level of impact identified into the future).

Mine water inflow monitoring will consist of daily measurements of rates and/or volumes of all water pumped from the mine pit using a suitable method. Mine produced waters will be subject to quarterly:

- Measurements of field water quality parameters (e.g. TDS, EC, pH); and
- Laboratory analyses of major ions, TDS, EC, dissolved metals (including aluminium, arsenic, selenium and vanadium) and hydrocarbons (TPH, TRH and BTEXN).

Groundwater monitoring (water quantity and quality) will occur on the MLs and off-lease during the construction, operational and post-operational phase of the Project to:

- Determine if an impact has or will likely be realised, which would trigger (based on pre-determined trigger thresholds) implementation of appropriate mitigation measures, including initial review and evaluation;
- Assess the environmental performance of any adopted management and mitigation measures once implemented, which may require expansion of the monitoring network and analytical program; and
- The location and configuration of monitoring bores is designed to provide sufficient coverage of identified aquifers and potential GDEs to detect and monitor groundwater effects resulting from the Project and provide a baseline from which management objectives are set. Groundwater monitoring bore locations are described in Chapter 10 – Groundwater.

Monitoring of groundwater drawdown and depressurisation will involve:

- Gauging of hydraulic head in selected groundwater monitoring bores and landholder bores located within the predicted zone of mine influence (Figure 16-128), as a minimum;
- Automated pressure transducers will be installed at selected monitoring bores to provide daily observations that can be used to distinguish short-term changes, such as seasonal recharge, from potential long-term effects of the Project (dewatering and backfilling); and
- Gauging hydraulic heads at selected locations outside of the predicted area of impact to confirm the extent of impact and to assess baseline conditions away from potential mining effects.

Groundwater quality monitoring will include the following:

- Mine water inflow monitoring will consist of daily measurements of all water pumped from the mine pit;
- Quarterly field measurements of EC and pH of groundwater sampled from monitoring bores located on the mine lease and monthly field measurements of the same parameters for water pumped from the mine;
- Quarterly field measurements of EC and pH of groundwater sampled from compliance monitoring bores located off the mine lease;
- Six monthly sampling (quarterly or more frequently for the first two years of mining, or if trigger is reached) of groundwater sampled from compliance monitoring bores for laboratory analyses of major ions, TDS, EC, dissolved metals (including aluminium, arsenic, selenium and vanadium) and hydrocarbons (TPH, TRH and BTEXN); and

- Six monthly sampling (quarterly or more frequently if trigger is reached) of groundwater from reference monitoring bores (located outside the predicted zone of drawdown influence) for laboratory analyses of major ions, TDS, EC and dissolved metals.

Groundwater chemistry data will be analysed for trends and any correlation with observed groundwater levels, mine inflow and rainfall. Data collected from the recently installed monitoring bores will be assessed and evaluated to allow adjustment of the nominated trigger values for groundwater quality (following 24 months of data collection).

If a monitoring trigger is breached, after review and where required the appropriate mitigation measure will be implemented and the monitoring program appropriately adjusted, e.g. if a water quality trigger is realised, sampling frequency for analysis of water quality may be increased from six monthly to quarterly or more frequently, and additional monitoring locations may be incorporated (i.e. between bores where the trigger is reached and the threatened receptor).

Groundwater compliance reports will be prepared to facilitate the transfer of monitoring data to relevant regulatory authorities. The frequency of reporting will be decided in the relevant Project environmental authority. Issues relating to groundwater samples that are reported by the landholder or mine staff will be recorded and documented in the monitoring report, including corrective actions.

Future improvements to the numerical model will be undertaken as and when new data become available, particularly where there is a divergence of observed groundwater system response from the predicted. New data may require a revision and update of the conceptual (eco-)hydrogeological model prior to updating and recalibrating the numerical model and re-running of predictive scenarios. Where this is deemed necessary, the REMP and WMP may also need to be updated depending on model predictions.

As mining progresses, a need for further model updates will be assessed every two years based on quarterly reviews of groundwater monitoring data and findings of impact verification. It is expected the confidence level of model predictions will increase over time as the model is updated to reflect the observed effects on groundwater from the monitoring program.

Where additional management strategies are required in response to environmental performance, the existing numerical model, or new models depending on the type of impact observed (e.g. density coupled models to simulate seawater intrusion), will be used to test the effectiveness of mitigation measures prior to implementation to improve the outcomes of the proposed measures.

16.15.4.2 GDE Monitoring

Targeted investigations of the hydrological requirements of potential GDEs have been carried out as part of works to inform the updated SEIS (refer Section 16.9.9.1). Ongoing GDE monitoring will incorporate some of these methods and inform how GDE water requirements can be maintained during and following mining.

GDE monitoring will include the following:

- Type 1 GDEs:
    - Stygofauna collected in November 2011 and March 2012 sampling events have been identified as belonging to Orders / Families that occur in all Australian states (Serov, 2002). To satisfy the ToR, endemism needs to be disproved at the Family or Order level for stygofauna. Any proposed mining activities associated with the Project will not

threaten or put at risk the survival of the taxa present at the Order / Family level of taxonomic resolution. Based on these results, no mitigation measures are required

- Stygofauna will be monitored at five-yearly intervals during the life of the mine to increase understanding of coastal stygofauna. Sampling will follow the procedures detailed in the State's *Monitoring and Sampling Manual* (DES 2018) as issued for Queensland waters and
- Monitoring will seek to identify obligate (groundwater dependent) stygofauna to the lowest possible levels to determine levels of endemicity of the stygofauna community within the aquifers. This community is the most disturbance sensitive environmental indicator for changes in aquifer conditions. Project groundwater bores included in the groundwater monitoring program will be sampled for stygofauna;

- Type 2 GDEs:
  - In-stream pool longevity and water sources supporting these water features to identify intra- and inter-annual trends (both natural and potentially Project affected)
  - Macroinvertebrate surveys to establish the existing distribution, abundance and richness of macroinvertebrate communities, in association with ongoing water quality monitoring and
  - Macroinvertebrate sampling will be conducted in accordance with standards and protocols detailed in the State's *Monitoring and Sampling Manual* (DES 2018) as issued for Queensland waters;
- Type 3 GDEs:
  - Identification of pre-mine condition (as affected by existing anthropological activities, climate variability)
  - Establish permanent vegetation monitoring transects to measure structural characteristics and baseline condition of GDE habitats subject to impact (also including the consideration of the need for control sites)
  - Monitoring transects will provide dedicated sites for structured and repeatable temporal measurements of Foliage Index / Leaf Area Index using canopy photography / hemispherical lenses
  - Temporal measurement of Leaf Water Potential at reference trees when GDE vegetation monitoring sites are established and at subsequent monitoring events, this will provide a direct measure of water stress
  - Capture of high resolution Normalised Differential Vegetation Index (NDVI) imagery over possible impact areas and any control sites, timed to coincide with monitoring events and undertaken biannually for the initial three years to establish a seasonal baseline for ongoing comparison (the data sets provide a measure of all vegetation, rather than selected sites within the transects); and
- Comparison of results against observed changes in GDE water budgets to link the cause, if possible, of observed stress to changes in the water budget attributable to the Project, and differentiating other potential factors such as climate change, fire, or introduced plant species. These factors could be as significant as the threats posed to groundwater resource condition by the Project.

16.15.4.3 Preliminary Management and Mitigation Measures

Mitigation measures will be defined to address unacceptable impacts arising on sensitive receptors from reduced groundwater quantity or diminished groundwater quality. The TARPS will form the basis for determining when management and mitigation measures will need to be confirmed and implemented.

It is recognised that GDEs within this landscape will have evolved some resilience, whereby they are able to cope with some degree of change to baseline water regimes (quantity, quality and timing). For example, Type 3 terrestrial GDEs (regarded as habitat for threatened MNES fauna) may be able to extend the depth of rooting to access deeper soil water or the capillary fringe, and macro-invertebrates may persist in a surface water pools that are reduced in surface area and depth compared to what may have existed pre-mining. Resilience levels need to be further assessed by ongoing monitoring, but for the purpose of identifying suitable mitigation measures it is conservatively assumed at this stage that sensitive ecosystems have no resilience to changed water regimes (i.e. the temporal nature of environmental water requirements is static / unchanging). In the first instance, mitigation measures are defined on this 'static' basis, but once environmental water requirements are better understood an adaptive mitigation plan will be able to be implemented.

The following sets out examples of groundwater management and impact mitigation measures for the Project. These and other mitigation measures will be further detailed in the Project REMP, building on from the baseline understanding of receptor water requirements with understandings developed from ongoing studies (see Section 16.9.3.1 and Section 6 of Appendix A6 – Groundwater Technical Report). It is anticipated that, where an adverse impact is indicated as part of the approved monitoring, evaluation and reporting program, a wide range of management and mitigation approaches will be considered, not only those that may be detailed in the REMP as additional approaches may evolve with time and technology, and new knowledge gained may lead to the development of new approaches that are not identified here. Any new mitigation measures identified as part of this process will require an update of the REMP.

Water Quantity

An approach that will be considered to manage impacts where Type 2 and Type 3 GDE access to groundwater might be compromised due to drawdown arising from mine dewatering involves supplementing environmental flows to waterways and soil water stores so that baseline flow/water availability regimes can be maintained or supported. Table 16-119 summarises the management and mitigation measure with details expanded upon below. For Type 2 GDEs, supplementary water can be provided directly to permanent or ephemeral pools in a manner that provides the minimum required volume and frequency to maintain GDE function, the understanding of which will be improved with ongoing monitoring.

The practice of supplementing surface water flow to maintain the aquatic system and riparian vegetation health is used as a management tool in providing environmental flow requirements to waterways and wetlands across Australia. Examples of where the provision of environmental flows made directly into pools in response to groundwater dewatering include the Collie Basin in south-west Western Australia (DoW 2009), Fortescue Metals Solomon Iron Ore Project Bore Field in Western Australia (FMG 2016) and Rio Tinto's Hope Downs Iron Ore Project in the Pilbara region of Western Australia (WA EPA 2001).

Table 16-119 Available management and mitigation measures

Direct effect	Instream habitat	Riparian/terrestrial habitat	Third party bores
Change in groundwater quantity/surface water – groundwater interactions	Supplementary environmental flows provided directly to pools from mine produced water or other groundwater (e.g. pumping bores)	Supplementary environmental flows provided via irrigation from mine produced water or other groundwater (e.g. pumping bores) Land contouring, which will retard surface water run-off and encourage additional recharge to the underlying soils	Lowering of pump/ deepening bore Provision of surplus water from mine dewatering if suitable Provision of an alternative water supply
Change in groundwater quality	Onsite water and hazardous materials management Containment or capture of contaminant/pollutant e.g. cut off walls, pumping bores. Treatment of contaminated/polluted water		

For Type 3 GDEs, supplementary water can be applied to soil water reservoirs (i.e. the root zone) either directly through irrigation or indirectly through leakage from water provided to waterways/wetlands/bunded areas. Contouring of the surface could be considered to encourage ponding of any surface runoff or direct rainfall to encourage additional recharge to the underlying soils. However, the efficacy of this approach also needs to consider impact to creek flow regimes.

The source of supplementary water would ideally be mine produced water, as there would be no associated additional drawdown impacts. Mine water balance modelling, as presented in Chapter 9 – Surface Water, predicts the mine water supply exceeds the mine water demand for the duration of mining almost all of the time, with a predicted minimum available excess in the order of 40 ML in the worst case dry year. This suggests that mine produced water is a likely to be a viable source of water to offset any reduction in groundwater baseflow to the dependent pools, with adequate treatment if necessary.

However, a supply deficit will exist post-closure when mine produced water is no longer available. Alternatively, sourcing the supplementary flows from a groundwater resource is a strategy that may be considered – whilst the Alluvium aquifer would likely not present as a viable long term option (due to drawdown effects), the Styx Coal Measures, which has similar water quality to the Alluvium may provide a suitable source. Modelling has been prepared examining water 'consumption' at a pool near the western boundary of ML 80187 (sample point To2; Figure 16-22) and assessing whether waterhole groundwater requirements can be met via abstraction from pumping wells accessing the Styx Coal Measures. The modelling has shown that the Styx Coal Measures is capable of supplying between 0.1 to 0.2L/s in the long-term, which could sustain around 2,400 to 4,800m^2 of pools, with little additional effect to the predicted drawdown (discussed in detail in Appendix A6 – Groundwater Technical Report).

Change in Groundwater Quality

There is a low potential for Project-related activities to impact groundwater quality (mining, water storages, waste rock stockpiles, and acid mine drainage) resulting in adverse impacts on GDEs. However, careful management and control measures of potential pollutants and contaminant sources will be maintained to prevent uncontrolled discharge to groundwater. These will include:

- Provision of appropriate spill control materials including booms and absorbent materials at refuelling facilities to contain spills (also refer Section 16.11.4.6);
- Establish procedures to ensure safe and effective fuel, oil and chemical storage and handling. This includes storing these materials within roofed, bunded areas to contain spills and prevent uncontrolled discharge to the environment; and

- Ensure all refuelling facilities and the storage and handling of oil and chemicals to comply with relevant Australian Standards. Management and mitigation measures for wastewater are discussed in Chapter 7 - Waste Management.

All uncontrolled discharges will be reported to the DES under legislative requirements of the EP Act. If groundwater quality impacts are identified, mitigation measures will include:

- Investigation to identify and rectify any activity / facility that has caused uncontrolled discharge; and
- Containment or interception of the impacted groundwater / pollutant source e.g. cut-off trenches.

Control of surface water discharges and dirty water management systems, including storage of mine dewatering water, are discussed in Section 16.7.3.7 and 0).

Environmental Offsets

A key mitigation measure of last resort that is available to deal with unacceptable outcomes that cannot be adequately managed involves committing to Project environmental offsets (refer Section 16.19). This would involve undertaking the studies required to understand how GDEs interact with groundwater and implementing management approaches, such as provision of supplementary water. Should all mitigation methods be unsuccessful and residual impacts to MNES-associated habitats / vegetation communities will be subject to the Project Offsets Management Plan (refer Appendix 18A).

16.15.5 Dust

Dust is not anticipated to significantly impact aquatic and terrestrial habitat in the area surrounding the Project. Nevertheless, vegetation communities and waterholes may be at risk from dust deposition issues such as riparian vegetation along Deep Creek and Tooloombah Creek, particularly those close to Project infrastructure such as the conveyors on Deep Creek. This has potential to impact MNES such as SEVT communities along Tooloombah Creek, and riparian Forest Red Gum habitat suitable for Koala.

A vegetation monitoring program will be implemented as part of the Project LUMP and will include measures to monitor the health of vegetation communities considered to be at risk from dust deposition issues. The Project REMP will also include water quality monitoring of at risk waterholes on the creeks. Results of the vegetation / water quality monitoring will be used to inform adaptive management of mitigation measures where impacts are found to be occurring.

General mitigation measures will involve:

- Preparation and implementation of an Air Quality Management Plan prior to commencing construction activities on site;
- Monitoring in the event of a complaint;
- Engineering control measures;
- Dust suppression measures;
- Rehabilitation of exposed surfaces; and
- Operational procedures.

Dust deposition and suspended particulate monitoring in accordance with relevant Australian Standard methodology will be undertaken to determine whether predicted emissions levels occur. In order to monitor background dust levels, a system of dust monitors will be installed upwind and downwind of the Project. Dust monitors will also be installed at sensitive receptors predicted to receive dust levels close to or reaching the EA conditions. Dust monitoring will also be performed in each of the MIAs. By monitoring dust upwind and downwind of the Project, together with monitoring at sensitive receptors, dust impacts will be quantified.

Dust suppression measures primarily include the application of water to control dust emissions. The following measures have been developed to ensure dust levels resulting from the Project are kept to a minimum:

- Minimising topsoil and vegetation removal and revegetation of disturbed areas as soon as possible;
- Revegetation of exposed areas to be exposed for more than three months;
- Minimise pre-strip to a maximum of one block ahead;
- Pave areas where practical around offices, carparks, maintenance and storage areas;
- Visual monitoring of dust daily with ramping down of activities in the instance of high dust emissions;
- Watering of haul roads to suppress dust emissions;
- Watering of ROM stockpiles using water sprays and water cannons that are operated on timers. The use of timers avoids the potential for missing a scheduled watering operation. The timers can also be operated manually in particularly hot or windy conditions;
- Fogging system on outlets from transfer points and sizing stations;
- Maintain appropriate moisture content of product coal and reject material as they leave the CHPP which avoids the need for supplementary watering;
- Implement an Integrated Coal Moisture Regulating System to minimise dust emissions from the product coal stockpile and to ensure that product coal delivered for train-loading has a coal - surface water content at the optimum level to ensure the effectiveness of veneering of loaded coal. The Integrated Coal Moisture Regulating System will use a water spray or fogging systems to apply optimum levels of supplementary coal watering; and
- Use of benign adhesives if water suppression methods are not effective. Should chemical suppressants be required to control dust, a risk assessment will be undertaken to assess potential for adverse impacts to water quality.

The following operational procedures for the Project will be implemented to meet targets for air quality performance:

- Use of water trucks to achieve sufficient watering of haul roads and other high-risk areas to suppress dust emissions, such as areas with relatively high sodic soils which are more vulnerable to wind erosion. The schedule for truck use will be developed for the Project and will incorporate consideration of recent rainfall and weather conditions;
- Use of water sprays and foggers as directed, with additional use as determined by ambient conditions;

- Maintenance of water spray equipment and engineering controls to minimise dust emissions;
- Implementation of an appropriate speed limit for vehicles on unsealed roads, especially where close to sensitive receptors;
- Design haul roads to have a less erodible surface, such as using materials with a lower silt content;
- Chemical suppressants and paving void removal additives may be used for semi-permanent haul roads (not for in-pit haul roads);
- Regular cleaning of machinery and vehicles tyres to prevent wheel entrained dust emissions;
- Manage topsoil stripping so that dust does not become a safety hazard or severe nuisance; and
- Restrict land disturbance to that necessary for the operation and minimise the area of land disturbed at any one time.

Where adverse conditions are encountered during operation of the Project, additional dust suppression measures will be implemented.

16.15.6 Pests and Weeds

Threatened species habitats, as well as threatened plant species potentially occurring within the Project area, may be susceptible to impacts from weeds. The potential impacts and mitigation measures would be like those described for TECs.

One of the key threats to Ornamental Snake is contact with Cane Toads. Cane Toads are already prevalent in the Project area and will have been present in the area for a long time. The Project may provide additional habitat for Cane Toads in the water storage (environmental) dams to be constructed for the Project. However, it is considered that given their presence within the Project area, which already contains several farm dams suitable for Cane Toad breeding, it is unlikely that the Project would significantly promote the presence of Cane Toads relative to numbers already present.

Key identified pest threats to Squatter Pigeon (as well as many native fauna species) include predation by Red Fox (*Vulpes vulpes*) and feral Cats (*Felis catus*), land degradation caused by European Rabbits (*Oryctolagus cuniculus*), and tramp ant invasion (refer Table 16-127). Rabbit were regularly encountered within the mine site area during surveys and cats were identified in the wider area during spotlighting surveys. Dingo (*Canis lupus dingo*) has been encountered in the area during previous surveys – a known predation risk for Koala.

Mitigation measures to limit attraction of the Project area to predators (e.g. appropriate waste management and limiting shelter sites) will be part of the LUMP. The presence of the mine is not considered likely to be conducive to increases in the abundance of Rabbits in the landscape and the surrounding area will remain open for cattle grazing. The LUMP will also ensure there is no likelihood of the importation of tramp ants into the area, which is most likely through the importation of construction machinery. It is considered unlikely that Project activities would introduce a new pest species or promote a population increase in pest species that are known to be present.

Weed and pest management will be an important and integral part of proposed site management activities, and will be detailed in the Project LUMP. This Plan will include measures and monitoring to be developed and managed in accordance with the requirements of the Biosecurity Act, and will include the following measures:

- Implementation of sediment control mechanisms to minimise the risk of weed seed washing into waterways;
- Implement control strategies outlined in the Department of Agriculture and Fisheries (Qld) (DAF) weed and pest animal fact sheets and other relevant Commonwealth State and local Government biosecurity management strategies;
- Pre-construction weed mapping be undertaken to accurately determine the extent of weeds and pests;
- Vehicle wash down procedures;
- Minimise the use of off-road vehicle movements;
- Onsite waste disposal strategies (particularly for food wastes) to be employed that will not encourage the presence of pest fauna;
- Cattle will be excluded from Tooloombah Creek and Deep Creek within lands controlled by Central Queensland Coal thereby reducing potential weed introduction / spread. The buffer will include riparian vegetation a minimum of 100 m from the centre line of the creek bed;
- Strategies for the storage of construction and operation materials / equipment to be employed that will not encourage the presence of resident pest fauna;
- Regular onsite inspections of site infrastructure / equipment for resident pest fauna and establishment of register for pest sightings; and
- Monitoring and weed and pest inspections particularly in responses to reported outbreaks or from complaints or adjacent property owners.

Waste storages are not likely to have significant impacts on native flora and fauna within the Study area, as all waste produced because of the Project will be stored and disposed of appropriately, as per the relevant legislation.

16.15.7 Fire

Fire management is an essential component to all coal mining operations and as such, the following measures have been developed to reduce the potential impacts of a site fire:

- Fire management measures for the Project will be developed and implemented within the LUMP prior to construction;
- Specific onsite smoking areas will be designated;
- Onsite burning of any material will be managed via a Risk Assessment;
- Reduced fuel and fuel free zones will be maintained surrounding facilities;
- Fire-fighting equipment will be regularly maintained and adequate staff training will be implemented. Training and equipment will address fighting fires on facilities, as well as for fighting wildfires; and
- Weed management to prevent habitat degradation and potential increased fire risk.

Should instances of spontaneous combustion occur during mining operations, the details of the materials involved, presence of pyrite, location, date, time and climatic conditions will be recorded on the mine survey plans. These areas will be assessed at closure to ensure appropriate mitigation measures are in place to minimise the likelihood of spontaneous combustion occurring post-mine closure.

16.15.8 Noise

Noise is not expected to have a significant effect on MNES fauna. Accepted noise management practices will be implemented to minimise noise disturbance. As defined in the EMP to be prepared for the Project, all operation vehicles (mine fleet and off-site transport) will be fitted with standard silencers (mufflers) and kept in good repair. Stationary equipment will be housed in buildings with noise attenuating walls, where practicable.

The following measures will be implemented to reduce any impacts which may result from construction and operational noise:

- Noise will be mitigated by properly maintaining all equipment used onsite in accordance with manufacturers specifications;
- Enforcing speed limits to ensure that all mining operations are operating at the lowest possible noise level to minimise the impacts of noise and vibration upon wildlife; and
- Further details of mitigation measures for noise control within the Project area are provided in Chapter 13 – Noise and Vibration.

16.15.9 Lighting

Project lighting is not considered to be a significant issue for fauna. Lighting required during the construction period is expected to be minor as construction is expected to be carried out largely in daylight hours.

Night lighting will mainly be limited to lights required for safety and security. During operations Project lighting will be minimised (i.e. low luminance) as far as possible, and directed towards the CHPP / MIA areas and open cut pit areas and thereby away from fauna habitat to reduce any minor localised impacts even further. Further investigations will be carried out during the detailed design phase of the Project into low-light spill lighting options.

A Construction and Operation Environmental Management Plan (CEMP and OEMP) will be produced prior to construction commencing. This will detail and illustrate the potential impacts from lighting during both the construction and operation phases of the Project and inform the Project lighting design to minimise these impacts. Further investigations will be carried out during the development of the CEMP / OEMP into low-light intensity spill lighting options. Draft CEMP and OEMP frameworks are at Appendix 12a – Draft Construction EMP Structure and Appendix 12b – Draft Operational EMP Structure.

16.16 Greenhouse Gas Assessment

Greenhouse gases (GHGs) are a natural part of the atmosphere. They absorb and re-radiate the sun's warmth, and maintain the Earth's surface temperature at a level necessary to support life. Human actions, particularly burning fossil fuels (coal, oil and natural gas), agriculture and land clearing are increasing the concentrations of greenhouse gases in the atmosphere. This is the enhanced greenhouse effect, which is contributing to warming of the Earth.

Greenhouse gases include water vapour, carbon dioxide (CO_2), methane, nitrous oxide and some artificial chemicals such as chlorofluorocarbons (CFCs). Water vapour is the most abundant GHG. These gases vary in effect and longevity in the atmosphere, but scientists have developed a system called Global Warming Potential to allow them to be described in equivalent terms to CO_2 (the most prevalent GHG) called equivalent carbon dioxide emissions (CO_2-e). A unit of one tonne of CO_2-e (t CO_2-e) is the basic unit used in carbon accounting. An emissions inventory, or 'carbon footprint', is calculated as the sum of the emission rate of each GHG multiplied by the global warming potential.

The following assessment determines the CO_2-e emissions from the Project according to international and Commonwealth guidelines. Further discussion is provided at Chapter 12 – Air Quality, which should be read in conjunction with this section.

16.16.1 Assessment Methodology

The DotEE monitors and compiles databases on anthropogenic activities that produce greenhouse gases in Australia and publishes GHG emission factors for a range of anthropogenic activities. The methodology for calculating GHG emissions is published in the *National Greenhouse Accounts* (NGA) *Factors Workbook* (DotEE 2016). This workbook is updated regularly to reflect current compositions in fuel mixes and evolving information on emission sources.

The scope that emissions are reported, as defined by the NGA Factors Workbook is determined by whether the activity is within the organisation's boundary (Scope 1 – Direct Emissions) or outside the organisation's boundary (Scopes 2 and 3 – Indirect Emissions). The scopes are described as follows:

- Scope 1 Emissions: direct (or point-source) emission factors give the kilograms of CO^2-e emitted per unit of activity at the point of emission release (such as fuel use, energy use, manufacturing process activity, mining activity, and onsite waste disposal);
- Scope 2 Emissions: indirect emissions from the generation of the electricity purchased and consumed by an organisation as kilograms of CO_2-e per unit of electricity consumed; and
- Scope 3 Emissions: indirect emissions for organisations that:
  - Burn fossil fuels: to estimate their indirect emissions attributable to the extraction, production and transport of those fuels; or
  - Consume purchased electricity: to estimate their indirect emissions from the extraction, production and transport of fuel burned at generation and the indirect emissions attributable to the electricity lost in delivery in the transmission and distribution network.

The definition, methodologies and application of Scope 3 emission factors are currently subject to international discussions and have the potential to cause much confusion. Large uncertainty exists in the accurate quantification of these emissions. Emission factors used in this assessment have been derived from either the DotEE, site-specific information, or from operational details obtained from similar emission sources.

Emission factors used in this report have been sourced from the NGA Factors Workbook (DotEE 2016) as indicated in Table 16-120. For this assessment Scope 1 emissions have been calculated in accordance with the NGA Factors Workbook methodology.

Table 16-120 Emission factors

Scope	Emission source	Emission factor	Source
1	Combustion emissions from ULP (stationary)	2.38 t CO2-e / kL	NGA Factors Workbook, 2016
	Combustion emissions from diesel (stationary)	2.68 t CO2-e / kL	NGA Factors Workbook, 2016
	Combustion for transport (general)	2.69 t CO2-e / kWh	NGA Factors Workbook, 2016
	Extraction of coal (fugitive) - Queensland	0.02 t CO2-e / tonnes raw coal	NGA Factors Workbook, 2016

16.16.2 Quantification of Emissions and Conclusion

At this stage, the Project will draw electricity from onsite generators which are quantified under Scope 1 emissions. As such there are no Scope 2 emissions required to be considered in this assessment. Table 16-121 outlines the estimated GHG emissions for the construction and maximum operational phase (2030) of the Project. The estimated total life of Project emissions is also provided. The following assumptions have been made for this assessment:

- The construction stage will require four months for completion;
- 100 construction staff will travel approximately 1.8 km round-trip in 10 vehicles per day;
- 500 operational staff will travel approximately 1.8 km round-trip in 20 vehicles per day; and
- No electricity will be purchased from the grid.

Table 16-121 Estimated GHG emissions (CO2-e tonnes)

Emission source	Scope	Annual emissions (t CO2e)		Life of Project emissions (t CO2-e)
		Construction	Operation (2030)	
Staff Movements	1 (direct)	4.1	24.9	125
Equipment	1 (direct)	17,574	216,748	1,512,483
Generator	1 (direct)	3.3	3,759	47,324
Haulage	1 (direct)	-	59,282	85,670
Fugitive Coal	1 (direct)	-	200,000	683,523
	Total	**17,581**	**479,814**	**2,329,125**

The results of the assessment of GHG emissions from the Project may be summarised as follows:

- The total emissions during the construction phase are 17,581 tonnes CO_2-e during the construction phase, with most of the emissions from the diesel consumption by the construction equipment;
- During the operational phase, the annual emissions are projected to be 479,814 tonnes CO_2-e, which is above the threshold of reporting of 25,000 tonnes CO_2-e. Therefore, this Project will trigger NGER reporting requirements;
- The Life of Project emissions are estimated to be 2,329,125 tonnes CO_2-e; and
- The estimated maximum annual operational phase emissions (479,814 tonnes CO_2-e) represent approximately 0.09% of Australia's latest GHG inventory estimates of 527 Mt CO_2-e (2015).

16.17 MNES Significant Impact Assessment

The natural habitat on and surrounding the Project area has been fragmented and disturbed by historical agricultural activities such as grazing. Much of the mine area is dominated by cleared lands and the introduced Buffel Grass. The southern and western areas are dominated by remnant vegetation communities subject to varying levels of disturbance. The dominant vegetation type is eucalypt woodlands. Despite this, the Project area holds value for MNES species and communities. This section provides an assessment of impacts of the Project on MNES values. The selection of impacts discussed and their evaluation is based on:

- The current understanding and layout of the Project (Section 16.4.4 and Chapter 3 – Description of the Project);
- Currently known information about the MNES affected (Section 16.13); and
- Information on potential impacts of Project construction and operation (Section 16.14) and proposed mitigation measures (Section 16.15) as detailed further in the following chapters:
  - Section 16.9 – Environmental Context - Land
  - Section 16.10 – Environmental Context - Surface Water
  - Section 16.11 – Environmental Context - Groundwater
  - Chapter 12 – Air Quality
  - Chapter 13 – Noise and Vibration.

16.17.1 Impact Significance - World Heritage Properties

This section provides a stand-alone significant impact assessment of the Project activities on the OUVs of the GBRWHA associated with the downstream values as identified in Section 16.13.1. This section is provided in response to a request for further information from DotEE regarding potential impacts to the OUVs from Project activities. Although already detailed in Section 16.14 (also refer Section 16.9.4, 16.10.6 and 16.11.3.6 for further detail), potential impacts, as applicable to the downstream OUVs are summarised below for the sake of clarity.

16.17.1.1 Potential Indirect Impacts to OUVs

The OUVs of the GBRWHA which are represented within Broad Sound include mangrove and saltmarsh communities and to a small degree, coral reefs. These environments support other OUVs including scenic vistas, shorebirds and sea birds, marine turtles and a diverse range of species including listed threatened species. Consideration has been given to how the construction, operation and rehabilitation of the Project may impact on these attributes within Broad Sound. Impacts considered most likely to be associated with Project activities relate to degradation of water quality, dust, altered hydrology and increased sediments and nutrients as these have the potential to degrade the mangrove and saltmarsh environments and water quality which support the other OUVs in the area.

To understand the degree to which the Project may potentially impact these OUVs, a number of assessments have been undertaken. These are discussed below and detailed in relevant chapters of the EIS and subsequent SEIS. Mitigation measures have been developed to reduce and where possible, eliminate any possible impacts to this internationally renowned environment.

Surface Water

The Project will involve the construction of structures and diversion systems which will modify surface water flows, and potentially surface water quality. The potential impacts of these may manifest mainly during the operational phase of the Project.

The main construction activities that could impact on surface water quality values are:

- Excavations and earthmoving including topsoil and mine spoil removal and stockpiling, for the construction of open cut mine pits and mine infrastructure including site access roads, cut and cover and drifts, environmental dams, the haul road and TLF. This may potentially lead to erosion and sedimentation, deterioration of water quality, and changes to water flows; and

- The use of fuels and chemicals for vehicles and construction equipment, potentially resulting in water contamination because of spills, leaks, or other uncontrolled releases.

Operational impacts are in relation to:

- Altered catchment conditions on the hydrology of waterways and drainage lines due to open cut mine pit excavations and associated redirection of minor waterways, buildings and infrastructure and water harvesting (dams); and

- Stormwater runoff, erosion and contaminants from the TLF, mine spoil areas and MIA / CHPP areas.

The Project layout has undergone substantial revision since the submission of the EIS which has resulted in a decrease in the overall footprint (over the life of the Project) of approximately 106 ha (i.e from 1,231 ha in the EIS down to 1,124 ha under the current layout. The potential impacts of the Project on surface water values remains unchanged.

The Project activities potential impact to surface water quality and hydrology are described in detail in Section 16.9.4 and 16.10.6. The impacts have been updated from that provided in the EIS where necessary. A detailed analysis of potential sediment / erosion management has been provided in Section 16.9.4. The updated design of the Project including the water management system, water storages and other water infrastructure components associated with the Project is described in Section 16.7.3.7. The potential impacts to surface water flows, local and downstream hydrology and water quality values have been little affected by the proposed changes in the Project layout and no additional or significant impacts to downstream water quality and habitats supporting GBR OUVs are expected given the application of the proposed mitigation measures already described in Section 16.9.4, 16.10.7 and 16.15.3.

Changes in Hydrology

Much of the catchment for Deep Creek and Tooloombah Creek lies upstream of the Project. Modelling of local flood levels in Deep Creek and Tooloombah Creek because of a reduction in catchment size due to Project activities shows only a very minor reduction in peak flows. This leads to lower depths and velocities within tributaries located downstream of the pits. The downstream end of the 2nd order minor tributary that runs through Open Pit 1 and Open Cut 2 now reports to Dam 1, bunding water below 36.4 m AHD into the local contours of the area.

Dam 1 is proposed to supply potable water for the life of the Project. As the upstream catchment will be removed due to Project construction, water is to be stored in the dam by pumping water from on-site environmental dams capturing stormwater run-off associated with Project infrastructure.

This results in a predicted reduction in peak flood level of approximately 0.02 m at the Styx River confluence of Deep Creek and Tooloombah Creek. In Deep Creek, a decrease in peak flood levels of about 0.07 m is predicted. Tooloombah Creek flood levels are predicted to decrease by about 0.03 m. As would be expected, peak velocities are predicted to decrease commensurately. The decrease is considered minor and is considered very unlikely to adversely affect aquatic ecology values, particularly as peak flows only occur for a short duration of time.

Watercourse and creek crossing structures may cause an increase in runoff velocity due to construction of culverts and conveyance features that eliminate natural features such as meanders and increase in slope. However, with appropriately designed stormwater and crossing structures this is unlikely to cause more than localised and very minor changes to surface hydrology.

Changes in water flows and quality have the potential to impact environments downstream, including the Styx River and Broad Sound. However, given the minor changes described above no significant impacts to the OUVs of Broad Sound and the GBRWHA are considered likely to result from Project-associated changes to hydrological regimes in the area.

Sedimentation of Waterways

During construction and operation sediment can be mobilised and transported by surface water during rainfall events ultimately discharging into Deep Creek drainage lines which can result in negative impacts on water quality and aquatic habitats. Specifically, increased suspended sediments can reduce light penetration, decreasing photosynthesis of aquatic flora (such as seagrasses) and decrease dissolved oxygen. Suspended sediments from runoff may contain elevated nitrogen and phosphorus levels due to the agricultural activities within the surrounding landscape. Increased nutrients can promote algal growth and in extreme cases result in blooms and surface water deoxygenation within low flow situations. This has potential to impact marine taxa such as seagrass and algae beds, and corals.

Unmitigated, this may impact downstream OUVs within the Styx River and Broad Sound. Some environments, such as the mangrove communities of the Styx River may benefit, as they may entrain suspended sediments contributing to the extension of existing mud banks (Furukawa 1996) in the area, potentially extending mangrove habitat and creating more foraging habitat for local shorebirds.

A detailed assessment of the sediment load that may be generated by the Project and the approach to how this will be managed is provided in Section 16.9.4. A comparison assessment of sediment loads associated with current grazing land use is provided in Section 16.9.3. It is important to note that when considering the sediment loads potentially generated by the Project or as a residual of grazing activities which the majority will cease once the Project commence, the majority (>95%) of the sediment load will be retained on site through specifically engineered and designed erosion and sediment controls. Conversely, little to no sediment controls exist in relation to managing the dispersal of sediment generated through current grazing activities. The 2013 Scientific Consensus Statement is a document prepared by a multidisciplinary group of scientists with expertise in Great Barrier Reef water quality, with oversight from the Reef Plan Independent Science Panel. It identified that agricultural lands are the main source of excess nutrients, fine sediments and pesticides to the Great Barrier Reef (Queensland Government 2017).

Table 16-104 summarises land use and pollutant run off data estimated for the Styx River Basin (approximately 3,000 km^2). Under current land use practises suspended solids (includes sediments) contained in rainfall run-off into the GBR catchment are estimated to have more than doubled over the pre-development scenario.

The mine has been designed to avoid any diversions of defined watercourses of high environmental value, namely Deep Creek and Tooloombah Creek. However, low order tributary gullies that discharge into Deep Creek and Tooloombah Creek and that intersect the ML are diverted around mine affected areas. These clean water diversions are aimed at maintaining the health of defined watercourses of higher environmental value and to reduce contamination of otherwise clean water runoff. During operations, rainfall runoff will be captured in a number of environmental dams for re-use or treatment. Several types of dams will be required to hold mine affected runoff as described in Section 16.7.3.7 and 16.10.4.

Central Queensland Coal have proposed destocking the majority of the property and restricting cattle access to already cleared habitat in the south-west and south of the property. This area encompasses approximately 1,000 ha. The remaining area, including the creek lines which lie adjacent to the mine area, will be managed and allowed to regenerate. This measure will contribute to localised water quality improvements, and contribute to improving the water quality entering Broad Sound and the GBRWHA through the following:

- The long-term restoration of this habitat, and in particular allowing vegetation to regrow along the riparian zones along Deep Creek and Tooloombah Creek (which are presently mostly narrow having been subject to extensive clearing), will capture / entrain sediment and nutrient run-off from the property;
- The restoration of cleared areas will also reduce soil erosion on cleared areas of the property, thereby reducing the entrainment of sediments entering creek lines during bouts of heavy rainfall; and
- The removal of cattle from much of the property will also remove a source of long-term nutrient input into creek lines following rainfall.

The waters of Broad Sound are subject to a large tidal regime with resulting high turbidity levels. The currents associated with the tides already lead to constant resuspension of sediment in the water column. As a result, there are few habitats supporting OUVs directly downstream of the Project in the Styx River estuary or the adjacent area waters of Broad Sound (such as coral reefs, seagrass meadows and large marine fauna) (refer Figure 16-132).

The OUVs of most relevance to the Project are downstream mangrove and saltmarsh communities and potential habitat for migratory wader species. Taking into account the mitigation measures proposed and given the background occurrence of high turbidity in Broad Sound waters and the likely contribution of background sediment emitted by the rest of the catchment (of which the Project ML accounts for less than 1% of the overall area) it is considered very unlikely that the accidental and temporary release of suspended sediments from Project activities will possibly be of a magnitude that may impact OUVs of Broad Sound and therefore the GBRWHA.

Accidental Release of Pollutants

The release of pollutants into the surrounding environment and waterways has the potential to cause mortality to aquatic fauna, degrade stream habitat quality near the Project and degrade downstream stream water quality. Without mitigation, potential exists for several potential contaminants to enter waterways including: contaminated mine dewatering runoff; contaminated runoff from waste rock stockpiles; aqueous waste streams including oily waste water (from heavy equipment cleaning); contaminated runoff from chemical storage areas; potentially contaminated drainage from fuel oil storage areas; and general washdown water.

Changes to surface water quality may also occur due to contaminated runoff from the haul road, overburden stockpile areas, coal stockpiles and other infrastructure elements such as environmental dams. Coal mine water collected in dewatering and sediment dams may contain a range of pollutants (depending on the source material) such as hydrocarbons and heavy metals.

All contaminated water on-site will be collected using site environmental dams, preventing water from entering local waterways. The Project will include six environmental dams. These dams will collect water from the CHPP / MIA areas, open cut pits, waste rock and coal stockpiles and the TLF, and store contaminated rainfall runoff across the site. This water will be used to supplement the demands for stockpile dust suppression, washdown and CHPP demand.

In addition to the installation of environmental dams, the following management measures will be implemented to minimise the risk of pollutants and contaminants entering the local waterways:

- Appropriate spill control materials including booms and absorbent materials will be onsite at refuelling facilities at all times. These will be used for mitigating and managing events where a substance is spilled into the surrounding waters;
- All refuelling facilities and the storage and handling of oil and chemicals will comply with relevant Australian Standards;
- Procedures will be established at the mine for safe and effective fuel, oil and chemical storage and handling. This includes storing these materials within roofed, bunded areas with a storage capacity of 100% of the largest vessel and 10% of the second largest vessel. The bunding will have floors and walls that are lined with an impermeable material to prevent leaching and spills; and
- Wash-down areas for plant and equipment will be clearly marked to prevent contaminated water from leaching into soils or flowing into nearby watercourses.

Uncontrolled contaminated runoff from site would have the potential to enter the Styx River and Broad Sound, temporarily impacting localised OUVs such as coastal mangroves and saltmarsh communities and migratory shorebirds. However, given the mitigation measures proposed and the transient nature of any release event (should it occur) and the large tidal regime in Broad Sound, it is considered any accidental release of contaminated runoff would be diluted by tidal waters and unlikely to cause any significant or lasting impact to these values.

Mine Affected Water Release

The release of mine affected water is proposed as a contingency measure after water reuse within mine operations. It is also considered prudent to have a release strategy to minimise the risk of non-compliant discharges through effective water balance of the mine water inventory and by discharging better quality water when possible instead of allowing contaminants to concentrate in storages. Releases of mine affected water may occur as ‘controlled’ release through a piped transfer to Tooloombah or Deep Creek in accordance with EA conditions or as an ‘uncontrolled’ release via flow over a designated spillway during extreme wet weather events. Controlled and uncontrolled releases may occur at the same time, for example, during emergency situations.

Release points have been designated for storages containing pit dewater volumes, overburden stockpile runoff and mine process water (refer Figure 16-77). Mine affected water dams have piped outlets that transfer water to release points within Tooloombah Creek, where instream dilution is possible. Environmental dams located within the Deep Creek catchment have piped transfers to release points within Deep Creek. Release points will also be located at erosion and sediment control structures at the MIA, TLF overburden stockpile areas.

The proposed release conditions are detailed in Chapter 23 – Draft EA Conditions, and have been developed based on DES's *Model Water Conditions for Coal Mines in the Fitzroy Basin* (EHP 2013). The proposed releases reside within the adjoining Styx Basin; however, the DES guidelines for the Fitzroy Basin form current regulatory expectations for mine water management and thus have been adopted as the basis of the release strategy.

Water monitoring will be undertaken at the discharge locations of the environmental dams and mine-affected water dams, and at reference locations both upstream and downstream of the Project area. If water quality levels exceed the water quality objectives set out in Central Queensland Coal's EA (as issued by the State), upstream (control) values will be compared to water quality within and downstream of the Project area to determine if the exceedance is site-specific, and thus likely to be a result of Project activities, or if it is likely to be natural (similar to water quality levels upstream).

Water quality release limits for mine affected water include electrical conductivity (µS/cm), pH, suspended solids (mg/L) and sulphate (mg/L). In addition to the release limits, release contaminant trigger investigation levels also apply. Should the contaminant trigger level be exceeded, further investigation of background levels would be required. Should the release contaminant levels be shown to exceed the background monitoring level, Central Queensland Coal is required to investigate the potential environmental harm and provide reporting to the administering authority outlining the actions taken to prevent environmental harm.

Flooding

Storm surges are a condition associated with cyclonic weather whereby tidal levels are much higher than normal due to the piling up effect of wind upon the ocean. Little information is available about the potential magnitude of storm surge in the Styx River. It is a relatively small, ungauged catchment, there is no history of flood heights or frequency and no local tidal data from which surge data could be inferred. Nevertheless, Queensland's Development Assessment Mapping System indicates sections of Deep Creek and Tooloombah Creek located downstream from the Project boundary as potentially subject to 'medium' level impacts from storm tide inundation.

On-site fieldwork observations indicate the upstream extent of irregular (peak) tidal inundation, as evidenced by the presence of scattered patches of Marine Couch on lower banks, occurs downstream of the confluence of Deep Creek and Tooloombah Creek. Representative creek bed elevation at this location is approximately 5.5 m AHD. At the Bruce Highway Bridge over Deep Creek, the representative creek bed elevation is approximately 25 m AHD, almost 20 m higher than the peak tidal level (Figure 16-148). Whilst storm surge creates tidal inundation (i.e. the storm tide) that travels further inland than regular tides, it would be highly unlikely that cyclonic conditions could create a surge of this magnitude.

Flooding within the Styx basin is seasonal and is often associated with a cyclonic event. These flooding events occur during the wet season, with the Styx River containing most of the flow within the channel and overbank before overflowing into the floodplain areas downstream of the Project towards the township of Ogmore. In the (low likelihood) event of being coupled with a storm surge flooding events may be exacerbated. Within the vicinity of the Project, Deep Creek and Tooloombah Creek are incised with channel depths of more than 5 m. Tooloombah Creek is well-defined with little evidence of floodplain discharges while Deep Creek demonstrates several locations of floodplain discharges within the Project area evident by the presence of erosion and lack of vegetation on the banks.

To manage the risks from flooding, a mine water management system has been developed (see Section 16.7.3.7 and Section 16.10.4). A system of flood protection levees and diversion drains has been developed to prevent ingress of clean water runoff to pits for up to and including the 0.1% AEP rainfall event. This provision reduces the volumes of water entering pits and becoming contaminated, and hence reduces the storage requirements of pit dewatering dams. Mine infrastructure (such as CHPP / MIA 2) is located within the lower floodplain of Deep Creek. These areas will sit on a fill pad at an elevation selected to ensure that infrastructure is not inundated under any scenarios up to the 0.1% AEP event.

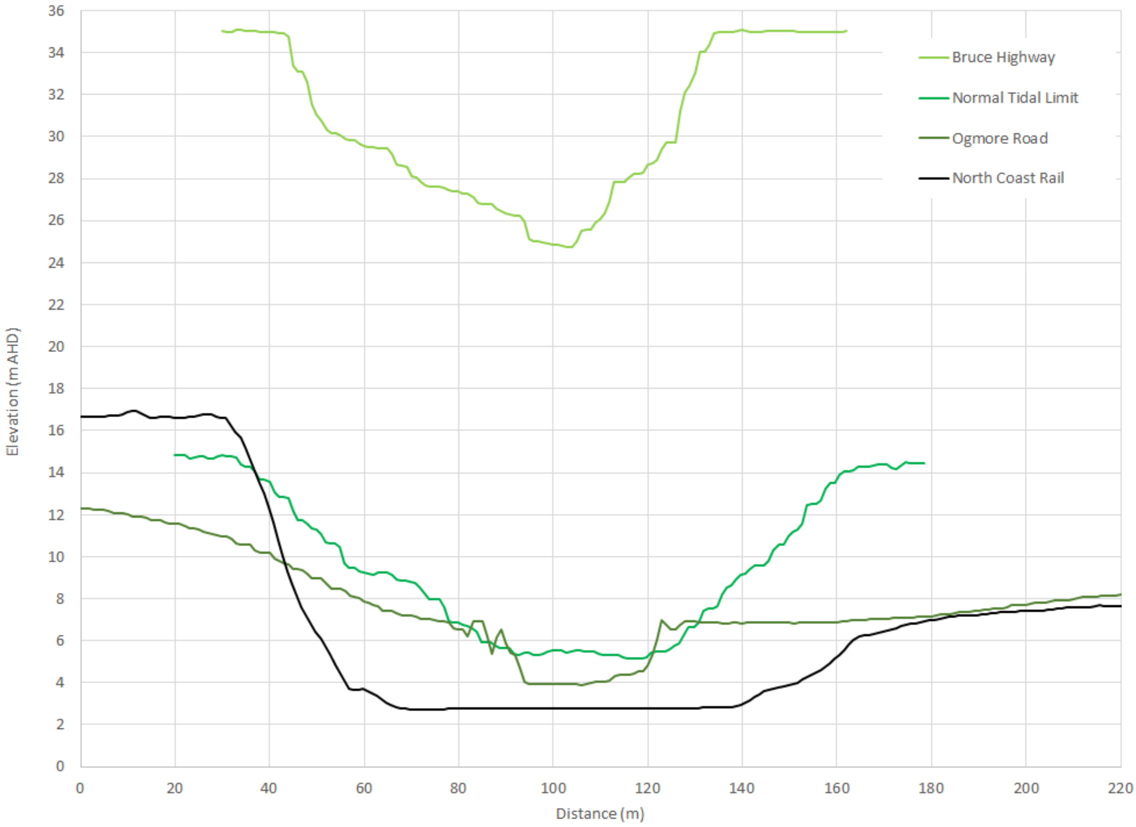


Figure 16-148 Comparative cross-section of watercourse crossings obtained from airborne laser survey

All regulated dams are conceptualised in accordance with Queensland DES guidelines and include storage provisions to reduce the probability of non-controlled discharges of contaminated water from dam failure or overtopping during extreme rainfall events or wet seasons. Water held in pit dewater dams is prioritised for reuse in mine operations, which reduces the net raw water demand from external sources. Environmental dams are located downstream of stockpiles and disturbed areas to reduce sediment loads entering the watercourses and controlled discharges reduced to a contingency measure and subject to EA conditions.

The mine water management system has been developed to withstand the flooding impacts of a 0.1% AEP rainfall event. It is therefore considered unlikely that a storm-tide event will have any measurable impact upon concurrent riverine flood levels throughout the project area.

