MNES Fauna - Emissions and Noise Assessments

Galilee Power Station, Central Queensland

Prepared for: **Waratah Coal Pty Ltd**
Report Status: **Final – October 2019**

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1. Introduction

1.1. Background and Purpose

Waratah Coal Proprietary Limited (Waratah Coal), a wholly owned subsidiary of Mineralogy Proprietary Limited, proposes to develop a 1400 MW ultra-supercritical power station adjacent to the Mining Lease for their Galilee Coal Project (Northern Export Facility – hereafter referred to as the Galilee Coal Project).

The Galilee Power Station will be developed as a contingent, but separate, component of the overall Galilee Coal Project. Accordingly, Waratah Coal is seeking approval for the Galilee Power Station under the Queensland *Planning Act 2016* (the Planning Act).

The Galilee Power Station will have the dual purpose of servicing the public network and providing the power needs for the Galilee Coal Project mine operations (which will undergo a slow ramp up to full capacity over 10 years), including;

- a coal slurry pipeline delivering mine processed, ready for export, coal to the RG Tanna Coal Terminal at Gladstone Port; and
- port operational needs.

Additionally, it is envisaged that the Galilee Power Station will also service the future power needs for Waratah Coal's proposed North Galilee coal mine development.

The Galilee Power Station is being considered as a stand-alone project, and separate activities such as transmission lines, the coal slurry pipeline, port and mine are being, or have been, addressed in separate studies and approvals processes. These separate approvals involve high voltage transmission connections to the existing Powerlink system and to pumping stations on the slurry pipeline, and potentially (subject to agreement with Ergon) the reinforcement of the power supply to the towns of Alpha and Jericho.

The assessment for the Galilee Power Station will consider these pieces of linear infrastructure only up to the boundary of the Power Station Site. See **Figure 1-1**, which shows the regional context of the Galilee Power Station.

This report investigates the potential impacts associated with noise and emissions of the proposed Galilee Power Station upon MNES Fauna.

1.2. Terminology, Nomenclature and Acronyms

The **project area** is located adjacent to Waratah Coal's mining tenements (EPC1040 and part of EPC1079), near Alpha in the Galilee Basin, Central Queensland. The **Galilee Power Station infrastructure footprint** is wholly contained within Lot 2 SP136836, in the north-east part of the project area (see **Figure 1-2**). The **surrounding area** refers generally to the lands surrounding and in the vicinity of the project area, including the townships of Alpha, Jericho, Aramac and Clermont.

Nomenclature used for this study follows Bostock & Holland (2010) for flora, Van Dyck & Strahan (2008) for non-flying mammals, Churchill (2008) and Reardon *et al.* (2008) for bats, Christidis & Boles (2008) for birds, Cogger (2000) for amphibians, and Wilson (2009) for reptiles. The common names for frogs follow the nomenclature of Ingram *et al*. (1993). The term **waterbird** refers to those species which are ecologically dependent upon wetlands (after Kingsford & Norman 2002). The term **shorebird** refers to both resident and migratory species which are ecologically dependent upon wetlands and form a subset of the waterbird grouping (after Geering *et al.* 2007).

The **conservation status** of a species is described in accordance with the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBCA) (e.g. *Endangered, Vulnerable,* or *Migratory*) and, for completeness where relevant, the Queensland *Nature Conservation Act 1992* (NCA) and its regulations and amendments (e.g. *Endangered, Vulnerable, Regionally Vulnerable, Near Threatened*[1] or *Least Concern*). *Threatened* is a common term used to collectively describe *Endangered* and *Vulnerable* species.

An **environmental weed** refers to any plant that survives in a natural area where its presence is undesirable, harmful or troublesome to native biodiversity. A **declared plant** refers to a species declared under the *Land Protection (Pest and Stock Route Management) Regulation 2002* (LPR).

A **threatened ecological community** (TEC) is a naturally occurring ecological community listed under section 181 of the *Environment Protection and Biodiversity Conservation Act 1999*. Categories for listing TECs under the EPBCA are: critically endangered; endangered; or vulnerable.