Flooding and Stormwater Drainage Assessment

A flooding and stormwater drainage assessment was undertaken and is detailed in Section 16.10.3. The assessment demonstrates the flood immunity of critical mine infrastructure and haul roads and assesses the impacts on flood behaviour due to mine construction. Also documented is the conceptualisation and hydraulic performance of the stormwater management system, including diversion drains, culverts, floodways and sediment basins.

Modelling was undertaken of the existing land use scenario and the proposed development case taking account of the available historical climatic data for the past 127 years.

Flooding of Hazardous Dams

Flood modelling confirms that all environment dams can contain the surface runoff generated by a 9.5% AEP event without overtopping. AEP refers to the probability of a particular sized rainfall event for any given year i.e. a 9.5% AEP rainfall event is considered likely to occur 1 in every 10 years.

Stormwater Management Overview

Stormwater runoff containment devices, namely environment dams and drainage sumps, function to capture dirty water runoff generated from disturbed areas such as stockpiles and workshops. Environment dams are sized based on the 9.5% AEP, 24 hour rainfall event in keeping with the Queensland DES *Stormwater Guideline* (EHP 2014b). Environment dams will have a low flow perforated riser pipe outlet to discharge treated water to the receiving environment. Environment dams are located at the MIA, overburdens stockpiles and TLF. MIA drainage sumps and proprietary oil removal devices are proposed to capture runoff from truck wash and workshop areas for treatment and reuse or disposal.

Runoff intercepted by or generated from haul roads will be captured in table drains and conveyed longitudinally towards culvert structures. In areas of steeper grade, sediment transport can be effectively managed using check-dam structures within the drain. Where haul roads cross drainage gullies or the Deep Creek watercourse, an appropriately sized culvert will be provided, allowing for fish passage where relevant.

Clean water runoff from local catchments will be diverted around open cut mining areas for events up to and including the 0.1% AEP flood. The volume of stormwater entering open mine pits and becoming mine affected water is therefore effectively limited to that rain which falls directly on the open pit area. Precipitation received in the open pits will be dewatered to an ex-pit storage (pit dewater dam) for reuse or discharged to receiving waters as controlled discharges under conditions licensed be the EA.

More detailed information regarding water management specifications is provided in Section 16.7.3.7 and Section 16.10.4.

Groundwater

Groundwater Drawdown

Modelling of the potential drawdown effect of the open cut mine operations has been carried out (refer Section 16.11.3.4). Predicted groundwater elevation contours for the Project area prior to the commencement of mining and at the end of mining (2036) shows there is very little to no change to water table elevations upstream (south, west and east) of the proposed mine over the mining period, but there will likely be significant reduction in water table elevation in the vicinity of the mine (more than 100 m). Figure 16-147 depicts the maximum extent of groundwater drawdown predicted as occurring 10 years after the cessation of mining. Drawdown impacts are not predicted to occur beyond the confluence of Tooloombah Creek and Deep Creek.

Mangroves can be impacted by groundwater drawdown. Groundwater prevents the salinity of the water around the roots of mangroves from reaching lethal levels. Coastal vegetation communities such as mangroves and saltmarsh are located outside of the area of predicted maximum groundwater drawdown. As such, there are no impacts expected to GBRWHA OUVs from groundwater drawdown associated with the Project.

Groundwater Contamination

Contaminated groundwater can cause mangroves to be polluted from affected areas upstream. The expectation that the pit voids act as permanent groundwater sinks means groundwater quality is unlikely to be impacted by the key mine water affecting activities (mining of pits and remaining pit voids). The pits will capture groundwater, i.e. any water quality effects will not migrate away from the pit voids (refer Section 16.11.3.6).

In addition, mitigation measures to prevent accidental release of pollutants to surface waters (Section 16.10.7.2) for construction and operational phases of the Project will also apply to groundwater. It is therefore considered that there will be no impact to GBRWHA OUVs as a result of groundwater contamination.

Acid Sulphate Soils and Groundwater

Acid sulphate soils (ASS) are generally associated with low energy coastal environments. ASS can; however, form inland when there are sources of sulfide and soils are saturated for long periods of time in favourable conditions. ASS have the potential to impact on groundwater in situations where groundwater levels are affected (i.e. groundwater drawdown) Where ASS exist within the soil profile at similar depths to the groundwater level, the surface groundwater is at risk of acidifying.

The CSIRO National ASS mapping illustrates that the bulk of EPC 1029 is described as having a low to extremely low probability of containing ASS. The National ASS mapping (Fitzpatrick et al. 2011) in relation to the proposed mine, and the location of the 10 AHD contour is shown at Figure 16-20. As can be seen, the site straddles the low to extremely low ASS categories and is located beyond the 20 m contour meaning the State Planning Policy 2/02 – Planning and Managing Development Involving Acid Sulfate Soils is not triggered.

Predicted contours of water table elevation and drawdown (Figure 16-126) show there will be little, if any, change to average water table elevations close to Ogmore, and so there is little to no risk of the Project causing onset of ASS conditions.

Dust

Airborne dust may be generated by construction activities, operational stockpiles and transport activities. Vegetation and waterbodies within, surrounding and downstream of the Project area, have the potential to be adversely impacted by the application of high dust loads. Consequently, there are potential, albeit spatially and temporally of a minor nature, for impacts to GBR OUVs downstream of the Project.

Coal dust can result in adverse impacts on plant photosynthesis and productivity (Chaston and Doley 2006), changes in soil properties ultimately impacting plant species assemblages' (Farmer 1993; Spencer and Tinnin 1997) and mortality and / or decrease in aquatic health on aquatic communities from the toxicity of poor water quality. Naidoo and Naidoo (2005) found coal dust on mangroves located within 3 km of a coal terminal in South Africa impaired the productivity of two out of four species tested by reducing photosynthetic activity. It is noted only leaves that were 'extensively covered and appeared black' were tested.

Chronic exposure to high and localised concentrations of fine coal particles (as associated with bulk coal marine transport spills) have been found to have lethal effects on coral and impact the growth rates of tropical fish and seagrass (Berry et al. 2016). Coal contains contaminants such as metals and polycyclic aromatic hydrocarbons which may pose a risk to aquatic organisms including marine species. However, recent research indicates the risk of these contaminants leaching into seawater is low (Jaffrennou et al. 2007; Lucas and Planner 2012, Berry et al. 2016). The risks of fine coal particles in water are likely to be physical processes where there is a concentrated point source or plume of particles. This may have effects such as the physical smothering of benthic fauna, and attenuation of light inhibiting algae (Jaffrennou et al. 2007) or seagrass growth.

The predominant wind directions from the region are as follows: from the north and northeast during spring; north, northeast and southeast during summer; in autumn, the winds are primarily from the southeast; and southerly and southeast winds are more frequent during the winter season.

Modelling of potential dust particle deposition resulting from both Project construction and operation activities showed the areas most likely to be impacted were receptor points located to the direct west of the Project (Tooloombah Creek service station) and in the Ogmore area to the north of the Project. However, these impacts were minimal in comparison to the modelled natural background dust concentration and all concentrations were below air quality criteria set by the State under the Environmental Protection (Air) Policy 2008 (refer Chapter 4 – Climate of the EIS for more information). With recommended mitigation measures, these concentrations can be reduced further below threshold standards.

The Styx River and the wetland areas within the GBRWHA boundary are located to the north of the township of Styx which is approximately 10 km north of the Project at the nearest point. The closest modelled sensitive receptor to this location is Ogmore township, which is approximately 5 km closer to the Project. The maximum predicted daily dust deposition generated by the Project activities at this sensitive receptor is 0.02 $mg/m^2/day$ which is much lower than the threshold criteria of 120 $mg/m^2/day$. Therefore, dust deposition impacts from the Project on the wetlands and waters of the GBRWHA and associated OUVs are considered negligible at worst. With recommended mitigation measures, these concentrations can be reduced further below threshold standards.

Upon decommissioning, all potential dust generating areas will be rehabilitated and revegetated, and dust is unlikely to cause further impacts.

16.17.1.2 Assessment of Significance

An assessment of impact significance has been completed as per the Commonwealth's Significant Impact Guidelines (DotE 2013). Under the guidelines 'an action is likely to have a significant impact on the World Heritage values of a declared World Heritage property if there is a real chance or possibility that it will cause:

- One or more of the World Heritage values to be lost;
- One or more of the World Heritage values to be degraded or damaged; or
- One or more of the World Heritage values to be notably altered, modified, obscured or diminished.'

The impact assessment has been undertaken with a focus on the OUVs as described for listing of the GBRWHA and outlined in Table 16-122. The assessment concluded that with the proposed mitigation and management measures in place, no World Heritage values will be lost, degraded, damaged, notably altered, modified, obscured or diminished as a result of the Project and therefore there will be no significant impact on a World Heritage property.

Table 16-122 Significant Impact Assessment - Great Barrier Reef World Heritage Area OUVs

<table>
<tr><th>Values</th><th>Assessment of nature and extent of impacts</th></tr>
<tr><td>Geology or landscape values</td><td>Significant impact to OUV - unlikely

The Project will not damage, modify, alter or obscure:
▪ important geological formations;
▪ landforms or landscape features; and
▪ landscape processes.

Neither will the project:
▪ divert, impound or channelise a river, wetland or other water body; or
▪ substantially increase concentrations of suspended sediment, nutrients, heavy metals, hydrocarbons, or other pollutants or substances in a river, wetland or waterbody in a World Heritage property.

Unmitigated, the Project has the minor potential to impact the GBRWHA through temporary changes to water quality and quantity, and increased sedimentation. Changes to water quality may have a negative impact on downstream marine ecological processes, although these impacts would be temporary and localised. The Project will have negligible impact on freshwater inflows into the Styx River and the only impact on the relevant OUV elements closest to the Project are water quality impacts. Background nutrient levels (derived from surface water quality monitoring for the Project) are already above water quality objectives for the Styx River. The waters of Broad Sound are already naturally turbid due to resuspension of sediments caused by the large tidal regime in the area.

As part of the Project activities, the proponent proposes to remove stock from most of the surrounding property and manage vegetation regeneration in previously cleared areas (refer Section 16.9.4.2 and 16.19.5 for further detail), thereby potentially reducing sediment loads and nutrient inputs emanating from the property into GBR waters.

With the proposed Project design and management measures appropriately implemented throughout all stages of the Project, no significant impact to water quality is expected and therefore no impacts to WHA values associated with geology and landscape.</td></tr>
<tr><td>Biological and ecological values</td><td>Significant impact to OUV - unlikely

The Project will not:
▪ reduce the diversity or modify the composition of plant and animal species in all or part of the GBRWHA;
▪ fragment, isolate or substantially damage habitat:
  - important for the conservation of biological diversity in the GBRWHA
  - for rare, endemic or unique animal populations or species within the GBRWHA; or
▪ cause a long-term reduction in rare, endemic or unique plant or animal populations or species in the GBRWHA.

As described in Section 16.13.1, the OUVs most relevant to the Project area are the extensive downstream mangrove and saltmarsh communities and migratory shorebird populations. The Project is located 9.5 km upstream of the WHA boundary. The only impact the Project could conceivably have are water quality impacts due to releases of contaminated water (mine dewater or chemical spills) and sediments. The Project will have negligible impact on freshwater inflows into the Styx River. Background stream nutrient levels (derived from surface water quality monitoring for the Project) are already above water quality objectives for the Styx River. The waters of Broad Sound are already naturally turbid due to resuspension of sediments caused by the large tidal regime in the area.

Significant impacts to estuarine vegetation are not likely due to the transient nature of the impact and the local effect (including dilution) of the large tidal regime. Impacts to marine fauna either directly or resulting from habitat degradation are also unlikely.

With the proposed Project design and management measures appropriately implemented throughout all stages of the Project, no significant impact to water quality in downstream environments is expected and therefore no impacts biological and ecological values of the GBRWHA.</td></tr>
</table>

Values	Assessment of nature and extent of impacts
Wilderness, natural beauty or rare or unique environmental values	**Significant impact to OUV - unlikely** The Project will not: ▪ involve construction of buildings, roads or other structures, vegetation clearance, or other actions with substantial, long-term or permanent impacts on relevant values; or ▪ introduce noise, odours, pollutants or other intrusive elements with substantial, long-term or permanent impacts on relevant values. The OUVs most relevant to the Project area are the extensive downstream mangrove (21 km downstream) and saltmarsh communities (14 km downstream) and migratory shorebird populations (closest known roost locations are 33 km north and north-north-east of the Project). The Project is located 9.5 km upstream of the WHA boundary. The only impact the Project could conceivably have are water quality impacts due to releases of contaminated water (mine dewater or chemical spills) and sediments. The Project will have negligible impact on freshwater inflows into the Styx River. Background stream nutrient levels (derived from surface water quality monitoring for the Project) are already above water quality objectives for the Styx River. The waters of Broad Sound are already naturally turbid due to resuspension of sediments caused by the large tidal regime in the area. Significant impacts to estuarine vegetation are not likely due to the transient nature of the impact and the local effect (including dilution) of the large tidal regime. Impacts to fauna resulting from habitat degradation are also unlikely. As part of the Project activities, the proponent proposes to remove stock from most of the surrounding property and manage vegetation regeneration in previously cleared areas (refer Section 16.9.4.2 and 16.19.5 for further detail), thereby potentially reducing sediment loads and nutrient inputs emanating from the property into GBR waters. With the proposed Project design and management measures appropriately implemented throughout all stages of the Project, no significant impact to water quality in downstream environments is expected and therefore no substantial, long-term or permanent impacts on relevant values are expected.

16.17.1.3 Net Benefit for Water Quality

The Project will provide a net benefit to water quality in the GBRWHA and is consistent with the objectives of the Reef 2050 Long-term Sustainability Plan (DotEE 2015). The Reef 2050 Long-term Sustainability Plan was released in March 2015 and is the overarching document for protecting and managing the GBR until 2050. The central objective of the Plan is 'to ensure the Great Barrier Reef continues to improve on its Outstanding Universal Value every decade between now and 2050.' The Plan seeks to coordinate management of activities in the WHA and adjacent catchment and addresses all values including species, their habitats, indigenous values and historic heritage.

The Plan identifies four key risks to the reef:

- Climate change – long-term risk addressed at both State and Commonwealth government levels to mitigate rising GHG emissions, adopt adaptation strategies and funding climate research;
- Land-based run-off – immediate system-wide risk associated with run-off from agricultural lands into the GBR lagoon;
- Coastal land use change – immediate local / regional risk associated with land use planning and development in coastal catchments including port development, coastal planning law, water extraction, and strengthening vegetation management; and
- Direct use – immediate local / regional risk associated with regulating activities within the reef itself including fishing and tourism.

Regarding the potential impacts specific to the Project (i.e. water quality releases in the GBR lagoon) the plan highlights the following water quality issues impacting the reef due to land-based run-off from agriculture:

- The success of recent efforts to reduce poor water quality run-off that have reduced pesticide, sediment and total nitrogen loads against 2009 baselines;
- Setting water quality targets for reduction in the following pollutants in 'priority areas' under the 2009 baseline (also refer Section 16.15.3.6):
  - Dissolved nitrogen by at least 50% (80% reduction by 2025)
  - Sediment loads by at least 20% (50% reduction by 2025)
  - Particulate nutrient loads by at least 20%
  - Pesticide loads by at least 60%
- Additional actions that may be applicable to the Project such as:
  - Working with industries to measure management efforts to achieve best practice water quality management
  - Reviewing and developing water quality objectives, targets and standards across the region
  - Strengthening protection of natural wetlands and riparian vegetation.

Surface water quality sampling for the Project (2011 and 2017 / 2018) recorded the following background data from the surface waters adjacent to the Project:

- Turbidity and suspended solids loads were generally low and below water quality objectives set for the Styx River catchment during periods of flow or following recent rains. High levels of turbidity and suspended solids (exceeding water quality objectives) were recorded, predominantly but not solely in sites on Deep Creek, following extended dry periods and no flow conditions (February 2018, November 2017 to April 2018); and
- Similarly, high levels of total nitrogen, ammonia and phosphorus were recorded (above local water quality objectives) across sites in Deep Creek and the Styx River following extended dry periods and no flow conditions. This effect was less marked in Tooloombah Creek.

It is also known that the waters of Broad Sound are naturally turbid and low in nutrients due to the large tidal range in the area (De'ath and Fabricius 2008).

The Project is in the lower catchments of both Tooloombah Creek and Deep Creek. It is uncertain to what extent the Project area currently contributes to sediment or nutrient loads entering the creeks. It is noted that the entire Project area is subject to cattle grazing (thereby contributing to nutrient run-off) and comprises areas of dispersive and sodic soils that are prone to erosion (as evident during site inspections).

The Project activities will not conceivably add nutrient loads to the Styx River. The Project layout and management approach will necessarily reduce the local catchment impacts through a reduction in catchment area, and the destocking of cattle and long-term revegetation of the surrounding property. Mine water releases from the Project will be avoided where possible and will be subject to the water quality objectives in place as set out under the Project's EA issued by the State. The

Project occupies a very small area within the Styx River catchment (much less than 1%) and is considered unlikely to provide additional water quality impacts to surface water entering the GBRWHA to those already existing in the catchment.

Central Queensland Coal has proposed destocking the majority of the Mamelon property and restricting cattle access to already cleared habitat in the south-west and south of the property. This area encompasses approximately 1,000 ha. The remaining area, including the creek lines which lie adjacent to the mine area, will be managed and allowed to regenerate. This measure will contribute to localised water quality improvements, and contribute to improving the water quality entering Broad Sound and the GBRWHA through the following:

- The long-term restoration of this habitat, and in particular allowing vegetation to regrow along the riparian zones along Deep Creek and Tooloombah Creek (which are presently mostly cleared), will capture / entrain sediment and nutrient run-off from the property;
- The restoration of cleared areas will also reduce soil erosion on cleared areas of the property, thereby reducing the entrainment of sediments entering creek lines during bouts of heavy rainfall; and
- The removal of cattle from much of the property will also remove a source of long-term nutrient input into creek lines following rainfall.

An assessment of the existing sediment loads on Mamelon property has been carried out under differing stocking regimes (refer Section 16.9.3). The results of the assessment show that for the areas assessed within ML 80187 the estimated annual sediment generation potential ranges between 595 to 2,797 t/ha (dependent on cattle stocking regime) (refer Table 16-18). Soil loss estimate calculations undertaken for the site indicate potential soil loss of between 67 to 1,392 tonnes per hectare per year (refer Table 16-25), assuming no erosion and sediment controls are implemented as part of Project activities. With the installation, operation and maintenance of sediment basins, at least 95% of sediments would be captured and retained. With the removal of cattle from much of the property, this represents a significant reduction in downstream sedimentation compared with the current grazing regime.

It is expected that the reduction of mobilised sediments will continue post mining as the intention is to set aside the property for nature conservation purposes. A key aspect of the destocking approach will be to allow the vegetation communities within the riparian corridors to regenerate without being subjected to ongoing grazing pressures. As vegetation coverage continues to increase within the riparian corridors and across the property more generally combined with the absence of grazing, the potential for sediments to mobilise reduces and will continue to do so.

The mitigation measures, as detailed in Section 16.15 of this chapter of the SEIS, are designed to at worst, maintain an existing background water quality in the adjacent creek lines. The implementation of a REMP will also provide continuous data on local water quality in the Styx River catchment which was not previously available. With the proposed destocking and vegetation management on the Mamelon property, reduction in catchment run-off area and proposed mitigation and monitoring measures the Project has the potential to provide a net benefit to water quality in the GBRWHA.

An assessment of the Project's activities against specific Reef 2050 Water Quality Targets based on the measures summarised above, and in detail in Sections 16.9.4, 16.10.7 and 16.11.4 is provided in Section 16.15.3.6.

16.17.2 Impact Significance - National Heritage Place

The GBR is the sole National Heritage Place triggered by the Project. An assessment of impact significance has been completed as per the Commonwealth's Significant Impact Guidelines (DotE 2013). Under the guidelines 'an action is likely to have a significant impact on the National Heritage values of a National Heritage place if there is a real chance or possibility that it will cause:

- One or more of the National Heritage values to be lost;
- One or more of the National Heritage values to be degraded or damaged; or
- One or more of the National Heritage values to be notably altered, modified, obscured or diminished.'

The National Heritage values of the GBR are the same as the World Heritage Property values as described in Section 16.13.1. As such, the significant impact assessment of the Project activities on GBRWHA values as provided in Table 16-122 also describes the assessment of National Heritage values for the GBR. The assessment concludes that with the proposed mitigation measures implemented, no National Heritage values will be lost, degraded or damaged, or notably altered, modified, obscured or diminished because of Project activities. Consequently, there will be no significant impact on a National Heritage Place.

16.17.3 Impact Significance – TECs

As noted in Section 16.13.8, two TECs have been encountered within the Project area: Brigalow and SEVT. Known information about Brigalow and SEVT and the significance of impacts to these communities potentially resulting from the Project [using the significant impact criteria provided in DotEE (2013)] is summarised in the following sections.

The significance of impacts for each of the two endangered ecological communities occurring within the Project area are evaluated in Table 16-123 (Brigalow) and Table 16-126 (SEVT) using the significant impact criteria provided in DotEE (2013). Clearing of remnant vegetation may not occur within either community with further Project design refinement resulting in no direct reduction in the extent of this ecological community.

16.17.3.1 Brigalow

Table 16-123 summarises the current knowledge of the Brigalow TEC as it pertains to the Project area, as well as current known threats and management concerns.

Table 16-123 Key data on Brigalow

Brigalow (*Acacia harpophylla dominant and co-dominant*)
Baseline Data Results
Current DNRME RE mapping identifies a single patch (12.4 ha) present within the ML80178, and a single patch (7.1 ha) present within ML700022 of vegetation community (RE 11.4.9) which is associated with the Brigalow TEC. *Ground-truthed data* Ground-truthing identified current DNRME mapping is incorrect and the currently mapped areas are composed of eucalypt communities (RE 11.3.35 or 11.4.2). A single isolated patch (0.54 ha) identified as having potential to constitute a Brigalow TEC located in the east of the ML80178, and a second isolated patch 3.37 in the south of ML700022 both mapped as RE 11.4.9. The community present satisfies threshold conditions for a Brigalow TEC (refer Butler 2007). There are scattered small patches in the surrounding area, particularly adjacent to Deep Creek and the northeast boundary of the mine ML.
Conservation Status
Endangered
Key Threats

Brigalow (*Acacia harpophylla dominant and co-dominant*)
The Brigalow ecological community has been historically extensively cleared for cropping and / or pasture. Current key threats to this threatened community are from activities which further reduce the extent, cause a decline in the condition of the vegetation, or impede the recovery of the community. Threatening activities include: continued tree clearing, high total grazing pressure, fire, lack of knowledge and proliferation of exotic species. Note that these threats do not operate in isolation but interact, sometimes in synergistic action (DotEE 2018).
Recovery Plans
There is no State or Commonwealth recovery plan for this community. The Commonwealth Approved Conservation Advice (TSSC 2013) for Brigalow TEC lists the following 'priority recovery and threat abatement actions' for this community applicable to the Project: ▪ Threat reduction / control including mitigating impacts where clearing of Brigalow communities is unavoidable such as minimising hydrological disruption, weed spread, dissection of patches and offsetting; ▪ Manage areas of Brigalow including fire, weed and pest management; and ▪ Encourage landholders to balance primary production and the conservation of native flora and fauna within and close to the ecological community.
Threat Abatement Plans
For the Brigalow TEC the following Commonwealth Threat Abatement Plan is considered relevant: ▪ Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (CoA 2011). ▪ The plan outlines objectives relating to the impacts caused by cane toads, largely on predatory fauna, rather than on the vegetation community itself. Cane toads were observed on the site during fauna surveys (including within Brigalow TEC) and are likely to have been present for a long time. The Project will not possibly interfere with any of the Plan's objectives and they are not considered further.

The Project layout has been revised since submission of the EIS (refer Figure 16-143) and there will no longer be any direct impacts to Brigalow TEC. The threat of weed invasion may also impact this community although the area is already degraded by introduced species at present. The Project LUMP will include measures to control weed invasion / proliferation across the Project area. Planned management of lands surrounding the Project including revegetation of cleared areas and weed management will in the long term increase the extent of Brigalow habitat in the area. No other potential impacts predicted from Project activities. The following table assesses the potential impact of the Project on the TEC using the Commonwealth significant impact criteria (DotE 2013).

Table 16-124 Assessment against significant impact criteria: Brigalow TEC

Criterion	Assessment against Significance Criteria
Brigalow (*Acacia harpophylla* dominant and co-dominant)	
Reduce the extent of an ecological community	There will be no direct clearing impacts to Brigalow TEC as a result of the Project. A vegetation monitoring program will be undertaken throughout the life of the Project. Should impacts be detected to the TEC (such as a decrease in habitat quality) that can be attributed to the Project activities, appropriate mitigation measures will be implemented to address the root cause of the impacts. Planned management of lands surrounding the Project including revegetation and weed management will in the long term increase the extent of Brigalow habitat in the area.
Fragment or increase fragmentation of an ecological community	The Project area has a long history of grazing land use. This has resulted in clearing of native vegetation such that this TEC is now heavily fragmented across the local landscape. The Project will not further fragment this TEC, as above ground activities are for the most part in cleared lands.
Adversely affect habitat critical to the survival of the community	There will be no direct clearing impacts to Brigalow TEC as a result of the Project. This is a widespread community extending from Charters Towers south to northern NSW and west to Cunnamulla. Given the wide extent of occurrence and the very minor and isolated extent of the TEC within the Project area it is considered unlikely the Project will adversely affect habitat critical to the survival of the community.

Criterion	Assessment against Significance Criteria
Modify or destroy abiotic factors necessary for an ecological community's survival	Brigalow communities are known to develop horizontal root systems and the majority of hydrological interactions occur in the top 1 m of soil (Tunstall and Connor 1981). Monitoring of bores in the Project area has indicated the current depth of groundwater to be more than 6 m below ground level in the Central Queensland Coal mine area. Groundwater drawdown associated with Project dewatering activities will result in some reduction of groundwater levels but is not expected to impact this community (refer Section 16.14.4.4). Potential changes to surface water quality (such as sedimentation and contaminated runoff) will be mitigated against using measures detailed in the Project ESCP and WMP. This is not expected to impact the minor occurrence of Brigalow associated with the area.
Cause a substantial change in the species composition of an occurrence of the ecological community	The Project is unlikely to impact the species composition within this TEC. The Project's overarching LUMP will incorporate effective weed management during all phases of the Project to minimise the likelihood of an increase in weed species populations or the introduction of new weed species to the Project area. The Project is considered unlikely to cause substantial change in the species composition of an occurrence of the TEC.
Cause a substantial reduction in the quality or integrity of an occurrence of the ecological community	There will be no direct clearing impacts to Brigalow TEC as a result of the Project. Quality or integrity may be defined as the extent and distribution of a vegetation community and its condition for designated purposes including habitat for fauna and flora species (DECC 2008). Weed and land management practices incorporated into the Project LUMP will aim to minimise the impact on communities. The Project will also develop an ESCP and WMP to minimise impacts associated with surface water runoff. Planned management of lands surrounding the Project including revegetation and weed management will in the long term increase the extent of Brigalow habitat in the area. With the mitigation measures in place, the Project is considered unlikely to cause a substantial reduction in the quality of an occurrence of the TEC.
Interfere with the recovery of the ecological community	There will be no direct clearing impacts to Brigalow TEC as a result of the Project. There is no State or Commonwealth recovery plan for this community. The Commonwealth Approved Conservation Advice (TSSC 2013) for the Brigalow TEC lists several priority management actions designed to conserve the community. The Project LUMP will incorporate pest and weed management, fire management and monitoring / management of groundwater and surface water values. Planned management of lands surrounding the Project including revegetation and weed management will in the long term increase the extent of Brigalow habitat in the area. The Project will not interfere with any of recommendations included within the Commonwealth Conservation Advice for this community and is considered unlikely to interfere with the recovery of the TEC.

16.17.3.2 Semi-evergreen Vine Thicket

Table 16-125 summarises the current knowledge of the SEVT TEC as it pertains to the Project area, as well as current known threats and management concerns.

Table 16-125 Key data on SEVT

SEVT of the Brigalow Belt (North and South) and Nandewar Bioregions
Baseline Data Results
Current DNRME RE mapping does not identify this community as occurring in the Project area or surrounds. *Ground-truthed data* There are five polygons of an SEVT TEC (RE 11.3.11) located along the edge of Tooloombah Creek and adjacent to the northwest boundary of the mine ML (total cover of 21.73 ha). The edge of two of these patches is located on the northwest edge of ML80178 covering 2.2 ha in total.
Conservation Status
Endangered

SEVT of the Brigalow Belt (North and South) and Nandewar Bioregions
Key Threats
The SEVT ecological community has been historically extensively cleared for cropping and / or pasture. This community now remains highly fragmented. Current key threats to this threatened community are from activities which further reduce the extent, grazing pressure from both introduced and native herbivores, and weed invasion, particularly those that promote the incursion of fires. Threatening activities include: continued tree clearing, high total grazing pressure, fire and proliferation of exotic species. Note that these threats do not operate in isolation but interact, sometimes in synergistic action (DotEE 2018).
Recovery Plans
National recovery plan for the listed SEVT ecological community (McDonald 2010) provides the main framework for the community's recovery. Objectives of the recovery plan include: ▪ To increase the area of the SEVT ecological community and its representation in conservation reserves or under conservation agreements (MOUs); ▪ Ensure 'best-practice' management is applied to sites containing the SEVT ecological community; and ▪ Encourage involvement of landholders and the community in the conservation and management of the SEVT ecological community.
Threat Abatement Plans
For the SEVT TEC the following Commonwealth Threat Abatement Plans are considered relevant: ▪ Threat abatement plan for the biological effects, including lethal toxic ingestion, caused by cane toads (CoA 2011). The plan outlines objectives relating to the impacts caused by cane toads, largely on predatory fauna, rather than on the vegetation community itself. Cane toads were observed on the site during fauna surveys (including within Brigalow TEC) and are likely to have been present for a long time. The Project will not possibly interfere with any of the Plan's objectives and they are not considered further. *Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs* (CoA 2017a). The plan outlines objectives and actions to reduce the impacts of feral pigs on MNES communities and species. The most applicable impact to the SEVT TEC is habitat degradation. Feral pigs already occur on the site. Pest management will be incorporated into the Project LUMP which will be in line with one of the objectives set out in the Plan. The Project will not possibly interfere with any of the Plan's objectives.

The Project layout has been revised since submission of the EIS (refer Figure 16-143) and there will no longer be any direct impacts to SEVT TEC. The threat of weed invasion may also impact this community although the community is already degraded by introduced species at present, particularly Rubber Vine. The Project LUMP will include measures to control weed invasion / proliferation across the Project area. Groundwater drawdown is not expected to impact SEVT (refer Section 16.14.4.4). The flora species present in this community do not appear to require access to groundwater apart from emergent eucalypts such as Forest Red Gum. Nevertheless vegetation health of these patches will be monitored under the Project LUMP. Should impacts be detected and unable to be ameliorated these areas will be included in the Project OMP. No other potential impacts are predicted from Project activities. The following table assesses the potential impact of the Project on the TEC using the Commonwealth significant impact criteria (DotE 2013).

Table 16-126 Assessment against significant impact criteria: SEVT TEC

Criterion	Assessment against Significance Criteria
SEVT of the Brigalow Belt and Nandewar bioregions	
Reduce the extent of an ecological community	There will be no direct clearing impacts to SEVT TEC as a result of the Project. Potential impacts may occur in the long-term outside of the ML due to groundwater drawdown although the extent of these impacts are uncertain. A vegetation monitoring program will be undertaken throughout the life of the Project (refer Section 16.15.4). Should impacts be detected to the occurrences of this TEC outside the mine ML boundary, such as a decrease in habitat quality that can be attributed to the Project activities (e.g. groundwater drawdown), appropriate mitigation measures will be implemented to address the root cause of the impacts such as the provision of supplementary water flows. Where mitigation measures are not found to ameliorate impacts to the TEC be detrimentally these areas will be incorporated into the Project OMP.
Fragment or increase fragmentation of an ecological community	The Project area has a long history of grazing land use. This has resulted in clearing of native vegetation such that this TEC is now heavily fragmented across the local landscape. The Project will not further fragment this TEC, as above ground activities are for the most part in cleared lands.
Adversely affect habitat critical to the survival of the community	There will be no direct clearing impacts to SEVT TEC as a result of the Project. There is no definition of habitat critical to the survival of this community. This is a widespread community extending from coastal Townsville south to the Liverpool Plains region of NSW. Given the wide extent of occurrence and minor extent of those fragments within the Project area it is considered unlikely the Project will adversely affect habitat critical to the survival of the community.
Modify or destroy abiotic factors necessary for an ecological community's survival	Potential changes to surface water quality (such as sedimentation and contaminated runoff) will be mitigated against using measures detailed in the Project ESCP and WMP (refer Section 16.9.4 and 16.15.3). This is not expected to impact the occurrence of SEVT associated with the area which is located away from the main channel of Tooloombah Creek. Groundwater drawdown associated with Project dewatering activities may result in some reduction of groundwater levels, but it is unlikely the SEVT community accesses groundwater (refer Section 16.14.4.4). Nevertheless, these areas will be monitored for changes in health as part of the LUMP. Should the TEC be found to detrimentally impacted, appropriate mitigation measures will be implemented to address the root cause of the impacts such as the provision of supplementary water flows. Where mitigation measures are not found to ameliorate impacts to the TEC be detrimentally these areas will be incorporated into the Project OMP. There is a low potential for Project activities to modify abiotic factors necessary for the SEVT TECs survival (i.e. groundwater drawdown) in the local area although this impact is considered very unlikely to occur.
Cause a substantial change in the species composition of an occurrence of the ecological community	The Project is unlikely to impact the species composition within this TEC. The Project's overarching LUMP will incorporate effective weed management during all phases of the Project to minimise the likelihood of an increase in weed species populations or the introduction of new weed species to the Project area. Should a decrease in understorey species associated with SEVT be observed during monitoring, understorey revegetation will be implemented. The Project is considered unlikely to cause substantial change in the species composition of an occurrence of the TEC.

Criterion	Assessment against Significance Criteria
Cause a substantial reduction in the quality or integrity of an occurrence of the ecological community	There will be no direct clearing impacts to SEVT TEC as a result of the Project. Quality or integrity may be defined as the extent and distribution of a vegetation community and its condition for designated purposes including habitat for fauna and flora species (DECC 2008). Weed and land management practices incorporated into the Project LUMP will aim to minimise the impact on vegetation communities. The Project will also develop an ESCP and WMP to minimise impacts associated with surface water runoff. Groundwater drawdown associated with Project dewatering activities is likely to result in localised reduction of groundwater levels, but it is unlikely the SEVT community accesses groundwater (refer Section 16.11.4.4). Nevertheless these areas will be monitored for changes in health as part of the LUMP and WMP. Should occurrences of the TEC be found to detrimentally impacted, appropriate mitigation measures will be implemented to address the root cause of the impacts such as the provision of supplementary water flows. Where mitigation measures are not found to ameliorate impacts to the TEC be detrimentally these areas will be incorporated into the Project OMP. There is a low potential for Project activities to cause a substantial reduction in the quality / integrity of localised occurrences SEVT TEC through groundwater drawdown although this impact is considered very unlikely to occur.
Interfere with the recovery of the ecological community	There will be no direct clearing impacts to SEVT TEC as a result of the Project. Groundwater drawdown is considered very unlikely to impact localised occurrences of this community further. An OMP will be developed to compensate for potential degradation of patches of the TEC adjacent to the Project resulting from groundwater drawdown in the unlikely event these occur. Hence, activities associated with the Project are not expected to interfere with the recovery of this TEC.

16.17.4 Impact Significance – Threatened Species

As noted in Section 16.13.9, four fauna species have been encountered within or near the Project area thereby being considered known or likely to occur and potentially be subject to Project impacts: Squatter Pigeon, Ornamental Snake, Greater Glider and Koala. Current information about each listed species is summarised in the 'key data' tables shown in the following sections. Assessment of impact significance has been completed as per the Commonwealth's Significant Impact Guidelines (DotE 2013). These included criteria for species listed as Vulnerable at the time the Section 75 decision for this Project was made (3 February 2017).

The vulnerable species assessments commence with an evaluation of the likely importance of the population, as defined within the significant impact criteria for vulnerable species:

'An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and / or that are:

- Key source populations either for breeding or dispersal;
- Populations that are necessary for maintaining genetic diversity; and / or
- Populations that are near the limit of the species range.

Given the specificity of the above definition and the scarcity of information and records available for most listed species and populations in the region (and Australia), it is difficult to determine: 1) attributes such as breeding and dispersal behaviour and whether the population is a 'key source' and 2) the genetic diversity of individuals inhabiting a population or sub-population. Given the paucity of information available, significance of impacts to threatened species has been based on experience of the assessment team and the latest available information.

16.17.4.1 Squatter Pigeon

Squatter Pigeon has been observed on multiple occasions within the Project area. Table 16-127 summarises the species presence in the Project area, known threats to the species, and the relevant Commonwealth and State documents applicable to the species recovery.

Table 16-127 Key data on Squatter Pigeon

Squatter Pigeon (southern) (*Geophaps scripta scripta*)
Baseline Data Results
Twenty-three WildNet records exist for Squatter Pigeon occurring within wider 50 km radius of study area. Individuals, pairs and small groups recorded within MLs and surrounds during surveys in March and September 2011, February 2012, February, September and November 2017, and January 2018. The species occurs in grassy woodlands and it is known to prefer sandy soils in areas close to water. The species can also occur in cleared areas. The species has been recorded in RE 11.11.15a and RE 11.4.2 within the MLs, but was more regularly recorded in cleared habitat close to permanent water and vegetated areas.
EPBC Status
Vulnerable
Key Threats
Squatter Pigeon has undergone a significant decline in the southern range of its previous extent. DotEE (2018) identified the following the following known threats to the Squatter Pigeon: ▪ Habitat loss through vegetation clearing; ▪ Degradation of habitat due to overgrazing by domesticated stock; ▪ Degradation of habitat by weed invasion such as Buffel Grass; and ▪ Predation by introduced species mainly cats and foxes.
Recovery Plans
There is no adopted recovery plan in place for this species. The Commonwealth's Approved Conservation Advice for Squatter Pigeon (southern) (TSSC 2015) lists the following priority conservation actions that may be applicable to the Project including: ▪ Protect and rehabilitate areas of vegetation that support important sub-populations; ▪ Protect sub-populations of the listed subspecies through the development of covenants, conservation agreements or inclusion in reserve tenure; ▪ Develop and implement a stock management plan for key sites; and Raise awareness of the squatter pigeon (southern) within the local community, particularly among land managers.
Threat Abatement Plans

For Squatter Pigeon, the following Commonwealth Threat Abatement Plans are considered relevant:
 	
▪ Threat abatement plan for predation by feral cats (DotE 2015b):
    – Sets out four objectives for controlling feral cats including control in different landscapes, effectiveness of control options, alternative strategies to aid threatened species recovery and public support for cat management
▪ Threat abatement plan for competition and land degradation by rabbits (DotEE 2016b):
    – Establishes a national framework to guide and coordinate Australia's response to the impacts of European rabbits on biodiversity. Identifies the research and management actions required to ensure the long-term survival of those native species and communities impacted by the presence of rabbits. Replaces the previous threat abatement plan published in 2008 (DEWHA)
▪ Threat Abatement Plan for Predation by the European Red Fox (DEWHA 2008):
    – Sets out prioritising management areas including ascertain the degree of threat to the survival of threatened species and communities, the potential for recovery of threatened species and communities, threatened species likely to benefit through fox control in specific areas, and cost efficiency and effectiveness of fox control in a particular area.

The subspecies range occurs north to Townsville and west to Charleville. Important populations of the Squatter Pigeon have been identified as those isolated and sparsely distributed sub-populations that occur south of the Carnarvon Ranges in central and southern Queensland including:

- Populations occurring in the Condamine River catchment and Darling Downs of southern Queensland;
- Populations occurring in the Warwick-Inglewood-Texas region of southern Queensland; and
- Any population that may potentially occur in NSW (Squatter Pigeon Workshop 2011).

North of the Carnarvon Ranges the species remains common and is considered to be distributed as a single, continuous (that is inter-breeding) sub-population (DotEE 2018). Therefore, individuals in the Project area are unlikely to be key sources for breeding, dispersal, or maintaining genetic diversity. Under the definition provided in the MNES guidelines (DotE 2013) the individuals occurring in the Project area cannot be considered an important population.

Figure 16-144 depicts Project records of the species presence, the Project footprint and the available remnant habitat for Squatter Pigeon on the site based on the vegetation communities present (RE 11.3.35 and 11.4.2) and suitable non-remnant foraging habitat. The Project footprint will require clearing a total of 81.45 ha of remnant habitat and 508 ha of non-remnant foraging habitat for the species.

Table 16-128 Assessment against significant impact criteria: Squatter Pigeon (southern)

Criterion	Assessment against significance criteria (vulnerable)
Squatter Pigeon (southern subspecies) (*Geophaps scripta scripta*)	
Lead to a long-term decrease in the size of an important population of the species	There is no important population existing on the site. It is uncertain how many individuals occur in the area. A maximum of 6 individuals were observed in a single area on one occasion. Other observations were largely of pairs or single birds. It is considered likely that individuals disturbed by construction activities will simply move away from the area of disturbance. The Project is unlikely to lead to a long-term decrease in an important population.
Reduce the area of occupancy of an important population	The species is known to occur within the mine area and surrounds. There is no important population existing on the site. Database records indicate the species occurs widely across the local and wider region. The species preferred habitat is grassy woodlands which occurs widely across the local region. Individuals were located in RE 11.4.2 and 11.11.15a. The species was also commonly observed in cleared habitat which is abundant across the wider area (>37,000 ha within a 10 km radius of the Project). Clearing for the Project is predicted to remove a total of 81.45 ha of RE 11.3.35 and 11.4.2. The entire Project footprint is estimated at 1,124 ha, the majority of which is already cleared lands – 1,016 ha. The Project will reduce the occupancy of the species across the local region although to no more than a very minor extent.
Fragment an existing important population into two or more populations	There is no important population existing on the site. The species is sparsely distributed across a wide range. The Project is unlikely to fragment an existing important population.
Adversely affect habitat critical to the survival of the species	The species occurs in grassy woodlands which remains abundant across much of its range including the local area surrounding the Project area. Squatter Pigeon may also occur in disturbed areas partially cleared for cattle grazing. The Project will not adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	There is no important population existing on the site and relatively few individuals have been recorded. The Project will not disrupt the breeding cycle of an important population.

Criterion	Assessment against significance criteria (vulnerable)
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The species occurs across a broad swathe of eastern Queensland from Townsville south to the NSW border. The species preferred habitat is grassy woodlands which occurs widely across this area. The species occurs in low numbers within the Project area. Given the extent of occurrence of Squatter Pigeon the Project is considered unlikely to decrease the availability of habitat to the extent the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	Weed and pest control measures will be incorporated into the Project LUMP to control the introduction and spread of weed species across the Project area. The LUMP will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project LUMP will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for this species. With mitigation of potential impacts incorporated within the Project LUMP, any potential impact on Squatter Pigeon will be minor and is considered unlikely to interfere with the recovery of the species.

Criterion	Assessment against significance criteria (vulnerable)
Assessment of potential for significant residual impacts	Database records indicate the species occurs widely across the local and wider region. The species preferred habitat is grassy woodlands which occurs widely across the local region. Individuals were located in RE 11.4.2, 11.10.7 and 11.11.15a. The species was also commonly observed in cleared habitat which is abundant across the wider area (>37,000 ha within a 10 km radius of the Project). Clearing for the Project is predicted to remove a total of 80.12 ha of RE 11.4.2 and 1.33 ha of RE 11.3.35. The entire Project footprint is estimated at 1,287 ha, the majority of which is already cleared lands – 1,182 ha. The Project will reduce the occupancy of the species across the local region although to no more than a minor extent. The significant impact guidelines define impacts on 'vulnerable' species in the terms of 'important populations' as follows: 'An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and / or that are: 1. Key source populations either for breeding or dispersal; 2. Populations that are necessary for maintaining genetic diversity; and / or 3. Populations that are near the limit of the species range (MNES Guidelines, DotE 2013). The subspecies range occurs north to Townsville and west to Charleville. Important populations of the Squatter Pigeon have been identified as those isolated and sparsely distributed sub-populations that occur south of the Carnarvon Ranges in central and southern Queensland including; 1. Populations occurring in the Condamine River catchment and Darling Downs of southern Queensland; 2. Populations occurring in the Warwick-Inglewood-Texas region of southern Queensland; and 3. Any population that may potentially occur in NSW (Squatter Pigeon Workshop 2011). North of the Carnarvon Ranges the species remains common and is considered to be distributed as a single, continuous (that is inter-breeding) sub-population (DotEE 2018). Therefore, individuals in the Project area are unlikely to be key sources for breeding, dispersal, or maintaining genetic diversity. The subspecies commonly occurs to the north and south of the Project. Populations south of Tin Can Bay (over 400 km south-east of the Project) are considered to be fragmented. The Project area is not at the edge of the species range. Under the definition provided in the MNES guidelines (DotE 2013) as issued and referred to by DotEE, the individuals occurring in the Project area cannot be considered an important population. None of the above nine-part tests of significance conclude a significant impact on the species. As such there will be no significant residual impact on an 'important population'. As quoted from the EPBC Act Environmental Offsets Policy 2012: 'For assessments under the EPBC Act, offsets are only required if residual impacts are significant.' Therefore no offsets are proposed for this species (see Section 16.19).

16.17.4.2 Ornamental Snake

Ornamental Snake has been recorded on two occasions to the west of the Project area. Table 16-129 summarises the species presence in the Project area, known threats to the species, and the relevant Commonwealth and State documents applicable to the species recovery.

Table 16-129 Key data on Ornamental Snake

Ornamental Snake (*Denisonia maculata*)
Baseline Data Results
There is a single record (ALA database) of the species in the wider area located 24 km northeast of the mine ML. Two individuals were recorded in remnant Brigalow habitat 3 km west of the northern boundary of the ML in September 2011. One individual was recorded in Brigalow habitat along a minor drainage line approximately 5.8 km northwest of the northern boundary of the ML in March 2011. No individuals detected within the Project area despite targeted searches in February 2012 and 2017. Nevertheless, there are suitable cracking clay soils within the mine ML north of the Bruce Highway where regrowth Brigalow occurs including extensive gilgai formations. There is very little remnant vegetation in this area.
EPBC Status
Vulnerable
Key Threats
The Ornamental Snake has undergone a decline in abundance in the past few decades. DotEE (2018) identified the following the following known threats to the Ornamental Snake: ▪ Habitat Loss: Clearing (roads, ploughing, railways, mining-related activities, pipeline constructions); ▪ Habitat fragmentation; ▪ Habitat Degradation: Overgrazing by stock, especially cattle, or grazing of gilgais during the wet season leads to soil compaction and compromising of soil structure; ▪ Alteration of landscape hydrology in and around gilgai environments; ▪ Alteration of water quality through chemical and sediment pollution of wet areas; ▪ Contact with Cane Toads: as the Ornamental Snake has a diet almost exclusively of various frog species, the species is susceptible to being lethally poisoned by ingesting Cane Toads, which are abundant within its range; ▪ Predation by feral species; and ▪ Invasive weeds.
Recovery Plans
There is no adopted recovery plan in place for this species. The Commonwealth's Approved Conservation Advice for Ornamental Snake (TSSC 2014) lists the following priority recovery / abatement actions that may be applicable to the Project including: ▪ Investigate formal conservation arrangements, management agreements and covenants on private land; ▪ Control introduced pests such as pigs to manage threats at known sites; and ▪ Raise awareness of the Ornamental Snake and other reptiles found in the brigalow Belt Bioregion within the local community.
Threat Abatement Plans
There are no identified Threat Abatement Plans considered relevant to this species.

The Commonwealth DotEE considers an occurrence of 'important habitat' for Ornamental Snake, as described in the 'Draft referral guidelines for the nationally listed Brigalow Belt reptiles' (DSEWPaC 2011a), is a surrogate definition for an 'important population' of the species. The guidelines state an occurrence of suitable habitat is considered important for Ornamental Snake when it is:

- Habitat where the species has been identified during a survey;
- Near the limit of the species' known range;
- Large patches of contiguous, suitable habitat and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations); or
- A habitat type where the species is identified during a survey, but which was previously thought not to support the species.

Ornamental Snake occurs as far north as Charters Towers (250 km northwest of the Project area) south to the Dawson River valley. The species has not been recorded within the Project area during site fauna surveys or from database records, although it is known to occur in remnant Brigalow habitat west of the Project. Suitable habitat for the species within the Project area (cracking clay soils close to wetlands / watercourses and featuring gilgais) occurs in the northern portion of the mine ML, although the majority of this is cleared lands. There is substantial similar habitat surrounding the Project footprint and it is unlikely the area may be considered as a viable landscape corridor. Under the guidelines there is no occurrence of 'important habitat' in the Project area.

The Project footprint will impact approximately 20.9 ha of degraded riparian vegetation located along an ephemeral drainage line within cracking clay soils which may provide suitable foraging and shelter habitat for Ornamental Snake. The Project may also impact 353 ha of non-remnant habitat for the species should it occur on the site (refer Figure 16-145). There is abundant non-remnant habitat in the surrounding area (>37,000 ha within a 10 km radius of the Project). In the long-term, the Project has potential to increase the extent of suitable habitat in the local area through land management practises on the Mamelon property in the area surrounding the Project footprint (refer Section 16.19.5).

The following significant impact assessment under the MNES guidelines (DotE 2013) has been informed by the information detailed above.

Table 16-130 Assessment against significant impact criteria: Ornamental Snake

Criterion	Assessment against significance criteria (vulnerable)
Ornamental Snake (*Denisonia maculata*)	
Lead to a long-term decrease in the size of an important population of the species	The species is known from the wider area but has not been identified in the Project area. As stated above no 'important habitat' has been identified within the Project area. Potential cracking clay habitat for the species has been identified in the northern portion of the mine area, the majority of which is cleared. This area will be impacted by clearing activities for the mine including 20.9 ha of suitable remnant habitat (degraded riparian habitat along a minor drainage line) within Brigalow on gilgais / cracking clays. This area will be subject to environmental offsets. The Project has potential to increase the extent of suitable habitat in the local area through land management practises on the Mamelon property in the area surrounding the Project footprint. With measures in place to protect surface water quality and quantity downstream of Project activities it is considered unlikely to lead to a long-term decrease in an important population.
Reduce the area of occupancy of an important population	No 'important habitat' has been identified within the Project area. Potential habitat observed within the mine area is restricted to the northern portion of the Project area. The Project has potential to increase the extent of suitable habitat in the local area through land management practises on the Mamelon property in the area surrounding the Project footprint. The Project is unlikely to reduce the extent of 'important habitat' for Ornamental Snake in the area.
Fragment an existing important population into two or more populations	No 'important habitat' has been identified within the Project area. There is little suitable habitat for this species within the entirety of the Project area. A dry ridge line separates the mine area from much of the transport corridor already acting as a natural dispersal barrier across the landscape for Ornamental Snake. Habitat to the west of the corridor is also hilly and dry. The Project will not fragment 'important habitat'.
Adversely affect habitat critical to the survival of the species	Ornamental Snake has not been identified as occurring within the Project area and no 'important habitat' has been identified. There is little suitable habitat for this species within the entirety of the Project area and it will not be subject to direct impacts (vegetation clearing). Potential indirect impacts through surface water quality changes downstream of the mine area will be monitored and mitigated against. It is considered unlikely the Project will adversely affect habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	Ornamental Snake has not been identified as occurring within the Project area and no 'important habitat' has been identified. There is little suitable habitat for this species within the entirety of the Project area. It is considered unlikely the Project will disrupt the breeding cycle of an important population.

Criterion	Assessment against significance criteria (vulnerable)
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Ornamental Snake has not been identified as occurring within the Project area and no 'important habitat' has been identified. Potential cracking clay habitat for the species has been identified in the northern portion of the mine area, the majority of which is cleared. This area will be impacted by clearing activities for the mine including 20.9 ha of suitable remnant habitat (degraded riparian habitat along a minor drainage line) within Brigalow on gilgais / cracking clays. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The LUMP will incorporate management strategies to control the introduction and spread of weed species across the Project area. The LUMP will be in place for the life of the Project, and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The LUMP will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	The Project does not interfere with the overall objectives of the *Draft Recovery Plan for the Queensland Brigalow Belt Reptiles*. With mitigation of potential Project impacts through progressive rehabilitation, surface water management, vegetation management on the surrounding property, an offset program (if required) and measures incorporated within the LUMP, any potential impact on Ornamental Snake, should it occur in the Project area, will be minor and is considered unlikely to interfere with the recovery of the species.
Assessment of potential for significant residual impacts	No individuals detected within the Project area despite targeted searches in February 2012 and 2017. Nevertheless, there are suitable cracking clay soils within the mine ML north of the Bruce Highway where regrowth Brigalow occurs including extensive gilgai formations. There is very little remnant vegetation in this area, although its presence has been assessed as likely. This area will be impacted by clearing activities for the mine including 29 ha of suitable remnant habitat (degraded riparian habitat along a minor drainage line) within Brigalow on gilgais / cracking clays. The Commonwealth DotEE considers an occurrence of 'important habitat' for Ornamental Snake, as described in the 'Draft referral guidelines for the nationally listed Brigalow Belt reptiles' (DSEWPaC 2011a), is a surrogate definition for an 'important population' of the species. The guidelines state an occurrence of suitable habitat is considered important for Ornamental Snake when it is: 1. Habitat where the species has been identified during a survey; 2. Near the limit of the species' known range; 3. Large patches of contiguous, suitable habitat and viable landscape corridors (necessary for the purposes of breeding, dispersal or maintaining the genetic diversity of the species over successive generations); or 4. A habitat type where the species is identified during a survey, but which was previously thought not to support the species. Although the Project area does not trigger an important population, any presence of the species in the Project area would trigger an important population under point 1. Therefore any clearance if the species is present in the cracking clay soils in gilgai areas, would potentially reduce the area of occupancy of an important population. As such, although none of the above nine-part tests of significance conclude a significant impact on the species, based on a conservative approach where the species is likely to occur, offsets of habitat for this species are proposed (see Section 16.19).

16.17.4.3 Greater Glider

Greater Glider was recorded in woodlands in the south of the Project area. Table 16-131 summarises the species presence in the Project area, known threats to the species, and the relevant Commonwealth and State documents applicable to the species recovery.

Table 16-131 Key data on Greater Glider

Greater Glider (*Petauroides volans*)
Baseline Data Results
No previous records of this species within 50 km radius of Project area. Individuals recorded in tall Narrow-leaf Ironbark dominated woodland in the south (February 2017) of the ML. and individuals recorded in riparian Forest Red Gum in the south of the mine ML in November 2017 and June 2018. Also recorded in February 2012. Remnant habitat across most of the ML and corridor appears less suitable as the species prefers continuous tracts of vegetation. Woodland in the south of the mine ML, and outside of any Project development, remains connected to a large tract of continuous vegetation and retains trees with large hollows.
EPBC Status
Vulnerable
Key Threats
The broad area of occurrence likely remains similar to pre-European settlement, although the actual area of occupancy has declined substantially (TSSC 2016). The following are considered known threats to the Greater Glider: ▪ Habitat loss and fragmentation; ▪ High intensity or frequent fires; ▪ Climate change may reduce area of occupancy, particularly in north Queensland; and ▪ Over-predation by owl species (TSSC 2016).
Recovery Plans
There is no recovery plan in place for this species. The Commonwealth's Approved Conservation Advice for Greater Glider (TSSC 2016) lists priority conservation actions that may be applicable to the Project including: ▪ Reduce the frequency and intensity of prescribed burns; ▪ Identify appropriate levels of patch retention, habitat tree retention, and logging rotation in hardwood production; and ▪ Protect and retain hollow-bearing trees, suitable habitat and habitat connectivity.

The species occurs from Victoria, north to the Atherton Tablelands in Queensland and is conventionally accepted as a single species. The north Queensland population is considered a separate subspecies (*P. v. minor*) from the widespread south eastern population (*P. v. volans*). The Project area is located within the occurrence of the central Queensland population in this case and is not located near the edge of the species range. There is no evidence to indicate a population in the area is likely to be a key population for breeding, dispersal or maintaining genetic diversity in the species.

Figure 16-145 depicts the suitable habitat for the species on the within the Project area. The Project layout has been revised since submission of the EIS and there will no longer be any direct impacts to Greater Glider habitat.

Table 16-132 Assessment against significant impact criteria: Greater Glider

Criterion	**Assessment against significance criteria (vulnerable)**
Greater Glider	
Lead to a long-term decrease in the size of an important population of the species	No 'important population' has been identified within the Project area. The most suitable habitat for the species appears restricted to where the species was recorded in the southern portion of ML80187 where woodland remains contiguous with extensive habitat. The Project does not require clearing any of this habitat. Habitat in the remainder of the Project area including the TLF is largely cleared, fragmented or restricted to narrow strips of riparian vegetation. Given the remaining habitat surrounding the Project area it is considered unlikely the Project will lead to a long-term decrease in the size of the local population of Greater Glider.

Criterion	Assessment against significance criteria (vulnerable)
Reduce the area of occupancy of an important population	No 'important population' has been identified within the Project area. The species has been recorded within the mine area. The Project does not require clearing of suitable habitat. It is considered unlikely the Project will reduce the area of occupancy of an important population of Greater Glider in the area.
Fragment an existing important population into two or more populations	No 'important population' has been identified within the Project area. The Project does not require clearing of any habitat in which the species is most likely to occur in the south of the ML. The species is less likely to occur elsewhere in the Project area. The Project will not fragment an existing 'important population' into two or more populations.
Adversely affect habitat critical to the survival of the species	There is no indication the Project area comprises habitat critical to the survival of the Greater Glider. The Project does not require clearing of any habitat in which the species is most likely to occur in the south of the ML. There is no indication the Project area comprises habitat critical to the survival of the Greater Glider.
Disrupt the breeding cycle of an important population	No 'important population' has been identified within the Project area. The Project does not require clearing of any habitat in which the species is most likely to occur in the south of the ML. A qualified fauna spotter will carry out a thorough survey for arboreal species prior to any clearing of potential habitat (comprising large tree hollows) taking place. It is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There is suitable woodland habitat for the species in the southern portion of the ML. Most of the Project area is cleared of remnant vegetation. There is abundant suitable habitat for the species in the area to the south and west of the ML. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The Project LUMP will incorporate measure to control the introduction and spread of weed and pest species across the Project area, although the local landscape is already subject to extensive weed infestation and pest species were also observed on several occasions including Dingo. The LUMP will be in place for the life of the Project and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project LUMP will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for this species. The Approved Conservation Advice for Greater Glider (TSSC 2016) outlines management actions intended to aid the recovery of the species. Given there is no suitable habitat clearing involved and with mitigation of potential Project impacts, including pre-clearing surveys, any potential impact on Greater Glider, should it occur in the Project area, will be minor and is considered unlikely to interfere with the recovery of the species or any of the actions outlined in the Approved Conservation Advice.

Criterion	Assessment against significance criteria (vulnerable)
Assessment of potential for significant residual impacts	There are no previous records of this species within 50 km radius of Project area. Two individuals recorded in tall Narrow-leaf Ironbark dominated woodland and one individual in riparian Forest Red Gum in the south of the mine ML in November 2017 and again in June 2018. Also recorded in February 2012. Remnant habitat across most of the ML and corridor appears much less suitable as the species prefers continuous tracts of vegetation. Woodland in the south of the MLs, and outside of any Project development, remains connected to a large tract of continuous vegetation and retains trees with large hollows. No 'important population' has been identified within the Project area. The most suitable habitat for the species appears restricted to where the species was recorded in the southern portion of ML80187 where woodland remains contiguous with extensive habitat. The Project does not require clearing any of this habitat. Habitat in the remainder of the Project area including the TLF is largely cleared, fragmented or restricted to narrow strips of riparian vegetation. The significant impact guidelines define impacts on 'vulnerable' species in the terms of 'important populations' as follows: 'An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and / or that are: 1. Key source populations either for breeding or dispersal; 2. Populations that are necessary for maintaining genetic diversity; and / or 3. Populations that are near the limit of the species range (MNES Guidelines, DotE 2013). The species occurs from Victoria, north to the Atherton Tablelands in Queensland and is conventionally accepted as a single species. The Project area is located within the occurrence of the central Queensland population in this case and is not located near the edge of the species range. There is no evidence to indicate a population in the area is likely to be a key population for breeding, dispersal or maintaining genetic diversity in the species. Under the definition provided in the MNES guidelines (DotE 2013) as issued and referred to by DotEE, the individuals occurring in the Project area cannot be considered an important population. None of the above nine-part tests of significance conclude a significant impact on the species. As such there will be no significant residual impact on an 'important population'. As quoted from the EPBC Act Environmental Offsets Policy 2012: 'For assessments under the EPBC Act, offsets are only required if residual impacts are significant.' Therefore no offsets are proposed for this species (see Section 16.19).

16.17.4.4 Koala

Koala has been recorded on five occasions within or close to the Project within a variety of eucalypt woodlands (Figure 16-146). Table 16-133 summarises the species presence in the Project area, known threats to the species, and the relevant Commonwealth and State documents applicable to the species recovery.

Table 16-133 Key data on Koala

Koala (*Phascolarctos cinereus*) (Qld, NSW and ACT populations)
Baseline Data Results
There are 11 WildNet records of Koala occurring within the wider 50 km radius of Project area. The nearest record to the Project is approximately 25 km northwest of the MLs along the Bruce Highway. The species was recorded on four occasions in 2017 / 2018 during spotlighting surveys in Narrow-leaved Ironbark / Poplar Box woodland (three times) and Poplar Gum woodland (once). Recorded twice on remote camera in Narrow-leaf Ironbark woodland in the south of the ML (October and November 2017). Remnant habitat within the proposed mine impact areas is predominantly Poplar Box dominated woodland and Forest Red Gum dominated open forest. Poplar Box is considered a forage tree species for Koala. Forest Red Gum occurs along creek lines and small areas of adjacent alluvial forest. This is a preferred forage tree for the species and is likely to be the most favoured habitat in the area (Australian Koala Foundation 2015).
EPBC Status
Vulnerable
Key Threats
Koala populations have undergone a substantial decline in the past few decades. DotEE (2018) identified the following the following known threats to the Koala: ▪ Habitat loss and fragmentation; ▪ Deaths from vehicle collisions; ▪ Deaths from dog (feral and domestic) attacks; ▪ Diseases including *Chlamydia* strains and Koala Retrovirus; and ▪ The effects of climate change and droughts.
Recovery Plans
There is no Queensland or national recovery plan for this species. A national recovery plan is to be developed to follow the objectives set out in the *National Koala conservation and management strategy 2009-2014* (NRMMC 2009). The strategy aimed to provide a framework to incorporate state and local actions into broader national actions. The Commonwealth's Approved Conservation Advice for Koala (TSSC 2012) lists priority management actions that may be applicable to the Project including: ▪ Developing plans to mitigate vehicle strike risk where Koalas are known to occur; ▪ Investigate formal conservation arrangements, management agreements and covenants on private land; ▪ Manage other known threats such as eucalypt dieback and dog predation; and ▪ Engage with private landholders and land managers responsible for the land on which populations occur.

The 'EPBC Act referral guidelines for the vulnerable Koala' (DotE 2014) does not refer to any 'important populations' of Koala due to a lack of information at the time of writing. The guidelines provide a 'koala habitat assessment tool' to assist in the determining the sensitivity, value and quality of lands potentially impacted under development proposals. The assessment tool is to be used to determine whether lands may be considered as 'critical to the survival of the Koala' and therefore critical to the long-term survival and recovery of the species. The results of the assessment are to aid the decision-making process and determine whether a Project may need to be referred to DotEE based on potential significant impacts to Koalas and / or habitat critical to the survival of the species. Although the Project is already the subject of an EPBC referral an assessment has been made of the habitats value to Koala within the Project area (Table 16-134) to inform the significant impact assessment.

Table 16-134 Koala habitat appraisal as per species impact guidelines

Attribute	Score		
Koala occurrence	2	Desktop	▪ EPBC online report identifies Koala as 'known to occur' in the Project area. ▪ 11 wildlife online records within a 50 km radius, although closest record is 24 km northwest of the Project. ▪ No other records of this species from the wider area.
		On-ground	▪ On-ground fauna surveys carried out across Project area over three survey periods and a total of 20 survey days. Five individual observations recorded within mine area during spotlighting and remote camera surveys in 2017.
Vegetation structure and composition	2	Desktop	▪ Eucalypt woodlands / open forest dominate the remnant vegetation remaining within both the mine area and haul road as per current DNRME mapping.
		On-ground	▪ The Project area is largely cleared. The dominant canopy trees in the remaining remnant vegetation includes Poplar Box (forage trees for Koala in the region) and Narrow-leaf Ironbark (considered a supplementary forage tree species, particularly in drought conditions). There are also narrow bands of riparian vegetation featuring Forest Red Gum along creek lines in the northern portion of the mine ML and in the haul road. Forest Red Gum is considered to be a preferred forage species (Australian Koala Foundation 2015).
Habitat connectivity	1	Desktop	▪ The remnant vegetation in the west of the site although fragmented remains connected to contiguous woodlands including riparian vegetation. Project area and adjacent riparian corridors bisected by 100 km/hr, two lane highway.
Key existing threats	0	Desktop	▪ The Australian Koala Foundation Koala map does not identify any road kill records in the wider area surrounding the Project area.
		On-ground	▪ Dingo encountered during several surveys but predation levels unknown. Road mortality recorded during site surveys in February 2017 on highway approximately 10 km east of Project area. Bruce Highway bisects site.
Recovery value	0	Desktop	▪ The impact area largely encompasses forage tree species which are widespread in the local region. Degraded riparian line featuring forage tree species in north of mine ML will be heavily impacted by Project. The haul road will impact minor extent of watercourse vegetation featuring forage tree species. ▪ The Project area lies within an already fragmented landscape. The Project area is not expected to function as an important corridor. A contiguous landscape corridor to the west of the Project, which is already bisected by an existing highway will not be impacted by the Project.
Total	**5**	**Decision – habitat considered 'critical to the survival of the Koala' as per the 'EPBC Act referral guidelines for the vulnerable Koala' (DotE 2014) (that is overall habitat score ≥ 5)**	

Under the referral guidelines for Koala (DotE 2014) it is recommended that a project be referred where it is proposed to 'clear ≥ 20 ha of habitat containing known Koala food trees in an area with a habitat score ≥ 8.' Where this is not proposed, the guidelines recommend that a referral be based on an appraisal of the Project considering factors such as Koala density and level of habitat fragmentation.

The species was detected within the mine area or surrounds on six occasions in 2017 / 2018. A road killed specimen was also recorded to the east of the site during the February 2017 survey. Signs of presence (tree scratches / scats) were identified in the area during previous surveys. There is preferred foraging habitat (comprising Forest Red Gums) within the mine area and haul road which will be disturbed by vegetation clearing. It is uncertain whether the species occurs in more than low densities in the area. The Project is understood to require the following clearing of habitat within the mine area and haul road:

- Clearing of 24.07 ha of preferred feed tree habitat (Forest Red Gum associated communities - RE 11.3.4, 11.3.25 and 11.3.27); and
- Clearing of 84.15 ha of feed tree habitat (Poplar Box RE 11.3.35 and 11.4.2).

In total 108.22 ha of habitat that may be considered critical to the survival of Koala (that is with a habitat score of 5) is proposed to be cleared for the Project.

Groundwater drawdown has potential to impact Forest Red Gum habitat associated with Tooloombah Creek and Deep Creek which is preferred foraging habitat for Koala (RE 11.3.25). There is uncertainty of the likelihood or extent of impact. Under ground-truthed vegetation mapping there is currently 42.5 ha of RE 11.3.25 located within modelled groundwater drawdown contours which are considered to be at moderate to high risk of adverse impacts i.e. greater than 0.5 m of groundwater drawdown when considered at its maximum extent (10 years after the cessation of mining) (refer Section 16.14.4.3). Vegetation health of these patches will continue to be monitored during the Project life and should impacts be detected and unable to be ameliorated these areas will be included in the Project OMP.

The following significant impact assessment (Table 16-135) under the MNES guidelines (DotE 2013) has been informed by the information detailed above.

Table 16-135 Assessment against significant impact criteria: Koala

Criterion	Assessment against significance criteria (vulnerable)
Koala (*Phascolarctos cinereus*) – Qld, NSW and ACT populations	
Lead to a long-term decrease in the size of an important population of the species	No 'important population' has been identified within the Project area. Habitat that may be considered as 'critical to the survival of Koala' occurs on the mine area and haul road. The species was identified as present in Poplar Box habitat in the eastern portion of the mine area north of the highway. The Project requires clearing of 108.22 ha of suitable habitat. The Project has the potential to lead to an increase in Koala road deaths in the local area. Mitigation actions including fauna crossing structures at the haul road crossing suitable for Koala will be included in the Project design. Given the Project area it is considered unlikely the Project will lead to a long-term decrease in the size of an important population of Koala.
Reduce the area of occupancy of an important population	No 'important population' has been identified within the Project area. The species has been recorded within the mine area. Habitat that may be considered as 'critical to the survival of Koala' may occur in the mine area and haul road. The Project requires clearing of 108.22 ha of foraging habitat. However, the Project area remains contiguous with abundant similar habitat in the wider surrounds. It is considered unlikely the Project will reduce the area of occupancy of an important population of Koala in the area.
Fragment an existing important population into two or more populations	Habitat that may be considered as 'critical to the survival of Koala' may occur in the mine area and haul road. However, most of the Project lies on cleared lands. The Project area including the adjacent riparian corridors along creek lines are already bisected by a highway. The Project design will incorporate fauna crossing structures on the haul road crossing of Deep Creek. It is considered unlikely the Project will fragment an existing 'important population' into two or more populations.
Adversely affect habitat critical to the survival of the species	Under the referral guidelines for Koala (DotE 2014) the Project area contains habitat that may be considered as 'critical to the survival of Koala.' The Project requires clearing approximately 108.22 ha of this habitat. Under the referral guidelines the Project will adversely affect habitat critical to the survival of the species. This habitat will be the subject of a Project OMP.

Criterion	Assessment against significance criteria (vulnerable)
Disrupt the breeding cycle of an important population	No 'important population' has been identified within the Project area. Where possible, clearing activities will take place outside the breeding season for Koala (October-May). A qualified fauna spotter will carry out a thorough survey for the species prior to any clearing of potential Koala habitat taking place. It is considered unlikely the Project will disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	There is suitable woodland habitat for the species in the mine area and haul road. However; most of the Project area is cleared of remnant vegetation. There is abundant suitable habitat for the species in the area surrounding the Project. It is considered unlikely the Project will impact the availability or quality of habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The Project LUMP will incorporate measure to control the introduction and spread of weed and pest species across the Project area, although the local landscape is already subject to extensive weed infestation and pest species were also observed on several occasions including Dingo. The LUMP will be in place for the life of the Project, and will minimise the potential for weed invasion and may in the long-term improve habitat condition within vegetation communities located adjacent to Project infrastructure. The Project is considered unlikely to result in invasive species becoming established in this species' habitat.
Introduce disease that may cause the species to decline	The Project LUMP will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the species to decline.
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for this species. The Approved Conservation Advice for Koala (TSSC 2012) outlines management actions intended to aid the recovery of the species. With mitigation of potential Project impacts through installation of fauna infrastructure on the haul road, an environmental offsets program and measures incorporated within the Project LUMP, any potential impact on Koala, should it occur in the Project area, will be minor and is considered unlikely to interfere with the recovery of the species or any of the actions outlined in the Approved Conservation Advice.
Assessment of potential for significant residual impacts	There are 11 WildNet records of Koala occurring within the wider 50 km radius of Project area. The nearest record to the Project is approximately 25 km northwest of the MLs along the Bruce Highway. The species was recorded on four occasions in 2017 / 2018 during spotlighting surveys in Narrow-leaved Ironbark / Poplar Box woodland (three times) and Poplar Gum woodland (once). Recorded twice on remote camera in Narrow-leaf Ironbark woodland in the south of the ML (October and November 2017). Habitat that may be considered as 'critical to the survival of Koala' occurs on the mine area and haul road. The species was identified as present in RE 11.4.2 in the eastern portion of the mine area north of the highway. The Project requires clearing of 108.22 ha of suitable habitat. As such, although none of the above nine-part tests of significance conclude a significant impact on the species, based on a conservative approach, and the Project resulting in clearance of vegetation classified as habitat critical to the survival of the koala, offsets of habitat for this species are proposed (see Section 16.19).

16.17.5 Impact Significance – Large Marine Fauna

As noted in Section 16.13.5 five marine fauna species are considered as 'likely' to occur in habitat within the wider Broad Sound area located downstream of the Project area and thereby potentially subject to Project impacts.

Current information about each listed species is summarised in Table 16-136 and Table 16-137 in the following sections. Assessment of impact significance has been completed as per the Guidelines (DotE 2013). These included criteria for species listed as threatened or as migratory at the time the Section 75 decision for this Project was made (3 February 2017).

16.17.5.1 Threatened Marine Turtles

Table 16-136 Key data on Green Turtle and Flatback Turtle

Green Turtle (*Chelonia mydas*) and Flatback Turtle (*Natator depressus*)
Desktop Data Results
Green Turtle Thirty-five ALA records exist within the boundary of the Broad Sound DIWA area including 12 records within the Styx River estuary. All records are from a single radio-tracked individual released from the Cairns turtle rehabilitation and reef HQ facility in 2010. The nearest record is 17 km north of the boundary of the Project area. *Flatback Turtle* No ALA records within the Broad Sound DIWA area, although many records directly north of this area. Important nesting rookery at Wild Duck Island approximately 74 km north-east of the Project.
EPBC Status
Vulnerable, Migratory (both species)
Key Threats
Although there have been severe declines in Green Turtle numbers in south-east Asia, populations in the rest of the world appear stable or increasing. The breeding population of Flatback Turtle in eastern Australia is considered to be stable although dependent on conservation measures. DotEE (2018) identified the following the following known threats which apply to all marine turtle species: ▪ Disturbance of nesting females and hatchlings due to terrestrial artificial lighting on nesting beaches; ▪ Disruptions to nesting beaches through development or tourism impacts; ▪ Ship or vessel strike; ▪ By-catch of various fisheries (trawling, gill nets and longlines); ▪ Nest predation by native (dingos, monitor lizards) or feral species (pigs, dogs and foxes); ▪ Ingestion of marine debris/rubbish and drowning caused entrapment in discarded fishing nets and fishing lines; ▪ Climate change impacting nesting areas through rising sea levels and temperature change of nests impacting sex ratios of hatchlings; and ▪ Traditional hunting (largely in northern Australia). Additionally, the *Recovery Plan for Marine Turtles in Australia* (CoA 2017b) also identifies the following: ▪ Impacts from underwater noise such as that generated by seismic surveys; ▪ Chemical and / or sediment runoff from land; and ▪ Diseases / infections exacerbated by poor water quality.

Green Turtle (*Chelonia mydas*) and Flatback Turtle (*Natator depressus*)
Recovery Plans
The *Recovery Plan for Marine Turtles in Australia* (CoA 2017b) was legislated in May 2017 replacing the previous recovery plan. The recovery plan oversees recovery goals for all six marine turtle species that occur in Australian waters. The priority actions specific to Green Turtle and Flatback Turtle populations relevant to the area surrounding the Project are identified below. *Green Turtle (southern GBR)* ▪ Quantify and predict the frequency of pulse flood events, their impacts on seagrass meadows, and implement relevant mitigation measures; ▪ Identify and protect suitable beaches and islands that could be used as nesting habitat under a rising sea level model/scenario, to ensure that these are suitable for colonisation in the future; ▪ Manage land-based pollution and recreational activities to reduce marine debris at the source; ▪ Quantify the impact of marine debris ingestion on stock viability; ▪ Understand the sub-lethal impacts of poor water quality and exposure to toxins; ▪ Continue long-term monitoring of index beaches and key foraging areas; and ▪ Support implementation of the Reef 2050 Long Term Sustainability Plan to build on existing turtle monitoring and water quality management programs in Queensland. *Flatback Turtle (eastern Australia)* ▪ Understand the decline in nesting numbers at Peak Island, including impacts of light; ▪ Quantify and model how changes in ambient temperatures (sand and water), sea level, frequency of extreme weather events, ocean circulation and acidification affect marine turtle nesting, sex ratios, hatching success, habitats, food availability and their ability adapt to these changes; ▪ Develop and implement best practice light management guidelines for existing and future developments adjacent to marine turtle nesting beaches; ▪ Support retrofitting of lighting at coastal communities and industrial developments, including imposing restrictions around nesting seasons; ▪ Understand flatback turtle foraging requirements and identify key foraging areas for this stock; and ▪ Continue long-term monitoring of index beaches and key foraging areas.
Threat Abatement Plans

For Green Turtle the following Commonwealth Threat Abatement Plans are considered relevant:
▪ Threat abatement plan for the impacts of marine debris on vertebrate marine life (DEWHA 2009):
    – Sets out four main objectives pertaining to marine debris including long-term prevention of occurrence of harmful debris, removing existing debris from the marine environment, mitigating the impacts on marine species and communities, and monitoring of quantities, origins and impacts and assessing the effectiveness of management arrangements.
▪ Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (CoA 2017a) (also considered relevant to Flatback Turtle):
    – Sets out six objectives for controlling feral pigs and understanding the threatening processes and impacts on native species / communities including prioritising species / communities / ecosystems and locations for strategic management, encourage integration of feral pig management into land management across all levels of government, further research into impacts, feral pig ecology and control methods, monitor control programs, and improve feral pig awareness / management among landholders and the public.
▪ Threat Abatement Plan for Predation by the European Red Fox (DEWHA 2008):
    – Sets out prioritising management areas including ascertain the degree of threat to the survival of threatened species and communities, the potential for recovery of threatened species and communities, threatened species likely to benefit through fox control in specific areas, and cost efficiency and effectiveness of fox control in a particular area.

The assessments of species listed as Vulnerable commence with an evaluation of the likely importance of the population, as defined within the significant impact criteria for vulnerable species: ‘An important population is a population that is necessary for a species’ long-term survival and recovery.

This may include populations identified as such in recovery plans, and / or that are:

- Key source populations either for breeding or dispersal;
- Populations that are necessary for maintaining genetic diversity; and / or
- Populations that are near the limit of the species range.

The *Recovery Plan for Marine Turtles in Australia* (the Plan) (DotEE 2017b) specifically identifies habitat that is to be considered 'critical to the survival' of marine turtle species and breeding stocks. For Green Turtles located in the southern GBR (i.e. the Plan identifies the following rookery sites including a 20 km 'internesting' buffer which applies from October to April:

- The Capricorn-Bunker Group of islands located over 210 km east of the Project off the coast of Gladstone;
- Bushy Island located approximately 180 km north of the Project off the coast of Mackay; and
- The mainland coast between Wreck Rock south to Burnett Head located over 280 km south-east of the Project area.

For Flatback Turtles located in eastern Australia the Plan identifies the following rookery sites including a 60 km 'internesting' buffer which applies from October to March:

- Wild Duck Island (74 km north north-east) and Avoid Island (75 km north) (refer Figure 16-133);
- Peak Island located off Rockhampton (145 km south-east), Curtis Island located in the Gladstone area (165 km south-east) and Mon Repos located north of Bundaberg (360 km south-east of the Project); and
- The islands of Broad Sound Islands National Park the closest of which are located at the southern tip of Long Island and are approximately 50 km from the boundary of the Project area (refer Figure 16-133).

The Project area lies within the boundary of the 60 km internesting buffer area placed around islands located south of Long Island. These islands are completely surrounded by mangroves and are thereby unsuitable for nesting marine turtles. The nearest sites recorded to the Project area recorded during turtle nesting surveys are low-density sites on Flock Pigeon Island and the adjacent mainland (approximately 57 km north of the Project area) (Limpus et al. 2002).

Nesting for the southern GBR breeding stock of Green Turtle largely occurs from Fraser Island (south-east Queensland) north to the Whitsunday Islands (Limpus 2008). No important or minor nest sites are known in the vicinity of Broad Sound downstream of the Project or nearby. Given the wide range of the species an 'important population' as defined under the Guidelines does not occur.

The eastern Australian breeding stock of Flatback Turtle may forage along the entire Queensland coast with nesting centred on the central Queensland coast region (Limpus 2007). The Recovery Plan identifies rookery sites on Wild Duck Island and the islands of Broad Sound Islands National Park as important and therefore these areas may be considered as 'important populations' under the Guidelines.

Table 16-137 Assessment against significant impact criteria: marine turtles

Criterion	Assessment against significance criteria (vulnerable)
Green Turtle and Flatback Turtle	
Lead to a long-term decrease in the size of an important population of the species	There is no important population of Green Turtle in the Broad Sound DIWA. There is an important population of Flatback Turtle (as defined under the Guidelines) in the vicinity downstream of the Project. The nearest known (low density) nest site is 57 km north of the Project or 32 km north of the mouth of the Styx River estuary. Potential impacts resulting from the Project to either species (nest sites or foraging individuals) are restricted to water quality issues resulting from sporadic releases of sediment laden water, chemical spills or mine water. It is considered that with appropriate monitoring and mitigation measures as detailed in Section 16.13 these potential impacts can be minimised or eliminated. In addition, the Project is not of a nature or scale that could plausibly lead to a long term decrease in the size of the Flatback Turtle population.
Reduce the area of occupancy of an important population	Flatback Turtle is the only species that may have an important population in the wider Broad Sound area. The nearest known nest site is approximately 57 km north of the Project. Wild Duck Island is located 74 km north of the Project. Potential impacts resulting from the Project to nest sites or foraging individuals are restricted to water quality issues resulting from sporadic releases of sediment laden water, chemical spills or mine water. It is considered that with appropriate monitoring and mitigation measures as detailed in Section 16.13 these potential impacts can be minimised or eliminated. The Project will not plausibly reduce the area of occupancy of an important population.
Fragment an existing important population into two or more populations	The Project contains no components that could plausibly fragment the existing populations of marine turtles.
Adversely affect habitat critical to the survival of the species	Flatback Turtle is the only species that may have critical habitat in the wider Broad Sound area. The nearest known nest site is approximately 57 km north of the Project. Wild Duck Island is located 74 km north of the Project. Potential impacts resulting from the Project to nest sites or foraging individuals are restricted to water quality issues resulting from sporadic releases of sediment laden water, chemical spills or mine water. It is considered that with appropriate monitoring and mitigation measures as detailed in Section 16.15.3 these potential impacts can be minimised or eliminated. The Project will not plausibly impact habitat critical to the survival of the species.
Disrupt the breeding cycle of an important population	The Project area and Broad Sound lie within the 60 km 'internesting' buffer zone identified around the Broad Sound Islands National Park, although it is very unlikely the species is able to nest on the islands nearest to the Project area due to the presence of unsuitable nesting habitat. It is noted there are no records of the species in the Broad Sound DIWA of Flatback Turtle despite there being many records of Green Turtle. The only potential impacts resulting from the Project are restricted to water quality issues and it is considered that with appropriate monitoring and mitigation measures as detailed in Section 16.15.3 these potential impacts can be minimised or eliminated. The Project will not plausibly disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	Both species occurs across a broad swathe of coastal Australia. The Project will not modify, destroy. Isolate or decrease the quality of the habitat to the extent that any decline in a marine turtle species will occur.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	The Project is terrestrial in nature and located well upstream of potential foraging habitat for marine turtles. Weed and pest control measures will be incorporated into the Project LUMP to control the introduction and spread of weed species across the Project area. The Project will not plausibly result in invasive species becoming established in marine turtle habitat.
Introduce disease that may cause the species to decline	The Project LUMP will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause any marine species to decline.

Criterion	Assessment against significance criteria (vulnerable)
Interfere substantially with the recovery of the species	The Commonwealth Recovery Plan for marine turtles describes priority actions for both species as listed in Table 16-127. The only potential impacts resulting from the Project are restricted to water quality issues and it is considered that with appropriate monitoring and mitigation measures as detailed in Section 16.3 these potential impacts can be minimised or eliminated. The Project is considered unlikely to interfere with the recovery of marine turtle species.

16.17.5.2 Migratory Marine Fauna

Table 16-138 Key data on Australian Humpback Dolphin and Australian Snubfin Dolphin

Australian Humpback Dolphin (*Sousa sahulensis*) and Australian Snubfin Dolphin (*Orcaella heinsohni*)
Desktop Data Results
Australian Humpback Dolphin No ALA records exist within the wider area surrounding Broad Sound. Recorded downstream of the Project on the western side of Rosewood Island in targeted surveys in 2013. Also known to occur in Shoalwater Bay. *Australian Snubfin Dolphin* Four ALA records within the Broad Sound DIWA area. Recorded downstream of the Project on the western side of Rosewood Island in targeted surveys in 2013. Also known to occur in Shoalwater Bay.
EPBC Status
Migratory (both species)
Key Threats
DotEE (2018) identified the following the following known threats which apply to all marine turtle species: ▪ Habitat loss and degradation including water pollution; ▪ By-catch of various fisheries; ▪ Overfishing of prey; ▪ Collision with vessel traffic; ▪ Underwater noise such as seismic surveys; and ▪ Adverse interactions with wildlife tourism.
Recovery Plans
There is no approved Conservation Advice or Recovery Plan for either species.
Threat Abatement Plans
There are no Commonwealth Threat Abatement Plans considered relevant to these species.

The migratory species impact assessment commences with an evaluation of the presence of ‘important habitat’ as defined within the significant impact criteria for migratory species:

‘An area of important habitat for a migratory species is:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;
- Habitat that is of critical importance to the species at particular life-cycle stages;
- Habitat utilised by a migratory species which is at the limit of the species range; and / or
- Habitat within an area where the species is declining.

There is no evidence Broad Sound supports an ecologically significant proportion of the population of, or provides critical habitat for, either species. There are few records of either species occurring in the Broad Sound DIWA area. Both species occur across a wide area across northern Australia occurring as far south as south-east Queensland. There is no evidence either species is declining in the area.

Table 16-139 Assessment against significant impact criteria: dolphin species

Criterion	Assessment
Migratory Species	
Does the migratory species habitat within the Project area represent 'important habitat'?	There is no evidence that habitat within the Project area should be considered as important habitat for the two inshore dolphin species. Both species are widespread, observed as individuals or small numbers and therefore with very small proportions of their populations likely to occur downstream of the Project area.
Substantially modify, destroy or isolate an area of important habitat for a migratory species	Migratory species habitat within the Project area is unlikely to represent 'important habitat', as noted above. The Project is located well upstream of suitable habitat for these species. The Project will not plausibly modify, destroy or isolate an area of important habitat for either dolphin species.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	The Project is terrestrial in nature and located well upstream of potential foraging habitat for the two inshore dolphin species. Weed and pest control measures will be incorporated into the Project LUMP to control the introduction and spread of weed species across the Project area. The Project will not plausibly result in invasive species becoming established in marine turtle habitat.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	What constitutes an 'ecologically significant proportion of the population' is ill-defined. Under the significant impact guidelines, factors that should be considered for each species includes the species' population status, genetic distinctiveness specific behavioural patterns including site fidelity and dispersal patterns (DotE 2013). None of the migratory species recorded were observed in large enough numbers that may represent an ecologically significant proportion of the population of a migratory species. Coupled with the lack of 'important habitat' for migratory species occurring within the Project area, no significant impacts on a migratory species are expected.

16.17.6 Impact Significance - Migratory Species

16.17.6.1 Migratory Species - Terrestrial

As noted in Section 16.13.10, five terrestrial fauna species listed as Migratory are considered known to occur, and a further two species are considered likely to occur and potentially be subject to Project impacts. One of these is listed as a Migratory Shorebird species.

Currently known information about the listed species is summarised in the community profiles shown in Table 16-140. Significance of the impacts to migratory species assessed using the significant impact criteria outlined in DotE (2013) (see Table 16-141).

The migratory species assessments commence with an evaluation of the presence of 'important habitat' as defined within the significant impact criteria for migratory species:

'An important population is a population that is necessary for a species' long-term survival and recovery. This may include populations identified as such in recovery plans, and / or that are:

- Habitat utilised by a migratory species occasionally or periodically within a region that supports an ecologically significant proportion of the population of the species;
- Habitat that is of critical importance to the species at particular life-cycle stages;
- Habitat utilised by a migratory species which is at the limit of the species range; and / or
- Habitat within an area where the species is declining.

Table 16-140 Key data on listed migratory species

Migratory species
Glossy Ibis (*Plegadis falcinellus*)
Baseline Data Results
Recorded on estuarine wetlands to the north of the Project area in 2011. There is potential shallow wetland habitat present for this species.
Key Threats
Threats to this species as identified by DotEE (2018) include; loss and / or degradation of foraging and especially breeding habitat through alteration of water flows, drainage and / or clearing of wetlands for development, frequent burning of wetland vegetation used as nest sites, salinization, groundwater extraction and invasion by exotic plants or fishes. Localised threats include hunting, use of pesticides, and general human disturbance.
Recovery Plans
Currently no recovery, conservation or threat abatement plans have been developed for the Glossy Ibis in Australia.
Latham's Snipe (*Gallinago hardwickii*)
Baseline Data Results
Up to 15 individuals recorded at a vegetated dam north of the highway and within the ML in February 2017. No other records of the species. This species inhabits open, freshwater wetlands with low, dense vegetation including swamps, flooded grasslands, heathlands, around bogs and other water bodies (DotEE 2018). This habitat may be abundant (as both natural or man-made wetlands) within the mine ML following heavy rains.
Key Threats
Key threats to this species include: ▪ Land clearing, habitat fragmentation and / or habitat degradation due to agricultural activity, as well as other rural and urban developments; ▪ Climate change altering atmosphere / hydrosphere temperatures, rainfall patterns and / or frequency of severe weather events; ▪ Competition and / or habitat degradation by weeds; ▪ Increased predation from feral species; ▪ Declining water quality (salinity, nutrient and / or turbidity) and changes in wetland hydrology; and ▪ Pollution due to oil spills and other chemical pollutants (DotEE 2018).
Recovery Plans
Wildlife Conservation Plan for Migratory Shorebirds (DEH 2006).
Oriental Cuckoo (*Cuculus optatus*)
Baseline Data Results
Single individual recorded in March 2011. Location unknown. Species has broad habitat requirements and may occur in wooded remnant habitats throughout.
Key Threats
There are no threats listed for this species.
Recovery Plans
The *Threat abatement plan for predation by feral cats* (DotE 2015b) has been adopted for this species.
White-throated Needletail (*Hirundapus caudacutus*)
Baseline Data Results
Recorded in November 2017. Likely to occur seasonally over the Project area. Aerial foraging visitor to eastern Australia.
Key Threats
Key threats to the White-throated Needletail include: ▪ Land clearing, habitat fragmentation and / or habitat degradation in northern hemisphere; ▪ Direct exploitation by humans including hunting; and ▪ Collision with human infrastructure including windows and utility and service lines.
Recovery Plans
No threat abatement or recovery actions either underway or proposed due to the limited nature of any threats to the species and its mobility (DotEE 2018).
Fork-tailed Swift (*Apus pacificus*)
Baseline Data Results
Recorded in March 2011 and February 2012. Likely to occur seasonally over the Project area. Aerial foraging visitor to the entire Australian mainland.

Migratory species
Key Threats
DotEE (2017) has identified collision with overhead wires, windows and lighthouses as threats to this species although it is recognised that these impacts affect only a few individuals. Hence these threats are not threats to the species overall.
Recovery Plans
Due to the limited nature of any threats to the species and its mobility, there are no threat abatement or recovery actions either underway or proposed.
Rufous Fantail (*Rhipidura rufifrons*)
Baseline Data Results
Recorded in 2011. Location unknown. Most suitable habitat in the Project area for this species is the closed canopy forest along Tooloombah Creek and Deep Creek.
Key Threats
The main threat to this species is the continued clearing and fragmentation of suitable moist forest habitat (particularly along migration routes) by expanding urbanisation and other development.
Recovery Plans
No recovery plans currently exist for this species.
Estuarine Crocodile (*Crocodylus porosus*)
Baseline Data Results
No individuals recorded. Slides observed on Deep Creek in June 2011. Anecdotal reports of species regular occurrence in Styx River where likely most suitable habitat (estuarine) occurs.
Key Threats
The main local threats to this species include entrapment in fishing nets and habitat destruction including by feral animals, particularly in the Northern Territory (DotEE 2018).
Recovery Plans
No recovery plans currently exist for this species.

Table 16-141 Assessment against significant impact criteria: Migratory species

Criterion	Assessment
Migratory Species	
Does the migratory species habitat within the Project area represent 'important habitat'?	There is no evidence that habitat within the Project area should be considered as important habitat for a migratory species. Four species listed as Migratory were observed during site surveys. All species are widespread, observed as individuals or small numbers and therefore with very small proportions of their populations observed on the Project area. Only Latham's Snipe was observed at a farm dam in relatively large numbers (15 individuals). Under the *EPBC Act Policy Statement 3.21 Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act listed migratory shorebird species* (DotEE 2015) important habitat for this species may be defined as areas that support at least 18 individuals. Although this remains a large number of individuals in a small area for this species, the habitat in which it was recorded remains widespread in the surrounding area. There is no habitat for Estuarine Crocodile within the Project area and there is unlikely to be 'important habitat' for this species in the local surrounds. None of the species observed or likely to occur are known to be declining or are at the limit of their range. Therefore, migratory species habitat within the Project area is unlikely to represent 'important habitat.'
Substantially modify, destroy or isolate an area of important habitat for a migratory species	Migratory species habitat within the Project area is unlikely to represent 'important habitat', as noted above. Several waterbodies within the Project footprint will be cleared / removed although and several environmental dams will be added. There is no reason to consider the Project will have a significant impact on 'important habitat' for any of the species.

Criterion	Assessment
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	Migratory species habitat within the Project area is unlikely to represent 'important habitat', as noted above. Habitat suitable for wetland migratory species within the Project boundary (creeks, waterholes, riparian vegetation, and farm dams) is already highly modified by past grazing practices. Weed species including Rubber Vine and Lantana were commonly observed in the understorey of riparian vegetation along Tooloombah and Deep Creeks. The Project LUMP will incorporate procedures for the management of invasive species to limit the potential impact of feral predators and weed species on migratory species and their habitat. The Project is considered unlikely to result in invasive species becoming established in migratory species habitat.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	What constitutes an 'ecologically significant proportion of the population' is ill-defined. For migratory shorebirds, this has been defined as a site supporting 0.1% of the flyway population (DEWHA 2009). The current flyway population estimate for Latham's Snipe is 30,000 (Hansen et al. 2016) i.e. an ecologically significant proportion of the population is 30 individuals. Under the significant impact guidelines, factors that should be considered for each species includes the species' population status, genetic distinctiveness specific behavioural patterns including site fidelity and dispersal patterns (DotE 2013). None of the migratory species recorded were observed in large enough numbers that may represent an ecologically significant proportion of the population of a migratory species. Only one species was recorded on more than a single survey event (Fork-tailed Swift). Coupled with the lack of 'important habitat' for migratory species occurring within the Project area, no significant impacts on a migratory species are expected.

16.17.6.2 Migratory Shorebirds

Habitat within the western Broad Sound area, including sites located downstream of the Project, can be considered as 'important habitat' for Migratory shorebird species as defined under the Industry Guidelines. The wader habitat across western Broad Sound is likely to consistently support nationally important numbers of migratory waders (>2,000 individuals), and nationally important numbers of migratory wader species including Eastern Curlew, Great Knot, Red-necked Stint, Whimbrel, and Sharp-tailed Sandpiper. The nearest of these sites are wader roosts at Charon Point (33 km north-north east or 45 km downstream of the Project) and Hoogly Point (33 km north or 43 km downstream of the Project).

The results of the assessment of potential occurrence (refer Table 16-110) indicates 12 Migratory shorebird species are considered as likely or known to utilise estuarine habitat associated with the Styx River downstream of the Project, and 16 species are likely or known to occur in the western Broad Sound area. It is noted a single Migratory shorebird species that occurs on inland wetlands is known to occur on the Project site and is assessed in the previous section: Latham's Snipe. No other Migratory shorebird species is 'likely' to occur on the Project site itself.

The Project lies approximately 14 km upstream of the nearest saltmarsh and potential shorebird habitat, at least 21 km upstream of the nearest mangrove habitat which species such as Whimbrel may utilise for roosting, and known 'important habitat' (roost sites) for migratory shorebirds are over 40 km downstream of the Project. Some species may also sporadically use the riverbed for foraging along the Styx River, which is exposed at low tide. Tern species such as Caspian Tern may forage along the length of the Styx River likely to the rail crossing where the river tends to narrow further south.

Several migratory shore bird species known to occur in the Broad Sound area are also listed as threatened under the EPBC Act including Eastern Curlew and Great Knot (both listed as Critically Endangered). The nearest known sighting of a Migratory shorebird species to the Project area is Eastern Curlew (two individuals) located on mudflats associated with the Styx River approximately

14 km north (or 20 km downstream) of the Project boundary. The nearest known wader roosts are more than 40 km downstream of the Project boundary. Given the distance the Project is located from potential habitat for these species no shorebird species is likely to be directly impacted or disturbed by Project activities.

The Industry Guidelines set out 'thresholds of significant impacts on Migratory shorebirds' (refer Table 2 in DotE 2015) referring to 'important habitat.' These are considered with reference to the Project considering the potential impacts and mitigation measures as discussed in Sections 16.11.3 and 16.12.3 respectively as follows:

- Loss of habitat (e.g. clearing, infilling or draining) – The Project boundary is located over 40 km upstream of known 'important habitat.' There are no Project activities that will lead to loss of 'important habitat' for migratory shorebirds;

- Degradation of habitat leading to a *substantial reduction* in migratory shorebird numbers – The single potential impact resulting from the Project to 'important habitat' for shorebirds is from the release of sediment laden and / or polluted waters impacting downstream habitat. The Project has incorporated a number of dams designed to capture mine water and mine-affected rainfall run-off (refer Section 16.7.3.7). A number of industry standard mitigation measures will be strictly applied to Project activities to reduce the potential for entrained sediments and chemical pollutants to enter waterways (and hence downstream shorebird habitat) during heavy rainfall events (refer Section 16.9.4 and 16.10.7). Proposed erosion and sediment control measures are estimated as capturing 90% of the sediments potentially emanating from the Project site. Water quality of surface waters in the adjacent creek lines as well as the release of Project-associated waters will be the subject of constant monitoring under the Project REMP (refer Section 16.10.7.4 and 16.11.4.5).

  The immediate surrounding lands on the Property will be managed for nature conservation in conjunction with environmental offsets associated with the Project OMP (refer Section 16.19.5 and Appendix A18). Land management will include removing cattle from the majority of the property and allowing natural revegetation to occur. In the longer term this will reduce sediment (and associated nutrient) inputs entering waterways under the current cattle grazing regime. Given the distance of the Project from 'important habitat' for shorebirds, the ephemeral nature of rainfall and flows in the area and the proposed mitigation and management measures to be applied to the Project it is considered any uncontrolled release of sediments / pollutants will only occur under an extreme rainfall event and will be transient in nature. The Project is considered very unlikely to degrade downstream shorebird habitat to the point there will be a *substantial reduction* in migratory shorebird numbers using the area;

- Increased disturbance leading to a *substantial reduction* in migratory shorebird numbers – The known 'important habitat' in western Broad Sound is remote and relatively free of human disturbance activities. The Project boundary is located over 40 km upstream of known 'important habitat.' There are no Project activities that will lead to increased disturbance of migratory shorebirds in Broad Sound. It is noted the proposed expansion by DoD of the Shoalwater Bay Training Area originally encompassed lands up to the east bank of the Styx River and close to the roost site at Charon Point. The current extent of the proposal is unknown; and / or

- Direct mortality of birds leading to a *substantial reduction* in migratory shorebird numbers - The single potential impact resulting from the Project that may lead to mortality of shorebirds is the release of chemically polluted waters into downstream habitat. As noted above the Project will apply a number of industry standard mitigation measures to ensure chemical pollutants associated with Project works do not enter waterways (refer Section 16.9.4 and

16.10.7) and interact with downstream shorebird habitat during rainfall events. Given the distance of the Project from 'important habitat' for shorebirds, the ephemeral nature of rainfall and flows in the area and the proposed mitigation and management measures to be applied to the Project it is considered an uncontrolled release of chemical pollutants with potential to cause downstream shorebird mortality is highly unlikely.

Threatened Migratory Shorebirds

The following 'key data' (Table 16-142) and significant impact assessments (Table 16-143 and Table 16-144) assesses the potential impacts of the Project on the shorebirds listed as both Threatened and Migratory under the EPBC Act and considered 'likely' or 'known' to occur (downstream of the Project area). Given the similarity of the species ecological requirements and associated actions conservation actions outlined in the Approved Conservation Advice for each species, and the distance of the Project from suitable habitat they are considered here as a whole rather than as separate species.

Table 16-142 Key data on threatened migratory shorebird species

Threatened migratory species
Critically Endangered **Great Knot (*Calidris tenuirostris*)** **Eastern Curlew (*Numenius madagascariensis*)** **Curlew Sandpiper (*Calidris ferruginea*)** **Endangered** **Lesser Sand Plover (*Charadrius mongolus*)** **Red Knot (*Calidris canutus*)** **Vulnerable** **Greater Sand Plover (*Charadrius leschenaultia*)** **Bar-tailed Godwit (baueri) (*Limosa lapponica baueri*)**
Baseline Data Results
Of these species only Eastern Curlew and Bar-tailed Godwit (baueri) have been detected during surveys associated with the Project in 2011/2012. Both species recorded foraging on mudflats adjacent to the Styx River approximately 20 km downstream of the Project area in February 2012. Eastern Curlew also observed on associated estuarine plains a further 5 km north in September 2011. All species known to occur in western Broad Sound area. Great Knot, Curlew Sandpiper, Lesser Sand Plover and Red Knot sporadically recorded in nationally important numbers at roost sites in surveys from 2008 – 2017. Eastern Curlew consistently recorded in nationally important numbers at roost sites during same surveys and on a single occasion was recorded in internationally important numbers at one roost site (refer Section 16.10.6).
Key Threats
Threats to migratory shorebird species as identified by CoA (2015) include: ▪ Habitat loss due to coastal development both in Australia, and in important 'staging' areas on migratory path (particularly the Yellow Sea); ▪ Invasive species impacting shorebird habitat such as freshwater and pasture plants, established species such as Pigs, and exotic marine pests which may affect benthic invertebrate communities; ▪ Degradation of migratory shorebird habitat from acute (e.g. oil spills) or diffuse chemical/industrial pollution sources; ▪ Altered hydrological regimes impacting wetland habitat; ▪ Disturbance from humans including from industry, urban development and recreational activity; ▪ Climate change impacting habitat through sea level rise and extreme weather events, or causing potential poleward shifts in species ranges; and ▪ Over-harvesting of shorebird prey at staging sites along Asian coastline.

Threatened migratory species
Approved Conservation Advice
The Commonwealth has issued an Approved Conservation Advice for all of the threatened shorebird species considered here including two in 2015 (for Eastern Curlew and Curlew Sandpiper) and the remainder in 2016. The recommended conservation and management actions for all the species are similar if not the same. The following conservation actions that may be applicable to the Project including: ▪ Support initiatives to improve habitat management at key sites; ▪ Manage important sites to identify, control and reduce the spread of invasive species; and ▪ Advocate for the creation and restoration of foraging and roosting sites in Australia.
Recovery Plans
No threat abatement plans are considered relevant to migratory shorebirds in Australia. The Wildlife Conservation Plan for Migratory Shorebirds (DEH 2006) lists the following specific objectives that are considered applicable to 'industry and commercial bodies': ▪ Ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment processes; ▪ Develop guidelines for wetland rehabilitation and the creation of artificial wetlands to support populations of migratory shorebirds; ▪ Investigate the significance of cumulative impacts on migratory shorebird habitat and populations in Australia.

Table 16-143 Assessment against significant impact criteria: migratory shorebirds (Critically Endangered or Endangered)

Criterion	Assessment against significance criteria (critically endangered or endangered)
Lead to a long-term decrease in the size of a population	There is 'important habitat' for these species downstream of the Project site. The Project lies approximately 14 km upstream of the nearest potential shorebird foraging habitat (saltmarsh / exposed mudflats). The nearest known 'important habitat' (roost site) is over 40 km downstream of the Project at Charon Point. Nevertheless, these species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. The sole potential impacts on shorebirds or their habitat from Project activities are associated with impacting downstream water quality (uncontrolled mine-affected water releases, increased sedimentation and/or degradation in water quality) and will be a rare and transient occurrence associated with an uncommon weather event. Given the relatively small area of interest within the species non-breeding range, and the transient nature of any potential impact occurrence (should it occur), the Project is considered unlikely to lead to a long-term decrease in a population.
Reduce the area of occupancy of the species	These species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. The sole potential impact on shorebirds or their habitat from Project activities are associated with impacting downstream water quality (uncontrolled mine-affected water releases) and will be a rare and transient occurrence associated with an uncommon weather event. Given the relatively small area of interest within the species non-breeding range, and the transient nature of any potential impact occurrence (should it occur), the Project is considered unlikely to lead to reduce the area of occupancy of the species.
Fragment an existing population into two or more populations	These species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. Project activities would not conceivably fragment an existing population as there is no direct loss of any shorebird habitat proposed.

Criterion	Assessment against significance criteria (critically endangered or endangered)
Adversely affect habitat critical to the survival of the species	These species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. Broad Sound may comprise 'important habitat' for shorebirds but there is no indication the area can be considered as critical to the survival of the species. Sites along the East Asian - Australasian flyway may be considered as critical to the species as staging areas during migration. The sole potential impact on shorebirds or their habitat from Project activities are associated with impacting downstream water quality (uncontrolled mine-affected water releases) and will be a rare and transient occurrence associated with an uncommon weather event. The project is considered very unlikely to adversely affect habitat critical to the survival of these shorebird species.
Disrupt the breeding cycle of an population	These species do not breed in the southern hemisphere. The Project will not disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	These species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. Known 'Important habitat' for shorebirds in western Broad Sound extends across a wide area, the nearest site being located over 40 km downstream of the Project at Charon Point. Potential impacts on shorebirds or their habitat from Project activities are associated with uncontrolled mine-affected water releases and will be a rare and transient occurrence associated with an uncommon weather event. The project is considered very unlikely to adversely impact shorebird habitat to the extent that the species is likely to decline.
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the critically endangered or endangered species habitat	On the evidence available habitat within the western Broad Sound area represents 'important habitat' for migratory shorebirds. Wetland habitat suitable for migratory species within the Project boundary (creeks, waterholes, riparian vegetation, and farm dams) is already highly modified by past grazing practices. Weed species including Rubber Vine and Lantana were commonly observed in the understorey of riparian vegetation along Tooloombah and Deep Creeks, and Olive Hymenachne was observed within shallow areas of several farm dams and natural wetlands. However, none of these species are capable of impacting the estuarine habitats preferred by migratory shorebirds. The closest potential habitat for migratory shorebirds is 14 km downstream of the Project and known 'important habitat' in the wider area is located more than 40 km downstream from the Project boundary, and therefore, any Project activities. The Project LUMP will incorporate procedures for the management of invasive species to limit the potential impact of feral predators and weed species on migratory species and their habitat. The Project is considered very unlikely to result in invasive species becoming established in important habitat for migratory shorebird species.
Introduce disease that may cause the species to decline	The Project LUMP will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the migratory shorebird species to decline.
Interfere with the recovery of the species	There is no State or Commonwealth recovery plan for these species. Project mitigation of potential water quality impacts have been incorporated within the design (mine-affected water storages, erosion and sediment controls, and chemical storage/spill controls), monitoring within the REMP, and management of the surrounding lands (removal of cattle and revegetation). The sole potential downstream impact on shorebirds or their habitat (through uncontrolled mine-affected water releases) will be a rare and transient occurrence (associated with an uncommon weather event) and is considered unlikely to interfere with the recovery of the species.

Table 16-144 Assessment against significant impact criteria: migratory shorebirds (Vulnerable)

Criterion	Assessment against significance criteria (vulnerable)
Lead to a long-term decrease in the size of an important population of the species	There is 'important habitat' for the two species downstream of the Project site. The Project lies approximately 14 km upstream of the nearest potential shorebird foraging habitat (saltmarsh / exposed mudflats). The nearest known 'important habitat' (roost site) is over 40 km downstream of the Project at Charon Point. Nevertheless, these species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. The sole potential impacts on shorebirds or their habitat from Project activities are associated with impacting downstream water quality (uncontrolled mine-affected water releases, increased sedimentation and/or degradation in water quality) and will be a rare and transient occurrence associated with an uncommon weather event. The relatively small area of interest within the species non-breeding range, and the transient nature of any potential impact occurrence (should it occur), the Project is considered unlikely to lead to a long-term decrease in a population.
Reduce the area of occupancy of an important population	The two species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. The sole potential impact on shorebirds or their habitat from Project activities are associated with impacting downstream water quality (uncontrolled mine-affected water releases) and will be a rare and transient occurrence associated with an uncommon weather event. Given the relatively small area of interest within the species non-breeding range, and the transient nature of any potential impact occurrence (should it occur), the Project is considered unlikely to lead to reduce the area of occupancy of the species.
Fragment an existing important population into two or more populations	The two species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. Project activities would not conceivably fragment an existing population as there is no direct loss of any shorebird habitat proposed.
Adversely affect habitat critical to the survival of the species	The two species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. Broad Sound may comprise 'important habitat' for shorebirds but there is no indication the area can be considered as critical to the survival of the species. Sites along the East Asian - Australasian flyway may be considered as critical to the species as staging areas during migration. The sole potential impact on shorebirds or their habitat from Project activities are associated with impacting downstream water quality (uncontrolled mine-affected water releases) and will be a rare and transient occurrence associated with an uncommon weather event. The project is considered very unlikely to adversely affect habitat critical to the survival of these shorebird species.
Disrupt the breeding cycle of an important population	The two species do not breed in the southern hemisphere. The Project will not disrupt the breeding cycle of an important population.
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	The two species are migratory and their populations are distributed across a wide swathe of (largely coastal) Australia in the non-breeding season. Known 'Important habitat' for shorebirds in western Broad Sound extends across a wide area, the nearest site being located over 40 km downstream of the Project at Charon Point. Potential impacts on shorebirds or their habitat from Project activities are associated with uncontrolled mine-affected water releases and will be a rare and transient occurrence associated with an uncommon weather event. The project is considered very unlikely to adversely impact shorebird habitat to the extent that the species is likely to decline.

Criterion	Assessment against significance criteria (vulnerable)
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species habitat	On the evidence available habitat within the western Broad Sound area represents 'important habitat' for migratory shorebirds. Wetland habitat suitable for migratory species within the Project boundary (creeks, waterholes, riparian vegetation, and farm dams) is already highly modified by past grazing practices. Weed species including Rubber Vine and Lantana were commonly observed in the understorey of riparian vegetation along Tooloombah and Deep Creeks, and Olive Hymenachne was observed within shallow areas of several farm dams and natural wetlands. However, none of these species are capable of impacting the estuarine habitats preferred by migratory shorebirds. The closest potential habitat for migratory shorebirds is 14 km downstream of the Project and known 'important habitat' in the wider area is located more than 40 km downstream from the Project boundary, and therefore, any Project activities. The Project LUMP will incorporate procedures for the management of invasive species to limit the potential impact of feral predators and weed species on migratory species and their habitat. The Project is considered very unlikely to result in invasive species becoming established in important habitat for migratory shorebird species.
Introduce disease that may cause the species to decline	The Project LUMP will incorporate the management of invasive species which will assist in the prevention of pest plant introduction and associated diseases resulting from Project activities. Project equipment sourced from overseas will be quarantined as required under State and Commonwealth legislation. The Project is considered unlikely to introduce disease that may cause the migratory shorebird species to decline.
Interfere substantially with the recovery of the species	There is no State or Commonwealth recovery plan for these species. Project mitigation of potential water quality impacts have been incorporated within the design (mine-affected water storages, erosion and sediment controls, and chemical storage/spill controls), monitoring within the REMP, and management of the surrounding lands (removal of cattle and revegetation). The sole potential downstream impact on shorebirds or their habitat (through uncontrolled mine-affected water releases) will be a rare and transient occurrence (associated with an uncommon weather event) and is considered unlikely to interfere with the recovery of the species.

Migratory Shorebirds

The following 'key data' (Table 16-145) and significant impact assessment (Table 16-146) assesses the potential impacts of the Project on the remaining shorebirds listed only as Migratory under the EPBC Act and considered 'likely' or 'known' to occur (downstream of the Project area) as a whole rather than as separate species.

Table 16-145 Key data on migratory shorebird species

Migratory shorebird species
Grey Plover (*Pluvialis squatorola*) **Whimbrel (*Numenius phaeopus*)** **Terek Sandpiper (*Xenus cinereus*)** **Sharp-tailed Sandpiper (*Calidris acuminata*)** **Red-necked Stint (*Calidris ruficollis*)** **Grey-tailed Tattler (*Tringa brevipes*)** **Common Greenshank (*Tringa nebularia*)** **Marsh Sandpiper (*Tringa stagnatilis*)** **Gull-billed Tern (*Gelochelidon nilotica*)** **Caspian Tern (*Hydroprogne caspia*)** **Crested Tern (*Thalasseus bergii*)**
Baseline Data Results
Of these species Whimbrel, Gull-billed Tern and Caspian Tern have been detected during surveys associated with the Project. Whimbrel recorded foraging on mudflats adjacent to the Styx River approximately 20 km downstream of the Project area in February 2012. Gull-billed Tern detected in September 2011 and Caspian Tern detected in February 2012 although recorded locations unknown. All species known to occur in western Broad Sound area from previous surveys. Red-necked Stint and Sharp-tailed Sandpiper recorded in nationally important numbers at roost sites in surveys on one occasion each. Crested Tern only recorded on a single occasion. Likely that western Broad Sound regularly supports nationally important numbers of some of these species when considered across all sites (refer Section 16.10.6). This does not include the tern species which do not make regular migrations from/to Australia and for which no flyway population estimates are made.
Key Threats
Threats to migratory shorebird species as identified by CoA (2015) include: ▪ Habitat loss due to coastal development both in Australia, and in important ‘staging’ areas on migratory path (particularly the Yellow Sea); ▪ Invasive species impacting shorebird habitat such as freshwater and pasture plants, established species such as Pigs, and exotic marine pests which may affect benthic invertebrate communities; ▪ Degradation of migratory shorebird habitat from acute (e.g. oil spills) or diffuse chemical/industrial pollution sources; ▪ Altered hydrological regimes impacting wetland habitat; ▪ Disturbance from humans including from industry, urban development and recreational activity; ▪ Climate change impacting habitat through sea level rise and extreme weather events, or causing potential poleward shifts in species ranges; and ▪ Over-harvesting of shorebird prey at staging sites along Asian coastline. Threats to Caspian Tern include much of the above threats, and the following as listed on the SPRAT profile (DotEE 2018). There are no threats listed for Gull-billed or Crested Tern. ▪ Chick predation by species such as Cats, Dingoes and Silver Gulls (*Chroicocephalus novaehollandiae*); ▪ Human disturbance or cattle trampling at nest sites; and ▪ Exposure to avian diseases and bioaccumulation of contaminants in fish.
Recovery Plans
There is no Approved Conservation Advice and no threat abatement plans considered relevant for these species. The Wildlife Conservation Plan for Migratory Shorebirds (DEH 2006) lists the following specific objectives that are considered applicable to ‘industry and commercial bodies’: ▪ Ensure all areas important to migratory shorebirds in Australia continue to be considered in development assessment processes; ▪ Develop guidelines for wetland rehabilitation and the creation of artificial wetlands to support populations of migratory shorebirds; ▪ Investigate the significance of cumulative impacts on migratory shorebird habitat and populations in Australia.

Table 16-146 Assessment against significant impact criteria: Migratory shorebird species

Criterion	Assessment
Migratory Shorebird Species	
Substantially modify, destroy or isolate an area of important habitat for a migratory species	On the evidence available habitat within the western Broad Sound area represents 'important habitat' for migratory shorebirds. Some species may utilise habitat associated with the Styx River and adjacent estuarine flats (closest habitat approximately 14 km downstream of Project). Whimbrel in particular may roost in mangroves (nearest mangrove habitat approximately 21 km upstream of the nearest mangrove habitat). The tern species may forage along the Styx River. However, the known important shorebird habitat (roost sites) in the wider area is located more than 40 km downstream from the Project boundary, and therefore, any Project activities. The single potential impact likely to result from Project activities to known 'important habitat' for shorebirds and surrounding foraging habitat is from the release of sediment laden and / or polluted waters impacting downstream habitat. A number of mitigations will be in place to reduce the potential for uncontrolled releases of mine-affected waters. Any uncontrolled release of sediments / pollutants will only occur under an extreme rainfall event and will be transient in nature. There is no conceivable reason to consider the Project will substantially modify, destroy or isolate an area of important habitat for a migratory species.
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	On the evidence available habitat within the western Broad Sound area represents 'important habitat' for migratory shorebirds. Wetland habitat suitable for migratory species within the Project boundary (creeks, waterholes, riparian vegetation, and farm dams) is already highly modified by past grazing practices. Weed species including Rubber Vine and Lantana were commonly observed in the understorey of riparian vegetation along Tooloombah and Deep Creeks, and Olive Hymenachne was observed within shallow areas of several farm dams and natural wetlands. However, none of these species are capable of impacting the estuarine habitats preferred by migratory shorebirds. The closest potential habitat for migratory shorebirds is 14 km downstream of the Project and known 'important habitat' in the wider area is located more than 40 km downstream from the Project boundary, and therefore, any Project activities. The Project LUMP will incorporate procedures for the management of invasive species to limit the potential impact of feral predators and weed species on migratory species and their habitat. The Project is considered unlikely to result in invasive species becoming established in important habitat for migratory shorebird species.
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species	On the evidence available habitat within the western Broad Sound area represents 'important habitat' for migratory shorebirds. However, the known shorebird habitat in the wider area is located more than 40 km downstream from the Project boundary and therefore any Project activities. It is noted these species do not breed in Australia. The only potential impact on migratory shorebird species from Project activities is the accidental release of sediments or waterborne pollutants into the waters of Broad Sound and thereby into foraging habitat for shorebirds. The Project incorporates a number of water management design specifications (refer Sections 16.7.3.7) and mitigation actions (refer Section 16.9.4 and 16.10.7) to reduce the potential for any unintentional releases of contaminated mine water into the adjacent creek lines (and thereby the Styx River and Broad Sound areas). Given the design and mitigation actions committed to, the transient nature of any uncontrolled mine water release event, and the distance of the Project to important wader habitat, the project is considered unlikely to seriously disrupt the lifecycle of an ecologically significant proportion of the population of a migratory species.

16.18 Cumulative Impacts

The nature of the Styx River catchment is rural with approximately 78% of lands occupied by agriculture dominated by cattle grazing. A review of the latest publicly available information regarding proposed developments in Queensland found no large-scale industrial or mining developments proposed for the catchment other than the Central Queensland Coal Mine Project and there are no such Projects within a minimum of 100 km radius of the Project area.

The nearest mining operation to the Project is the Kunwarara magnesite mine located 60 km to the southeast. The mine began operation in 1991 and is currently owned by Sibelco. Magnesite resides close to the surface layers and is mined using open cut pits generally between 15 m to 18 m deep. The mine is mainly divided into three sections - KG1, KG2 and KG3 pit areas. The KG1 pits are located in predominantly cleared lands. The KG2 and KG3 pit areas are located adjacent to patches of Endangered vegetation. There is no information available regarding any current or proposed expansion plans for the project and the project is not considered further.

The only major development known from the surrounding area is the proposed expansion of the Shoalwater Bay Training Area by the Department of Defence. This area lies largely within the adjacent Shoalwater catchment which also drains into Broad Sound to the northeast of the Project area. The original proposal identified a 'likely expansion area' stretching west from the existing training area to the approximate east bank of the Styx River located to the north of the Project and close to the known migratory shorebird roost site located at Charon Point. Based on opposition from local communities it was assessed that a reduced expansion area is 'achievable' (DoD 2017). The extent of the proposed expansion is currently subject to 'in-confidence' negotiations with willing landowners to acquire local properties within the expansion footprint. The potential changes to land use are unknown at this stage.

The next closest proposed development is the Capricorn Integrated Resort proposed by Iwasaki Sangyo and located 110 km due east of the Project at Corio Bay. Although a final ToR was issued for the Project in May 2014 no further documentation regarding the Project is available. The Project EIS is said to be still in preparation.

Given there are no other large projects currently known to have identified lands within the Styx River catchment, the Project impacts to terrestrial ecology will only add to those impacts that are a result of current land use in the catchment. These background land use impacts have already been characterised within this chapter. There are no other projects in the catchment or surrounds which the potential Project impacts to terrestrial ecology subject to this assessment could conceivably add to.

16.19 Biodiversity Offsets

16.19.1 Introduction

The *EPBC Act Environmental Offsets Policy 2012* (Offsets Policy) defines offsets as measures that compensate for the residual adverse impacts of an action on the environment. The Queensland Environmental Offsets Policy (QEOP) identifies an environmental offset as an action taken to counterbalance unavoidable, residual impacts to Matters of National, State, and / or Local Environmental Significance that result from an activity or a development. In both cases, an offset may be located within or outside the geographic site of the impact and are applicable as an additional management tool once residual impacts from an action have been incurred despite measures to avoid or minimise impacts being applied.

Avoidance and mitigation measures are the primary strategies for managing the potential significant impacts of a project. Offsets are not intended to reduce the likely impacts of the Project but are implemented to compensate any residual (after mitigation) significant impacts (see Section 16.19.4).

It is essential for the Project to address and incorporate these offsets issues and policies early in the Project planning lifecycle to examine design options that avoid impacts, reduce any likely impacts through mitigation, and accept that any residual impacts associated with the Project be offset.

16.19.2 Legislation

The Offsets Policy outlines the approach to environmental offsets under the EPBC Act. The policy applies to offsetting requirements in terrestrial and aquatic (including marine) environments and applies to projects assessed under the EPBC Act.

Under the Offsets Policy, offsets act as a compensation mechanism for impacts (direct and indirect) to all protected matters under the EPBC Act including the two relevant MNES for this Project:

- Listed threatened species and ecological communities; and
- Migratory species.

Offsets under Commonwealth legislation are only required where residual impacts are considered significant as defined under the detailed significance criteria (DEWHA 2009). Hence the Project will not require offsets where it is able to either avoid or successfully mitigate potential impacts such that the net residual impact is not significant.

The key aims of the Offsets Policy are to:

- Ensure the efficient, effective, timely, transparent, proportionate, scientifically robust and reasonable use of offsets under the EPBC Act;
- Provide proponents, the community and other stakeholders with greater certainty and guidance on how offsets are determined and when they may be considered under the EPBC Act;
- Deliver improved environmental outcomes by consistently applying the policy;
- Outline the appropriate nature and scale of offsets and how they are determined; and
- Provide guidance on acceptable delivery mechanisms for offsets.

Ten overarching principles are defined in the Offsets Policy to be applied in determining the suitability of offsets.

The first eight principles require that suitable offsets must:

- Deliver an overall conservation outcome that improves or maintains the viability of the aspect of the environment that is protected by national environment law and affected by the proposed action;
- Be built around direct offsets but may include other compensatory measures;
- Be in proportion to the level of statutory protection that applies to the protected matter;
- Be of a size and scale proportionate to the residual impacts on the protected matter;

- Effectively account for and manage the risks of the offset failing;
- Be additional to what is already required, determined by law or planning regulations or agreed to under other schemes or programs (this does not preclude the recognition of state or territory offsets that may be suitable as offsets under the EPBC Act for the same action);
- Be efficient, effective, timely, transparent, scientifically robust and reasonable; and
- Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced.

The last two principles require that in assessing the suitability of an offset, government decision-making will be:

- Informed by scientifically robust information and incorporate the precautionary principle in the absence of scientific certainty; and
- Conducted in a consistent and transparent manner.

For this Project, any residual impacts must be offset in accordance with the Commonwealth legislation.

16.19.2.1 State Legislation

The QEOP provides a single, streamlined framework for environmental offsets which replaces a number of former policies. The framework was introduced in July 2014 and includes:

- *Environmental Offsets Act 2014* – this is the primary legislation that establishes a head of power for the State to impose offset conditions and rules around how offsets will be required and delivered. It outlines offsets will be required to counterbalance a significant residual impact of a prescribed activity on a prescribed environmental matter. Key definitions are established and it also provides for the making of an Environmental Offsets Policy;
- *Environmental Offsets Regulation 2014* – the regulation defines those prescribed environmental matters that may require an offset and are referred to as 'Matters of State Environmental Significance'. It also sets out the requirements of an Offset Delivery Plan and provisions for advance offsets; and
- *Environmental Offsets Policy 2014* – this policy provides operational detail and as to how offsets will be assessed and need to be delivered. The policy includes information on relationship between Commonwealth and State offsets, criteria that offsets must meet, offset delivery options and staging of offsets.

16.19.3 Method for Developing Offsets Delivery Plan

Central Queensland Coal have developed a draft Offset Management Plan (OMP) in accordance with the relevant Commonwealth and State policies (refer Appendix A18). The Plan offsets the residual impacts detailed in the previous section. The aim of Plan will be to provide an overall net environmental gain. Central Queensland Coal considers the most effective and efficient way to achieve this is to provide an OMP which includes all aspects of the Project, rather than a piecemeal approach to offsetting. The Plan will incorporate the provision for acquiring future offsets should they be required due to the impacts of future groundwater drawdown, or other unforeseen impacts resulting from Project activities.

Central Queensland Coal will continue to collaborate with the relevant agencies (such as DAF, DNRME, DES, and DotEE) regarding offset options to ensure optimal environmental net benefit is attained. The Plan will identify solutions that:

- Will protect against or repair residual impacts to matters of Commonwealth and State environmental significance;
- Relate specifically to the matter (for example, species or their habitat) being impacted; and
- Seek to ensure that the health, diversity and productivity of the environment are maintained or enhanced.

16.19.3.1 Development of an Offsets Delivery Plan

It is proposed that the key steps for development and implementation of an ODP will be as follows:

- Step 1: Identifying and quantifying residual Project impacts;
- Step 2: Identification of applicable offset requirements to address residual Project impacts;
- Step 3: Smart consolidated approach to meeting offset requirements – finalisation of Draft Plan;
- Step 4: Relevant agency input and approval of ODP;
- Step 5: Implementation of ODP; and
- Step 6: Ongoing monitoring of ODP.

Central Queensland Coal has developed a draft OMP that it believes acceptably satisfies approval requirements, in an ecologically strategic manner. The draft OMP includes further ground-truthing verification and detailed assessment of the following aspects:

- Location and type of land / vegetation required to be offset and field assessment of the quality of this habitat (using DES habitat quality assessment guidelines);
- Identification and assessment of land / vegetation that could be utilised in offsets (using detailed analysis of mapping, aerial imagery, and field habitat assessment);
- Land use and land management techniques that will improve on methods contributing to historical degradation; and
- Ongoing monitoring and management techniques and schedules. Applicable recovery plans, EPBC Act Conservation Advice, and Threat Abatement Plans specific to impacted species are also used for guidance regarding offset management.

The following section provides a summary of the quality and quantity of areas required to be offset as a result of project activities. This includes habitat quality assessments (as per State guidelines – DES, 2017) of directly impacted (i.e. vegetation clearing) and potentially impacted (i.e. through future groundwater drawdown) vegetation communities within the Project area. Section 16.19.5 summarises the quality and quantity of proposed offset sites and proposed management of these areas. The draft OMP is presented as Appendix A18. It is anticipated that DotEE and DES will issue a condition of approval, requiring a final OMP to be prepared and submitted for review prior to Project construction occurring.

16.19.4 Potential Residual Impacts

Sections 16.14, 16.15 and 16.17 identify the Project's potential environmental impacts and the mitigation measures. The current Project footprint and design have been planned to avoid significant environmental impacts, where possible or practicable, however, unavoidable residual environmental impacts have been identified. This section includes the identified and potential future residual impacts that may require offsets.

Ground-truthed MNES within the overall Project area include:

- Two Endangered REs (all of which are equivalent to EPBC Act listed TECs);
- Known habitat for Squatter Pigeon, Koala, Greater Glider and migratory bird species; and
- Potential habitat for Ornamental Snake.

Direct clearing of TECs has been eliminated during refinement of the design of the mine and infrastructure footprint. The areas of predicted impact of vegetation clearing based on ground-truthed vegetation mapping are detailed in Table 16-147. Several of these matters overlap and the overall extent of impact encompasses an area of 108.22 ha. The clearing of vegetation for both listed species will remain as residual impacts, thereby requiring offsetting.

Table 16-147 Identified residual and potential impacts to MNES

Matter of concern	Description	Impact area total (ha)
Identified residual impacts from Project clearing activity		
Habitat for threatened fauna	Ornamental Snake: RE 11.3.25 where occurs within cracking clay soils. Overlaps with habitat for Koala.	20.9
Habitat for threatened fauna	Koala (based on presence of foraging habitat') – 11.3.4, 11.3.25, 11.3.27b, 11.3.35 and 11.4.2.	108.22
	Overall impact area	**108.22 ha**

As discussed in Section 16.17.4, significant impacts on Greater Glider and Squatter Pigeon as a result of Project activities have been discounted and no offsetting of habitat for these species is proposed. However, it is noted habitat in the Project area and surrounds for both of these species overlaps directly with that of Koala and environmental offsets established for Koala will very likely also support these species.

There is further potential in the long-term for impacts to MNES because of possible groundwater drawdown impacts in the vicinity of open cut mining operations which may impact sections of Deep Creek and Tooloombah Creek. This is restricted to potential impacts to Forest Red Gum communities comprising riparian (RE 11.3.25) and alluvial (RE 11.3.4) communities which provide foraging habitat for Koala.

The area of impact on these communities is depicted in Figure 16-149 and detailed in Table 16-148. It is uncertain at this stage what level of groundwater drawdown may be required to cause impacts to the vegetation communities. Areas mapped as RE 11.3.25 have a low to moderate threat of being impacted where groundwater drawdown is less than 1 m. Above this level there is a moderate to high threat. Areas mapped as RE 11.3.4 are located within the predicted 5 m drawdown contour where a low to moderate threat has potential to occur. These areas will be subject to vegetation monitoring under the Project LUMP and wetland health monitoring and management under the REMP (refer Section 16.10.7.4 and 16.11.4.5). Where vegetation communities are found to be unavoidably impacted by groundwater drawdown these areas will be subject to the Project OMP.

Table 16-148 Potential impacts to ground-truthed MNES vegetation communities from predicted groundwater drawdown (maximum extent – 10 years following mine closure)

Extent of predicted maximum drawdown	Potential impact area (ha)		
	Tooloombah Creek	Deep Creek	
	11.3.25	11.3.25	11.3.4
< 1 m	40.3	62.4	-
> 1 m	8.3	34.2	-
< 5 m (RE 11.3.4 only)	-	-	14.25
Total	**48.6**	**96.6**	**14.25**

16.19.4.1 Habitat Quality of Impacted Areas

Land-based offsets under the State and Commonwealth Offsets Policies require the quality of vegetation to be at least similar to that impacted. The quality of the vegetation associated with the draft Project OMP (Appendix A18) (both impacted sites and proposed offset sites) has been assessed using the 'Guide to determining terrestrial habitat quality V1.2' (EHP 2017) (hereon referred to as the Guide). The assessment methods are based on the BioCondition Assessment Manual (developed by the Queensland Herbarium), and align with the habitat quality measures required for input into the EPBC Act 'Offsets Assessment Guide' thereby determining land-based offset ratios. This allows for a consistent framework for environmental offsets between the State and Commonwealth approval process.

The assessment of habitat quality ensures a proposed offset site is of a suitable quality and extent to achieve a gain that is sufficient to compensate for the loss of ecological values (for MNES) at the Project impact site. The habitat quality of the Project area is summarised below relating to the relevant MNES and whether impacts are direct (vegetation clearing) or potentially indirect (future groundwater drawdown).

Direct Impacts – vegetation clearing and Project construction

Areas of vegetation on site requiring environmental offsetting due to vegetation clearance comprise:

- Habitat for a MNES threatened species - Koala (comprising RE 11.3.4, 11.3.25, 11.3.27, 11.3.35, 11.4.2); and
- Habitat for a MNES threatened species – Ornamental Snake (comprising areas of RE 11.3.25 – overlaps with above).

State based offset requirements for offsetting 'Of Concern' REs (RE 11.3.4 and 11.4.2) will be discharged by offsetting for species habitat under the EPBC Act.

The habitat quality assessment of impact sites was carried out in July 2018 and comprised 14 assessment sites as shown in Figure 16-150. Assessment sites comprised seven sites in vegetation communities associated with Project clearing and seven sites associated with potential future groundwater drawdown impacts. The various blocks of vegetation subject to impact are treated in the following sections as two 'assessment units' as referred to in the Guide i.e. for Koala and Ornamental Snake. This information is also summarised in the draft Offset Delivery Plan provided as Appendix A18.

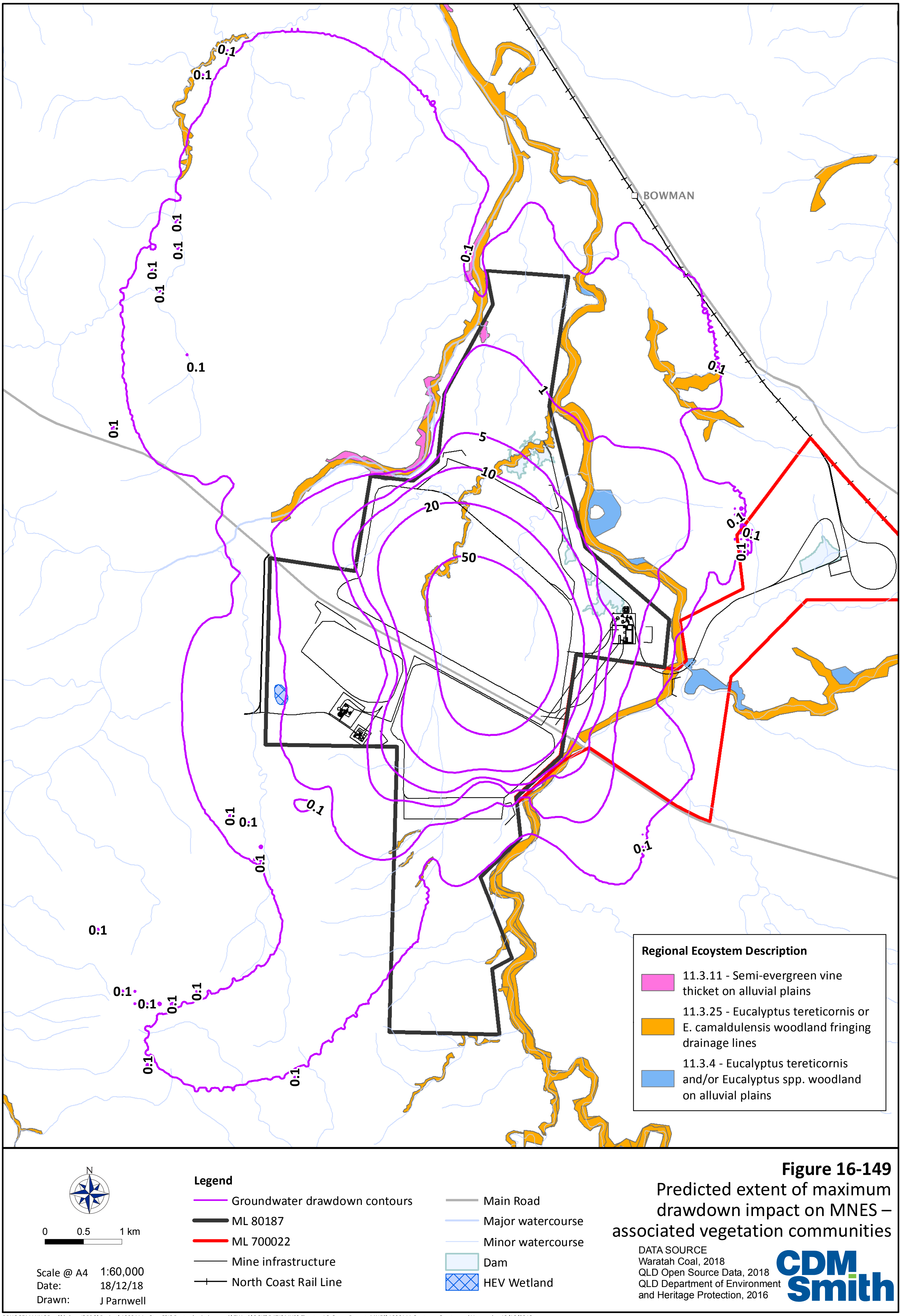


Figure 16-149
Predicted extent of maximum drawdown impact on MNES – associated vegetation communities

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
QLD Department of Environment and Heritage Protection, 2016

CDM Smith

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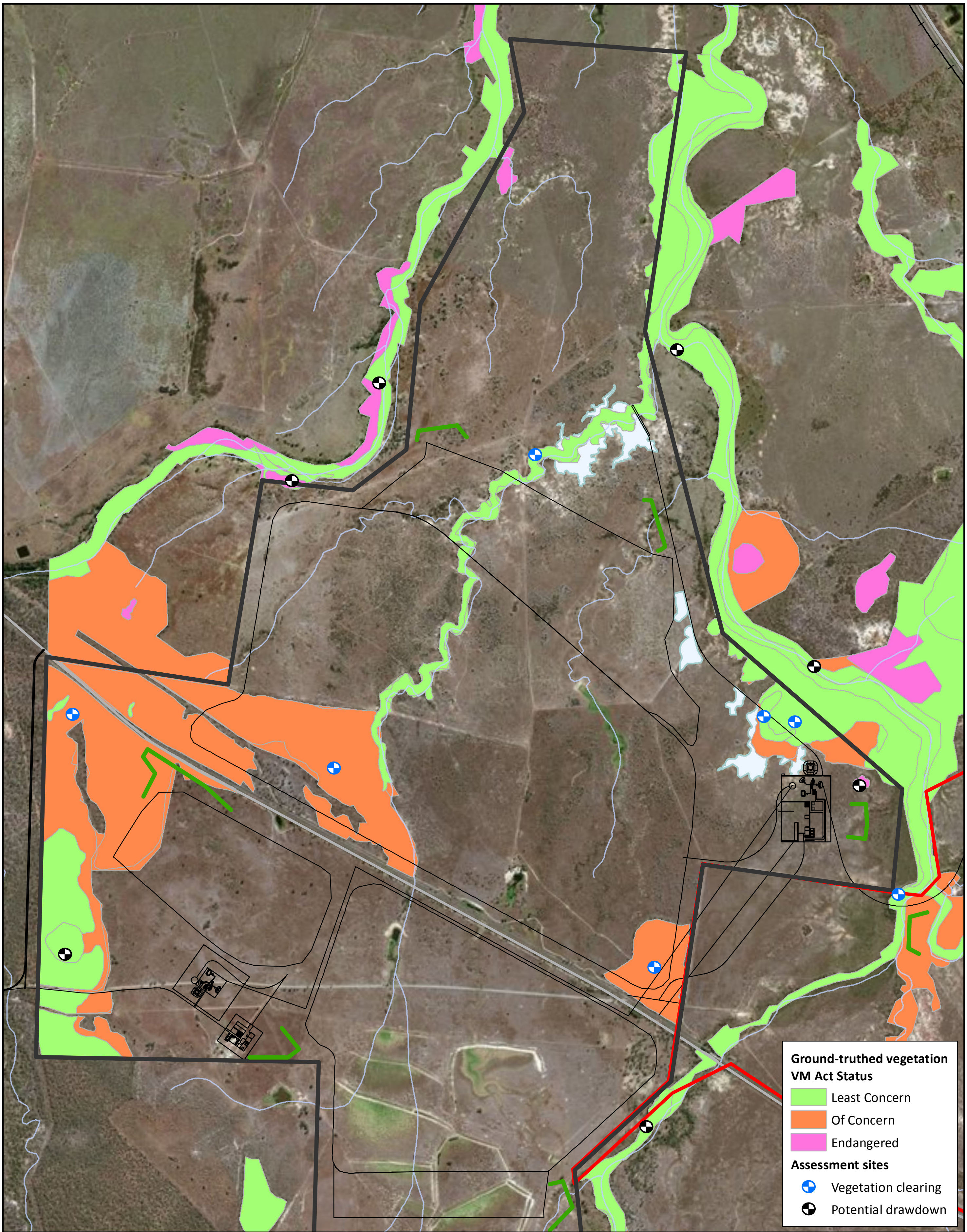

N

0 0.5 1 km

Scale @ A4 1:30,000
Date: 18/12/18
Drawn: J Parnwell

Legend

- ML 80187
- ML 700022
- Mine infrastructure
- Environmental Dams
- Cadastral boundary
- Main Road
- North Coast Rail Line
- Watercourse
- Dam

Figure 16-150
Habitat quality assessment sites – Project impact areas

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
QLD Department of Environment and Heritage Protection, 2016

CDM Smith

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 14_Supp_Report_Terrestrial Ecology\1000111 Biocondition Sites Northern Chapter__14-13.mxd 12/18/2018

Habitat quality was assessed following the attributes detailed in the Offsets Assessment Guide under the EPBC Act Environmental Offsets Policy. Under the EPBC Offset Assessment Guide there are three components to be considered when calculating habitat quality: site condition, site context, and species stocking rate. These differ slightly from the DES' Guide which describes site condition, site context and fauna species habitat (i.e. the ability of an area to support the threatened species in focus). The following habitat quality values (for both impact and offset sites) are provisional and based on precedents set under recent projects. As such, the habitat attributes as measured onsite have been apportioned differently to the method in the DES Guide so as to inform the three habitat components described in the EPBC Offset Assessment Guide.

Site condition and site context are described using 15 and seven attributes respectively (refer Appendix A18 for more detail). Species stocking rate is considered as a measure of the species presence on the site. For this assessment species stocking rate has been assessed on a scale of 0 – 4 as described in Appendix A18. The overall scores (out of 10) for site condition and site context have then been weighted at a 30% contribution each to the overall habitat quality score used in the EPBC Offset Assessment Guide (based on level of importance). The species stocking rate number contributes the remaining 40% of the final habitat quality score (refer Appendix A18 for more detail).

The habitat quality of the Project area to the Koala is summarised in Table 16-149 and to Ornamental Snake in Table 16-150. Individual habitat value measures associated with individual assessment sites are provided as Attachments to the Draft ODP located in Appendix A18.

Table 16-149 Habitat quality in the Project area for Koala

Attribute	Discussion
Area	Koala has been recorded within or adjacent to the proposed impact areas during surveys for the Project. The overall impact area covers a total of 108.22 ha across six areas. These areas consist of grassy ironbark dominated woodlands subject to cattle grazing, and riparian Forest Red Gum habitat.
Quality	
Site condition	Grassy woodlands encompass 84.15 ha of the overall impact area. These areas are currently subject to cattle grazing. These grassy woodlands comprise a number of eucalypt species suitable for Koala foraging including the dominant Narrow-leaved Ironbark, Poplar Box and Pink Bloodwood. Forest Red Gum open forest (including fringing wetlands) comprises 24.07 ha of the remaining impact area. For the most part these areas exist as a thin degraded strip along a minor waterway and are subject to cattle disturbance. The canopy is dominated by Forest Red Gum and is a favoured forage tree species for Koala. The understorey often comprises shrubby weed species including Lantana and Rubber Vine. Weed cover in riparian REs was well above benchmark conditions. Site assessments indicated tree height and canopy cover in the woodland sites and riparian forest sites are comparable to benchmark sites for the same vegetation communities as set out under the BioCondition benchmarks for the Brigalow Belt (Queensland Herbarium 2016).

<table>
<tr><th>Attribute</th><th colspan="2">Discussion</th></tr>
<tr><td>Site context</td><td colspan="2">Koala occurs as far north as the Atherton Tablelands in north Queensland, into southern Australia, and extends west into central Queensland. The impact sites occupy a very small area within the species overall distribution and is very unlikely to be of importance to the overall population. Given the relatively small area the impact sites occupy across the Koala’s wider distribution it is likely the local population plays a very minor role in relation to the overall population.

The impact areas are located in a fragmented landscape and are located outside of any ecological corridors (as mapped by DES). Nevertheless, tracts of similar eucalypt woodland habitat occur adjacent to the west and further to the south of the proposed impact areas. Riparian open forest occurs along the eastern boundary and to the north and north-west of the impact area providing habitat connectivity to woodlands to the east and west. Much of the Project impacts already cleared lands and the Project will not further fragment surrounding habitat.

The woodland impact sites comprise the majority of the impacted area and lie adjacent to the Bruce Highway, thereby providing an elevated risk of road collisions in these sites. Dingo/wild dog (a known risk to Koala) has been sighted in the Project area on several occasions during Project surveys.</td></tr>
<tr><td>Species stocking rate</td><td colspan="2">The species has been identified on six occasions during spotlighting in or near the impact sites (four individuals over four separate spotlighting events) and camera trapping further to the south of the Project area (two records).

There is no local data as to the species population density in the area. Further west in the Springsure area the species uses an average home range of 38 ha (females) to 80 ha (male) (Melzer 1995). Individuals further north (Blair Athol) occupy larger home ranges of 101 ha (females) to 135 ha (male) (Ellis et al. 2002).

Given only individuals have been observed during surveys the species appears to occur at low densities across the local area. As such a ‘stocking rate’ number of 1 has been attributed to the impact sites.</td></tr>
<tr><td>Assessed habitat quality value</td><td>5</td><td>As per desktop and habitat attributes measured using the DES Guide and species stocking rate as per the EPBC Act Offsets Assessment Guide (refer Appendix A18 for site attribute details and calculations).</td></tr>
<tr><td>Total quantum of impact (adjusted ha)</td><td>54.1</td><td>As per the results of the EPBC Act Offsets Assessment Guide (refer Appendix A18 for output results).</td></tr>
</table>

Table 16-150 Habitat quality in the Project area for Ornamental Snake

Attribute	Discussion
Area	Ornamental Snake has been recorded 3 km to the west of the proposed impact areas during surveys for the Project in 2011/2012. The species has not been detected within the Project area. The overall impact area covers a total of 20.9 ha across two areas of riparian Forest Red Gum habitat. located within a matrix of cleared Brigalow habitat with gilgais on cracking clay soils.
Quality	
Site condition	The impact site exists as a thin degraded strip along a minor waterway located within a matrix of cleared Brigalow habitat with gilgais on cracking clay soils. This habitat is subject to cattle disturbance. The understorey comprises a range of SEVT species and shrubby weed species including Lantana and Rubber Vine. Site assessments indicated that suitable habitat factors (presence of coarse woody debris) were well below the benchmark data for the same vegetation community as set out under the BioCondition benchmarks for the Brigalow Belt (Queensland Herbarium 2016). Weed cover was also well above benchmark conditions.

<table>
<tr><th>Attribute</th><th colspan="2">Discussion</th></tr>
<tr><td>Site context</td><td colspan="2">Ornamental Snake occurs as far north as Charters Towers in north Queensland, west to Emerald and the Belyando River and south into the Dawson River floodplain. The species has not been identified on or near the impact sites which occupy a very small area within the species overall distribution. Given the relatively small area the impact sites occupy across the Ornamental Snake's wider distribution it is likely any local population, should one occur in the area, plays a very minor role in relation to the overall population.

The impact areas are located in a heavily fragmented and cleared landscape. Extensive similar habitat occurs to the west of Tooloombah Creek where the species was identified in remnant Brigalow habitat in 2011 / 2012. Similar cleared habitat also occurs to the immediate north to the confluence of Deep Creek and Tooloombah Creek, and cleared habitat to the west of Deep Creek.

Dingo/wild dog and feral cat have been sighted in the Project area on several occasions during Project surveys and Cane Toad has been sighted on most surveys. The site is subject to invasive weeds which may also impact the values of habitat for the species.</td></tr>
<tr><td>Species stocking rate</td><td colspan="2">The species has not been identified on the site despite extensive survey effort. The species has been identified 3 km to the west in remnant Brigalow habitat in 2011/2012.

There is no data available as to the species population density. Observations elsewhere in central Queensland (the Belyando River floodplain) indicate the species may be common where suitable habitat occurs (pers. Comm. B. Taylor).

Given the species has not been identified on the site a 'stocking rate' number of 0 has been attributed to the impact sites.</td></tr>
<tr><td>Assessed quality value</td><td>3</td><td>As per desktop and habitat attributes measured using the DES Guide and species stocking rate as per the EPBC Act Offsets Assessment Guide (refer Appendix A18 for site attribute details and calculations).</td></tr>
<tr><td>Total quantum of impact (adjusted ha)</td><td>6.27</td><td>As per the results of the EPBC Act Offsets Assessment Guide (refer Appendix A18 for output results).</td></tr>
</table>

Indirect Impacts – groundwater drawdown

Groundwater drawdown has potential in the future to impact vegetation requiring access to groundwater. The groundwater assessment for the Project has identified the potential for impacts to GDEs including MSES-associated vegetation communities dominated by Forest Red Gum (RE 11.3.25). The maximum predicted extent of impacts from groundwater drawdown (i.e. 10 years following the cessation of mining activities) may impact 42.5 ha of RE 11.3.25 where the drawdown is predicted to exceed more than 1 m (Moderate to high chance of impact), and 102.7 ha where drawdown is less than 1 m (low to moderate chance of impact). Drawdown has a low to moderate chance of impacting 14.25 ha of RE 11.3.4 where drawdown is less than 5 m and the water table sits above 10 mbgl. These and adjacent areas will be subject to vegetation health monitoring throughout the life of the Project. Should impacts be identified these will require further offsets located outside the boundary of potential groundwater drawdown impacts.

Areas of vegetation on site that may require environmental offsetting due to the predicted effects of groundwater drawdown comprise habitat for a MNES threatened species - Koala (RE 11.3.25 and 11.3.4). The habitat quality of the Project area to the Koala is summarised in Table 16-151 and is based on four assessment sites (Figure 16-150). Individual habitat value measures associated with individual assessment sites are provided as attachments to the draft OMP located in Appendix A18.

Table 16-151 Habitat quality for Koala – predicted groundwater drawdown zone

<table>
<tr><th>Attribute</th><th colspan="2">Discussion</th></tr>
<tr><td>Area</td><td colspan="2">Koala has been recorded in the local area during surveys for the Project and is therefore likely to use the Forest Red Gum communities (RE 11.3.25 and 11.3.4) along the adjacent creek lines. The overall potential maximum groundwater drawdown impact area (refer Figure 16-149) covers a total of 159.45 ha across the two creeks (Table 16-148).</td></tr>
<tr><td colspan="3">Quality</td></tr>
<tr><td>Site condition</td><td colspan="2">These areas exist as a relatively thin degraded strip along Tooloombah Creek. This habitat is more variable along Deep Creek with some areas buffered by adjacent floodplain vegetation. Deep Creek appears less subject to cattle disturbance. The canopy is dominated by Forest Red Gum and is a favoured forage trees pecies for Koala.

Site assessments indicated tree height and canopy cover in the woodland sites and riparian forest sites are comparable to benchmark sites for the same vegetation communities as set out under the BioCondition benchmarks for the Brigalow Belt (Queensland Herbarium 2016). The understorey often comprises shrubby weed species including Lantana and Rubber Vine. Weed cover in riparian REs was well above benchmark conditions.</td></tr>
<tr><td>Site context</td><td colspan="2">Koala occurs as far north as the Atherton Tablelands in north Queensland, into southern Australia, and extends west into central Queensland. The site occupies a very small area within the species overall distribution. Given the relatively small area the impact sites occupy across the Koala’s wider distribution it is likely the local population plays a very minor role in relation to the overall population.

The potentially impacted areas are located in a fragmented landscape. Riparian open forest extends to the north and south.

The southern extent of the drawdown area potentially impacting Deep Creek lies adjacent to the Bruce Highway providing an elevated risk of road collisions in these sites. Dingo/wild dog (a known risk to Koala) has been sighted in the Project area on several occasions during Project surveys.</td></tr>
<tr><td>Species stocking rate</td><td colspan="2">The species has been identified on six occasions during spotlighting in or near the impact sites (four individuals over four separate spotlighting events) and camera trapping further to the south of the Project area (two records).

There is no local data as to the species population density in the area. Further west in the Springsure area the species uses an average home range of 38 ha (females) to 80 ha (male) (Melzer 1995). Individuals further north (Blair Athol) occupy larger home ranges of 101 ha (females) to 135 ha (male) (Ellis et al. 2002).

Given only individuals have been observed during surveys the species appears occur at low densities across the local area. As such a ‘stocking rate’ number of 1 has been attributed to the impact sites.</td></tr>
<tr><td>Assessed habitat quality value</td><td>5</td><td>As per desktop and habitat attributes measured using the DES Guide and species stocking rate as per the EPBC Act Offsets Assessment Guide (refer Appendix A18 for site attribute details and calculations).</td></tr>
<tr><td>Total quantum of impact (adjusted ha)</td><td>79.5</td><td>As per the results of the EPBC Act Offsets Assessment Guide (refer Appendix A18 for output results).</td></tr>
</table>

16.19.5 Offset Activities

Under the Offsets Policy it is recognised that direct land-based offsets should comprise a minimum of 90% of the offset requirements for any given impact. At this stage, the residual significant impacts due to vegetation clearing for the Project is 108.22 ha of habitat for MNES threatened species. Central Queensland Coal will continue to liaise with the relevant State governing body (DES) and DotEE to discuss the preferred approach and outcomes for offsetting these impacts.

16.19.5.1 Proposed Offset Site

Mamelon Property

Central Queensland Coal owns the Mamelon property, of which the majority of the Project's disturbance footprint occurs. Central Queensland Coal will utilise areas outside of the ML and within Mamelon for offsetting purposes for predicted residual impacts of the Project. Central Queensland Coal will seek to achieve synergistic habitat and conservation benefits through the retention and improvement of existing vegetation, and the rehabilitation of previously cleared lands on the property.

Central Queensland Coal intends to use areas of the Mamelon property that are outside of the ML for environmental offsetting purposes. The practise of recommending the use of vegetation located within a property but outside the Project footprint for environmental offsetting purposes is not without precedent. The proponents of the Carmichael Coal Mine and Rail Project (Adani Mining) own Moray Downs property on which the northern section of the Project is situated. The Moray Downs property was recommended as providing sufficient values to support the Project's Environmental Offsets Package (Ecofund 2014). It is noted the Project has been approved without conditions stipulation against the use of the property for offsetting purposes.

The Mamelon property is currently used for cattle grazing. This landuse will cease across the majority of the property on approval of the Project and the land within Mamelon will be set aside for conservation purposes. Grazing post-mining will be rrestricted. Under current Queensland vegetation legislation there is little control as regards the potential clearing of remnant vegetation on the property for 'improved pasture.' Central Queensland Coal considers that, with suitable management of the available lands on the property (outside of the Project footprint), a conservation benefit can be derived that goes well beyond the immediate direct impacts of vegetation clearing for the Project.

Mamelon encompasses a total area of 6,478 ha of which the Project ML covers 2,275 ha. This leaves a total of 4,203 ha remaining outside of the Project boundary with significant portions remaining as remnant vegetation largely subject to cattle grazing impacts. A summary of the remnant vegetation remaining on the property and outside the Project footprint as mapped under State vegetation mapping is provided at Table 16-152.

Although the project will result in a small loss of habitat for listed species, the improvement of habitat and management of potentially threatening processes (such as weed invasion and uncontrolled bushfires), across the property and adjacent to the project is anticipated to compensate the residual impact of that loss. In the long-term there will be an increase in the overall extent of habitat in the area through management of regrowth vegetation in previously cleared areas on the property.

The property is topographically complex with two central rocky hills encircled by foothill slopes and alluvial flats bordered by Deep Creek to the south and Tooloombah Creek and a major tributary to the north and west. As such the property comprises a range of habitat types. Within the wider landscape Mamelon is well connected to a large remnant habitat patch to the north and less well connected to several large patches to the south, west, east and north-east. These patches, particularly to the south, provide linkages to extensive habitat in the Connors Range which is mapped under the Queensland Biodiversity Planning Assessment process (BPA) as a state-wide ecological corridor of 'State' importance. Central Queensland Coal believes that with appropriate vegetation restoration and management, including the proposed Offset Management Areas (OMAs), the property will improve regional connectivity linkages to the south and west and to this ecological corridor, thereby allowing faunal movement across the wider landscape (Figure 16-151).

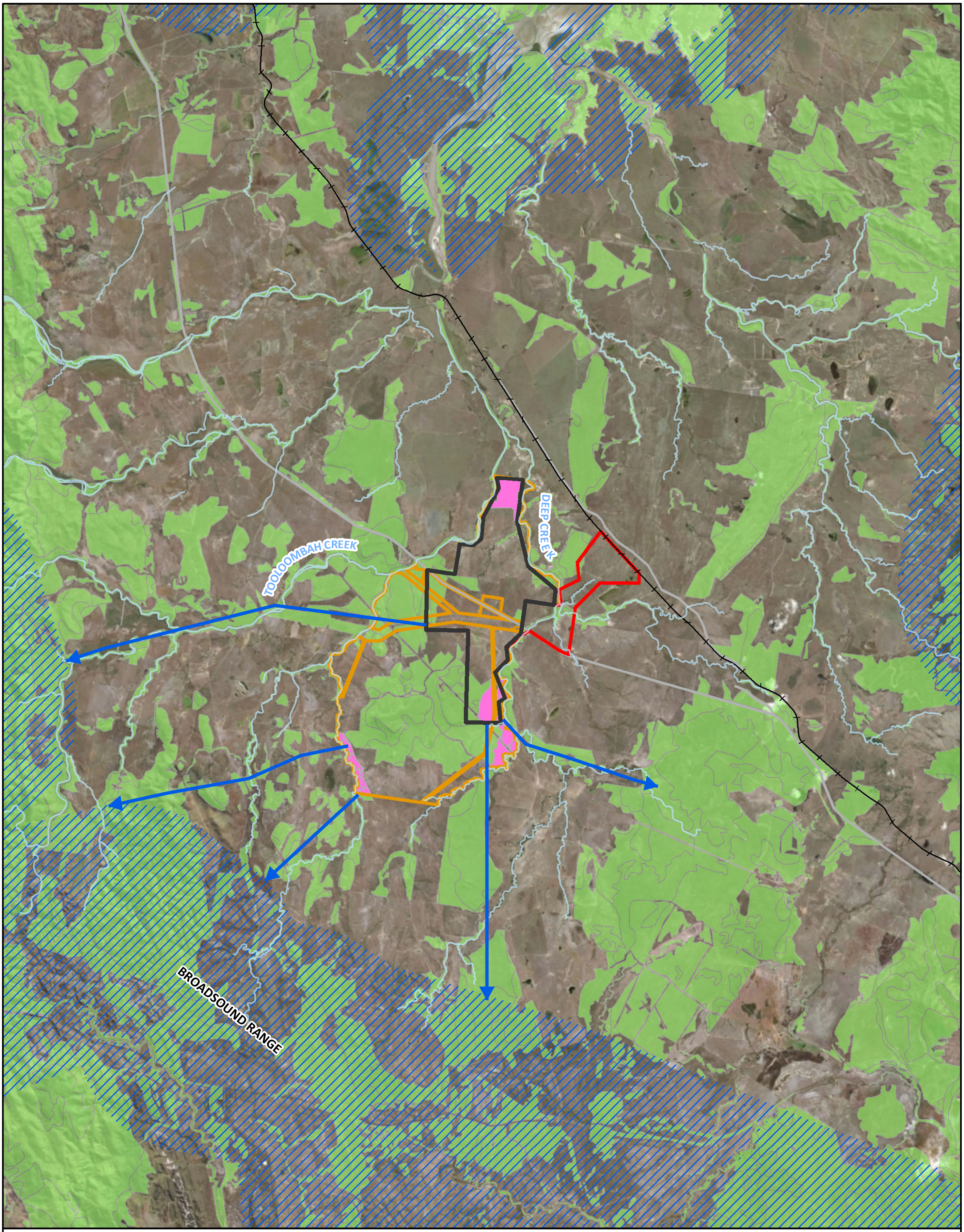

Figure 16-151

Mamelon Property, OMAs and landscape connectivity corridors

N

0 2 4 km

Scale @ A4 1:200,000
Date: 18/12/18
Drawn: Gayle B.

Legend

- ML 80187
- ML 700022
- Main Road
- North Coast Rail Line
- Watercourse
- Mamelon
- Bioregional Corridors (BPA)
- Remnant vegetation (DNRME)
- Proposed OMA
- Connectivity Corridor

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
ESRI Basemaps, 2017

CDM Smith

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 mamelon_OMAs_landscape connectivity.mxd 12/18/2018

Remnant Vegetation

A total of 2,590 ha of remnant vegetation occurs on Mamelon outside of the Project ML. The major direct impact to MSES / MNES as a result of the Project is to habitat for Koala. Current vegetation mapping indicates that up to 792 ha of remnant vegetation is available within Mamelon that provides favoured foraging habitat for Koala (Table 16-152) and is suitable for Squatter Pigeon and Greater Glider (all species that are known to occur in the area). This includes 74.4 ha of vegetation comprising primary foraging habitat for Koala (RE 11.3.4 and 11.3.25). There is a further 1,736 ha of eucalypt habitat which the species may also utilise and in which it has been recorded during Project surveys (Figure 16-152). In addition, there is currently 4.6 ha of habitat mapped as threatened REs and as EPBC Act-listed TECs: Brigalow vegetation (RE 11.4.9), and 45 ha of SEVT vegetation. Inspection of aerial imagery indicates this may be a substantial underestimation of the extent of SEVT on the property (with other patches seemingly present on west facing slopes of the rocky hills to the west of the highway).

Within the Project ML itself there are an additional 402 ha of remnant vegetation that will not be impacted under the Project footprint. Ground-truthing vegetation surveys indicate this includes 357 ha of vegetation suitable for Koala (RE 11.3.25, 11.3.27, 11.3.35, 11.4.2, 11.5.8a, 11.10.7 and 11.11.15a) and therefore also suitable for potential use as environmental offsets for the project.

All of the remnant habitat as described is currently subject to varying degrees of cattle grazing. The majority of the remnant vegetation located outside of the Project ML is Least Concern and under current legislation is subject to very little control. Central Queensland Coal proposes to remove cattle from the majority of the property and manage the remaining remnant vegetation (through weed and fire management) thereby improving habitat values for fauna on the site.

Table 16-152 Mamelon property - remnant vegetation outside of Project footprint

RE	Area (ha)	Suitability for MNES
Extent of vegetation communities (DNRME) outside of Project ML (80187)		
11.3.4	15.5	Variety of eucalypt species present including Forest Red Gum. Suitable for Koala.
11.3.25	58.9	Canopy dominated by Forest Red Gum. Occurs along creek lines. Suitable for Koala and potentially Ornamental Snake.
11.3.29	125.2	Variety of eucalypt species present over *Melaleuca* understorey. Suitable for Koala.
11.4.2	219.2	Poplar Box dominated woodland. Suitable for Koala.
11.4.9	4.6	Brigalow (TEC). Suitable for Ornamental Snake.
11.5.8a/11.7.2	344.1	Variety of eucalypt species present in 11.5.8a (90% dominance in community polygon) including Forest Red Gum. Suitable for Koala. *Acacia* species dominate 11.7.2 which is generally unsuitable for Koala.
11.10.7	488.6	Narrow-leaved Ironbark dominated woodland. Foraging habitat for Koala.
11.10.7/11.10.1	638.1	Narrow-leaved Ironbark dominated woodland for 11.10.7 (90% dominance in community polygon). Foraging habitat for Koala. 11.10.1 Dominated by Spotted Gum (*Corymbia citriodora*) with other species. Suitable for Koala.
11.11.1	135.0	Narrow-leaved Ironbark dominated woodland. Foraging habitat for Koala.
11.11.15a	538.4	Narrow-leaved Ironbark dominated woodland. Foraging habitat for Koala.
11.11.18	45.6	Semi-evergreen vine thicket (TEC).
Total remnant	2,590	

Extent of ground-truthed vegetation communities within Project ML (outside footprint)		
11.3.11	2.2	SEVT along creek lines.
11.3.12	4.2	Broad-leaved Paperbark over an ephemeral wetland.
11.3.25	5.3	Canopy dominated by Forest Red Gum. Occurs along creek lines. Suitable for Koala.
11.3.27	1.2	Forest Red Gum over ephemeral wetland depression. Suitable for Koala.
11.3.35	27.3	Poplar Gum dominated woodland. Foraging habitat for Koala.
11.4.2	126.5	Poplar Box dominated woodland. Suitable for Koala.
11.4.9	0.54	Brigalow (TEC). Suitable for Ornamental Snake.
11.5.8a	33.4	Variety of eucalypt species present in 11.5.8a (90% dominance in community polygon) including Forest Red Gum. Suitable for Koala.
11.10.3	36.6	Lancewood dominated open forest.
11.10.7	76.4	Narrow-leaved Ironbark dominated woodland. Foraging habitat for Koala.
11.11.15a	88.3	Narrow-leaved Ironbark dominated woodland. Foraging habitat for Koala.
Total remnant	401.94	

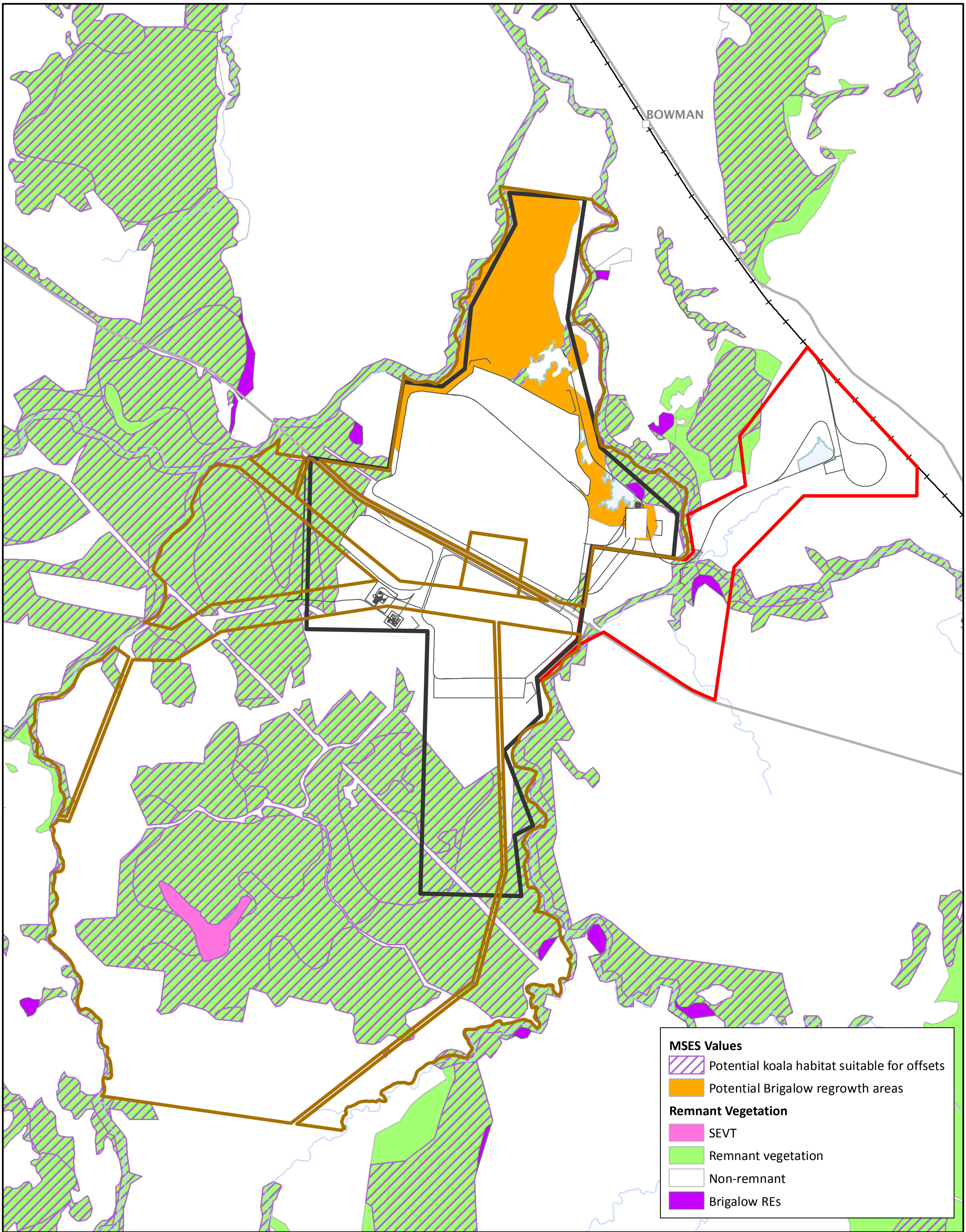

Figure 16-152

Mamelon property – remnant vegetation suitable for MNES habitat offsets

N

0 0.5 1 km

Scale @ A4 1:70,000
Date: 18/12/18
Drawn: Gayle B.

Legend

- ML 80187
- ML 700022
- Mamelon Property
- Mine infrastructure
- Main Road
- North Coast Rail Line
- Watercourse
- Dam

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018

CDM Smith

BRUGGEMANNGD \\brbsvr1\PRO\Project\1000111 - Styx SEIS Post submission work\7Work\3GIS\DATA\MXD\Chapter 16_Supp_Report_MNES\1000111 Mamelon - veg mnes habitat__16-46.mxd 12/18/2018

16.19.5.2 Proposed Offset Areas

Central Queensland Coal proposes three specific Offset Management Areas (OMA) within Mamelon to manage the significant residual impacts resulting from the Project works as depicted in Figure 16-153. Although it is noted the intention is to manage the entire property for conservation purposes into the future. Vegetation communities identified as potential offset locations on the property, were assessed during vegetation surveys carried out in August 2018. A total of 18 assessment sites were established as per the Guide (Figure 16-153). The OMAs were selected based on their potential to acquit the Project's offset requirements.

The RE composition of each proposed OMA is detailed in Table 16-153. This information is also provided in the draft Offset Delivery Plan provided as Appendix A18.

Table 16-153 Styx Project Offset management Areas – ground-truthed RE composition

RE	Area (ha)	Suitability for MNES
OMA 1		
11.3.25	6.19	Canopy dominated by Forest Red Gum. Suitable for Koala.
11.3.35	29.33	Variety of eucalypt species. Suitable for Koala.
11.4.2	118.9	Narrow-leaved Ironbark / Poplar Box dominated woodland. Suitable for Koala.
11.4.9	2.35	Brigalow (TEC). Suitable for Ornamental Snake.
11.11.15a	84.7	Narrow-leaved Ironbark dominated woodland. Suitable for Koala.
Non-remnant	13.54	Cleared habitat, potentially suitable for Ornamental Snake.
Total area	255.01	
OMA 2		
11.3.4	2.12	Canopy dominated by Forest Red Gum with other eucalypt species. Suitable for Koala.
11.3.25	16.62	Canopy dominated by Forest Red Gum. Suitable for Koala.
11.4.2	28.99	Narrow-leaved Ironbark / Poplar Box dominated woodland. Suitable for Koala.
11.9.7	8.03	Narrow-leaved Ironbark dominated woodland. Marginal foraging habitat for Koala.
11.10.7	8.15	Narrow-leaved Ironbark / Poplar Box dominated woodland. Suitable for Koala.
Non-remnant	37.82	Cleared habitat with partial regrowth. Suitable for restoration of Koala habitat.
Total area	101.73	
OMA 3		
Non-remnant (total area)	128	Cleared gilgai habitat with scattered regrowth Brigalow, suitable for Ornamental Snake and restored as Brigalow TEC.

The surveys specifically identified the following REs associated with Project impacts to Koala habitat within the designated OMAs (refer Figure 16-152):

- RE 11.4.2 - 147.89 ha;
- RE 11.3.4 – 2.12 ha;
- RE 11.3.35 – 129.33 ha; and
- RE 11.3.25 – 22.95 ha.

There is an additional 100.88 ha of remnant vegetation also considered suitable for Koala due to the presence of forage species including Narrow-leaved Ironbark and Poplar Box (RE 11.9.7, 11.10.7 and 11.11.15a). In total OMA 1 and OMA 2 comprise 303.03 ha of remnant habitat suitable for Koala. OMA 3 comprises 128 ha of non-remnant habitat considered suitable to support Ornamental Snake.

An assessment of the Mamelon OMAs suitability to achieve positive environmental outcomes for impacted MSES / MNES matters (namely Koala and Ornamental Snake) has been carried out using the EPBC Act Offsets Assessment Guide. Based on the assessment the proposed OMAs can acquit the Project's direct impacts resulting from vegetation clearing.

EPBC Act Offset Assessment Calculations

The habitat assessment surveys examined the habitat quality of proposed offset areas, and enabled calculations of the habitat value of the proposed area (accounting for averted loss and quality improvements) to be undertaken following the EPBC Act Offsets Assessment Guide calculator.

Considering the assessment described above (incorporating current habitat quality of the proposed offset sites, habitat improvement measures and risk of loss), the proposed offset locations will exceed the offset requirements for the Project. The areas of habitat will constitute more than a 'like-for-like' offset provided habitat management practices identified are implemented over the area.

A copy of the offset calculations are provided as an appendix to the draft OMP (Appendix A18). Table 16-154 summarises the inputs to the EPBC Act offsets assessment guide for Koala habitat. Both OMA 1 and OMA 2 have been assessed as a combined entity as habitat quality within the areas were considered similar through the results of the habitat quality assessments. Table 16-155 summarises the inputs to the EPBC Act offsets assessment guide for Ornamental Snake habitat associated with OMA 3.

Based on the output from the EPBC Act Offset Assessment Guide the OMAs will acquit the Project's environmental offset requirements for both species. The property is considered more than likely to be able acquit additional impacts resulting from groundwater drawdown on Koala habitat in the future (as identified in Table 16-148), should they occur. Offset calculations based on the maximum total area of predicted drawdown impact (159.45 ha) and the habitat attributes detailed in Table 16-154 indicate in the unlikely event of this occurring, 407 ha of lands will be required to acquit this loss. There are extensive areas of eucalypt woodlands remaining on the property which are suitable for Koala, as well as non-remnant areas that can be restored (refer Table 16-152) and can then be used for further offsets into the future.

Table 16-154 Summary of offset calculations and habitat values for Koala

Attribute	Rating	Discussion
Start habitat quality	5	There are six records of Koala from the property from fauna surveys in 2017 and 2018 (refer Figure 16-142). Two of these are located 800 m and 300 m (respectively) to the west of OMA 1. Given the proximity of the records to the OMAs the species is expected to occur in these areas. The site assessment observed the woodland areas (RE 11.4.2) had been subject to 'heavy logging' (particularly of ironbarks) with few large trees present. The impact of heavy cattle grazing were also noted at assessment sites. The understorey of riparian open forest was noted as having a relatively dense understorey of Lantana at all survey sites. Lantana thickets may restrict Koala movement (DECC 2008) and thereby access to forage trees. OMA 2 and OMA 3 both comprise remnant vegetation that connects vegetation on Mamelon with tracts to the immediate south. The retention and improvement of these areas, along with regeneration of cleared lands elsewhere on the property will improve these connections as well as improving habitat for Koala in the local for the long-term.
Risk of loss (%) without offset	10	Without the establishment of the proposed OMAs there will be continued cattle grazing (through agistment practises as is currently carried out) impacting canopy tree recruitment, associated land management practises, and impacts of unmanaged weeds. Site assessments indicated that past thinning / logging of these areas has occurred in the past to increase productivity of cattle grazing. It is reasonable to assume these management practises would continue into the future, potentially degrading the habitat present further. However, recent changes in the Qld VM Act may decrease the potential for clearing / thinning activities to occur. Where other normal land management practices are considered to continue into the future then a 10% risk of loss is considered reasonable.

Attribute	Rating	Discussion
Future habitat quality without offset	5	Continued cattle grazing in the OMAs will lead to long-term degradation of suitable habitat for Koala including overgrazing and soil compaction. Riparian habitat is also at risk from the proliferation of existing weed species such as dense patches of Lantana which can impact Koala access to forage trees and suppress canopy tree recruitment. Woodland habitat has potential to be impacted by uncontrolled and high intensity bushfires which may cause direct Koala mortality and impact woodland habitat through mortality of mature and juvenile forage trees. Feral dogs/Dingos may impact Koala through predation through direct predation. Nevertheless, it is reasonable to assume that current management practises would continue into the future and therefore the current habitat quality of the subject lands will be retained into the future.
Risk of loss (%) with offset	0	The Mamelon property will be managed for conservation purposes (excluding the mine footprint). The OMAs will be protected under State legislation (as a voluntary declaration under the VM Act) following agreement with DES and DotEE and will remain in perpetuity including after the cessation of the Project. This protection mechanism will preclude development within the designated OMAs for the current landowners (Fairway Coal) and for any future landowners. With intended land management practises to be carried within the OMAs there will be no loss of habitat quality and it is expected there will be improvement over time.
Future habitat quality with offset	7	Habitat quality for Koala will be improved by the application of active habitat management across Mamelon property with a specific emphasis on the OMAs. 'Future quality' will be improved and will be represented by an improvement in the habitat quality score as measured by annual habitat and biannual fauna monitoring assessments. An OMP will be developed detailing generic management measures and Koala presence monitoring to be applied across Mamelon and specific management measures for the OMAs. Managemnt actions will be developed and guided by the approved Commonwealth 'Conservation Advice' for the species. There are no recommended threat abatement plans of recovery plans for the species. Management actions will include (but not be restricted to): ▪ Removal of cattle grazing to eliminate degrading processes such as soil compaction, and suppression of native tree regeneration; ▪ Increased tree cover by allowing canopy species recruitment; ▪ Fire management to eliminate the potential for high intensity bushfires which may cause direct Koala mortality, and mortality of canopy trees and and juvenile canopy trees; ▪ Managing problem weed species including Lantana (already known on-site) which can impede Koala access to forage trees and suppress native tree recruitment. Pest and weed management within Mamelon and the OMAs will be integrated with measures within the Project LUMP; and ▪ Managing pest species as part of an integrated including potential predators (e.g. feral Dogs/Dingos).
Confidence in result (%) (habitat quality)	90	There is an inherent risk in restoring ecological communities as present conditions may differ from historic conditions in which the community developed. As a result it may be difficult to predict with accuracy the direction of restoration development. Nevertheless, with the application of management measures within the OMP including detailed and measureable objectives, and habitat (and species monitoring) monitoring to measure progress, there is a high degree of confidence the future habitat quality score can be realised. This is reflected in a 'confidence' score of 90%.

Attribute	Rating	Discussion
Confidence in result (%) (averted loss)	90	There is reasonable confidence that without protection and improved land management the area will be subject to continued cattle grazing and continue to decline in habitat quality. The management measures to be applied as part of the OMP are standard methods and widely used. Improvement in habitat quality measures is expected to be gradual but almost certain. Mamelon property including the designated offset areas (excluding the mine footprint) will be protected under State legislation (as a voluntary declaration under the VM Act) following agreement with DES and DotEE and will remain in perpetuity including after the cessation of the Project. This protection mechanism will preclude development within the designated OMAs for the current landowners (Fairway Coal) and for any future landowners.
Time over which loss is averted	20	The Mamelon property will be managed for conservation purposes (excluding the mine footprint). The OMAs will be protected under State legislation (as a voluntary declaration under the VM Act) following agreement with DES and DotEE and will remain in perpetuity including after the cessation of the Project. As such the 'time over which loss is averted' is considered as the maximum available time – 20 years.
Time until ecological benefit	15	OMA 1 and OMA 2 comprises 303.03 ha of habitat considered suitable for Koala and the species is likely to occur in the area. Management of the offset will include the removal of cattle, fire and weed and pest management. This will have relatively immediate ecological benefits in the OMAs through the control of introduced predator impacts on the species. Other ecological benefits will take time to provide measurable ecological gains given the dry nature of the habitat in focus. An increase in the habitat quality score within a 15 year period will be achieved through the following: ▪ Reducing degrading processes (particularly soil compaction and canopy tree recruitment) through the removal of cattle; ▪ Managing high intensity bushfires in eucalypt habitat; ▪ Managing problem weed species including Lantana which can suppress canopytree recruitment and impede access to forage trees where present; and ▪ Managing pest species including potential predators (e.g. feral Dogs/Dingos).
Final % of impact offset	109.9	As per EPBC Act Offset Assessment Guide output (refer Appendix A18)

Table 16-155 Summary of offset calculations and habitat values for Ornamental Snake

Attribute	Rating	Discussion
Start habitat quality – OMA 3	3	There are no records of Ornamental Snake from the property. However, the species has been recorded nearby during earlier Project surveys in 2011 / 2012. OMA 3 has been cleared in the past and now comprises non-remnant habitat with patchy Brigalow and Belah regrowth and gilgai formations. The introduced Buffel Grass is prevalent in the ground layer. The offset area is located between Tooloombah Creek and vegetation abutting Deep Creek. Therefore the offset also provides opportunity to increase Brigalow TEC in the landscape and increase landscape connectivity by creating a vegetation connection between the two creek lines. OMA 1 is considered to present ample opportunity to improve the condition of lands suitable for Ornamental Snake due to the presence of primary habitat features for the species presence – cracking clay soils and gilgai formations.
Risk of loss (%) without offset	20	Without the establishment of the proposed OMA there will be continued cattle grazing (through agistment practises as is currently carried out) and associated land degradation, particularly soil compaction and weed invasion. The vegetation in this area is non-remnant and woody vegetation has been actively suppressed in the past to increase productivity and management of cattle. Therefore it is reasonable to assume these management practises would continue into the future, further degrading the habitat present through soil compaction, erosion and degradation of water quality, and weed spread. Based on this it is considered that 20% is a reasonable estimated risk of loss of habitat quality without offsetting and improved land management.
Future habitat quality without offset	3	Continued cattle grazing in OMA 3 could lead to further degradation of suitable habitat for Ornamental Snake including overgrazing and soil compaction. Gilgai habitat is also at risk from the proliferation of existing weed species such as Olive Hymenachne which can choke wetlands adversely impacting habitat for prey species (frogs). Feral species may impact Ornamental Snake through direct predation or through wetland habitat degradation by Pigs. Nevertheless, it is reasonable to assume that current management practises would continue into the future and therefore the current habitat quality of the subject lands will be retained into the future
Risk of loss (%) with offset	0	The Mamelon property will be managed for conservation purposes (excluding the mine footprint). The OMAs will be protected under State legislation (as a voluntary declaration under the VM Act) following agreement with DES and DotEE and will remain in perpetuity including after the cessation of the Project. This protection mechanism will preclude development within the designated OMAs for the current landowners (Fairway Coal) and for any future landowners. With intended land management practises to be carried within the OMAs there will be no loss of habitat quality and it is expected there will be improvement over time.

Attribute	Rating	Discussion
Future habitat quality with offset	5	Habitat quality for Ornamental Snake will be improved by the application of active habitat management across Mamelon property with a specific emphasis on the OMAs. 'Future quality' will be improved and will be represented by an improvement in the habitat quality score as measured by annual habitat monitoring assessments. An OMP will be developed detailing generic management measures to be applied across Mamelon and specific management measures for the OMAs. Management actions will be developed and guided by the approved Commonwealth 'Conservation Advice' for the species. There are no recommended threat abatement plans or recovery plans for the species. Management actions will include (but not be restricted to): ▪ Removal of cattle grazing to eliminate degrading processes such as soil compaction, trampling of habitat features that serve as shelter sites (such as fallen timber), and degradation of water quality in gilgais by mobilising sediments during rainfall events. In the long-term removal of cattle will allow OMA 1 to return to remnant vegetation status; ▪ Increased tree cover by allowing Brigalow to recover across the area will in the long-term shade out weed species and provide additional shelter sites in the form of fallen timber; ▪ Fire management to eliminate the potential for high intensity bushfires which may impact Brigalow recruitment and reduce potential shelter sites (fallen timber); ▪ Managing problem weed species including Olive Hymenachne (already known on-site) which can invade and choke wetlands including gilgai habitat. Pest and weed management within Mamelon and the OMAs will be integrated with measures within the Project LUMP; and ▪ Managing pest species as part of an integrated including potential predators (e.g. feral Cats and Red Fox) and species that degrade wetland (gilgai) habitats such as feral Pigs. Methods may include trapping and baiting.
Confidence in result (%) (future habitat quality)	90	There is an inherent risk in restoring ecological communities as present conditions may differ from historic conditions in which the community developed. As a result it may be difficult to predict with accuracy the direction of restoration development. Nevertheless, with the application of management measures within the OMP including detailed and measureable objectives, and habitat (and species monitoring) monitoring to measure progress, there is a high degree of confidence the future habitat quality score can be realised. This is reflected in a 'confidence' score of 90%.
Confidence in result (%) (averted loss)	90	There is reasonable confidence that without protection and improved land management the area will be subject to continued cattle grazing and continue to decline in habitat quality. The management measures to be applied as part of the OMP are standard methods and widely used. Improvement in habitat quality measures is expected to be gradual but almost certain. Mamelon property including the designated offset areas (excluding the mine footprint) will be protected under State legislation (as a voluntary declaration under the VM Act) following agreement with DES and DotEE and will remain in perpetuity including after the cessation of the Project. This protection mechanism will preclude development within the designated OMAs for the current landowners (Fairway Coal) and for any future landowners.
Time over which loss is averted (years)	20	The Mamelon property will be managed for conservation purposes (excluding the mine footprint). The OMAs will be protected under State legislation (as a voluntary declaration under the VM Act) following agreement with DES and DotEE and will remain in perpetuity including after the cessation of the Project. As such the 'time over which loss is averted' is considered as the maximum available time – 20 years.

Attribute	Rating	Discussion
Time until ecological benefit (years)	10	OMA 3 comprises 128 ha of habitat considered suitable for Ornamental Snake and the species is likely to occur in the area. Management of the offset will include the removal of cattle, and weed and pest management. This will have relatively immediate ecological benefits in the OMA through the reduction of known threatening processes on the species and assisted recruitment of tree cover. An increase in the habitat quality score is likely within a 5 - 10 year period and will be achieved through the following: ▪ Reducing degrading processes (particularly soil compaction and browsing of vegetation) through the removal of cattle; ▪ Increased tree cover by allowing Brigalow to recover across the area; ▪ Managing high intensity bushfires that may eliminate Brigalow regrowth and fallen timber; ▪ Managing problem weed species including Olive Hymenachne which can invade and choke wetlands including gilgai habitat; and ▪ Managing pest species including potential predators (e.g. feral Cats and Red Fox) and species that degrade wetland habitats such as feral Pigs.
Final % of impact offset	464.69	As per EPBC Act Offset Assessment Guide output (refer Appendix A18)

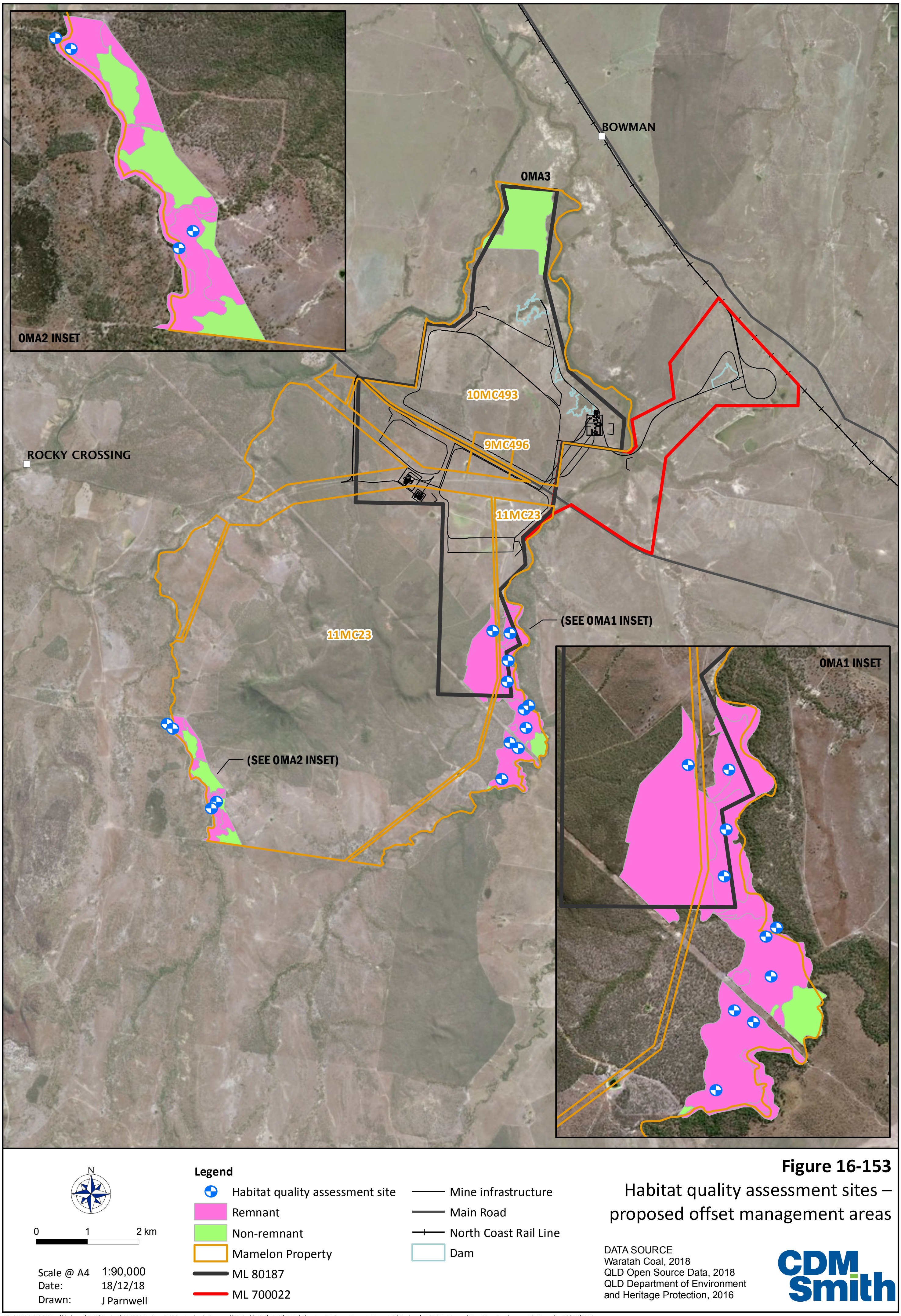

Figure 16-153

Habitat quality assessment sites – proposed offset management areas

DATA SOURCE
Waratah Coal, 2018
QLD Open Source Data, 2018
QLD Department of Environment and Heritage Protection, 2016

CDM Smith

16.19.5.3 Mamelon Property – Habitat Management

Vegetation regeneration and de-stocking of cattle across the property in general, will in the long-term increase vegetation cover and landscape connectivity, and contribute to localised surface water quality improvements in the adjacent creek lines, through a reduction in surface erosion and nutrient entrainment during rainfall events.

Erosion and Sediment Load Reduction

An assessment of the existing sediment loads on Mamelon property has been carried out under differing stocking regimes (refer Section 16.9.3). The results of the assessment show that for the areas assessed within ML 80187 the estimated annual sediment generation potential ranges between 777 to 3,653 t/ha (dependent on cattle stocking regime). Soil loss estimate calculations undertaken for the site (refer Section 5-11 of Chapter 5 – Land) indicate a maximum soil loss of 217 tonnes per hectare per year, assuming no erosion and sediment controls are implemented as part of Project activities. With the removal of cattle from much of the property, this represents a significant reduction in downstream sedimentation compared with the current grazing regime.

This has follow-on impacts by contributing to improving the water quality entering Broad Sound and the Great Barrier Reef World Heritage Area. Thereby providing a positive contribution to the future of the Great Barrier Reef by reducing localised nutrient and sediment run-off in the Great Barrier Reef lagoon, a key action in improving the health and resilience of the reef (CoA 2015).

A key aspect of the destocking approach will be to allow the vegetation communities within the riparian corridors to regenerate without being subjected to ongoing grazing pressures. As vegetation coverage continues to increase within the riparian corridors and across the property more generally combined with the absence of grazing, the potential for sediments to mobilise reduces and will continue to do so.

Non-remnant Vegetation

There are extensive areas of non-remnant lands previously subject to vegetation clearing / management, within and outside the Project ML (1,725 ha and 676 ha respectively). These areas will be managed so as to allow regeneration of the original vegetation communities (including within the non-remnant areas within the OMAs). This will extend the availability of threatened fauna habitat in the area and improve habitat linkages between remnant vegetation patches to the south and north-east of the property.

The northern portion of the Project ML is dominated by cleared habitat or scattered Brigalow regrowth on cracking clay soils. Cleared habitat to the north of Waste Rock Stockpile 2 will be managed within OMA 3 and allowed to regenerate tree cover over 128 ha. There is approximately 50 ha of lands to the east of Open Cut 2 and Waste Rock Stockpile 2 also likely to be suitable for Brigalow regeneration. Weed management, particularly for existing problem species in the area such as Rubber Vine and Lantana, will be a necessary part of managing these areas. Similar smaller patches between Deep Creek and Project infrastructure (such as the cleared habitat around CHPP / MIA 2) will also be allowed to regenerate cover. This will have several positive conservation outcomes in the long-term including:

- Substantial increase in the cover of Brigalow vegetation on the property and in the wider area;
- Increase the width of riparian vegetation along Tooloombah Creek and Deep Creek potentially increasing SEVT cover and preferred Koala habitat trees (Forest Red Gum), and / or providing a vegetated buffer to riparian habitat;

- Substantial increase and improvement of habitat for Ornamental Snake on the property; and
- Improved vegetation connection of Tooloombah Creek to Deep Creek, thereby improving landscape connection to several large habitat patches to the north-east of the property (Figure 16-152).

In the southern portion of the ML regeneration could also be applied to vegetation on and adjacent to sections of Deep Creek (which are relatively thin due to past clearing), and currently cleared habitat to the south of Open Cut 1 and Overburden Stockpile 1a. Allowing these areas to regenerate will increase suitable eucalypt habitat for Koala and Greater Glider.

Within the remainder of the Mamelon property (outside of the Project ML) there are extensive areas of cleared vegetation (1,725 ha as noted above) in the south and south-west. . This includes 51 ha of non-remnant cleared lands within OMA1 and OMA 2 (refer Table 16-153). Allowing these areas to regenerate has the capacity to improve localised conservation outcomes including:

- Restore several kilometres of watercourse vegetation that has been cleared in the catchments of both Tooloombah and Deep Creeks;
- Improve the connectivity of vegetation within the property to the south of Deep Creek and to habitat tracts to the west (refer Figure 16-151);
- Substantially increase available habitat for Koala, Squatter Pigeon and Greater Glider in the wider area; and
- Several small patches of Brigalow TEC can be allowed to increase in size and connect in the south-east corner of the property.

Central Queensland Coal will implement a management and monitoring approach for all vegetation to increase the overall vegetation coverage and connectivity of such communities across the Mamelon property, and improve the health of existing vegetation communities, particularly with regard to problem weed species.

16.19.5.4 Offset Management Areas – Offset Management Plan

A draft OMP has been prepared and details Central Queensland Coal's management methods and monitoring scheduling for the OMAs on the Mamelon property. For the purposes of the SEIS submission, an outline of what the plan will contain is provided below with further detail provided in Appendix A18.

The following sections provide a summary of habitat management measures to be applied onsite.

Vegetation Clearing

Vegetation clearing within the OMAs will be restricted to clearing necessary for the removal of non-native weeds, to establish and maintain fencing around the boundary of the OMA, or establish and maintain firebreaks. Any vegetation clearing will follow best practice management methods, and any applicable legislative requirements. Stockproof fencing will be established to assist in managing grazing around the OMAs, and no other disturbance activities such as forestry, cultivation, ploughing, contour banking, construction of irrigation, earthworks and stockpiling will be allowed.

Any vegetation clearing will be overseen by the Project Environmental Officer in accordance with clearing mitigation measures carried out for the Project. Quarterly inspections will monitor and document clearing that has occurred for an approved purpose. Any unapproved occurrences will be documented and corrective actions developed (such as revegetation).

Weed and Pest Management

Weed and pest control measures have been incorporated into the draft OMP and integrated with similar measures within the Project LUMP to control the introduction and spread of weed species across the Property. The local landscape is already subject to extensive weed infestation. Lantana , Rubber Vine and Olive Hymenachne are known to be present within the OMAs. Pest species including Dingo, Cat, Pig and Chital have all been observed on the property. A feral pest and weed control program will be developed by a Suitably Qualified Person appointed by the Project Environmental Officer.

Weed mapping will be undertaken upon establishment of the OMAs to accurately determine the weed species present and their extent on the sites. Subsequent to this, weed mapping within the OMAs will occur on an annual basis.

Where infestation by a targeted weed species is recorded, the infestation will be subject to species specific control measures. Species specific weed and pest control methods/strategies will be informed by methods outlined in the Department of Agriculture and Fisheries weed and pest animal fact sheets and other relevant government biosecurity management strategies. The results of control measures applied to a weed infestation will be subject to further monitoring to inform future management of the area (where required).

Other general measures to prevent weed invasion/spread associated with Project activities and within the LUMP will also be incorporated into the final OMP such as vehicle washdown procedures. A vehicle washdown facility will be established and maintained at the mine area. All machinery, vehicles and mobile plant equipment entering the OMAs will be washed down in the washdown facility.

Feral fauna species will surveyed within the OMAs using a variety of methods including baited camera traps and recording of scats and tracks as well as direct observations. Incidental observations by Project staff will also be documented with all pest sightings recorded on a register associated with the wider Project.

The presence of feral fauna and weeds within the OMAs will be regularly monitored under the offset monitoring program. This will allow for an adaptive management approach to weed / pest control including regular review and audit of the control strategies in place.

Fire Management

Fire management is an essential component to all coal mining operations and as such, control measures have been incorporated into the draft OMP and integrated with similar measures within the Project LUMP. Uncontrolled high-intensity bushfires have the potential to cause direct mortality of fauna, mature trees, and regrowth/seedlings impacting the conservation and habitat quality improvement aims of the OMAs and the wider property.

Fire management measures appropriate to the region will be developed by a suitably qualified person and will be overseen by the Project Environmental Officer. Fire will, where possible, be excluded from the OMA by maintaining firebreaks (collocating firebreaks with existing tracks and fence lines where possible), and not using fire as a tool for regrowth management. Quarterly inspections will document evidence of wild fire and document if controlled burns have occurred.

Any unapproved occurrences will be documented and corrective actions developed (including repairing firebreaks and reassessing fuel load management practices).

Strategic 'low intensity' burning may be required to minimise fuel loads and form fire breaks across the landscape. The burning regime will seek to maintain ecological diversity through the development of a mosaic presenting a range of patches of varying burning history across the OMAs and wider Property. This will serve to reduce the potential for intense dry-season bushfires by reducing fuel loads. Any 'low intensity' fuel reduction burning will be subject to a risk assessment to assess the potential for impacting habitat quality within the OMAs with a focus on the presence of small vegetation (woody) regrowth and fallen woody debris (where Ornamental Snake is likely to occur).

The following measures will be incorporated within the final OMP to reduce the potential impacts of high-intensity fires within the OMAs:

- Regular inspections within and surrounding the OMAs for fuel hazard assessment;
- Weather conditions and current bushfire risk will be assessed prior to any proposed burning activity;
- Road access across the property and OMAs will be maintained appropriately for fire management access including for any management initiated burns;
- Onsite burning of any material will be managed via a Risk Assessment;
- All fuel-reduction burn carried out will be recorded and integrated with fire management across the property and Project LUMP;
- Access to water supply on the property (dams or creek line waterholes) will be maintained in a trafficable condition at all times;
- Fire-fighting equipment will be regularly maintained and adequate staff training will be implemented. Training and equipment will address fighting wildfires, as well as for fighting fires around facilities;
- Weed management to prevent potential increased fire risk (such as Lantana); and
- Quarterly inspections will document evidence of wild fire and document if controlled burns have occurred. Any unapproved occurrences will be documented and corrective actions developed (including repairing firebreaks and reassessing fuel load management practices; and
- Weed management to prevent habitat degradation and potential increased fire risk.

Vegetation Health and Habitat Monitoring

The draft OMP includes monitoring of vegetation communities within the OMAs for vegetation health and habitat quality. Monitoring methods will follow the methods detailed in DES' 'Habitat quality assessment guide' as used to establish baseline habitat quality measures within the OMAs. Monitoring locations will be those established for the habitat quality baseline survey as depicted in Figure 16-152. The results of the habitat assessment will allow a revised calculation following the EPBC Act Offset Assessment Guide calculator to compare the OMA over the term of the offset and measure any improvement in condition. These are site based, and quantitative, and therefore repeatable over the life of the offset.

The habitat monitoring assessments will:

- Assess how the offset area is progressing against target criteria detailed in the OMP over time;
- Identify and manage potential risks to achieving the OMP objectives; and
- Assist in developing corrective management actions to improve progress towards achieving the OMP objectives.

Photo and visual assessment monitoring points will be established within the OMAs at the habitat monitoring sites and at other sites considered as representative of the vegetation communities present. Central Queensland Coal will engage a suitably qualified person to monitor condition at each site annually, to assess visual changes over time. The visual assessment will record parameters relating to vegetation health such as:

- Foliar discolouration;
- Partial defoliation;
- Evidence of pathogenic attack; and
- Tree death.

As impacts become apparent, mitigation measures will be developed on a case by case basis, and potential for offset requirement determined.

Targeted fauna surveys will be carried out as part of the habitat monitoring. The surveys will target Koala (OMA 1 and OMA 2) and Ornamental Snake (OMA 1).

Surveys for Ornamental Snake will include nocturnal surveys during periods of frog activity (i.e. after rainfall events between October to March) and will be carried out in suitable habitat for the species within OMA 1. Other methods such as funnel trap lines may also be used. Timing will be flexible to coincide with rain events and suitable conditions for the species and will follow Survey Guidelines for Australia's Threatened Reptiles (DSEWPaC 2011b).

Surveys for Koala will be carried out in accordance with direct and indirect methods outlined in EPBC Act referral guidelines for Koala. Surveys will be conducted between August and January when activity is at a peak. Methods will include transects, nocturnal spotlighting and remote sensor activated cameras. Indirect observation methods will include identification of tree scratches and scats, but will take into account factors which affect the detectability and persistence of signs.

OMP Monitoring Activities

An offset monitoring program will be prepared as part of the OMP to guide the management and monitoring of each OMA and ensure offset habitat condition improvements and associated timeframes are achieved. Monitoring activities will include habitat quality assessments, vegetation health and photo monitoring, weed surveys, pest animal surveys, targeted fauna surveys and general inspections of fencing, access tracks and firebreaks. Site and species specific details for monitoring will be defined in the OMP. Indicative activities are summarised as follows:

- Habitat quality assessments will be carried out annually for the first five years of the offset, then every five years until defined completion criteria within the ODP are achieved;
- Vegetation photo monitoring carried out annually and visual health surveys carried out biannually;

- The occurrence and distribution of weed infestations will be mapped and monitored on an annual basis within the offset management areas. Quarterly observations will also be made under General Inspections (see below);
- Biannual surveys of pest animals (e.g. dogs, cats and pigs) will be undertaken;
- Surveys for targeted fauna species within the OMAs will be carried out annually; and
- General site inspections will be carried out on a quarterly basis. This will include inspections of site infrastructure (such as fencing, signage, access tracks and firebreaks), incidence of fire, grazing animal incursion (and evidence of vegetation damage), opportunistic weed surveys, and evidence of erosion events. More frequent inspections may be required in the case of an extreme event (e.g. fire). Observations, subsequent corrective actions and incidences of fire, unauthorised access, fence maintenance, pest animals, pest plants and grazing will be recorded during the inspections.

To summarise the outputs from the offset monitoring activities, CQC will prepare offset area monitoring reports and submit the reports to the administering authority every 5 years for the life of this plan.

16.19.5.5 Securing the Project Offset Management Areas

The proposed OMAs will be secured using a legally binding mechanism as available under State legislation on land title for ensuring the protection of an environmental offset and implementation of measures under the OMP. Available legislative measures include:

- An area declared as 'high conservation value' under Section 19F of the VM Act secured for the purposes of an environmental offset;
- An 'offset protection area' as declared under Section 30 of the *Environmental Offsets Act 2014*;
- An area declared as a 'nature refuge' under Section 46 of the NC Act secured for the purposes of an environmental offset; or
- An area declared as a 'protected area' under Section 29 of the NC Act secured for the purposes of an environmental offset'.

The legislative approach adopted for the Project will be subject to approval following agreement with DES and DotEE.

16.19.5.6 Summary of Mamelon's Value to MNES Fauna and General Landscape Values

With the management of the majority of the Mamelon property for conservation purposes, including those measures detailed in Section 6 for the OMAs, Central Queensland Coal considers the site has the capacity to improve outcomes for the threatened species of concern (Koala and Ornamental Snake) as well general localised conservation outcomes including the following:

- Improvement in the current values of remnant habitat through management of key attributes such as:
  - Vegetation health management
  - Weed and pest management, particularly with regard to problem weed species known to be present such as Lantana and Rubber Vine
  - Bushfire management

- In the long-term increase the extent of suitable habitat (through managed regrowth in cleared areas) on the property for both Koala and Ornamental Snake (and other known threatened species in the area such as Squatter Pigeon and Greater Glider) by > 1,000 ha;
- Restore several kilometres of watercourse vegetation that has been cleared in the catchments of both Tooloombah and Deep Creeks;
- Improve the landscape connectivity of vegetation within the property to the south of Deep Creek and to habitat patches to the south-west and west linking to State-wide ecological corridors to the south and west;
- A large extent of Brigalow vegetation (potential TEC) can be restored to the north of the mine area and several small patches of Brigalow can be allowed to increase in size and connect in the south-east corner of the property; and
- Patches of semi-evergreen vine-thicket TEC along Tooloombah Creek can be allowed to increase in size and connect with adjacent vegetation through assisted regrowth and weed management.

16.19.6 Conclusion and Offsets Delivery Plan

Offsets will be applied to compensate residual environmental impacts from Project activities remaining after all practical and practicable management and mitigation actions have been applied. Unavoidable residual ecological impacts have been quantified for the above-ground construction and operation activities associated with the Project as described above.

Central Queensland Coal seeks to achieve synergistic benefits on CQC lands, thereby providing net environmental benefits close to the area of impacts.

Central Queensland Coal has prepared a draft OMP for State and Commonwealth comment (attached to this SEIS as Appendix A18). The draft OMP provides a detailed account of the proposed offset settlement which has been summarised here in Section 16.17.5 and includes the following:

- Identification of the proposed offset lands including a description of current land use;
- Ecological condition (through the habitat quality assessment process) of potentially impacted areas within the Project area and the proposed offset lands;
- Legislative measure selected to secure the land as an approved offset area; and
- Accompanying management and monitoring measures to ensure the required conservation outcome occurs.

Water Resources Assessment

The size and purpose of the development was identified by the Commonwealth Minister as being a controlled action for the purposes of the water trigger. This section describes the impacts from the mine on water resources, along with any potential impacts from the supply of water for the mining operations. Consideration of the 'Guidelines for Proposals Relating to the Development of Coal Seam Gas and Large Coal Mines where there is a Significant Impact on Water Resources and Significant Impact Guidelines 1.3: Coal seam gas and large coal mining developments—impacts on water' has been considered during the assessment process and is provided in detail in Chapter 9 – Surface Water and Chapter 10 – Groundwater. A checklist allowing reference of the guidelines with information provided in this chapter and Chapter 10 – Groundwater is provided at the end of this section (Table 16-156).

16.20 EPBC Water Trigger

On 22 June 2013, the *Environment Protection and Biodiversity Conservation Amendment Act 2013,* came into effect which amended the EBPC Act to include water resources related to coal seam gas and large coal mining developments as a MNES (the 'water trigger'). Under the EPBC Act, an action which involves a coal seam gas development or large coal mining development requires approval from the Minister if the action has or is likely to have a significant impact on a water resource. A large coal mining development is described under section 528 of the EPBC Act as:

'Any coal mining activity that has, or is likely to have, a significant impact on water resources (including any impacts of associated salt production and / or salinity):

(a) in its own right; or

(b) when considered with other developments, whether past, present or reasonably foreseeable developments.'

The 'Significant impact guidelines 1.3: Coal seam gas and large coal mining developments – impacts on water resources' (the Guideline) explains the relevant assessable impacts are those that relate to impacts on a water resource of activities that form part of the process of extracting coal. Associated infrastructure, that is not part of the extraction process, is not included in the above definition of a 'large coal mining development'.

16.20.1 Coal Extraction Activities

The water trigger is limited to the assessment of impacts from the following activities:

- Water supply for use in the extraction of coal;
- Management of water generated because of extraction of coal;
- Impacts to groundwater from mining activities; and
- Management of waste generated because of extraction of coal.

These activities are considered to form part of the extraction of coal process. Activities independent to the coal extraction process are not required to be considered for the water trigger.

Activities that are preliminary and necessary for the extraction of coal to occur are captured under this definition and hence, are assessed against the EPBC Act, such as:

- Open cut including removal of overburden;
- Process water dam construction;
- Construction of the dewatering dam;
- Construction of the two CHPPs and MIAs; and
- Operational water supply for dust suppression on haul roads, firefighting water and other extraction purposes.

16.20.2 Associated Infrastructure

The Guideline states that development of associated infrastructure that is not part of the extraction process is not included in the definitions of 'coal seam gas development' or 'large coal mining development'.

This may include:

- Transport infrastructure, such as pipelines, road or rail infrastructure;
- Office / housing and amenity construction; and
- Environment protection, monitoring and associated land management activities.

As such the water demand for the construction and the operation of the following components of the Project are not considered to be captured under the water trigger and not included within this assessment:

- Construction of the haul road;
- Construction of the railway loop and TLF;
- Construction of the water supply infrastructure; and
- Construction of onsite access roads and flood protection levees.

16.20.3 Exemptions from the Water Trigger

A review of the available exemptions demonstrated that there were no applicable exemptions to the Project.

16.20.4 Significant Impact Assessment

A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Assessments of significant impact consider the sensitivity, value, and quality of the water resource which is impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. These values, and potential Project impacts and mitigation measures have been identified and discussed in detail in Section 16.10 (Environmental Context – Surface Water) and Section 16.11 (Environmental Context – Groundwater), which should be read in conjunction with this Water Resources Assessment. Additional impacts and mitigations associated with erosion and sediment control are detailed in Section 16.9 (Environmental Context – Land). Project impacts and mitigations relating to surface and groundwater values are also summarised in Sections 16.14 and Section 16.15 respectively.

The key chapters within the SEIS that this section needs to be read in conjunction with are Chapter 5 – Land, Chapter 9 – Surface Water, Chapter 10 – Groundwater, Chapter 12 – Air Quality, Chapter 14 – Terrestrial Ecology and Chapter 15 – Aquatic Ecology. Other information pertainin g to the assessment of MNES can also be found in the remainder of the SEIS chapters and should be reviewed should information be considered lacking from the MNES chapter.

16.20.4.1 Significant Impact Criteria

The general criteria under the Guideline is 'an action is likely to have a significant impact on a water resource if there is a real or not remote chance or possibility that it will directly or indirectly result in a change to the hydrology of a water resource or the water quality of a water resource, that is of sufficient scale or intensity as to reduce the current or future utility of the water resource for third party users, including environmental and other public benefit outcomes, or to create a material risk of such reduction in utility occurring.'

A significant impact criteria assessment considers the precautionary principal, mitigation and management measures and any beneficial impacts from the use of the water.

16.20.4.2 Styx River Catchment

The Styx River catchment is located on the coast in Central Queensland, approximately 180 km south from Mackay and 150 km north of Rockhampton. The catchment is bordered by the Connors Ranges in the northwest, the Broadsound Ranges to the southwest and empties into Broad Sound near Rosewood Island, south of Saint Lawrence. The Styx catchment represents a transitional zone between the slow-flowing streams of the adjacent and much larger Fitzroy Basin and steep, fast-flowing streams located to the north.

The Styx River Catchment covers approximately 302,000 ha, and the main tributaries include: Deep, Granite, Montrose, Stoodleigh, Tooloombah, Waverly and Wellington Creeks. Many of the creeks are poorly documented and observations from Project surveys indicate the waterways in the catchment are intermittent / ephemeral with only brief periods of flow (dependent on localised heavy rainfall).

The main land use is agriculture which occupies 78% of the catchment, and cattle grazing is the predominant form of agriculture carried out in the region (Melzer et al 2008). Many cleared areas are badly eroded from sheet and gully erosion, particularly in the centre of the catchment and this occurs in association with particular soil types (Melzer et al 2008).

The water quality of rivers and streams within the study area is classified as high and the catchment is classified as being only slightly modified from the natural condition. Many of the creeks of the region record high turbidity during periods of high flow due to the erodible and dispersive soils present in the catchment (Melzer et al. 2008).

The mine area and TLF is situated within the lower catchments of Tooloombah Creek and Deep Creek. Both creeks feed directly into the Styx River (2 km north of the Project area) which discharges into the Broad Sound area approximately 33 km northeast of the Project. Deep Creek has a total catchment area of 29,801 ha and Tooloombah Creek has a catchment area of 36,968 ha. The haul road to the TLF crosses Deep Creek and Barrack Creek (which lies within the Deep Creek catchment). Tooloombah Creek and Deep Creek are non-perennial or ephemeral, and largely flow only following heavy rainfall events.

The Project mine area is situated within the Mamelon property and is currently used for cattle grazing. The Mamelon property is owned by the Proponent and is currently being leased for these uses. Supporting this land use is a series of farm dams and surface contour bunds that capture and store rainfall runoff generated by the local contributing catchments. Groundwater bores also lift water to dams and / or storage tanks in the surrounding region for domestic and stock water use.

16.20.4.3 Local Water Resources – Identified Values

Surface Water Values

Existing Waterways and Local Catchments

The primary surface water features near the Project area are Tooloombah Creek which lies adjacent to the northwest boundary of ML80187, and Deep Creek lying adjacent to the eastern boundary and crossed by the haul road (Figure 16-30). Several minor (first or second order) drainage lines located within the Deep Creek catchment also traverse the mine area. The most distinct of which is the 2nd order stream that runs through the Open Cut 1 in a northeast direction, passing under the Bruce Highway and finally discharging to Deep Creek to the north of Project activities (refer also Section 16.10.1.3 for further information). This creekline has been heavily degraded by tree clearing and cattle access.

Deep Creek borders the Project area to the east, outside of the ML, and will be traversed by the proposed haul road that connects the MIA2 with the TLF. The creek runs in a northerly direction, meeting Tooloombah Creek 2 km downstream of the Project area and forming the Styx River thereafter. Most locations inspected during February 2017 were dry with some shallow pools (< 1 m depth) identified at localised depressions. The channel bed comprised of silty sand / gravelly substrate, with the channel generally described as smooth with little vegetation which would provide resistance to flow. Several trees were observed to have fallen across the channel, creating an obstruction to flow and causing visible erosion on the banks. The water was highly turbid, indicative of the presence of fines (clays and silts) that are not readily settled by gravity.

Tooloombah Creek borders the Project area to the west, outside of the ML. Tooloombah Creek was observed in February 2017 with depths of water accumulated within the creek banks greater than 0.5 m. The creek at the highway crossing was identified as having boulders, protruding rock bars and a rocky substrate that was clearly visible under the water. Significant and dense vegetation had established on the banks, creating a stable bank that appeared resistant to scour. Downstream sites featured a more gravelly / cobbled substrate. The rocky substrate produces less silt and therefore lower turbidity than observed in Deep Creek.

Styx River, downstream of the confluence of Deep Creek and Tooloombah Creek, was observed during February 2017 with significant depth of water accumulated within the river banks. The river is tidally influenced, with the water surface level rising significantly on two occasions over the day at Site St2. The tidal influence extends upstream towards the confluence of Deep and Tooloombah Creeks with irregular tidal inundation recorded at Site St2. The Styx River at this point supports well established vegetation on the river banks, making the banks stable and resistant to scour. The water is visibly saline as evidenced by the clearer green tint colour when compared to the turbid brown colour of waters observed in Deep Creek. This is further supported by electrical conductivity values of 13,103 µs/cm observed in the Styx River.

Wetlands

There are two mapped palustrine wetlands (non-riverine with emergent vegetation) located in the west of the Central Queensland Coal mine area. One of these is considered to be of High Ecological Value being listed as a Wetland Protection Area (WPA) under the Queensland 'map of referable wetlands' of the GBR catchment (refer Figure 16-101; and Section 16.10.1.4).

Wetland 1 is roughly circular, encompasses approximately 4 ha and is mapped as a WPA. The wetland is largely surrounded by eucalypt woodland on sandy soils with a small area of woodland on clay spoils adjacent on the eastern edge. The wetland is characterised by a central stand (covering approximately 2 ha) of Broad-leaved Paperbark (with occasional Forest Red Gum also present) surrounded by a vegetated open area with ground cover only. The wetland was inspected during the February 2017 survey and was completely dry at the time. Following heavy rains in May 2017 the wetland had filled up with limited open water around the edge (Plate 16-20). Cattle were present using the wetland area on all occasions the wetland was inspected. Feral Pigs were also observed using the area.

The second mapped wetland encompasses approximately 0.6 ha being 180 m in length and 40 m wide at its widest point. The wetland is surrounded by intact woodland and is likely to be used by cattle. The wetland has been inspected on several occasions with water levels appearing to be relatively constant, thereby indicating the wetland may be permanent.

There are several rural water storage dams on either side of the Bruce Highway alignment. The dams within the mine area are used for stock watering on Mamelon Station. There is a large area of bunded lands located to the south of the highway used to capture rainfall run-off and improve grazing values. The dams / bunded areas have not been defined as wetlands by DES and all are characterised as artificial lacustrine wetlands. Lacustrine wetlands are typically open, water-dominated systems (for example, lakes). This definition also applies to modified systems (for example, dams), which are like lacustrine systems (for example, deep, standing or slow-moving waters).

Plate 16-20 Wetland of high ecological value within ML80187 (May 2017)

Existing Water Users

There are several surface water entitlements in Tooloombah and Deep Creek for irrigation, stock and domestic supply. The entitlements that may be impacted by the Project by being located adjacent to or downstream of operations include the following:

- 119/CP900367 - Irrigation entitlement (extraction from Deep Creek – 20 ha) located on parcel of land adjacent to the northeast boundary of Mamelon property, separated by Deep Creek, and approximately 1 km downstream of the mine water dam release point located offstream of (but draining into) Deep Creek;
- 1/RP616700 - Domestic / stock supply entitlement (extraction from Tooloombah Creek – 18 ML) located on a parcel of land adjacent to the western boundary of Mamelon property, and straddling the Bruce Highway and Tooloombah Creek. The extraction point appears to supply a small off-stream storage on the western overbank of Tooloombah Creek, on the Bar-H property; and
- 45/MPH26062 - Irrigation entitlement (extraction from Tooloombah Creek – 8 ha) on parcel of land directly bordering the Project to the north and extracting from Tooloombah Creek approximately 3 km downstream of an environmental dam release point.

A water demand assessment has been undertaken for the Project (refer Section 16.10.4). This assessment has confirmed that there will be adequate water availability through existing farm dam water supplies until the Raw Water Dam (Dam 1; Figure 16-21) becomes operational. Should make-up water be required during construction, this will be trucked to site. The operational water requirement will be supplied from catchment of on-lease stormwater runoff, mine affected water from pit dewatering activities and water reuse within the CHPP. Consequently, Central Queensland Coal does not anticipate a requirement to obtain water permits to harvest water from Tooloombah Creek.

Existing Surface Water Quality

There are no DNRME stream gauges in the Styx River catchment from which to derive past water quality or flow data. Local climate patterns contributing to surface water and groundwater values are described in Section 16.10.1.1. Surface water field assessments have been conducted at a total of 13 sites across sampling events in 2011 to 2012 (eight sampling events), February 2017 followed by monthly water quality sampling events from May 2017 to October 2018 (17 sampling events). The 2011 / 2012 assessments included eight sites across a wider area including Deep Creek, Tooloombah Creek and the Styx River (including estuarine sites). The 2017 and 2018 surveys were initially restricted to seven sites adjacent to the Project including Deep Creek, Tooloombah Creek and one site in the Styx River downstream of the confluence of Deep and Tooloombah Creek. Subsequent surveys included additional sites on Deep Creek samples, Barrack Creek and the Styx River. Sampling on Barrack Creek was restricted to two events due to lack of flow. Normal conditions in the area over the survey periods was generally 'no flow.' Flowing creeks were recorded in June 2011 and May 2017 and June 2017 (following Cyclone Debbie in April 2017).

The sampling locations within the current and historical sampling scopes are presented in Figure 16-22. The relevant scope of each of the sampling locations is shown in Table 16-34. The baseline results from these sampling events are presented in Appendix A5b – Surface Water and Groundwater Quality Results and are discussed in detail in Section 16.10.2.2 (2011 / 2012 results) and Section 16.10.2.3 (2017 onwards). The historical results for 2011-2012 and recent data for 2017 – 2018 were collated and the mean, median, 20th and 80th percentiles presented in Table 16-36. The samples are compared against the Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values, Water Quality Objectives (2014a), and the Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Results of the recent sampling carried out for the Project are summarised below for the key parameters.

Turbidity shows a seasonal response to rainfall, increasing in the wet season and during residual flows. Water quality within Deep Creek was often elevated above the trigger value of 50 NTU and on occasion in Tooloombah Creek during the 2017 / 2018 wet season (Figure 16-31). Suspended solids exceeded 40 mg/L for twenty-one of the seventy-five water samples. Although turbidity and suspended solids show a seasonal influence it is also likely that natural creek structure and landuse influence levels observed. Exceedances observed in Deep Creek are possibly the result of the finer streambed substrate being mobilised by turbulent streamflows and possibly erosion as well as stock having access to the pools. Turbidity levels in Tooloombah Creek were less than found in Deep Creek pools, likely due to a combination of catchment hydrology (less erosion and slower flows), reduced stock access and increased residence time of pool water enabling sediments to settle.

Testing showed that all surface water samples exceeded the ANZECC guideline value for conductivity. High conductivity values can result from excess sodium, magnesium, calcium, chloride, sulphate and bicarbonate in streams. These salts may originate from irrigation water, soils or fertilisers. High salinity values in streams may also result from rising water tables. Surface water samples along Tooloombah Creek shows that the salinity is generally higher than Deep Creek regardless of flow conditions, ranging from around 170 to 2,700 µS/cm EC. Tooloombah Creek is a rocky creek and markedly different in form from Deep Creek. The conductivity results likely indicate a differing geological background or parent source between the two creeks. Water samples at St1 and St2 in the Styx River show the Styx River is tidally influenced, with electrical conductivity ranging from fresh (125 µS/cm) to brackish (more than 5,000 µS/cm), generally increasing during periods of dry / no flow, and following the first flush of salts experienced at the beginning of the wet season.

Styx River, Deep Creek and Tooloombah Creek show a broad range of pH over time as illustrated in Figure 16-34. The pH typically sits between 7-8 with Tooloombah Creek reporting more alkaline conditions than the other creeks. Figure 16-35 illustrates the seasonal and highly aligned response in pH over time between the creeks and river. Elevated pH levels typically occurred during low flow conditions and likely represent the influence of local geology and groundwater inflows, with water quality in the Styx River also influenced by tidal conditions.

Total nitrogen exceeded the guideline value of 0.5 mg/L at Deep and Tooloombah Creeks and Styx River, with Deep Creek reporting consistently higher levels with an average concentration of ~1.0 mg/L (Figure 16-36). Elevated levels occur during both 2017 and 2018 wet season flows as illustrated in Figure 16-37 although exceedances occur within the dry season potentially associated with stock access (particularly to Deep Creek). The greater responsiveness within Deep Creek to wet season total nitrogen concentrations may also be reflective of the relationship between the size of the sub-catchment inputs and its dominant influence on creek flows and quality.

Between 2017-2018 total phosphorous is reported predominantly within the water quality objective of 0.5 mg/L. Exceedances occur as outliers predominantly in Deep Creek but also in Styx River as shown in Figure 16-38. The time series data plots (Figure 16-39) show that exceedances occur within Deep Creek in February 2017 (De2 and De3), between February and June 2018 (De1-De5) and once in September 2018 (De5). These patterns reinforce the positive relationship with wet season flows with exceedances occurring during the low or no-flow periods likely a response to locally introduced organic matter.

Ammonia-N was typically elevated above the water quality objective of 0.02 mg/L at all locations with the highest concentrations occurring in Styx River and Deep Creek (Figure 16-40). Concentrations are observed to increase during the wet season with sustained flows in 2018 resulting in sustained elevation of ammonia-N concentrations into the months of July and August (see Figure 16-41).

Dissolved aluminium concentrations within Deep and Tooloombah creeks occur predominantly above the water quality guideline value of 0.05 mg/L, with concentrations in Styx River greater than this level occurring only occasionally as illustrated by the log-scale box plots in Figure 16-42. The time series plot (Figure 16-43) that spikes occur at all Deep and Tooloombah creek sites in March 2018 which is likely reflective of groundwater inputs following the large rain event in February.

The majority of results for the creeks and river show dissolved copper concentrations generally exceed the water quality guideline value 0.0014 mg/L (Figure 16-44), with Tooloombah Creek reporting the highest spikes in concentrations. Dissolved copper shows a similar seasonal behaviour to aluminium with some spikes following rainfall events in 2017 and 2018 (log-scale time series Figure 16-45). Deep Creek is an exception which reports a higher average dissolved copper concentration throughout the dry season.

Dissolved zinc was consistently higher in Styx River compared with the creek sites, however similar peaks in concentration are observed in both Deep and Tooloombah creeks (Figure 16-46). The water quality guideline of 0.008 mg/L is exceeded at all three waterways with peaks in dissolved zinc concentration occurring within a month following rain events and may indicate groundwater influence (Figure 16-47).

Levels of dissolved lead above the water quality objective of 0.0034 mg/L were reported for Styx River, Deep Creek and Tooloombah Creek with the greatest levels occurring within Styx River (Figure 16-48). Higher levels of reporting in 2011-2012 of 0.01 mg/L (subsequently increased to 0.001 mg/L in 2017-18) contribute to an overall low percentage of detection however the data suggests that elevated levels are observed during first rains and residual flows. This is not well represented in the 2017-2018 time series chart (Figure 16-49) with spikes in dissolved lead only occurring in Styx River in August and October 2018 and in Deep Creek in October 2018.

Groundwater Values

The Project lies within, and targets the coal reserves of, the Styx geological basin (Styx Basin). The geology of the area as it relates to groundwater values is described in detail in Section 16.11.1.1. Hydrogeology of the area is described in detail in Section 16.11.1.2 and summarised below.

Central Queensland Coal has installed 46 monitoring bores between late 2017 and late 2018 ("Styx Project WMP bores"), and a summary of the installations is provided in Table 16-73. Figure 16-79 and Figure 16-80 present locality plans showing the location of different types of bores and drillholes in the Styx River Basin, including landholder bores, Project groundwater monitoring bores and drillholes, and registered bores.

Groundwater Head and Flow

The general direction of catchment-scale groundwater flow is toward Styx River and the coast. However, groundwater flow patterns vary across the catchment in response to local-scale recharge and discharge mechanisms. Figure 16-81 presents the 2017 / 2018 wet season water table elevation contour plan for the Styx River catchment. The contours have been inferred from data sourced from GWDBQ, Project exploration drillholes and Styx Project WMP bores. The plan shows the water table surface is likely a subdued reflection of topography, and that it generally occurs within 15 m of the ground surface in the less elevated parts of the Basin, and is very shallow in lower areas close to Styx River and Broad Sound (Figure 16-81).

The only timeseries groundwater elevations within the Styx River Basin are from unregistered third party bores identified during the bore census and from some of the Styx Project WMP bores. There are no timeseries groundwater levels from registered bores within the Styx River catchment. The following observations are made from hydrographs showing all available timeseries data:

- Generally little seasonal variation in Basement and Styx Coal Measures groundwater elevations is observed; and
- Some variation in alluvium groundwater elevations is observed with up to 3 m difference in heads between the wet and dry seasons, but a strong seasonal response is not evident across the monitoring network.

Recently constructed nested Styx Project WMP bores (locations shown on Figure 16-79) provide information by which to assess vertical hydraulic gradients in the immediate area of the Project during the wet and dry seasons, depending on time of installation. It is expected a saltwater interface occurs beneath coastal areas of the Styx River Basin, but its exact location is unknown as there are no known measurements of groundwater pressures or salinity profiling near to the coast.

The available data show there is little evidence of a distinct seasonal response to rainfall and stream flow events in any of the stratigraphic units, particularly the Styx Coal Measures and Basement. The groundwater elevation data show the lower reaches of Tooloombah and Deep Creeks, and both Styx River and Broad Sound are zones of nett groundwater discharge. An assessment of the vertical hydraulic gradients typically shows upward gradients and potential for flow. This is observed at Styx River near Broad Sound, and further upstream near to both Deep and Tooloombah Creeks.

Groundwater Yield

The available aquifer testing data and results of analysis show the alluvium is typically more permeable than the underlying coal measures, generally by more than two orders of magnitude. Residual basement may have permeabilities ranging around the maximums observed for the alluvium, but unweathered basement can typically be expected to have permeabilities lower than either of the alluvium or coal measures. Significant heterogeneity exists in the Project area groundwater system.

Hydrostratigraphy

There are four HSUs present in the Project area – Alluvium, Styx Coal Measures, Weathered Basement, Unweathered Basement. Of these HSUs, only the Alluvium presents as what would normally be referred to as an aquifer. The Styx Coal Measures can at best be described as a poor aquifer, whilst the Weathered Basement may form an aquifer in places. Unweathered Basement forms a basal aquitard to regional the groundwater system.

Groundwater Chemistry

Groundwater samples have been collected periodically during 2017 and 2018 from privately owned bores identified in the 2017 census, as well as Project WMP bores. Figure 16-88 presents surface water and groundwater sample locations. The number of baseline sampling events at privately owned bores and Project WMP bores is presented in Table 16-80. Concentrations of chemicals in groundwater are compared against: the Australian and New Zealand Guidelines (ANZECC Guidelines) (ANZECC and ARMCANZ 2000) that are relevant to protection of freshwater aquatic ecosystems and stock drinking water; the Australian Drinking Water Quality Guidelines (ADWG) (NHMRC, NRMMC 2011); and WQOs set for the three Groundwater Chemistry Zones (GCZs) within the area that may be impacted by the Project.

The results of a review of groundwater salinity data recorded in the GWDBQ, privately owned bores and Styx Project WMP bores are summarised in Table 16-81. Figure 16-89 presents the spatial distribution of groundwater salinity for each HSU, based on the data presented in Table 16-81. The data show groundwater salinity (as total dissolved solids; TDS) is variable across the Styx River Basin, ranging from drinking water quality (TDS less than 600 mg/L) to water quality unacceptable for drinking or livestock (TDS greater than 1,200 and 5,000 mg/L, respectively):

- Alluvium aquifer (HSU1) groundwater salinity ranges from 190 to 33,290 mg/L, notably with the higher salinities reported for alluvial groundwaters in the Project area (e.g. WMP02, WMP04, WMP08, WMP09 and WMP26) compared to those closer to Broad Sound and the coast;
- Groundwater sampled from the Styx Coal Measures (HSU2) is generally more saline than groundwater in the other HSUs with salinity ranging from 1,170 to 37,400 mg/L, notably there is no apparent trend in high salinity groundwaters across the Project area and beyond;
- Basement (HSU3/HSU4) groundwater salinity (Back Creek Group or Carmila Beds) ranges from 530 to 8,500 mg/L;
- Of the available data, approximately 60% of samples report TDS concentrations within the acceptable salinity tolerance of most livestock (2,000 to 5,000 mg/L TDS);

- There is no evidence of a seawater – freshwater interface in the deep 'aquifer' units located near Broad Sound (the nested WMP29 wells), with the most saline groundwater sampled from the deeper alluvial sequence (WMP29B; screened between 16 and 20 mbgl – the deepest bore, WMP29E, is screened between 220 and 228.5 mbgl and groundwater sampled from this bore reports a salinity that is 75% of WMP29B groundwater).

Approximately 60% of samples report TDS concentrations within the acceptable salinity tolerance of most livestock (2,000-5,000 mg/L TDS). The majority of groundwater samples collected have salinity that falls into the unacceptable palatability category for drinking water. The dominant ion chemistry associated with the Styx Coal measures tends to be sodium-chloride (Na-Cl) which likely reflects the shallow marine / estuarine depositional environment of the Styx Coal Measures and possibly low recharge rates. Sodium-chloride type is consistent with ocean derived salts mixed with rainfall recharge, or mixing of terrestrial groundwater and marine groundwater in areas of seawater intrusion near the coast. Groundwater that is not Na-Cl type signifies geochemical interactions between groundwater recharge and subsurface minerals. In general the Styx Coal Measures groundwater does not show seasonal variability in chemical composition.

The available major ion data from the sampled Styx Coal Measures groundwater do not show a distinctly seawater signature, but do show evidence of direct recharge from rainfall and / or interaction with surface water. Seasonal variability in water quality is also not evident in these groundwaters. Hydro-chemical signatures for alluvial groundwater also show evidence of direct recharge from rainfall or interaction with surface water, and also interaction with Styx Coal Measures groundwater. Seasonal variability in water quality is evident in these groundwaters.

Testing for concentrations of dissolved metals in groundwater within the area of Styx Basin recorded levels of aluminium, arsenic, cobalt copper, lead, manganese, molybdenum, iron, fluoride, zinc, chromium, barium, nickel, silver, uranium and vanadium occur above the WQOs defined for each of the GCZs within which the Project area. Hydrocarbons are reported in laboratory analyses, particularly for groundwaters sampled from the Styx Coal Measures.

Groundwater – Surface Water Interaction

A conceptual understanding of surface water – groundwater interactions in the Styx River catchment has been developed from the information detailed in Section 16.11.1.2. Analysis of available hydraulic head, topographical and hydrochemical data shows the main sources of water present in Styx River are derived from tidal (estuarine) waters or surface water runoff. Groundwater baseflow to Styx River, whilst likely occurring, is not significant compared to these other sources. Groundwater interaction with Tooloombah Creek is likely more sustained over the dry season than is the case along Deep Creek. Ecological reliance on groundwater (either as baseflow or as a shallow water table) is possible toward the northern extents of the Tooloombah and Deep Creek catchments.

The conceptual processes driving interactions between surface water and groundwater in the Styx River catchment are depicted in Figure 16-98. The following provides a general description:

- General

  The Project area is characterised by local to intermediate groundwater flow systems (i.e. the distance between recharge and discharge zones ranges between less than a few kilometres up to 20 km). Groundwater flow lines presented in Figure 16-81 show groundwater discharges locally to the major tributaries of Styx River (Tooloombah and Deep Creeks), as well as Styx River itself and the Broad Sound estuary. Groundwater discharge is also expected to low lying areas closer to the coast (beyond the confluence of Styx River with the Broad Sound estuary) via evaporation. Significant amounts of groundwater are expected to be lost via evapotranspiration

(ET), either directly from the water table or from plant transpiration, across the broader study area.

- Losing stream conditions

  When stream water levels are above the adjacent water table, a hydraulic gradient is generated away from the watercourse, resulting in stream losses to groundwater (i.e. the stream is losing). As well as recharging the water table aquifer, these stream losses potentially replenish storage in the stream banks (bank storage). In disconnected stream reaches, bank storage will drain away to the water table or back to the stream as flood heights decline.

  All watercourses in the tributary Tooloombah and Deep Creek catchments of Styx River are likely to experience losing conditions during and following high streamflow events. Given there is no streamflow gauging in the Styx River catchment, the frequency and magnitude of flows are not known but it is inferred that losing conditions will sometimes occur during and following high intensity rainfall and runoff events from tributary catchments.

  Downstream of the confluence of Tooloombah and Deep Creeks, Styx River will likely be a losing stream during hide tide periods when the river pool level is higher than the adjacent water table.

- Gaining stream conditions

  Gaining conditions occur in 'connected' stream reaches as the stream water levels recede and the hydraulic gradient reverts back towards the stream, i.e. the water table elevation adjacent to the watercourses is higher than the stream height. Once bank storage is depleted, gaining conditions can be sustained where a local groundwater flow system drives flow to the stream, or where shallow water tables are intersected by the streambed (providing a "window to the water table").

- Tooloombah Creek and the lower portion of Deep Creek (downstream of De4; refer Figure 16-22) are likely to be permanently connected to groundwater and receive inputs from a combination of bank storage return following stream flow events and local groundwater flow systems in drier periods. Watercourse pools that persist for long periods after stream flow events are likely maintained by groundwater discharge.

- Below the confluence of Tooloombah and Deep Creeks, Styx River is, on average, a nett gaining stream, i.e. even though stream losses to groundwater may occur during high tide periods the overall water balance is dominated by groundwater discharge to the river.

All of the information and conceptualisations presented in Section 16.11.1.2 provide the basis for developing a conceptual hydrogeological model for the Project area and more broadly. Figure 16-99 presents a schematic of the conceptual model.

Third Party Groundwater Users

Third party bores have been identified through a search of the GWDBQ as well as a bore census, undertaken by CDM Smith in 2017. Details of third party bores identified are discussed in the following sections. A search of the GWDBQ (February 2018) identified 447 bores within a 50 km radius of the Project, of which, 118 are within the Styx River Basin (Figure 16-104 and Table 16-85). Of the bores located within the portion of Styx River catchment, 94 (80%) are listed as existing and the remaining 24 (20%) are listed as abandoned and destroyed. DNRME is listed as the owner of 24 bores (20%), and the remainder have unspecified ownership but are likely to be privately owned. Table 16-85 presents statistics sourced from the GWDBQ concerning the purpose of these bores.

A census of third party groundwater bores within an approximate 10 km radius of the Project was conducted by CDM Smith in February 2017. The census plan included 27 bores, identified from the GWDBQ or previous studies. Of these locations, 20 could be visited and verified, four could not be accessed and three could not be found (expected to be abandoned/destroyed). An additional six bores were identified during the census, which are expected to be unregistered or location details in the GWDBQ inaccurate. Table 16-86 summarises the census results.

Depth to water level measurements were possible in 17 bores and collection of water samples were possible in eight bores. The following general observations are made:

- Several bores identified from the GWDBQ were either found in different locations or could not be found;
- Bores that were not in use were generally in poor condition;
- Pumping equipment present within some bores prevented access for measurement of water levels and collection of water samples;
- Bores that were operational are used for stock watering, domestic or industrial / farm use; and
- Bores are between 6 and 31 m deep and water levels are inferred to be representative of the water table.

Groundwater Dependent Ecosystems

Riparian and aquatic vegetation, a relatively diverse freshwater fish fauna, and freshwater turtles have been recorded in or along a number of pools along Deep Creek and Tooloombah Creek that are potentially dependent on subsurface expression of groundwater (refer Appendix A9e – Aquatic Ecology Results); therefore, ecological values are identified with shallow groundwater.

Whilst regional groundwater systems provide water sources for pastoral and other anthropogenic uses, groundwater also supports surface (above ground) and subsurface (below ground) ecosystems that are assessed as beneficial users of groundwater. The Australian GDE toolbox (Richardson et al. 2011) provides a framework to assist with the identification of GDEs and the management of their water requirements. The toolbox adopts the approach of Eamus et al. (2006) by classifying GDEs based on the role groundwater plays in maintaining biodiversity and ecological condition. Three types of GDEs are defined:

- Subterranean ecosystems dependent on water held in aquifers (e.g. stygofauna) or inundated caves (Type 1 GDEs). These ecosystems typically include karst aquifer systems, sedimentary aquifers and fractured rock groundwater environments;
- Ecosystems dependent on the surface expression of groundwater (Type 2 GDEs), including wetlands, lakes, seeps, springs, and river baseflow systems. In these cases, surface expression of groundwater exists to provide water that can support aquatic biodiversity through access to habitat (especially when surface run-off is low or non-existent), as well as regulation of water quality and temperature; and
- Ecosystems dependent on subsurface presence of groundwater (Type 3 GDEs), including terrestrial and riparian vegetation that depends on groundwater either seasonally, episodically or permanently to prevent water stress and avoid adverse impacts to their condition. Groundwater that Type 3 GDEs depend on is not visible from the surface. Type 3 GDEs can exist wherever the water table and capillary fringe is within the root zone of the plants, either permanently or episodically. The capillary fringe is the semi-saturated zone of soil above the water table.

There are two sources of information pertaining to the presence of GDEs, the National Atlas of GDEs and the Queensland Wetland GDE Layer. The GDE Atlas presents the current knowledge of ecosystems that may depend on groundwater across Australia. The Queensland Wetland GDE Layer presents the current knowledge of ecosystems reliant on groundwater across Queensland. A desktop analysis and review of the available information was carried out and was supplemented by a targeted on-site GDE assessments in February, July and August 2018. Methods used for the targeted GDE assessments are summarised in Section 16.12.6.1 and detailed in Section 5.2 of Appendix A6. The results are summarised in the following sections. Further detail is provided in Section 16.11.2.1.

GDEs Reliant on the Subterranean Water (Type 1)

A comprehensive seasonal study sampling for the presence of stygofauna has been carried out for the Project in November 2011 and March 2012. Sampling was carried out at seven landholder bores from the surrounding area and 23 Project-related bores, 20 of which were located within the Project boundary. Forty samples were collected over the two surveys (refer Appendix A9f – Stygofauna Results). Most of the Project-related bores are located within the potential area of predicted groundwater drawdown related to the Project. The landholder bores are all located outside of the predicted drawdown area.

Over the two surveys, five sites recorded the presence of subterranean fauna, with four sites recording subsurface species which can be classed as stygofauna. A total of six morpho-species were found within four higher taxa (refer Appendix A9f - Stygofauna Results). All but one location is located well outside of the Project boundary and potential groundwater drawdown area (refer Figure 16-100). Samples from a single Project-associated bore hole, located adjacent to Deep Creek contained five individuals of a single species of *Acari* that may be considered to have a 'stygophile' life habit. Stygophiles are facultative subterranean species, able to complete their whole life cycles both underground and on the surface. The remaining taxa were found in landholder bores located more than 5 km from the predicted area of maximum groundwater drawdown (Figure 16-147) and will not be impacted by Project activities.

The absence of stygofauna from the remaining sampled locations does not indicate stygofauna are not present in the aquifers sampled. However, absence of stygofauna can be attributed to a number of factors, e.g. unsuitable geological conditions (low porosity, low hydraulic conductivity), poor water quality (e.g. high EC or presence of other toxicants) or sampling from a recently drilled bore that has yet to stabilise and attract stygofauna (reduced likelihood of collection).

It is considered unlikely the single morpho-species identified within the drawdown zone is restricted to the predicted zone of impact related to the Project. The Project will not cause the loss of a localised endemic stygofauna community.

GDEs Reliant on the Surface Expression of Groundwater (Type 2)

The GDE Atlas identifies potential GDEs that are reliant on the surface expression of groundwater (Type 2 GDEs) along extensive reaches of water courses both within and marginal to the Project area (i.e., Styx River, Tooloombah Creek and Deep Creek). There are also several small isolated patches away from riparian zones (artificial wetlands or farm dams), including two 'natural' wetlands which are also identified under Queensland vegetation mapping. Most of these potential Type 2 GDEs are classified as having high potential for interaction with groundwater (refer Figure 16-101).

Watercourse Pools

Field investigations have identified the presence of surface pools along the ephemeral watercourses (Tooloombah and Deep Creeks) that have persisted throughout dry periods (refer Table 16-83 and Section 16.12.6 for details). The observations indicate a potential seasonal reliance of surface expression of groundwater, which is supported by available data (e.g. as presented in Section 10.5.6.7) including:

- Groundwater elevation contours and flow lines which show relatively steep horizontal hydraulic gradients and local groundwater flow along the length of Tooloombah Creek, the down-catchment reach of Deep Creek near the confluence with Tooloombah Creek, and along Styx River (Figure 16-81);
- Water table mapping, which shows depth to water table along riparian zones is typically between 10 and 15 mbgl (Figure 16-82; note that the monitoring bores used to develop the water table mapping are typically installed on ground adjacent to steeply incised creeks meaning the water table beneath the creek beds is shallower than these data suggest). The incised streambeds (to depths of up to around 10 m) likely intersect the water table in places and at different times, e.g. in response to water table fluctuations due to recharge (Figure 10-22 to Figure 10-26 in Chapter 10);
- Measured water levels at nested monitoring bores show upward vertical hydraulic gradients (Figure 16-83), which possibly supports groundwater discharge to the surface and prevents drainage of pools;
- Water chemistry data, which shows similarities between surface waters and nearby groundwaters, indicating that watercourse pools are likely to be sourced at least partly by groundwater;
- Analysis of surface water samples for radon isotopes reported concentrations of ^{222}Rn in Tooloombah Creek pools that are indicative of groundwater discharge. However, reported concentrations of ^{222}Rn at Deep Creek pools indicated low connectivity during the time of sampling (July 2018, dry season). Figure 16-102a plots ^{222}Rn against chloride concentrations and Figure 16-102b plots ^{222}Rn against bicarbonate/chloride ratios:
  - Figure 16-102a indicates groundwater contributes only a limited amount of water to Deep Creek (very low chloride and 222Rn) while Tooloombah Creek possibly receives a comparatively higher amount of groundwater inflow (higher amounts of chloride and 222Rn). The lower 222Rn values encountered at Deep Creek suggest that the pools along Deep Creek have a longer residence time relative to Tooloombah Creek
  - Figure 16-102b indicates that groundwater baseflow to some extent contributes to water sampled from pools in both creeks (medium values for the bicarbonate/chloride ratio, see Appendix A6 – Groundwater Technical Report for details) at the time of sampling. The isotope analysis indicates that, overall, both creeks are connected to groundwater to some extent and undergo evaporation.
- Observations of thick stands of potentially groundwater dependent vegetation along riparian zones, as well as algae and aquatic vegetation in areas where pools are permanent, indicating permanence of water that is likely supported by a shallow water table; and
- Observed watercourse pools are broadly consistent with the mapped Type 2 GDEs along riparian zones.

The nature of surface water – groundwater interactions supporting Type 2 (baseflow) GDEs in the area have been classified based on the two typical stream reach types that can be inferred from the available data. These stream reach types are described by the temporal nature of connection and flow dynamics, as outlined in Table 16-84 (see Figure 16-98 for reference). Both stream reach types are interpreted to have a period of losing conditions during high flows but differ according to the degree of sustained connection with groundwater during low / no flow periods.

Offstream wetlands

Wetland 1 and Wetland 2 are formed in shallow depressions of less than around 1 m depth (see Figure 10-50) that become inundated after large rainfall runoff events, as evidenced during two field surveys in early-2017 (see Plate 16-10 and Plate 16-11), which likely serve to maintain the soil water reservoir at these locations.

Based on depth to water table data (see bores WMP25 and WMP27; Figure 16-79 and Figure 16-82), mapped potential Type 2 GDEs located away from riparian zones (i.e. Wetland 1 and Wetland 2) are unlikely to be supported by surface expression of groundwater. Depth to water table at these locations is more than 10 mbgl and observed seasonal variation of the water table is around 3 m (refer Figure 10-22 and Figure 10-23 in Chapter 10). These wetlands are unlikely to interact with groundwater, except as a recharge source for the local aquifer.

Figure 16-103 presents those areas mapped as potential GDEs based on available Project-specific data (i.e. they have been ground-truthed). The presence of Type 2 GDEs is confined to the riparian environments, but not to the identified wetlands (1 and 2; refer Figure 16-101). Type 2 GDEs are likely to have year-round access to groundwater in the lower catchment (i.e. Styx River and lower reach of Deep Creek, near the confluence) and along the mid- to lower-reach of Tooloombah Creek (at least from the confluence up to Bruce Highway). Elsewhere (e.g. middle and upper reaches of Deep Creek), Type 2 GDEs, if present, are likely to only be seasonally connected to groundwater. The dominant source of groundwater supporting Type 2 GDEs in the area is likely to be discharge from the shallow alluvial aquifer, whilst bank storage return after streamflow events will contribute some water back to the watercourses.

GDEs Reliant on the Sub Surface Expression of Groundwater (Type 3)

The GDE Atlas identifies potential GDEs that are reliant on the subsurface expression of groundwater (Type 3 GDEs) along the drainage lines (i.e. riparian zones) associated with Styx River, Deep Creek and Tooloombah Creek. Deep Creek and Tooloombah Creek, and areas of low to moderate potential Type 3 GDEs on the southwestern and southeastern margins of the Project area (Figure 16-101). A number of the vegetation communities mapped in these areas during field surveys (refer Section 16.13.8) have the potential for incorporating some component of groundwater in their water requirements. These include:

- Forest Red Gum woodland fringing drainage lines (RE 11.3.25) – occurs along riparian areas of drainage lines, largely outside of the Project boundary. Vegetation is dominated by Forest Red Gum and Weeping Tea Tree;
- Forest Red Gum woodland on alluvial plains (RE 11.3.4) – occurs in patches across the eastern side of the Project area where it is associated with the alluvial plains adjacent to Deep Creek. Vegetation is dominated by Forest Red Gum, Poplar Gum with Carbeen;
- Broad-leaved Paperbark on alluvial plains (RE 11.3.12) – This is an isolated community occurring on a natural depression on the western side of the Project area (i.e. wetland 2). The wetland is characterised by a centralised patch of Broad-leaved Paperbark with a ground layer

of low sedges and forbs underneath and around the wetland margin. Hydrophytes are present where there is surface water; and

- Areas of SEVT (RE 11.3.11) occurring adjacent to riparian areas of Tooloombah Creek and Deep Creek.

In riparian areas, the depth to water varies from around 10 m along floodplain terraces (Figure 16-82), to being very shallow in areas adjacent to the watercourses themselves. Vegetation communities in areas of shallow water table are likely to use groundwater during dry periods when the soil water reservoir becomes depleted (i.e. seasonally), but groundwater use is expected to be less where the water table is deeper.

A targeted GDE investigation was carried out in September 2018 in the area of Semi-Evergreen Vine Thicket along Tooloombah Creek, and in the areas of Wetland 1 and 2 to better understand plant water use in these ecological community. The following presents a summary of the findings of the investigations, and Appendix A6 - Groundwater Technical Report presents the details:

- Semi-Evergreen Vine Thicket
  - Soil and plant material were sampled and analysed to provide stable isotopes of water data, and at the same time measurements were made of soil water and leaf water potentials;
  - Groundwater was not encountered during sampling as the water table was beyond the limit of sampling (drilling refusal), which was 10 m; and
  - The soil and leaf water potentials together with the isotope measurements, strongly indicate a shallow vadose zone (soil water) source of water for the plants sampled, which is well above the water table.
- Wetland 1 (Plate 16-10 and Plate 16-11)
  - Soil and plant material were sampled and analysed to provide stable isotopes of water data, and at the same time measurements were made of soil water and leaf water potentials;
  - The water table was 10.2 m deep at the time of sampling (bore WMP25);
  - Stable isotopes of water data indicate vegetation is sourcing almost all of its water from the near surface (well above the water table); and
  - Leaf water potentials were equilibrated to a zone of moist soil immediately above the water table (between 8 and 10.2 m deep).
- Wetland 2
  - Soil and plant material were sampled and analysed to provide stable isotopes of water data, and at the same time measurements were made of soil water and leaf water potentials; and
  - The water table was 20.5 m deep at the time of sampling (bore WMP27).
  - Both stable isotopes of water data and the water potential measurements indicate no interaction with groundwater, meaning the vegetation is solely supported by the soil water reservoir.

Figure 16-103 presents those areas mapped as potential GDEs based on available Project-specific data (i.e. they have been ground-truthed). The following presents key outcomes arising from the GDE investigations undertaken.

Summary

There is no indication of groundwater use by the riparian Semi-Evergreen Vine Thicket vegetation (RE 11.13.11), with sampled vegetation accessing the soil water reservoir at depths well above the water table measured in this area.

During dry periods, although the results of the study are inconclusive, there is some potential for groundwater to support the Broad-leaved Paperbark trees on wetland 1 (RE 11.3.12 / UFI 379 7128), Forest Red Gum woodland fringing drainage lines (RE 11.3.25), and Forest Red Gum woodland on alluvial plains (RE 11.3.4), where water tables are less than 10 mbgl.

There is no indication the coastal/sub-coastal floodplain swamp (UFI 379 7178; Wetland 2) and other terrestrial areas are reliant on groundwater, particularly where depths to water table are more than 10 mbgl.

In all instances, the results of the GDE assessment indicates that maintenance of the surface hydrological regime (stream flows and run-off to wetlands) will be critically important for maintenance of environmental water requirements for all identified GDEs.

16.20.4.4 Project Impacts to Hydrological Characteristics

Surface Water

The Project layout is depicted in Figure 16-10. The Project's approach to flooding and stormwater drainage and water resource management is based on detailed modelling presented in Sections 16.10.3 and 16.10.4. The Project's mine drainage network is depicted in Figure 16-21. Water balance modelling based on the network of Project dams indicates the following:

- Water reuse potential is high for the mine due to the predicted groundwater inflow volumes and runoff volumes collected in open pits, relative to mine water demands;
- For MIA 1 and MIA2 Process Dams, the inflows and water transfers were able to meet the CHPP demand;
- For Dam 1, the maximum storage capacities reached 700 ML, and was able to supply the mine demand for the majority of historical climate simulations; and
- The water deficit over the duration of mining operations is predicted to be minimal, with any deficit most likely to occur during peak production years. Figure 16-76 demonstrates the demand over the 18-year mining simulation; no deficits were observed for a reliability of supply greater than 99%. Dam 1 does not dry out and the combined system of water storages are able to provide a reliability of greater than 99% over the life of mine.

The release of mine affected water is proposed as a contingency measure after water reuse within mine operations. Notwithstanding this, it is considered prudent to have a release strategy to minimise the risk of non-compliant discharges through effective balance of the mine water inventory and by discharging better quality water when possible instead of allowing contaminants to concentrate in storages. The project's proposed strategy for mine affected water releases is presented in detail in Section 16.10.5 and includes proposed water release points, water quality monitoring points, installation of streamflow gauging stations and streamflow triggers.

The Project's potential impacts on surface waters described in Section 16.10.6 and are summarised in the following sections.

Increased Sedimentation of Waterways and Sediment Runoff

During construction and operation, sediment can be mobilised and transported by surface water during rainfall events, ultimately discharging into Deep Creek drainage lines. This may result in negative impacts on water quality and aquatic habitats. Due to the ephemeral nature of the drainage features and watercourses, this is unlikely to be an impact in the immediate area but would more likely cause impacts downstream and in the Styx River where more permanent refugial pools exist. Impacts to Tooloombah Creek are unlikely, as most of the Project area drains towards Deep Creek with only 15% draining towards Tooloombah Creek.

Erosion and sedimentation during the operation phases is most likely to occur from stormwater runoff from the coal stockpile, MIA and from ongoing minor earthworks associated with the maintenance of roads and dams. If stormwater runoff is not adequately contained, there is a potential for increased sedimentation and contamination to adversely impact surface water receiving environments, particularly Deep Creek. Baseline water quality monitoring results indicated that existing waterways generally have low to moderate turbidity and suspended sediment loads during and following flow periods. During extended dry periods with no flow (as sampled in February 2017, and November 2017 to April 2018) when the waterways are reduced to isolated pools, high levels of turbidity and suspended sediment loads were recorded predominantly (but not solely) in Deep Creek sites.

Direct Disturbance of Waterways

The Project MIA, open cut pit and stockpiles are unlikely to directly disturb the watercourses. However, the abovementioned Project components and infrastructure will cut-off the two drainage features that traverse the open pit locations. This will result in lower flows in the reaches downstream of the open pits. Most of the waterway disturbance will occur at the haul road crossings of Deep Creek, Barrack Creek and an unnamed tributary of Deep Creek.

At these crossings, impacts may include: riparian vegetation clearing, direct deformation of the bed and banks, and alteration of hydrological flows. Consequential impacts may include: decreased habitat, increased potential for erosion and an increase in runoff velocity due to effective increase in bed slope that can result from the construction of cross-drainage structures.

Accidental Release of Pollutants

During general Project construction activities, the refuelling of vehicles and maintenance of equipment has the potential to release fuels and chemicals into the two watercourses on either side of the Project area. This source of potential contamination is continued during the operations of the mine. Accidental release of pollutants may adversely impact Deep Creek as the majority of the Project footprint majority lies within the Deep Creek catchment. Impact on Tooloombah Creek is less likely as the local Environmental Dams 1a, 2a and 2b are the only infrastructure to potentially discharge into the creek. Several items of infrastructure have the potential to accidentally release contaminants to either Deep Creek or Tooloombah Creek, owing to their proximity including the waste rock stockpiles, MIA / CHPP areas and Dam 1 (refer Figure 16-67).

Without mitigation, potential exists for aqueous waste streams to potentially enter waterways. Potential impacts of accidental pollutant and contaminant releases, if not adequately mitigated, have potential to produce moderate impacts on local and downstream water quality and aquatic ecology, (including downstream impact on the waters of Broad Sound and the Great Barrier Reef World Heritage Area), irrigation, farm supply, stock water.

Hydrology and Water Flows

The major changes in catchment hydrology relates to the addition of drains to divert the catchments upstream of the mine pits. This will result in increased volumes of runoff presenting at the Deep Creek Bridge. All catchments to the west of MIA 1 will be diverted around Waste Rock Stockpile 1b into an environmental dam that reports into Tooloombah Creek under extreme circumstances, where the additional contributing catchment may also result in increased runoff volumes with respect to the current situation.

The addition of hardstand areas such as the MIA, haul roads and access roads will also change hydrologic characteristics, as these surfaces are relatively impervious and transform a higher proportion of rainfall into run-off, increasing peak runoff rates. Waste rock areas; however, are generally comprised of loose spoil and have a high capacity to absorb rainfall. Incident precipitation slowly percolates through the spoil before discharging to the environmental dam. This process has the effect of reducing peak runoff.

Hydraulic modelling indicates that a general reduction in peak flows is likely downstream of the site boundary, because of the reduction in contributing catchment area caused by the construction of the open cut pits.

The overall impact is relatively minor – for example, under the 0.1% AEP design flood event a reduction in peak flood level of approximately 0.02 m is predicted at the Styx River confluence of Deep Creek and Tooloombah Creek. In Deep Creek, a decrease in peak flood levels of about 0.07 m is predicted. Tooloombah Creek flood levels are predicted to decrease by about 0.03 m. As would be expected, peak velocities are predicted to decrease commensurately. Given the very minor predicted change in peak flow characteristics it is considered to have only have a very minor impact (if at all) on aquatic ecology EVs.

Groundwater

Modelling of the potential groundwater drawdown effect of the open cut mine operations has been carried out based on based on detailed modelling presented in detail in Section 16.11.3.4 and Appendix A6 – Groundwater Technical Report.

The magnitude of groundwater drawdown ranges up to 100 mbgl. The greatest extent of dewatering (0.1 m to 100 m) occurs 10 years after the cessation of mine operations and is centred around the immediate open cut pit areas between Tooloombah and Deep Creek. Drawdown of more than 5 mbgl is for the most part restricted to the mine ML. Substantial recovery of the water table is expected approximately 60 years after the end of mining operations. The cone of depression is initially steep, reflecting the change in geology from Quaternary sediments to the outcropping Bowen basin units. The decline in the groundwater levels propagates to the north-west, albeit shallowly, to a distance of 5.6 km from open cut operations Creek. Groundwater levels are not predicted to extend north to the Styx River area (refer Figure 16-106 through Figure 16-115).

The Project's potential impacts on groundwater values are detailed in Section 16.11.3.6 and are summarised in the following sections.

Potential for mobilisation of the seawater – fresh water interface

Groundwater flowlines within the deeper Styx Basin sediments and basement rocks are also expected beneath the shallower groundwater system, with discharge occurring near to the coast or via ET from low lying coastal areas. Vertical hydraulic gradients near to Broad Sound (Figure 16-83) show the deep coal seams and interburden as well as the underburden have a higher head than the shallow Styx River alluvials, indicating the potential for upward leakage and deeper throughflow toward the coast. The head in the deeper units of the Coal Measures HSU would need to decline by around 1.5 m in response to mine dewatering to induce downward seepage of more saline shallower alluvial groundwaters to the Coal Measures.

Predicted contours of water table elevation (Figure 16-106 to Figure 16-109) and drawdown (Figure 16-110 to Figure 16-115) show there will be little, if any, change to average water table elevations along Styx River or below Ogmore, indicating the potential for mobilisation of the seawater-fresh water interface (which has not been observed at confluence of Styx River and Broad Sound estuary) is negligible.

Potential for Acid Sulfate Soil Release

The Styx River catchment, including Tooloombah and Deep Creeks, is classified as largely having low to extremely low probability of ASS generation potential (see Section 10.5.6.5), with only a small pocket of high probability of ASS occurrence around 7 km downstream of the Project, near Broad Sound (Figure 16-20). Predicted contours of water table elevation (Figure 16-106 to Figure 16-109) and drawdown (Figure 16-110 to Figure 16-115) show there will be little, if any, change to average water table elevations below Ogmore and beyond the boundaries of ML 80187, and so there is little to no risk of the Project causing onset of ASS conditions.

Potential for Groundwater Quality Degradation / Salinisation

Mine dewatering will result in altered vertical and lateral hydraulic gradients within and between HSUs, which may have the effect of inducing flow of water of different quality (groundwater and surface water) towards depressurised parts of the groundwater system. Dewatering of the alluvial aquifer (HSU1) and the Coal Measures' (HSU2) overburden and coal seams / interburden is required for mining to proceed. As such, evaporative loss of water from the pits will have limited potential to result in the evaporative concentration of salts in groundwater. Backfilling of the pits as mining progresses will also give rise to limited potential for salinisation of groundwater due to evaporative concentration of salts.

Because baseline groundwater salinity of the Styx Coal Measures in the vicinity of the mine pits is shown to be brackish to saline (e.g. WMP04, Figure 16-89), it is not expected salts remaining in the pit prior to backfilling will cause a significant increase in the salinity of recovering groundwater in the backfill materials. Movement of groundwater toward pits during mining and after closure (until recovery is complete) is unlikely to result in adverse water quality change as salinity and other analyte concentrations for Coal Measures, except alluvium, is consistent although widely varying.

Potential for Acidic Metalliferous Drainage (AMD)

As summarised in Section 16.7.3.6 waste rock characterisation has been undertaken for the Project by RGS Environmental (2012). Waste rock and fine rejects were classified as:

- Acid consuming:
  - Will likely remain pH neutral to alkaline following excavation (composite waste rock and potential coal reject samples are alkaline, with pH ranging from 8.6 to 10)
  - Dissolution of heavy metals in an acidic environment is unlikely
- Having low potential to be potentially acid forming;

- Having moderate saline drainage potential (salinity of the samples ranged from 440 to 660 µS/cm, falling within baseline range; see 'Groundwater Chemistry' in Section 16.11.1.2); and
- Potential to be highly sodic.

Based on works to date, the waste rock and coarse/ fine rejects generated during the extraction and processing of the resource have limited potential to impact upon environmental values. Leach testing demonstrates there is low potential for generation of acid from waste materials (including coal rejects), and that leachate generated from waste materials is expected to be less saline than baseline surface water and groundwater. However, there is the potential for some metals / metalloids (such as As, Mo, Se and V) to be elevated above aquatic ecosystem criteria (e.g. ANZECC 2000) although many metals / metalloids occur naturally above these criteria (refer pp. 16-256, 'Groundwater Chemistry' in Section 16.11.1.2).

Human Use

The potential for irrigation supplies to be impacted by the mine (during and following closure) will be restricted to any alluvial aquifer supplies located within the zone of water table decline. A single registered pair of bores is located within the western boundary of ML. However, these bores are no longer in use and are on the Mamelon property which is owned by Central Queensland Coal. There are no other registered or landholder bores located within the predicted zone of influence (refer Figure 16-147). No significant impacts via disruption of local aquifers are predicted because of the Project.

GDEs

Type 1 GDEs

Groundwater drawdown has potential to impact on the vertical extent of stygofauna habitat. A maximum drawdown of around 13 m is predicted at the location of the bore (STX 093) where stygofauna have been identified (Figure 16-147) between 2036 and 10 years following the end of mining. At this location the alluvial aquifer is estimated to have a saturated thickness of around 15 m, corresponding to an approximate maximum 90% loss of vertical habitat for stygofauna. Impacts are expected to extend to approximately 25 years after the end of mining. The predicted rate of drawdown at this location is around 1.5 m/yr (Figure 16-118). Water is not suddenly removed, possibly allowing stygofauna to move deeper into the alluvium water column.

Stygofauna at this site are therefore likely to undergo a substantial decrease in localised habitat availability and may no longer occur in the area. However, it is considered extremely unlikely that the stygofauna taxon found at the bore (unknown taxa of water mite – Acari) will be restricted to this area or the local catchment. Other locations where stygofauna were detected are located over 5 km north of the nearest modelled groundwater drawdown contour and are not likely to be impacted.

Type 2 GDEs

Groundwater drawdown has potential to impact on baseflow rates (flux) to streams and, consequently, aquatic ecosystem function. Predicted water table contours during mining show groundwater flow is diverted to the mine pit (due to dewatering / depressurisation) impacting the mid-catchment of Tooloombah and Deep Creeks.

A detailed water balance model examining the potential extent of impacts on waterholes in Tooloombah Creek and Deep Creek due to the Project is located in Section 4 of Appendix A6.

Groundwater baseflow reduction will occur along the entire reach of Deep Creek and tributaries with the following predicted effects:

- Less than 10% reduction for the upper reach (i.e. upstream of the confluence of Deep Creek and Barrack Creek; refer Figure 16-147) with a slow return to pre-mining levels within around 75 years after closure;
- Upwards of 40% reduction for the middle reach (i.e. between the confluence of Deep Creek and Barrack Creek and the confluence with the tributary that runs through ML 80187 and is impacted by Dam 1; refer Figure 16-147) with a slow return to pre-mining levels after closure (~25% recovery by around 60 years after closure, and the remaining ~75% occurring within another 20 years or so); and
- Less than 10% reduction for the lower reach (from the confluence with the tributary downstream to the confluence of Deep and Tooloombah Creeks; refer Figure 16-147) with flux slowly returning to background within around 75 years after closure.

A low threat of adverse effects are expected along stream reaches supporting permanent pools within the predicted 0.1 m to 0.5 m drawdown contour, while more than 1 m drawdown is expected to cause a moderate to high threat. Based on this classification, mining effects are expected to pose a low threat of adverse impact to 3.4 km of Tooloombah Creek and 3.3 km of Deep Creek, while a moderate to high threat is expected at 2.4 km of Tooloombah Creek and 3.9 km of Deep Creek (Figure 16-147). This is an overestimate of the extent of potential impact area given permanent pools do not occur along the entire length of creek bed.

Type 3 GDEs

Type 3 GDEs along riparian zones and adjacent alluvial areas of Tooloombah and Deep Creek comprising Forest Red Gum communities (RE 11.3.25 and RE 11.3.4). A decline in groundwater levels may result in a reduction in the volume of water available to Type 3 GDEs for transpiration and consequently, an adverse impact on riparian and terrestrial ecosystem function. Between 0.1m and 5 m drawdown is predicted beneath riparian GDEs (RE 11.3.25) along Tooloombah Creek. Between 0.1 and 10 m drawdown is predicted beneath riparian GDEs (RE 11.3.25) along the majority of Deep Creek. A small section of Deep Creek to the south of the Bruce Highway is predicted to be impacted beyond the 10 m drawdown contour (refer inset Figure 16-147). Between 0.1 m and 5 m drawdown is predicted beneath terrestrial Forest Red Gum woodlands on alluvial plains (RE 11.3.4) associated with Deep Creek (Figure 16-147). No drawdown is predicted along the lower reaches of Tooloombah and Deep Creeks (immediately upstream of their confluence), or the Styx River and Broad Sound estuary and less than 1 m of drawdown is predicted on the western side of Tooloombah Creek and the eastern side of Deep Creek.

Given the limited understanding of the temporal nature of the use of groundwater for Type 3 GDEs relevant to the Project, the impacts have been considered based only on whether or not groundwater is available for use (i.e. the time of exposure to direct effects has not been taken into account). Drawdown of between 0.1 m and 1 m in riparian areas is considered to cause a low threat of adverse impacts to Type 3 GDEs while more than 1 m of drawdown is considered a moderate to high threat. Based on this classification and ground-truthed vegetation mapping, mining effects are predicted to pose a low level threat to an area of 40.3 ha of vegetation communities along Tooloombah Creek and 62.4 Ha along Deep Creek. A moderate to high threat is predicted in vegetation communities encompassing 8.3 ha along Tooloombah Creek and 34.2 ha along Deep Creek.

In terrestrial areas, a low to moderate threat is considered to occur if drawdown is between 0.1 m and 5 m where the water table is less than 10 mbgl where the vegetation community occurs. Mining effects are predicted to cause a low to moderate threat to 14.25 ha of terrestrial Type 3 GDEs based on ground-truthed vegetation mapping. No areas of terrestrial Type 3 GDEs are predicted to be subject to moderate to high impacts from groundwater drawdown.

The rate at which draw down occurs is expected to influence the extent of adverse impacts. It is expected that a slow rate of draw down will result in a lesser impact as it is expected that root systems will, in part and over time, adjust to the lower water table. Conversely, a sharp and severe reduction in groundwater levels would be expected to result in a greater adverse impact.

Summary

The following provides a summary of the key findings of the groundwater impact assessment:

(i) During mining, maximum predicted drawdowns of more than 100 m are restricted to ML 80187, in the immediate vicinity of the mine pits. The predicted 10 m drawdown contour is almost wholly constrained between Tooloombah and Deep Creeks, and within ML 80187. The 1 m drawdown contour intercepts the mid-portion of Tooloombah Creek and Deep Creek and the 0.1 m drawdown contour (assumed to represent the zone of drawdown influence) extends to a maximum of approximately 5.5 km northwest and less than 2 km southeast of the mine at around year 10 after mine closure.

(ii) The predicted zone of mine-related drawdown influence is aligned northwest to southeast, and does not interfere with the tidal reach of Styx River.

(iii) The mine pits will be progressively backfilled as mining advances, which removes the possibility of the pits acting as long-term evaporative sinks for the groundwater systems. As a result the groundwater system is conservatively predicted to fully recover sometime after 50 years (but before 100 years) after closure.

(iv) Drawdown of the water table within the Tooloombah and Deep Creek catchments results in dewatering, to some extent, of the alluvial aquifers that likely support the mid- to lower reaches of the two creeks (baseflow reduction) and associated riparian zones (water table depth).

(v) Model predictions and the results of predictive uncertainty support the hydrogeological conceptualisation that the Tooloombah and Deep Creek catchments, within which the Project is located, are essentially closed groundwater catchments.

(vi) The groundwater model is most sensitive to the K of the Styx Coal Measures coal seams and interburden, underburden, alluvium; and recharge rates. Uncertainty analysis has determined the K of the coal seams and interburden, however, is the most critical in terms of predicting catastrophic failure of the groundwater system in response to mine dewatering. K of the coal seams and interburden is shown to unlikely be greater than 0.01 m/d, which is consistent with aquifer testing results.

(vii) Predicted drawdown associated with mine water affecting activities is very unlikely to extend to areas where there is a potential for exposure of ASS, including along the tidal reach of Styx River. Consequently, any threat to marine and aquatic ecosystems associated with ASS is considered negligible.

(viii) The lack of drawdown predicted for the lower reaches of Tooloombah and Deep Creeks, as well as downstream of the confluence of these creeks along Styx River, and the lack of evidence of a seawater-freshwater interface near the confluence of Styx River with Broad Sound indicates the risk of seawater intrusion in response to mine dewatering is low to negligible.

(ix) Predictive uncertainty analysis indicates the calibrated model, and the predictions presented in this report, are representative and consistent with the conceptual hydrogeological model.

(x) The predicted zone of influence from mine dewatering activities is predicted to not change the nature of groundwater – surface water interactions along Styx River, i.e. the river remains a predominantly groundwater discharge zone during and following mining. North of ML 80187 continued groundwater discharge to Tooloombah and Deep Creeks is also predicted.

16.20.4.5 Cumulative Impacts

The catchment the Project is located within is relatively small. The Tooloombah Creek catchment comprises approximately 36,000 ha and Deep Creek comprises a further 29,000 ha. For the purposes of this cumulative impact assessment on water resources we have chosen to restrict the assessment to the overall Styx River catchment as it is inconceivable the Project will have impacts beyond this area. The ranges to the west and south of the Project catchment areas drain into the Fitzroy Basin which remains separate from the Styx River catchment.

The nature of the Styx River catchment is rural with approximately 78% of lands occupied by agriculture and dominated by cattle grazing. There is no background data available examining water quality emanating from the catchment under current conditions. Water borne pollutant inputs to the GBR lagoon (and hence Broad Sound) from current land uses in the Styx Basin have been modelled as part of reporting for the wider Fitzroy Basin on the reduction of pollutant loads in the GBR catchment through improved land management practices (Dougall et al. 2014). The modelling for the Styx Basin is based on generalised data from across the catchment coupled with land use cover estimates, as there are no stream gauges in the Styx catchment to provide flow or water quality data.

A summary of results pertinent to the Styx Basin compared to the much larger Fitzroy Basin as reported in the 2013 assessment is provided in Table 16-104. It's important to note the modelled area includes minor drainages to the north which do not feed into the Styx River catchment. The modelling indicated the Styx Basin exhibits pollutant loads per basin area slightly above that exhibited by the Fitzroy Basin.

There are three surface water entitlements in Tooloombah and Deep Creek. The existing water entitlements are small with extraction requirements of 18 ML and 8 ha. The combined existing water extraction is unlikely to impact the water flow within Tooloombah Creek as the Project is not planning to extract water from the creeks.

Overland flows are presently directed away from Deep Creek and Tooloombah Creek to several water storages constructed to support the existing grazing activity on Mamelon property. Prior to the commencement of operations, water diversions will be established to divert overland flows back to Deep Creek and Tooloombah Creek prior to entering the mine disturbance area. This water will be in addition to what currently reports to Deep Creek and Tooloombah Creek, and is considered beneficial in terms of providing additional water to support environmental flows and lessen environmental impacts associated with the water abstraction by the existing licence holders.

A review of the latest publicly available information regarding development in the region found no large-scale industrial or mining developments proposed for the catchment other than the Central Queensland Coal Mine Project. The Project resides within the middle region of Styx Basin in which there are numerous proposed mines and developments. Many the exploration permits within the basin are dominated by mineral and coal exploration permits The Styx River is currently undeveloped which effectively minimises surface water cumulative impacts associated with the Project as there are no developments which are likely to increase the impacts.

The nearest mining operation to the Project is the Kunwarara magnesite mine located 60 km to the southeast which is outside the Styx River catchment and is not connected to the local aquifers. The mine began operation in 1991 and is currently owned by Sibelco. Magnesite resides close to the surface layers and is mined using open cut pits generally between 15 m to 18 m deep. There is no information available regarding any of the mine's impacts regarding groundwater or surface water or any current or proposed expansion plans for the Project and the Project is not considered further.

The only major development known from the wider area is the proposed expansion of the Shoalwater Bay Training Area by the Department of Defence. This area lies largely within the adjacent Shoalwater catchment which also drains into Broad Sound to the northeast of the Project area. The original proposal identified a 'likely expansion area' stretching west from the existing training area to the approximate east bank of the Styx River located to the north of the Project. Based on opposition from local communities it has been recently assessed that a reduced expansion area is 'achievable' (DoD 2017). As such, the extent of the proposed expansion and the potential changes to land use are unknown at this stage.

Given there are no other large projects currently known to have identified lands within the Styx River catchment or the Styx groundwater basin, the Project impacts to local water resources will only add to those impacts that are a result of current land use in the catchment. These background land use impacts are already characterised within this section through the identification of local water quality values and description of aquatic EVs such as stygofauna and GDEs. There are no other projects in the catchment or surrounds which the potential Project impacts to water resources subject to this assessment could conceivably add to.

16.20.4.6 Management and Mitigation Measures

The following sections summarise the mitigation measures proposed to be applied to Project activities to manage the potential impacts to surface water values identified in the previous Section (also refer Section 16.9.4, 16.10.7 and 16.15.3).

Surface Water

Land Management

The Project is located on the Mamelon property. Mamelon encompasses a total area of 6,478 ha of which the Project disturbance footprint covers approximately 1,124.8 ha. Central Queensland Coal have proposed destocking the majority of the property and restricting cattle access to already cleared habitat in the south-west and south of the property, outside of the ML. This area encompasses approximately 1,000 ha. The remaining area, including the creek lines which lie adjacent to the mine area, will be managed and allowed to regenerate. In the longer term this measure will contribute to localised water quality improvements, and contribute to improving the water quality entering Broad Sound and the GBRWHA through the following:

- The long-term restoration of this habitat, and in particular allowing vegetation to regrow along the riparian zones along Deep Creek and Tooloombah Creek (which are presently mostly cleared), will capture / entrain sediment and nutrient run-off from the property;
- The restoration of cleared areas will also reduce soil erosion on cleared areas of the property, thereby reducing the entrainment of sediments entering creek lines during bouts of heavy rainfall; and
- The removal of cattle from much of the property will also remove a source of long-term nutrient input into creek lines following rainfall.

The mobilisation of sediments from grazed environments occurs through different mechanisms and at differing scales. Within the Project area the typical mechanisms that exist within the more frequently grazed areas are sheet erosion, gully erosion and stream bank erosion. Hillslope erosion is also a contributing mechanism within the Project area although these areas are not grazed to the same extent as the more productive undulating to gently undulating country.

In the absence of specific data for the Styx catchment, erosion estimations for land under grazing were undertaken using the HowLeaky? model developed for the Eden Bann Weir EIS (refer Section 16.9.3 for more information). The results of the assessment show that for areas of 1% slope under the grazing regimes described at Table 16-17, the estimated annual sediment generation potential ranges between 595 to 2,797 t/ha and 182 to 856 t/ha for ML 80187 and ML 700022 respectively. For areas of 3% slope under grazing regime C as described at Table 16-17, the estimated annual sediment generation is 230 t/ha and 99 t/ha for ML 80187 and ML 700022 respectively.

Central Queensland Coal has committed to the destocking the majority of the Mamelon property to allow for the natural regeneration of vegetation across the property. The small portion of the property that is not proposed to be destocked is on land of >3% slope and was not considered in the assessment at Table 16-18. The destocking of Mamelon will allow for the natural regeneration of land undisturbed by the mine and allow for the continued progressive rehabilitation of land disturbed by the mine. Noting the Project will be implementing a wide range of specifically engineered and designed sediment control measures to prevent sediment from leaving the site, there is expected to be a significant reduction in mobilised sediments compared to that of the current grazing regime.

Erosion and Sediment Control

Section 16.9.4 provides a detailed assessment of the potential for erosion and sediment impacts from the Project and the required control measures / infrastructure under a detailed ESCP. Section 16.10.7.1 outlines the Project approach to erosion and sediment control and is summarised below. Further information and detail on erosion and sediment control measures are provided in Section 16.9.4.4 including 'Minimising erosion on disturbed surfaces' and 'Sediment and drainage controls' (refer pp. 16-95).

An effective ESC strategy considers the interrelated processes of drainage control (minimising water flows through erosion prone areas), erosion control (minimising the detachment of sediment), and sediment control (capturing sediment displaced by up-slope erosion processes). Therefore, the key strategies adopted in the ESCP will involve diversion of water flowing into disturbance areas, minimising erosion within the disturbance areas, and trapping the majority of sediment that is generated before it is mobilised off site.

The following steps will be taken to minimise sedimentation during the active phase of the site:

- The Project has been designed to ensure surface water flows into creeks are maintained as close as possible to natural conditions;
- Diversion drains and banks will be used to redirect any "clean" surface water flows around the main site areas. This minimises the potential for erosion by limiting the amount of water flowing through the disturbance areas and protects infrastructure from flooding during extreme events. Design and sizing of diversion drains, banks and culverts is discussed further in Chapter 9 – Surface Water;
- Exposed soil surfaces will be engineered to minimise erosion potential. This will be achieved through careful material selection, slope grading, and other surface treatments; and
- Any sediment-laden water within the disturbance areas will be captured and treated in a manner which minimises amount of sediment released into the surrounding environment.

The key ESC infrastructure proposed for the site includes:

- Clean water diversions - Diversion drains and bunds are proposed to divert clean water runoff around the mine affected areas, including the open pits and waste areas;
- Dirty water diversions - Dirty water drains collect runoff from waste rock stockpiles and processing facilities within the vicinity of the CHPP, ROM and MIA, and discharge to the CHPP Environmental dams and waste area environmental dams. These dirty water drains will be sized to capture runoff generated from a 24 hour 1 in 10-year ARI event;
- Environmental dams - Environmental dams (sediment basins) around the Project collect catchment runoff and transfer water to the MIA Dams. Each of the CHPP and MIA's, waste areas and TLF have an environmental dam. Environmental Dams are sized to capture the 1 in 10-year ARI 24 hr duration storm event in accordance with The DES Stormwater Guideline (EHP 2014b); and
- Culvert crossings - The proposed haul road connecting the MIA and CHPP 2 with the TLF crosses several drainage gullies, therefore requiring cross-drainage culvert infrastructure. The crossings are conceptualised as box culvert crossings with capacity to pass a minimum 1 in 10-year ARI design discharge. Discharges above the design event will pass over the box culvert as a floodway-type arrangement.

Control of Pollutants and Contaminants

All contaminated water on-site will be collected using site environmental dams, preventing the water from entering local waterways. The Project will include six environmental dams. These dams will collect water from the MIA, CHPP, waste rock storage, coal stockpile and the TLF and store contaminated rainfall runoff across the site. This water will be used to supplement the demands for stockpile dust suppression, washdown and CHPP demand.

In addition to the installation of environmental dams, the following management measures will be implemented to minimise the risk of pollutants and contaminants entering local water ways:

- Appropriate spill control materials including booms and absorbent materials will be onsite at refuelling facilities at all times. These will be used for mitigating and managing events where a substance is spilled into the surrounding waters;
- All refuelling facilities and the storage and handling of oil and chemicals will comply with relevant Australian Standards (management and mitigation measures for wastewater is discussed in Chapter 7 – Waste Management);

- Procedures will be established at the mine for safe and effective fuel, oil and chemical storage and handling. This includes storing these materials within roofed, bunded areas with a storage capacity of 100% of the largest vessel and 10% of the second largest vessel. The bunding will have floors and walls that are lined with an impermeable material to prevent leaching and spills; and
- Wash-down areas for plant and equipment will be clearly marked to prevent contaminated water from leaching into soils or flowing into nearby watercourses.

Monitoring for Seepage

The detailed design of the environmental and water dams on site will consider and make provision for the detection and management of seepage where it may result in safety and / or water quality impacts to the receiving environment. In general, the site water management strategy indicates that mine-impacted water will be of good to moderate quality, having been in contact with coal and / or sediment. The largest amount of seepage is likely to occur within the floor of the environmental and water dams, resulting in in-detectable to minor increases in contribution to shallow aquifer groundwater. The magnitude of seepage through the floor is difficult to measure but can be modelled in the site-wide water balance model. Seepage via the dam wall / embankments is also likely to be filtered and of good to moderate quality. Seepage has been considered in the consequence category of the dams. The site water management plan will address monitoring, including visual inspections for seepage from embankments, along with trigger and action plans based on the volume, rate and quality detected.

Surface Water Quality Management and Monitoring

The Project has five proposed mine affected water release points (see Table 16-63). Water monitoring will be undertaken at the environmental dams, mine-affected water dams, discharge locations and locations both upstream and downstream of the Project area (Figure 16-77). In addition, ongoing monitoring will be undertaken at the sample locations identified in Table 16-64 to assess water quality impacts on waterway flows. This will enable Central Queensland Coal to continually monitor water quality within the waterways (upstream of the Project area at the control sites) and the potentially impacted watercourses (within the Project area and downstream of the Project area at the impact and monitoring sites).

Receiving Environment Monitoring Program

A Project REMP will be developed in accordance with Guidelines, including the technical guideline - Wastewater Release to Queensland Waters (EHP 2016a), and will be periodically updated as required throughout the life of the Project. The REMP will encompass both surface water and groundwater elements.

The REMP will incorporate the following elements pertaining to surface water:

- Development of Final WQOs, with trigger values set at the 20th and 80th percentiles and in accordance with the Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives. Percentiles will be identified through ongoing baseline investigations undertaken prior to construction (responses to trigger values are explained below). Baseline water quality monitoring to determine locally derived WQOs for the Project. If DES deems that insufficient data has been collected prior to construction to determine baseline trigger values, interim WQO trigger values will be applied as per Styx River, Shoalwater Creek and Water Park Creek Basins Environmental Values and Water Quality Objectives;

- An ongoing baseline assessment and interpretation of water quality data, undertaken in accordance with relevant guidelines, including the Monitoring and Sampling Manual 2009 (EHP 2009a), QWQG (EHP 2009), and ANZECC guidelines. The monitoring program will outline, as a minimum:
  - Measures to further derive local WQOs from data collected from reference sites, chosen in accordance with the QWQG (EHP 2009)
  - Frequency and locations for sampling
  - Relevant water quality parameters, including physico-chemical and estimation of local stream flow
  - Water quality sampling methods
- A plan for ongoing ecotoxicological monitoring, including direct toxicity assessment of discharges to surface waters where appropriate;
- The recording of all data used to determine locally-derived WQOs. Data shall be recorded in an electronic format for review by the administering authority if requested;
- Monitoring that includes inspections of construction areas and surrounding waters for visual changes to water quality. Specifically, the programme will include:
  - Event based monitoring throughout the life of the Project, carried out at a minimum of six sampling locations (one location upstream and one location downstream of release points, for each for Deep Creek, Tooloombah Creek and tributary of Deep Creek)
  - Ongoing quarterly monitoring of water quality, to be carried out on the mine affected water dams, when standing water is present
- Physical and chemical water quality monitoring, both up and down stream of work sites, and in all Project affected water dams and defined watercourses within the Project area;
- A plan that includes the actions required if a trigger level is exceeded. Specific actions will include:
  - A comparison of upstream and downstream results to determine if the pollutant source is likely to have come from the Project
  - A review of construction methods to determine ways of improving works to minimise the risk of further contamination
  - The identification of corrective actions to prevent any future exceedances.

The incident reporting processes to DES will be completed as per EA conditions set by the State.

Trigger Action Response Plans

Trigger Action Response Plans (TARPs) will outline actions and responses necessary should monitoring identify exceedances in the Project water quality criteria (trigger levels). In addition, the TARP will outline the criteria, monitoring and reporting measures for environmental incidents, unplanned events or cases of unauthorised discharge. The draft TARPs will be finalised once EA conditions are finalised and form part of the REMP response to the ongoing monitoring program and actions required to address exceedances. The criteria, monitoring and reporting measures for ongoing Project surface water monitoring, reductions in baseflow and for unforeseen events / unplanned discharges are presented at Table 16-69 to Table 16-71.

Water Management Plan

In addition to the REMP, a Water Management Plan (WMP) will be prepared for the Project. Both documents together form the approach to management onsite water usage and storage, and the monitoring of EV in relation to water usage (including groundwater drawdown) and water release. It is assumed that the WMP will be a requirement of the Project's EA.

The WMP be developed to minimise the risk of adverse impacts on surface and groundwater systems. The WMP will describe the mine water balance, key water infrastructure (i.e. water storages, pipe network, drainage system), flood immunity infrastructure and will be split to describe the water management requirements for the construction and operational phases of the Project. In addition, the WMP will also:

- Specify the water source for each water storage;
- Identify the likely water quality of each water storage and the worst possible water quality that could occur under extreme climate conditions;
- Identify the flood and extreme rainfall events that each water storage is designed to contain before an uncontrolled release occurs; and
- Identify design parameters such as the amount of freeboard that will be maintained.

Groundwater

Central Queensland Coal commits to responsible resource recovery, including mitigation of potentially unacceptable mining related impacts on groundwater resources and connected surface systems in order to protect groundwater values and ensure groundwater continues to meet the requirements of identified sensitive groundwater receptors (e.g. GDEs and third party users). To this end, Central Queensland Coal will prepare and implement the following documents:

- A Water Management Plan (WMP) (refer Section 16.11.4.3); and
- A Receiving Environment Monitoring Plan (REMP) (refer Section 16.11.4.5).

The WMP and REMP together form the approach to management of onsite water usage and storage, and monitoring of EVs in relation to water management (including groundwater drawdown) and water release.

Baseline Studies

The current conceptualisation of GDEs associated with the Project has been developed from monitoring data. As such, GDEs are considered supported to some extent by Alluvial or shallow Styx Coal Measures groundwater resources, either within an aquifer (Type 1 GDEs), expressed at the surface (Type 2 GDEs) or available in the sub-surface (Type 3 GDEs).

The existing baseline investigations are presented in Section 16.11.1 and 16.11.2. The following sets out details of further works planned to provide additional understanding of:

- The degree or frequency of reliance by ecosystems on groundwater to meet environmental water requirements;
- The pre-mine condition (i.e. function) of GDEs, and to establish the possible extent to which they may already be impacted by anthropogenic effects such as clearing, grazing, fire, pests and weeds; and

- The level of resilience and resistance GDEs might have groundwater conditions altered from the baseline.

The outcomes of these investigations will assist in the development of the REMP including:

- Setting management objectives;
- Refinement of the monitoring program; and
- Detailed and effective management and mitigation strategies, should they be required.

Ongoing monitoring and assessment will include:

- Extended baseline hydrological and hydrogeological monitoring (e.g. depth to water table, hydraulic gradients, water quality).
- Isotope analysis of surface waters and groundwaters for assessment of interactions supporting in-stream pools (Type 2 GDEs).
- Analysis of soil and plant xylem stable isotopes of water, and leaf and soil water potentials at locations of identified potential groundwater dependent vegetation (Type 3 GDEs), to improve the understanding of plant water use and reliance on soil water and groundwater.

In addition to the above, the following investigations will be undertaken:

- Development of a detailed water and solute balance for in-stream pools (Type 2 GDEs; building on from the work documented in Appendix A6 – Groundwater Technical Report) to determine and quantify water source(s) sustaining all permanent pools identified along Tooloombah and Deep Creeks. The work will rely on the following data
  - outcomes of further 222Rn and major ion sampling;
  - in-stream flow measurements to quantify streamflow rates and stage heights;
  - pool surveys to map the extent and depth of pools and longevity between stream flow events;
  - site specific climate data (rainfall, evaporation); and
  - extended record of near-stream groundwater levels through time.
- Analytic modelling of leaf water potential data to understand the implications of a declining water table for plant water requirements.
- Development of a soil water reservoir balance to assess the quantity of soil water available to meet plant water requirements between wet seasons.
- Pre-mining GDE condition monitoring including vegetation and aquatic surveys discussed further in Section 16.11.4.5.

Water Management Plan

The WMP will describe the mine water balance, key water infrastructure (e.g. water storages, water distribution network, drainage system) and flood protection infrastructure. The WMP will address both the construction and operational phases of the Project. From a groundwater management perspective, the WMP will also:

- Specify the water source for each water storage; and
- Identify the likely water quality for each water storage and possible worst case water quality that could occur under extreme climate conditions.

Mine water inflow monitoring will be carried out under the WMP consisting of daily measurements of rates and/or volumes of all water pumped from the mine pit using a suitable method (note: aquifer testing strongly indicates ex-pit dewatering bores will not provide an effective means of mine water control). Mine produced waters will be subject to quarterly:

- Measurements of field water quality parameters (e.g. TDS, EC, pH).
- Laboratory analyses of major ions, TDS, EC, dissolved metals (including aluminium, arsenic, selenium and vanadium) and hydrocarbons (TPH, TRH and BTEXN) using laboratories that are NATA-registered for the analyses undertaken, using methodologies that are suitable for comparison with the baseline monitoring.

Receiving Environment Management Plan

The REMP will document proposed groundwater monitoring and evaluation commitments, and outline appropriate mitigation measures that can be employed if water management activities are shown to not achieve environmental objectives. The REMP will include:

- Roles and responsibilities.
- Management objectives, with consideration of the Environmental Authority conditions.
- The TARP process, including trigger thresholds and detailed management and mitigation responses.
- Detailed monitoring program including:
  - GDE condition monitoring, including vegetation and aquatic surveys
  - groundwater monitoring, including level gauging, water sampling and laboratory testing program, consistent with baseline monitoring analytes
  - monitoring of mine water dewatering rates/volumes and produced water laboratory testing program
  - a monitoring schedule, detailing the required monitoring locations, monitoring frequency, methods and protocols, and analytes to be sampled
  - data evaluation criteria and requirements
  - requirements for revision of the REMP and
  - reporting requirements

The various components of the REMP are described in detail in Section 16.11.4.5. The following describes the current monitoring approach to groundwater and GDEs associated with the Project.

Groundwater monitoring (water quantity and quality) will occur on the MLs and off-lease during the construction, operational and post-operational phase of the Project to:

1) Determine whether an impact has or will likely be realised, triggering (based on pre-determined trigger thresholds) implementation of appropriate mitigation measures, including initial review and evaluation; and

2) Assess the environmental performance of any adopted management and mitigation measures once implemented, which may require expansion of the monitoring network and analytical program.

The groundwater monitoring program will be designed to monitor the condition of the target 'end point' of the system - in this case, the EVs identified for the Styx River catchment and associated sensitive receptors (Type 1, 2 and 3 GDEs, third party water users).

The location and configuration of monitoring bores is designed to provide sufficient coverage of: identified HSUs and GCZs, as well as sensitive receptors within the Project and surrounding area; to detect and monitor groundwater effects from the Project; and provide a baseline from which management objectives are set, updated or maintained. Groundwater monitoring bore locations are shown in Figure 16-128 and described in Table 16-97. Based on the information collected during the first few years of mining, a need for expansion or rationalisation of the monitoring network may be identified.

The monitoring program will be designed to take into consideration the Environmental Authority conditions, as well as State and National groundwater monitoring guidelines.

The initial monitoring program will include at least:

- Monitoring of groundwater drawdown and depressurisation, which will involve:
  - Gauging of hydraulic head in selected groundwater monitoring bores and landholder bores located within the predicted zone of mine influence (compliance bores, see Table 16-97), as a minimum
  - Automated pressure transducers will be installed at selected monitoring bores to provide daily observations that can be used to distinguish short-term changes, such as seasonal recharge, from potential long-term effects of the Project (dewatering and backfilling)
  - Gauging hydraulic heads at selected locations outside of the predicted area of impact to confirm the extent of impact and to assess baseline conditions away from potential mining effects (reference bores, see Table 16-97)
- Monitoring of groundwater quality, which will involve:
  - Quarterly field measurements of EC and pH of groundwater sampled from compliance monitoring bores located on the mine lease (Table 16-97) and monthly field measurements of the same parameters for water pumped from the mine
  - Quarterly field measurements of EC and pH of groundwater sampled from compliance monitoring bores located off the mine lease (Table 16-97)
  - Six monthly sampling (quarterly or more frequently for the first two years of mining, or if trigger is reached) of groundwater sampled from compliance monitoring bores (Table 16-97) for laboratory analyses of major ions, TDS, EC, dissolved metals (including aluminium, arsenic, selenium and vanadium) and hydrocarbons (TPH, TRH and BTEXN) using laboratories that are NATA-registered for the analyses undertaken, and methodologies that are suitable for comparison with the baseline monitoring
  - Six monthly sampling (quarterly or more frequently if trigger is reached) of groundwater from reference monitoring bores (located outside the predicted zone of Drawdown influence; Table 16-97) for laboratory analyses of major ions, TDS, EC and

dissolved metals using laboratories that are NATA-registered for the analyses undertaken, and methodologies that are suitable for comparison with the baseline monitoring

 - Groundwater chemistry data will be analysed graphically for trends (e.g. using concentration vs. time graphs, Piper plots and Stiff patterns) and any correlation with observed groundwater levels, mine inflow and rainfall
 - Data collected from the recently installed monitoring bores will be assessed and evaluated to allow adjustment of the nominated trigger values for groundwater quality (following 24 months of data collection)
 - If a monitoring trigger is realised, after review and where required the appropriate mitigation measure or offset will be implemented and the monitoring program appropriately adjusted, e.g. if a water quality trigger is realised, sampling frequency for analysis of water quality may be increased from six monthly to quarterly or more frequently, and additional monitoring locations may be incorporated (i.e. between bores where the trigger is reached and the threatened receptor)

- Ongoing GDE condition monitoring, which will involve:
  - Type 1 GDEs

    Sampling event at nominated bores every in accordance with the DES's *Monitoring and Sampling Manual: Environmental Protection (water) Policy 2009* (2018)
  - Type 2 GDEs

    In-stream pool longevity and water sources supporting these water features to identify intra- and inter-annual trends (both natural and potentially Project affected)

    Macroinvertebrate surveys to establish the existing distribution, abundance and richness of macroinvertebrate communities, in association with ongoing water quality monitoring; and

    Macroinvertebrate sampling will be conducted in accordance with standards and protocols detailed in *Monitoring and Sampling Manual: Environmental Protection (water) Policy 2009* (2018)
  - Type 3 GDEs

    Identification of pre-mine condition (as affected by existing anthropological activities, climate variability)

    Establishment of permanent vegetation monitoring transects to measure structural characteristics and baseline condition of GDE habitats subject to impact (also including the consideration of the need for control sites);

    Monitoring transects will provide dedicated sites for structured and repeatable temporal measurements of Foliage Index / Leaf Area Index using canopy photography / hemispherical lenses;

    Temporal measurement of LWP at reference trees when GDE vegetation monitoring sites are established and at subsequent monitoring events, this will provide a direct measure of water stress; and

    capture of high resolution Normalised Differential Vegetation Index (NDVI) imagery over possible impact areas and any control sites, timed to coincide with monitoring events and undertaken biannually for an initial three years to establish a seasonal baseline for ongoing comparison (the data sets provide a measure of all vegetation, rather than selected sites within the transects).

– Comparison of results against observed changes in GDE water budgets to link the cause, if possible, of monitored stress to changes in the water budget attributable to the Project, and other factors such as existing land-use, climate variability, fire, pests and weeds.

Preliminary Management and Mitigation Measures

Mitigation measures will be defined to address any unacceptable impact arising to sensitive receptors from reduced groundwater quantity or diminished groundwater quality, when and where these outcomes arise. The TARPS will form the basis for determining when management and mitigation measures will need to be confirmed and implemented.

It is recognised that GDEs within this landscape will have evolved some resilience, whereby they are able to cope with some degree of change to baseline water regimes (quantity, quality and timing). For example, Type 3 terrestrial GDEs may be able to extend the depth of rooting to access deeper soil water or the capillary fringe, and macro-invertebrates may persist in surface water pools that are reduced in surface area and depth compared to what may have existed pre-mining. Resilience levels need to be further assessed by ongoing monitoring but, for the purpose of identifying suitable mitigation measures, at this stage it is conservatively assumed that sensitive ecosystems have no resilience to changed water regimes (i.e. the temporal nature of environmental water requirements is static / unchanging). So, in the first instance, mitigation measures are defined on this 'static' basis, but once environmental water requirements are better understood an adaptive mitigation plan will be able to be implemented.

The following sets out examples of groundwater management and impact mitigation measures for the Project. These and other mitigation measures will be further detailed in the REMP, building on from the baseline understanding of receptor water requirements with understandings developed from ongoing studies (also refer Section 16.11.4.6).

Physical Disruption to Aquifers

The proposed open cut mining method will physically disrupt and drain the saturated profile below the water table, resulting in groundwater depressurisation of deeper lithologies and decline of the potentiometric surface in the immediate area of the open cut pits during mining – all of which is controlled by HSU hydrogeological properties and final depth of mining. The mine plan has evolved to include the progressive backfilling of mine voids as mining proceeds, which is a primary management and mitigation measure in relation to long-term potential groundwater drawdown.

Placement of waste materials, which is restricted by the area of the ML, has the potential to mechanically load the water table aquifer resulting in reduced porosity and higher pore water pressures in the saturated zone. This effect has the potential to reduce aquifer transmissivity and higher water tables up-hydraulic gradient of the landforms. Backfilling of the mine voids is an important management measure to mitigate this effect, as the remnant waste landforms will be much smaller than would have been otherwise. Apart from these two strategies there are no other effective mitigation measures that can be implemented to manage the effects of aquifer disruption caused by mining.

Water Quantity

An approach that will be considered to manage impacts where Type 2 and Type 3 GDE access to groundwater might be compromised due to drawdown arising from mine dewatering involves supplementing environmental flows to waterways and soil water stores so that baseline flow/water availability regimes can be maintained or supported. Table 16-96 presents summary details, which are expanded upon below.

The practice of supplementing surface water flow to maintain aquatic ecosystems and riparian vegetation health is widely used as a management tool in providing environmental flow requirements to waterways and wetlands across Australia. Examples of where the provision of environmental flows is made directly to pools in response to groundwater dewatering include the Collie Basin in southwest Western Australia (2009), and Fortescue Metals Solomon Iron Ore Project Bore Field (FMG 2016) and Rio Tinto's Hope Downs Iron Ore Project in the Pilbara region of Western Australia (WA EPA 2001).

For Type 2 GDEs, supplementary water can be provided directly to permanent or ephemeral pools in a manner that provides the minimum required volume and frequency to maintain GDE function, the understanding of which will be improved with ongoing monitoring. If surface water is the dominant source of water in at risk pools, the groundwater supplementing pool levels may need to be treated prior to application. However, if groundwater provides a major component of Type 2 GDE water requirements it is probable that water treatment will not be required for this purpose, but this will be further explored as part of REMP development.

Supplementary water can be sourced from excess mine water during the life of mine, but there remains a risk of impact to GDEs after mine closure when mine produced water will not be available. In this circumstance it may be necessary to continue with the mitigation measure at least until sufficient recovery of groundwater heads occurs.

For Type 3 GDEs, supplementary water can be applied to soil water reservoirs (i.e. the root zone) either directly through irrigation or indirectly through leakage from water provided to waterways/wetlands/bunded areas. Contouring of the surface could be considered to encourage ponding of any surface runoff or direct rainfall to encourage additional recharge to the underlying soils. However, the efficacy of this approach also needs to consider impact to creek flow regimes.

The source of supplementary water would ideally be mine produced water, as there would be no associated additional drawdown impacts. Mine water balance modelling, as presented in Section 16.10.4, predicts the mine water supply exceeds the mine water demand for the duration of mining almost all of the time, with a predicted minimum available excess in the order of 40 ML in the worst case dry year, when in-stream pools would be expected to be naturally under stress. This suggests that mine produced water is likely to be a viable source of water to offset any reduction in groundwater baseflow to the dependent pools, with adequate treatment if necessary. However, a supply deficit will exist post-closure when mine produced water is no longer available. Alternatively, sourcing the supplementary flows from a groundwater resource is a strategy that may be considered – whilst the Alluvium aquifer would likely not present as a viable long term option (due to drawdown effects), the Styx Coal Measures, which has similar water quality to the Alluvium (see Section 16.11.1.2) may provide a suitable source.

To provide a preliminary analysis of the amount of water potentially 'consumed' by a pool located near the northwestern boundary of ML 80187 (sample point To2; Figure 16-22) a water balance model has been prepared, the details of which are presented in Appendix A6 – Groundwater Technical Report, Section 4. The water balance model indicates the amount of water required to sustain in-stream pools during the dry season is around 4 mm/d, on average. The numerical groundwater model has been used to assess whether pool-groundwater requirements can be met via abstraction from pumping wells accessing the Styx Coal Measures (discussed in Section 3.6.2.4 in Appendix A6 – Groundwater Technical Report). The modelling has shown the Styx Coal Measures is capable of supplying between 0.55 to 0.7 L/s in the long-term, which could sustain around 13,000 to 17,000 m^2 of pools over a dry season, with little additional effect to the predicted drawdown. Solar energy could be used to power these types of bores after closure.

Water Quality

The proposed groundwater monitoring network (Table 16-97 and Figure 16-128) will provide the capacity to identify where there may be situations that water quality is impacted and requires mitigation. However, the circumstances contributing to water quality decline will need to be investigated to identify (natural variability or activity or facility) and rectify the cause of observed trends prior to identifying an appropriate mitigation strategy.

Any evidence of PAF or AMD impacted seepage waters from waste storages, for example, will be addressed immediately by investigating potential scale of impact, and followed up as required by implementing management / mitigation strategies such as mixing or compartmentalising with materials having neutralising capacity, or backfilling to base of pits.

Adverse groundwater quality impacts arising from uncontrolled discharge of possible contaminants can be mitigated through engineered or non-engineered measures that have the objective of containing, intercepting and/or treating impacted groundwater / pollutant source (e.g. cut-off walls, interception trenches or recovery bores), but mitigation strategies outlined in the REMP would need to be adapted for site specific conditions.

To prevent potential contamination of groundwater from uncontrolled release of contaminants , the REMP will detail onsite water and hazardous materials management protocols. These will include:

personnel training and awareness in regards to the potential for groundwater quality to be impacted and the requirement to report any spills

- Provision of appropriate spill control materials including containment booms and absorbent materials at refuelling facilities to contain spills;
- Personnel training in the use of spill control materials, and appropriate reporting protocols;
- Ensure all refuelling facilities, and the storage and handling of hazardous goods and chemical complies with relevant Australian Standards (management and mitigation measures for wastewater are discussed in Chapter 7 - Waste Management); and
- Establish procedures to ensure safe and effective fuel, oil and chemical storage and handling, including storing materials within roofed and bunded areas to contain spills, and prevent uncontrolled discharge to the environment.

All uncontrolled discharges will be reported to the DES under legislative requirements of the EP Act. Control of surface water discharges and dirty water management systems, including storage of mine dewatering water, are discussed in Section 16.10. Reducing the potential for salinisation of pit waters through evapo-concentration of salts will be mitigated by efficiently removing water from sumps. A summary of available indicative management and mitigation measures that may be employed are summarised in Table 16-97.

Third Party Users

If access to groundwater for third party users is compromised by effects from the Project, the following mitigation measures may be implemented:

- where sufficient available drawdown exists, lowering pumps deeper within the bore column can be undertaken;
- where sufficient unscreened aquifer interval exists, deepening of a bore can be undertaken or a new bore can be established outside of the area of impact;
- provision of surplus water from mine dewatering, if the quality is deemed suitable for the existing use; and
- provision of an alternative water supply of comparable quantity and quality to the meet the existing demand.

Where the Project impacts on third party water use, Central Queensland Coal will liaise with landholders to agree arrangements that will ensure provision of water of adequate yield and quality during and after mining until the aquifers are replenished or access to groundwater for stock water is no longer deemed compromised.

Validation and updating of the conceptualisation and groundwater model

Future improvements to the numerical groundwater flow model will be undertaken as and when new data become available, particularly where there is a divergence of observed groundwater system response from the predicted. New data may require a revision and update of the conceptual (eco-) hydrogeological model prior to updating and recalibrating the numerical model and re-running of predictive scenarios. Where this is deemed necessary, the REMP and WMP may also need to be updated depending on any reconceptualisation and model predictions.

As mining progresses, a need for further model updates will be assessed every two years based on quarterly reviews and evaluation of groundwater monitoring data and findings of impact verification. It is expected the confidence level of model predictions will increase over time as the model is updated to reflect the observed effects on groundwater from the monitoring program.

Where additional management strategies are required in response to environmental performance, the existing numerical model, or new models depending on the type of impact observed (e.g. density coupled models to simulate seawater intrusion, which has been shown to be unlikely), will be used to test the effectiveness of mitigation measures prior to implementation to improve the outcomes of the proposed measures.

Environmental Offsets

A last resort mitigation measure that is available to deal with unacceptable outcomes that cannot be adequately managed involves committing to Project environmental offsets (see Section 16.19).

Central Queensland Coal will commit to an offset for the direct loss of habitat within the mine footprint (e.g. Type 3 GDEs), and will commit to appropriate monitoring and management efforts to monitor for potential indirect loss of habitat outside the mine footprint (i.e. Type 2 and Type 3 GDEs), as appropriate.

16.20.5 Conclusion of Water Resources Assessment

Based on the assessment provided above, the Project is predicted to affect some existing water resources because of the extraction of coal, although the extent of these impacts remains uncertain.

The Project will have a negligible impact on surface water flows in the area. There is potential for impact to local and downstream surface waters through the entrainment of sediments / pollutants during heavy rainfall events. However, with the application of a detailed Project water management system and ESCP these impacts will be mitigated. With the improvement of land management practises on the property surrounding the Project for conservation purposes there is potential to actually improve water quality emanating from the property itself.

Surface water features predicted to be affected include permanent waterholes within the mid-reach of both Tooloombah Creek and Deep Creek because of groundwater drawdown. There may also be some potential for impacts to riparian and alluvial vegetation featuring Forest Reds Gum communities although this remains far from certain.

A single registered pair of bores is located within the western boundary of ML. These bores are no longer in use and are on the Mamelon property which is owned by Central Queensland Coal. There are no other registered or landholder bores located within the predicted zone of influence. No water resources used for human consumption will be affected.

With the ongoing groundwater monitoring and refinement of the groundwater modelling process, and implementation of management measures and appropriate monitoring and development of a supplementary flow program (in the event groundwater drawdown impacts are detected on groundwater dependent ecosystems) to make good any impacts on water resources, the Project is not expected to result in a significant impact on water resources under the EPBC Act.

Table 16-156 IESC Guidelines cross reference checklist

IESC Guidelines	MNES Chapter Section	Chapter 10 – Groundwater	Chapter 9 – Surface Water
Description of the proposed project			
A regional overview of the proposed project area including a description of the geological basin, coal resource, surface water catchments, groundwater systems, water-dependent assets, and current and reasonably foreseeable coal mining, CSG developments and other water-intensive activities, including irrigation, should be provided.	Section 16.9.1 Section 16.10.1 Section 16.11.1 Section 16.20.4.2 Section 16.20.4.3	Section 10.5 Section 10.6	Section 9.4 Section 9.12
The description of the proposed project should clearly describe the proposal's location, purpose, scale, duration, disturbance area, and the means by which it is likely to have a significant impact on water resources and water-dependent assets.	Section 16.4.4 Section 16.7 Section 16.9.4 Section 16.10.6 Section 16.11.3 Section 16.20.5.4	Section 10.7	Section 9.7 Section 9.8 Section 9.10
Description of impacts to water resources and water-dependent assets			
For all relevant water resources and water dependent assets, a description of existing conditions, conceptual and / or numerical modelling of potential impacts and a description of proposed mitigation and management measures are needed.	Section 16.9.4 Section 16.10.2 Section 16.10.3 Section 16.10.7 Section 16.11.1 Section 16.11.3.4 Section 16.11.4 Section 16.20 Appendix A6 – Groundwater Technical Report	Section 10.5 Section 10.6 Section 10.7 Section 10.8	Section 9.4 Section 9.5 Section 9.6 Section 9.7 Section 9.10 Section 9.11
For each potential impact, the impact to the water resource, the resultant impact to any water-dependent assets, and the consequence or significance of the impact should be clearly articulated.	Section 16.10.6 Section 16.11.3 Section 16.20	Section 10.7.4	Section 9.10
2.1 Conceptual modelling			
Conceptual models must be based on the best available science and should consider relevant field data and investigations, expert advice, relevant scientific literature, and other appropriate information sources. Conceptual models should identify the geological formations, water resources, and water-dependent assets likely to be impacted by the proposal. They should be developed at appropriate scales which enable clear description of important impact pathways, how these would be influenced by the proposal, and the expected responses in identified water resources and water-dependent assets.	Section 16.11.1.2 Section 16.11.2.1 Section 16.11.3.4 Section 16.11.3.5 Appendix A6 – Groundwater Technical Report	Section 10.5.6 Section 10.6.1 Section 10.7.4	Not applicable

IESC Guidelines	MNES Chapter Section	Chapter 10 – Groundwater	Chapter 9 – Surface Water
In general terms, a conceptual model can be effectively summarised by pictorial hydrological, hydrogeological and ecological representations of the project site showing the stores, flows and uses of water, including use of water by ecosystems. Reliable conceptual models provide the scientific basis for developing analytical and numerical models and site water and salt balances. Conceptual models are also useful in the problem formulation stage of ecological risk assessment to show stressors, sources and cause-effect pathways.	Section 16.11.1.2 (Figure 16-99) Appendix A6 – Groundwater Technical Report – Section 3.4 and Section 4	Section 10.5.6 Section 10.7	Not applicable
2.2 Analytical and numerical modelling			
Modelling should be undertaken to fulfil a specific purpose such as understanding potential impacts to a particular water resource. This purpose should inform the model design and assumptions which should be clearly described and justified in the project assessment documentation. The model should be constructed in accordance with the conceptual model, and calibrated and verified with appropriate baseline data.	Section 16.10.3 Section 16.10.4 Section 16.11.1.2 Section 16.11.3.4 Section 16.11.3.5 Section 16.20 Appendix A6 – Groundwater Technical Report	Section 10.5.6 Section 10.7.4	Section 9.6 Section 9.7 Section 9.8
Results from modelling should be presented to show a range of possible outcomes based on uncertainty analysis.	Section 16.11.3.5 Appendix A6 – Groundwater Technical Report	Section 10.7.4.7	Not applicable
Impact analysis should be based on modelling results (or other methods, where appropriate) and should clearly articulate the potential impact pathways. Details of the proposed monitoring and management plans should be clearly linked to the impact analysis.	Section 16.10.3 Section 16.10.7 Section 16.11.3.6 Section 16.11.4 Section 16.20.4.4 Section 16.20.4.5 Appendix A6 – Groundwater Technical Report	Section 10.7 Section 10.8	Section 9.10 Section 9.11
2.3 Water and Salt Balances			

IESC Guidelines	MNES Chapter Section	Chapter 10 – Groundwater	Chapter 9 – Surface Water
Site-specific salt and water balances, complemented by an understanding of the inputs, outputs and diversions of water in a region, should be provided for both pre- and post-development scenarios under a range of potential climatic conditions.	16.10.4.1 Appendix A6 - Groundwater Technical Report	Sensitivity analysis undertaken in Groundwater Technical Report explores the effects of higher and lower recharge and potential aquifer salinisation and groundwater and surface water interaction	Section 9.7
3. Data, management and monitoring			
Baseline data provides the foundation for developing environmental objectives and outcomes. Baseline measurements are also required to measure changes to water resources and water-dependent assets because of a development proposal. Baseline data is needed for all water resources, including contextual information such as dates and locations of measurements, sampling protocols, flow conditions and elevations of the reference points from which water levels were measured.	Section 16.10.2 Section 16.11.1.2 Appendix A5 – Surface Water and Groundwater Quality Results Appendix A6 - Groundwater Technical Report	Section 10.5.6.5 Section 10.6.1 Section 10.6.2	Section 9.5.2 Section 9.5.3 Section 9.5.4 Section 9.5.5
Baseline ecological data should be sufficient to identify all surface water dependent and groundwater-dependent assets, and the current condition of and stressors on these assets, to inform ecological risk assessment. Results of habitat, fauna (including stygofauna) and flora surveys should be included.	Section 16.10.1.3 Section 16.10.1.4 Section 16.11.2.1 Chapter 15 – Aquatic Ecology Appendix 9b – Terrestrial Flora Reports Appendix A9e – Aquatic Ecology Results Appendix A9f – Stygofauna Results	Section 10.6.1	Section 9.4.5 Section 9.4.6

IESC Guidelines	MNES Chapter Section	Chapter 10 – Groundwater	Chapter 9 – Surface Water
Adequate ecological and hydrological (for quick response systems) baseline data would generally be for a period of around two years, at a frequency sufficient to capture likely changes in the system. Relevant information generated by a bioregional assessment should be included.	Section 16.10.1 Section 16.10.2 Section 16.11.1 Appendix A5 – Surface Water and Groundwater Quality Results Appendix A6 - Groundwater Technical Report	Section 10.5.6	Section 9.5
Proposed management and mitigation measures should be detailed, and references provided to previous projects, case studies or scientific literature that support the adequacy of the measure in the project context. The monitoring plan should detail how performance of the proposed mitigation measures will be assessed. It should also outline contingency plans if the environmental objectives are not met. If offsets are proposed, the potential management options that were considered and investigated prior to offsetting should be described.	Section 16.9.4 Section 16.10.7 Section 16.11.4 Section 16.15.3 Section 16.5.4 Section 16.20.5.7	Section 10.8 Specific groundwater level and quality trigger levels to be set in the EMP based on further monitoring (refer to Chapter 23 – Draft EA conditions).	Section 9.11
Plans for ongoing monitoring and management are expected where significant impacts to water resources and water-dependent assets are predicted. Plans should focus on a robust monitoring programme to inform the management and mitigation of likely impacts and to reduce the uncertainty of predicted impacts.	Section 16.10.7 Section 16.11.4 Section 16.20.5.7 See also Chapter 23 – Draft Environmental Authority Conditions	Section 10.8.4 Section 10.8.5	Section 9.11.3 Section 9.11.4
The rationale and design for monitoring programmes should be provided, including appropriate quality assurance. These should include the hypotheses to be tested by the monitoring programmes, the temporal and spatial frequency (or resolution) of monitoring, the potential parameters and indicators to be monitored, and the analytical methods to be applied. The monitoring programmes should identify the triggers and thresholds associated with environmental objectives and outcomes and the proposed management measures if those levels are reached or exceeded. Triggers and thresholds should be based on the best available science, including expert opinion. Any departures from published guidelines or standard monitoring methods should be justified based on site-specific data.	Section 16.10.7 Section 16.11.4 Section 16.20.5.7 See also Chapter 23 – Draft Environmental Authority Conditions	Section 10.8.4 Section 10.8.5	Section 9.9 Section 9.11.3 Section 9.11.4

IESC Guidelines	MNES Chapter Section	Chapter 10 – Groundwater	Chapter 9 – Surface Water
Information is needed on findings from monitoring programmes, including raw data, analysis of data, and the performance of mitigation measures against the environmental objectives. The monitoring and management programmes should be robust and provide for an adaptive management approach to predicted impacts to water resources and water dependent assets.	Section 16.10.2 Section 16.10.7.4 Section 16.11.1.2 Section 16.11.2.1 Section 16.11.4 Appendix A5 – Surface Water and Groundwater Quality Results Appendix A6 - Groundwater Technical Report (Section 6 and Section 6) See also Chapter 23 – Draft Environmental Authority Conditions	Section 10.5.6.5 Section 10.6.1 Section 10.8	Section 9.5.5 Section 9.11.4
4. Cumulative Impacts			
The assessment of cumulative impacts needs to consider all relevant past, present and reasonably foreseeable actions, programmes and policies that are likely to impact on water resources.	Section 16.18 Section 16.20.5.6		Section 9.12
The scale of a cumulative impact assessment needs to cover spatial and temporal boundaries large enough to include all potential significant impacts on water resources from the proposed project, when considered with other activities within the region.	Section 16.18 Section 16.20.5.6		Section 9.12
A quantitative assessment of cumulative impacts is preferred. However, a qualitative or semi-quantitative approach may be used if data are lacking. Assessments may also require consideration of interactive or synergistic impacts in addition to a summation of individual proposals or impacts.	Section 16.18 Section 16.20.5.6		Section 9.12
There may be a need to further develop groundwater and surface water models to enable the prediction of cumulative impacts. Local-scale cumulative impact assessments should be undertaken by the proponent. These would ideally be informed by regional assessments such as strategic assessments, Cumulative Management Area models and / or completed Bioregional Assessments.	Section 16.10.7.4 Section 16.11.4 Appendix A6 for groundwater model discussion	Section 10.8 and discussed variously through Chapter 10 – Groundwater Appendix A6 for groundwater model discussion	Section 9.11.4
5. Risk Assessment			

IESC Guidelines	MNES Chapter Section	Chapter 10 – Groundwater	Chapter 9 – Surface Water
Where a proposal referred to the IESC could have a significant impact on water resources and water-dependent assets, the proponent will need to determine the scope of potential impacts and their likelihood and consequence. The risk assessment should address the potential impact of the proposed project as well as the potential cumulative impact of all past, present and reasonably foreseeable actions that are likely to impact on water resources and water-dependent assets. The IESC will also consider whether the proponent has demonstrated that the risk can be either avoided or suitably mitigated and may suggest further actions to mitigate or manage residual risks.	Section 16.10.6 Section 16.10.7 Section 16.11.3 Section 16.11.4 Section 16.14 Section 16.15 Section 16.18 Section 16.20	Section 10.7 Section 10.8 Section 10.9	Section 9.10 Section 9.11 Section 9.12 Section 9.13
Available bioregional assessments will assist in the risk analyses by identifying possible risks and consequences of impacts to water resources and water dependent assets from CSG and large coal mining development proposals within specific bioregions. Where a development proposal occurs within an area subject to a bioregional assessment, the IESC will consider the bioregional assessment in its review of the proponent's risk assessment.	Not applicable to this assessment	Not applicable to this assessment	Not applicable to this assessment

16.21 Conclusion

The Project is located largely within the Marlborough subregion of the Brigalow Belt South bioregion. A small portion in the south of the Central Queensland Coal mine area lies within the adjacent Nebo-Connors Ranges subregion. The region has experienced a long history of human disturbance due to agriculture and mining activities. The Project area is representative of the wider region and landscape with over 79% of the Project area cleared and currently mapped as non-remnant. Remnant vegetation within the Project area is largely confined to the south and west of the mine area and along the adjacent creek lines of Tooloombah Creek and Deep Creek. Within the Central Queensland Coal mine area, the ground layer in cleared habitats was generally observed to be highly disturbed and often dominated by the exotic Buffel Grass, particularly on the dark clay soils north of the Bruce Highway.

The Project lies approximately 8 km from the boundary of the Great Barrier Reef World Heritage Area which occurs along the Styx River estuary. The Styx River empties into Broad Sound which is listed in the Directory of Important Wetlands of Australia. The wetland lies north of the Project and encompasses the Great Barrier Reef waters and comprising the Outstanding Universal Values pertinent to the Project.

The Broad Sound wetland encompasses an area of approximately 2,100 km^2 comprising a complex aggregation of tidal marine and estuarine wetlands. These have been formed in a sheltered embayment and have a very large tidal range of approximately 9 m. The large tidal range has substantial impacts on water quality in the area due to tidal resuspension impacting water clarity, which in turn inhibits the occurrence and diversity of habitat such as seagrasses and coral communities. This in turn appears to limit potential habitat for a number of MNES marine species associated with the Great Barrier Reef.

Broad Sound comprises a number of Outstanding Universal Values (OUVs) associated with the Great Barrier Reef including wetland habitats such as lower intertidal and supratidal mudflats and saltmarsh, and mangroves. Brackish and freshwater swamps and lagoons occur in adjacent upland areas. The wetland is noted as providing significant habitat for waterbirds including substantial aggregations of a range of migratory shorebirds. Surveys at shorebird roost sites in western Broad Sound indicates the area regularly supports nationally important numbers of a range of species such as Eastern Curlew and Great Knot. The nearest roost sites to the Project are Charon Point (32 km north-east of the Project) and Hoogly Point (35 km north).

Small fringing reefs occur on Turtle Island and Charon Point approximately 35 km north-northeast of the Project boundary where the mouth of the Styx River empties into the main body of Broad Sound. A larger reef area occurs on the southwest edge of Long Island (52 km northeast), a continental island to the west of the Torilla Peninsula. Several small reefs also occur in the Clairview area as do the nearest substantial areas of seagrass (approximately 55 km north).

Marine fauna species considered likely to occur in Broad Sound and listed as MNES and contributing to the OUVs of the Great Barrier Reef include Green Turtle and Flatback Turtle (both listed as Vulnerable and Migratory under the EPBC Act), and Australian Snubfin Dolphin, and Australian Hump-back Dolphin (both listed as Migratory under the EPBC Act). In particular, Flatback Turtle is known to have large nesting aggregations on islands in the surrounding area at Wild Duck Island (74 km north north-east of the Project) and Avoid Island (75 km north of the Project). There are few records of these species downstream of the Project. The nearest suitable habitat for these species is considered to be in the lower estuary of Styx River around Rosewood Island due to the wide ranging tides and lack of habitat upstream of this area.

Vegetation within the Project area was composed of 12 different vegetation communities situated on five landforms: alluvial river and creek flats; Cainozoic clay plains; Cainozoic sand plains / remnant surfaces; coarse-grained sedimentary rocks; moderately to strongly deformed and metamorphosed sediments and interbedded volcanics; reflecting the underlying geology and position in the landscape. Field verification within the Project area identified inconsistencies in current vegetation mapping, relating to vegetation composition and polygon size. Remnant vegetation communities listed as the Brigalow TEC and SEVT TEC were observed during field assessments. Brigalow was recorded as a small polygon located in the east of the mine area, with a second larger polygon located in the south of the TLF ML. Several polygons of SEVT associated with riparian vegetation along Tooloombah Creek are located adjacent to the western boundary of the mine ML.

No listed flora species were observed during the field assessments and no species identified as occurring in the wider area during desktop searches was identified as having a high likelihood of occurring within the Project area.

Listed fauna species observed in the Project area include Greater Glider, Koala and Squatter Pigeon (all listed as Vulnerable under the EPBC Act) and several bird species listed as Migratory (EPBC Act). Ornamental Snake (listed as Vulnerable under the EPBC Act) was recorded 3 km west of the Project area in 2011 and 2012.

The Project will require unavoidable significant impacts to ecological matters of Commonwealth significance including habitat that may be considered as 'critical to the survival' of Koala. Significant impacts will be a result of clearing for open cut mining and associated infrastructure and the haul road. The total extent of these impacts to all MNES has been calculated to be 108.22 ha and will be the subject of the Project OMP.

The Project area is dominated by shallow alluvial aquifers. Groundwater modelling indicates there are potential long-term impacts associated with groundwater drawdown on Groundwater Dependent Ecosystems (GDEs). This includes riparian vegetation dominated by emergent Forest Red Gums along the creek lines that provide habitat for Koala. The magnitude of drawdown on these habitats ranges up to approximately 10 mbgl although for the most part are below 5 mbgl. The maximum extent of drawdown is predicted to occur 10 years after the cessation of mining. Impacts to GDEs are predicted to occur in the mid-reach areas of Tooloombah Creek and Deep Creek closest to open cut pit operations.

Based on ground-truthed vegetation mapping, mining effects are predicted to pose a low level threat (< 1 m drawdown) to areas of riparian Forest Red Gum vegetation (RE 11.3.25) along Tooloombah Creek (40.3 ha) and Deep Creek (62.4 ha). A moderate to high threat (> 1 m drawdown) is predicted in vegetation communities encompassing 8.3 ha along Tooloombah Creek and 34.2 ha along Deep Creek. There may also be a low to moderate threat (< 5 m drawdown) on 14.25 ha of a terrestrial Forest Red Gum vegetation community (RE 11.3.4).

The mitigation measures proposed as part of the Project will minimise additional indirect impacts to terrestrial fauna and flora communities within and surrounding the Project area from construction and operational activities, including downstream impacts to the Great Barrier Reef World Heritage Area. These measures include fauna crossing infrastructure to minimise fauna traffic collisions along the haul road, a comprehensive water management system and ESCP, and a detailed REMP to monitor the health of vegetation, aquatic health and fauna communities adjacent to the Project for indirect impacts such as dust, surface water contamination and groundwater drawdown. A detailed targeted study program has been developed and implemented to better understand the local connections between the water table and GDEs. This program will continue and be expanded to provide input into improving actions within the REMP and further mitigations to potential groundwater drawdown impacts. With control measures in place indirect impacts to fauna and flora are not expected to be significant.

The Project is located on the Mamelon property which encompasses a total area of 6,478 ha of which the Project footprint covers approximately 1,124 ha. Central Queensland Coal have proposed destocking the majority of the property and restricting cattle access to already cleared habitat in the south-west and south of the property. The remaining area, including the creek lines which lie adjacent to the mine area, will be managed and allowed to regenerate. Approximately 303 ha of this will be utilised for environmental offsets to offset residual impacts of the Project. This measure will in the long-term increase the area of remnant vegetation on the property and reduce nutrient inputs from cattle dung, reduce soil erosion and mobilisation of sediments during rainfall events. This will provide benefits to adjacent and downstream aquatic values including that of the Great Barrier Reef World Heritage Area. The draft OMP describes the approach taken by Central Queensland Coal to offset significant residual impacts to MNES.

16.22 Commitments

Central Queensland Coal's commitments, in relation to MNES are provided in Table 16-157.

Table 16-157 Commitments – MNES

Commitments
Develop and implement a Land Use Management Plan which will establish a vegetation monitoring program, identify pest and weed management controls, fire management measures and principles for managing fauna.
Develop and implement finalised Significant Species Management Plans for managing those threatened species known or likely to occur on the site.
Fauna infrastructure (barriers and underpasses) to be installed along the haul road where it intersects with a potential fauna corridor (Deep Creek / Barrow Creek area).
A trained ecologist or other qualified environmental specialist to inspect potential roost or den habitat (such as tree hollows and large woody debris) for resident fauna prior to any clearing works.
Construction areas that pose a risk to fauna will be fenced off where practical.
Fauna crossings will be erected to warn drivers of areas throughout the site utilised by fauna populations.
Appropriate speed limits to be in place throughout the site and all contractors to be educated on the risks to local fauna. Speed limits will also minimise the impacts of noise and vibration upon wildlife and reduce the potential for dust accumulation impacts on fauna habitat.
Where clearing hollow-bearing trees is required and arboreal fauna (such as gliders or microbats) are detected, appropriate nest boxes will be installed adjacent to those areas. Nest box use will be regularly monitored to ensure effectiveness of nest box design and placement.
Measures for monitoring and recording wildlife road collision incidents throughout construction and operation to help remediate 'high risk' collision areas and set conditions for attending to injured native wildlife.
Ensure mine vehicles and traffic are strictly controlled and do not operate in areas (such as threatened species habitat) outside the needs of mine operations.
Prepare and implement a Water Management Plan that outlines the monitoring and management measures for surface water and groundwater.
Develop and implement a Receiving Environment Monitoring Program (REMP) in accordance with DES Guidelines and periodically update as required throughout the life of the Project.
Ensure REMP and LUMP include coordinated measures to assess the ecological function and monitor GDEs adjacent to the Project that may be impacted by groundwater drawdown.
Design and implement a Project Erosion and Sediment Control Plan to be certified by a suitably qualified person, prior to construction.
Develop and implement a series of dust mitigation and monitoring measures.
Implement noise management measures to minimise noise disturbance.
Project lighting will be minimised (i.e. low luminance) as far as possible and directed towards work areas and thereby away from fauna habitat.
Develop and submit to DES and DotEE a finalised Offsets Management Plan in accordance with the relevant State and Commonwealth policies, prior to construction.

16.23 ToR Cross-reference Table

Table 16-158 ToR cross-reference

Terms of Reference	Section of the EIS
Background and description of the action	
The MNES section must include background to the action and describe in detail all components of the action for example (but not limited to), the construction, operation and (if relevant) decommissioning components of the action.	Sections 16.4 and 16.7
This must include the precise location of all works to be undertaken (including associated offsite works and infrastructure), structures to be built or elements of the action that may have impacts on MNES.	Sections 16.4.5 and 16.14
The description of the action must also include details on how the works are to be undertaken (including stages of development and their timing) and design parameters for those aspects of the structures or elements of the action that may have relevant impacts.	Section 16.7
The MNES section must include how the action relates to any other actions (of which the proponent should be reasonably aware that have been, or are being, taken or that have been approved in the region affected by the action. A map showing relevant regional projects must be provided.	Section 16.10.8 and 16.18
The MNES section must provide details on the current status of the action as well as any feasible alternatives to the action to the extent reasonably practicable, including: • If relevant, the alternative of taking no action	Section 16.5.1
• a comparative description of the impacts of each alternative on the MNES protected by controlling provisions of Part 3 of the EPBC Act for the action, and	Section 16.5.1
• sufficient detail to make clear why any alternative is preferred to another.	Section 16.5
Short, medium and long-term advantages and disadvantages of the options should also be discussed.	Section 16.4.1, 16.4.2, 16.4.3 and 16.5
Should the proponent wish to conduct development and associated offsets in stages, the EIS must include a description of stages, using maps where appropriate, and discuss any risks and or benefits of staging the action.	Section 16.7
Description of the environment including MNES	
The MNES section must provide a description of the environment of the proposal site and the surrounding areas that may be affected by the action. It is recommended that this include the following information: • A description of the location, extent and heritage values of the Great Barrier Reef World Heritage Area and National Heritage Place and the environment of the Great Barrier Reef Marine Park that may be impacted by the action.	Sections 16.13.1 and 16.13.2, 16.13.5 and 16.13.6
• A description of the surface and groundwater resources which may be impacted by the action, and Listed threatened and ecological communities, and migratory species (including suitable habitat) that are likely to be present in the vicinity of the site, including details of the scope, timing (survey season/s) and methodology for studies or surveys used to provide information on the listed species/community/habitat at the site (and in areas that may be impacted by the project).	Sections 16.10, 16.11 and 16.13
• Include details of: ○ how best practice survey guidelines are applied, and ○ how the surveys are consistent with (or a justification of divergence from) published Australian Government guidelines and policy statements.	Sections 16.12.4, 16.12.5 and 16.12.7
The draft EIS must include a habitat assessment for each relevant listed threatened species and communities, and migratory species. The habitat assessment must include, but not	Section 16.14.1.2

Terms of Reference	Section of the EIS
limited to, the habitat area (in hectares), quality, location and use specifications of known and potential suitable habitat in relation to the project disturbance area. The Department would expect the habitat assessment be informed by, at a minimum, a desktop assessment of relevant Commonwealth and State Government databases and the outcomes of field surveys.	
The draft EIS must consider and discuss the value of suitable habitat present within the project site and how it may be impacted by the project (as per the requirements below). **Relevant impacts** The MNES section must include a description of all of the relevant impacts of the action. Relevant impacts are impacts that the action will have or is likely to have on MNES. Impacts during the construction, operational and (if relevant) the decommissioning phases of the project should be addressed, and the following information provided: • a description of the relevant impacts (direct, indirect and consequential) of the action on MNES taking account of any relevant approved Conservation Advices for listed threated species and communities as well as any agreements or plans that cover impacts on MNES including (but not limited to): recovery plans, threat abatement plans for processes that threaten species; wildlife conservation plans, strategic assessments, etc.)	Sections 16.14 and 16.17
• provide an analysis of potential and likely impacts of the proposed action on the integrity and Outstanding Universal Value of the Great Barrier Reef World Heritage property ○ including on impacts relating to water quality – fine sediment and nitrogen, and impacts relating to habitat – seagrass, mangroves, saltmarsh and shallow reef	Section 16.17.1
• provide an analysis of potential and likely impacts of the proposed action on the values of the Great Barrier Reef National Heritage place	Section 16.17.2
• demonstrate how the proposed action will provide a net benefit for water quality in the Great Barrier Reef World Heritage property, consistent with The Reef 2050 Long-Term Sustainability Plan (2015), and	Section 16.15.3.7 and 16.17.1.3
• reference the key values and attributes outlined in the Great Barrier Reef Outlook Report 2014 (Great Barrier Reef Marine Park Authority) that may be impacted by the proposed development	Section 16.13.1
• a detailed analysis of the nature, extent and significance of the likely direct, indirect and consequential impacts relevant to MNES and/or their known and potential habitat, including likely short-term and long-term impacts (refer to the Significant Impact Guidelines 1.1 - Matters of National Environmental Significance for guidance on the various types of impact that need to be considered)	Section 16.14 and 16.17
• a statement whether any relevant impacts are likely to be unknown, unpredictable or irreversible	Section 16.21
• any technical data and other information used or needed to make a detailed assessment of the relevant impacts, including a description of the methodology used to determine whole of project impacts (in hectares) to habitat for listed threatened species and communities and listed migratory species; and	Section 16.15.1 and 16.19.4
• an explanation of how Indigenous stakeholders' views of the action's impacts to biodiversity and cultural heritage have been sought and considered in the assessment, including where relevant, how guidelines published by the Commonwealth in relation to consulting with Indigenous peoples for proposed actions that are under assessment have been considered and applied, and	Section 16.4.8

Terms of Reference	Section of the EIS
• where the proposal is a coal seam gas development or large coal mining development and likely to significantly impact on a water resource refer to the: ○ *Independent Expert Scientific Committee's (IESC) information guidelines for proposals relating to the development of coal seam gas and large coal mines where there is a significant impact on water resources*. ○ *Significant Impact guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources*.	Section 16.20
The project will be submitted to the Independent Expert Scientific Committee on Coal Seam Gas and Large Coal Mining Development (IESC). The draft EIS must include a completed checklist (located within the IESC Guidelines) to ensure that the information requirements for the IESC review have been addressed.	Section 16.20.5
The MNES section should also provide a detailed assessment of any likely impact that this proposed action may facilitate on the following (at the local, regional, state, national scale): • sections 12 and 15A (world heritage values of a declared World Heritage property)	Sections 16.9.4, 16.10.6, 16.11.3.6, 16.14 and 16.17.1
• sections 15B and 15C (the heritage values of a National Heritage place)	Sections 16.14 and 16.17.2
• sections 18 and 18A (Listed threatened species and communities)	Sections 16.14, 16.17.3, 16.17.4 and 16.17.5
• sections 20 and 20A (Listed migratory species)	Sections 16.14 and 16.17.6
• sections 24B and 24C (Great Barrier Reef Marine Park)	Section 16.14 and 16.17.1
• sections 24D and 24E (a water resource, in relation to coal seam gas development and large coal mining development).	Section 16.9.4, 16.10.6, 16.11.3.6 and 0
The MNES section should identify and address cumulative impacts, where potential project impacts are in addition to existing impacts of other activities (including known potential future expansions or developments by the proponent and other proponents in the region and vicinity).	Section 16.10.8, 16.18 and 16.20.4.5
The MNES section should also address the potential cumulative impact of the proposal on ecosystem resilience.	Section 16.18
The cumulative effects of climate change impacts on the environment must also be considered in the assessment of ecosystem resilience.	Section 16.16
Proposed avoidance and mitigation measures	
The MNES section must provide information on proposed avoidance and mitigation measures to manage the relevant impacts of the action on MNES.	Section 16.9.4, 16.9.5, 16.10.5, 16.10.7, 16.11.4 and 16.15
The information provided must discuss how the proposed action is not inconsistent with: • any relevant threat abatement plan for listed threatened species and communities • any relevant recovery plan for listed threatened species and communities, and	Section 16.17.3, 16.17.4 and 16.17.5
• relevant conventions and agreements of which a migratory species is listed, including the Bonn Convention, CAMBA, JAMBA and agreements relevant to the conservation of the species.	Section 16.17.6
The MNES section must include, and substantiate, specific and detailed descriptions of the proposed avoidance and mitigation measures, based on best available practices and must include the following elements:	Section 16.9.4, 16.9.5, 16.10.5, 16.10.7,

Terms of Reference	Section of the EIS
• A consolidated list of measures proposed to be undertaken to avoid, mitigate and manage the relevant impacts of the action on MNES, including: ○ a description of proposed avoidance and mitigation measures to deal with relevant impacts of the action, including mitigation measures proposed to be taken by State/Territory governments, local governments or the proponent	16.11.4, 16.15 and Section 16.22
○ assessment of the expected or predicted effectiveness of the mitigation measures, including the scale and intensity of impacts of the proposed action and the on-ground benefits to be gained through each of these measures	Section 16.9.4, 16.9.5, 16.10.5, 16.10.7, 16.11.4 and 16.15
○ discussion of how the proposed mitigation and management measures are consistent with actions included in relevant Recovery Plans and Threat Abatement Plans for listed threated species and communities	Section 16.17.3, 16.17.4 and 16.17.5
○ a discussion of how the proposed mitigation and management measures are consistent with the objectives of The Reef 2050 Long-Term Sustainability Plan (2015)	Section 16.15.3.6
○ including how impacts to surface water flow and quality and to groundwater quality and groundwater regimes will be managed during construction, operation and decommissioning of the project	Sections 16.9.4, 16.10.7, 16.11.4, 16.15.3, 16.15.4 and 16.20.4.6
○ how final voids will be managed to avoid ongoing impacts to MNES following the end of the operational phase of the project	Section 16.7.3, 16.10.3.1, 16.11.3, 16.11.4.6, 16.17.1.1 and 16.20.4.6
○ details of the rehabilitation of the site, including how this will be staged and the outcomes proposed to be achieved to ensure habitat for listed threatened species and communities is reinstated, and	Section 16.7.6
○ any statutory or policy basis for the mitigation measures.	Variously throughout Section 16.9, 16.10.4, 16.10.5, 16.10.7 and 16.11.4
• A strategy for the continuing management, mitigation and monitoring of relevant MNES impacts of the action, including a description of the outcomes that will be achieved and any provisions for independent environmental auditing.	Section 16.10.7.4 and 16.11.4.5 Appendix A18 draft Significant Species management Plan
• A detailed outline of a Construction Environmental Management Plan (CEMP) for the continuing management, mitigation and monitoring of relevant impacts of the action on MNES.	Section 16.15.9 and Appendix 12a and Appendix 12b
• The CEMP outline must be consistent with the Department's Environmental Management Plan Guidelines (2014), and must include: ○ objectives ○ risk assessment ○ environmental management activities and mitigation measures ○ the timing of actions ○ a monitoring program, which must include: ▪ performance indicators (clear and concise criteria against which achievement of outcomes are to the measured), which are capable of accurate and reliable measurement ▪ outcomes (time bound outcomes as measured by performance indicators), which might include milestones (interim outcomes) ▪ monitoring requirements (timing and frequency of monitoring to detect changes in the performance indicators,	Appendix 12a and Appendix 12b

Terms of Reference	Section of the EIS
to determine if outcomes are being achieved, and to inform adaptive management), and ▪ trigger values for corrective actions • potential corrective actions to be implemented if trigger values are reached, and how environmental incidents and emergencies will be managed • roles and responsibilities (clearly stating who is responsible for activities), and • auditing and review mechanisms.	
Greenhouse Gases	
The MNES section is to outline the cumulative direct and indirect greenhouse gas emissions of the proposed action. An inventory of the projected greenhouse gas emissions associated with the proposed action is to be provided. This inventory should include scope 1 and 2 emissions and, for context, an outline of total global greenhouse gas emissions.	Section 16.16
Environmental Outcomes	
The MNES section may include information on the outcomes that the proponent will achieve for matters of national environmental significance. Outcomes need to be specific, measurable and achievable, and must be based on robust baseline data.	Section 16.9.4.2, 16.15.3.3, 16.17.1.3 and 16.19.5 Appendix A18 draft Offset Management Plan Discussed variously throughout Chapter 14 – Terrestrial Ecology, Chapter 15 – Aquatic Ecology and Chapter 17 – Biosecurity
Outcomes must be developed in consideration of DOEE's *Outcomes-based Conditions Policy 2016* and *Outcomes-based Conditions Guidance 2016,* with suitable justification for considerations identified in the policy and guidance.	
The MNES section may include the details of specific environmental outcomes to be achieved, and reasoning for these in reference to relevant Recovery Plans, Conservation Advices and Threat Abatement Plans.	
Residual significant impacts/offsets	
Environmental offsets are broadly understood to mean actions taken outside a development site that compensate for the significant residual impacts of that development. Offsets are not intended to replace avoidance and mitigation which are expected to be the primary strategies for managing the potential impacts of development proposals. Note: offsets do not make an unacceptable impact acceptable and do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact. The MNES section must provide details of: • residual significant impacts on MNES that are likely to occur after the proposed activities to avoid and mitigate all impacts are taken into account	Section 16.19.4
• where residual significant impacts are likely to occur, the reasons why the avoidance or mitigation of these significant impacts is not expected to be achieved.	
The MNES section must include details of an offset package proposed to be implemented to compensate for the residual significant impact of the project if these are determined likely, as well as an analysis about how the offset(s) meets the requirements in the Department's Environmental Protection and Biodiversity Conservation Act 1999 Environmental Offsets Policy October 2012 (EPBC Act Offset Policy).	Section 16.19.5
The offset package can comprise a combination of direct offsets and other compensatory measures, so long as it meets the requirements of the EPBC Act Offset Policy. Offsets should align with conservation priorities for the impacted protected matter and be tailored specifically to the attribute of the protected matter that is impacted in order to deliver a conservation gain. Proponents also have the option of using the Australian Government Reef Trust to deliver biodiversity-related offsets, for example for residual significant impacts relating to water quality and to habitat associated with the Great Barrier Reef.	Section 16.19.5

Terms of Reference	Section of the EIS
Offsets should compensate for an impact for the full duration of the impact (i.e. should impacts be in perpetuity the offsets should also be in perpetuity).	Noted. Refer Appendix A18 draft Offsets management Plan
Offsets must directly contribute to the ongoing viability of the MNES impacted by the project and deliver an overall conservation outcome that improves or maintains the viability of the MNES as compared to what is likely to have occurred under the status quo, that is, if neither the action not the offset had taken place.	Noted
Offsets required by the State can be applied if the offsets meet the Department's EPBC Act Offset Policy. The outcomes of the offset strategy need to be specific, measurable and achievable, and should be based on robust baseline data.	Noted. Refer Appendix A18 draft Offsets management Plan
Note: offsets do not make an unacceptable impact acceptable and do not reduce the likely impacts of a proposed action. Instead, offsets compensate for any residual significant impact.	Noted
The MNES section must include an offset strategy to compensate for significant residual impacts on MNES. The offsets strategy must include: • objectives	Section 16.19 Appendix A18 draft Offsets management Plan
• quantity of impacts which are being offset	Section 16.19.4
• the type of offsets proposed (direct/indirect)	Section 16.19.5
• the location (including a geo-referenced map) and suitability of proposed direct offsets	Section 16.19.5 Appendix A18 draft Offsets management Plan
• current land tenure of any proposed offset and the method of securing enduring protection of the offset site and managing the offset for the life of the impact	Appendix A18 Draft Offsets management Plan
• how any proposed staging of the overall development will impact the delivery of offsets	
• specific environmental outcomes to be achieved, and reasoning for these in reference to relevant statutory recovery plans, conservation advices and threat abatement plans	
• a completed 'offsets guide'. All figures used to determine the suitability of offsets including habitat quality scores at the project site must be derived using a suitably robust and repeatable framework. Details about each framework must also be provided	
• risk assessment	
• environmental management activities and mitigation measures or customize, by referring to specific measures as follows, including the timing of actions	
• a monitoring program, which must include: ○ performance indicators (clear and concise criteria against which achievement of outcomes are to the measured), which are capable of accurate and reliable measurement	
○ outcomes (time bound outcomes as measured by performance indicators), which might include milestones (interim outcomes)	
○ monitoring requirements (timing and frequency of monitoring to detect changes in the performance indicators, to determine if outcomes are being achieved, and to inform adaptive management), and	
○ trigger values for corrective actions	
• potential corrective actions to be implemented if trigger values are reached, and how environmental incidents and emergencies will be managed	
• roles and responsibilities (clearly stating who is responsible for activities)	

Terms of Reference	Section of the EIS
• auditing and review mechanisms, and • an analysis of how the offset package meets the requirements of the EPBC Act Offsets Policy.	
Environmental record of person(s) proposing to take the action	
The information provided must include details of any proceedings under a Commonwealth, State or Territory law for the protection of the environment or the conservation and sustainable use of natural resources against: • the person proposing to take the action	Section 16.3
• details of any consultation with Indigenous stakeholders	Section 16.4.8
• projected economic costs and benefits of the project, including the basis for their estimation through cost/benefit analysis or similar studies, and	Section 16.4.2 and 16.4.3
• employment opportunities expected to be generated by the project (including construction and operational phases).	Section 16.4.3 Appendix A17 Social Impact Assessment
Economic and social impacts should be considered at the local, regional and national levels. Details of the relevant cost and benefits of alternative options to the proposed action should also be included. Identification of affected parties is required, including a statement mentioning any communities that may be affected and describing their views.	Section 16.4.3 Appendix A17 Social Impact Assessment
Documentation must be provided substantiating how estimated benefit/cost figures have been derived.	Chapter 19A – Economic
Information sources	
For information given in the MNES section, the proponent must state: • the source of the information; • how recent the information is; • how the reliability of the information was tested; • what uncertainties (if any) are in the information; and • what guidelines, plans and/or policies were considered.	Noted
Conclusion	
An overall conclusion as to the environmental acceptability of the proposal on each MNES should be provided, including: • a discussion on compliance with the requirements of the EPBC Act, including the objects of the EPBC Act, the principles of ecologically sustainable development and the precautionary principle • reasons justifying undertaking the proposal in the manner proposed, including the acceptability of the avoidance and mitigation measures, and • if relevant, a discussion of residual impacts and any offsets and compensatory measures proposed or required for significant residual impacts on MNES, and the relative degree of compensation and acceptability.	Section 16.21