The definition of a **Regional Ecosystem** (RE) follows that provided by Sattler & Williams (1999), *i.e.* a vegetation community in a bioregion that is consistently associated with a particular combination of geology, landform and soil. This definition forms the basis of the Queensland *Vegetation Management Act 1999* (VMA[2]), which also defines the "*pre-clearing extent*" of a regional ecosystem as the extent of the regional ecosystem before it was cleared. *Regrowth vegetation* means woody vegetation that is not remnant as defined under the VMA.

The conservation status (under the VMA) of REs follows that of the Regional Ecosystem Description Database (REDD) published and maintained by Queensland Herbarium (2018). Each RE is assigned status under the VMA as *Endangered*, *Of Concern* or *Least Concern*. The status of all REs mapped for Queensland is provided in the VMA Vegetation Management Regulation 2000 (VMR): VMR Schedule 1 - *Endangered* Regional Ecosystems; VMR Schedule 2 - *Of Concern* Regional Ecosystems; and VMR Schedule 3 - *Least Concern* Regional Ecosystems.

Acronyms and Terms used in this report are provided in **Tables 1-1 and 1-2.**

[1] Previous reports referred to in this report have included reference to *Rare* species. This conservation status was superseded by the status *Near Threatened* with the introduction of the *Nature Conservation (Wildlife) Amendment Regulation (No. 1) 2010*.

[2] Under the VMA, remnant vegetation is defined as "vegetation that had at least 70% of the height and 50% of the cover of the dominant stratum, relative to the undisturbed height and cover of that stratum and was dominated by species characteristic of the vegetation's undisturbed canopy" (Wilson *et al.* 2002). Only vegetation that falls within this definition is mapped as a regional ecosystem in Queensland. Mapped regional ecosystems thus include 'vegetation that has not been cleared or has been lightly thinned or vegetation that has been cleared or heavily thinned but substantially regrown (Wilson *et al.* 2002).

Table 1-1 Report Acronyms

Acronym	Name, Term or Expression
BPA	Biodiversity Planning Assessment
BOM	Bureau of Meteorology
CAMBA	China-Australia Migratory Bird Agreement
CITES	Convention on International Trade in Endangered Fauna and Flora
dB	Decibel - unit of sound production level (logarithmic scale)
DE	Former Commonwealth Department of the Environment
DEE	Commonwealth Department of the Environment and Energy
DEHP	Former Queensland Department of Environment and Heritage Protection
DERM	Former Queensland Department of Environment and Resource Management
DES	Queensland Department of Environment and Science
DEWHA	Former Commonwealth Department of Environment, Water, Heritage and the Arts
DUB	Desert Uplands Bioregion
EAAF	East Asian-Australasian Flyway
EHP	Queensland Department of Environment and Heritage Protection
EIS	Environment Impact Statement
EM Plan	Environmental Management Plan
EP Act	*Queensland Environmental Protection Act 1994*
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*
Ha	Hectares
Hz	hertz - cycles per second (measure of sound frequency)
IUCN	International Union for Conservation of Nature and Natural Resources
JAMBA	Japan-Australia Migratory Bird Agreement
kHz	Kilohertz (thousand hertz)
Km	Kilometre
LC50	A concentration of a substance that produces death in 50% of a population of experimental animals after exposure for a period of time which is usually specified (e.g. '96-hour LC50'). This term is used when the substance exists in the organism's ambient environment at the specified concentration, e.g. fish in water in which the substance is present at the specified concentration.
LD50	A dose of a substance that produces death in 50% of a population of experimental animals. It is usually expressed as milligrams per kilogram (mg/kg) of body weight. This term is used when the exposure pathway is by absorption of the specified dose.
Leq	Decibel on A-weighted scale (levels weighted according to sound frequency)
LP Act	*Queensland Land Protection (Pest and Stock Route Management) Act 2002*
ML	Megalitre
MNES	Matter of National Environmental Significance (as defined under the EPBCA)
MSES	Matter of State Environmental Significance (as defined under the NCA)
MPa	Megapascals

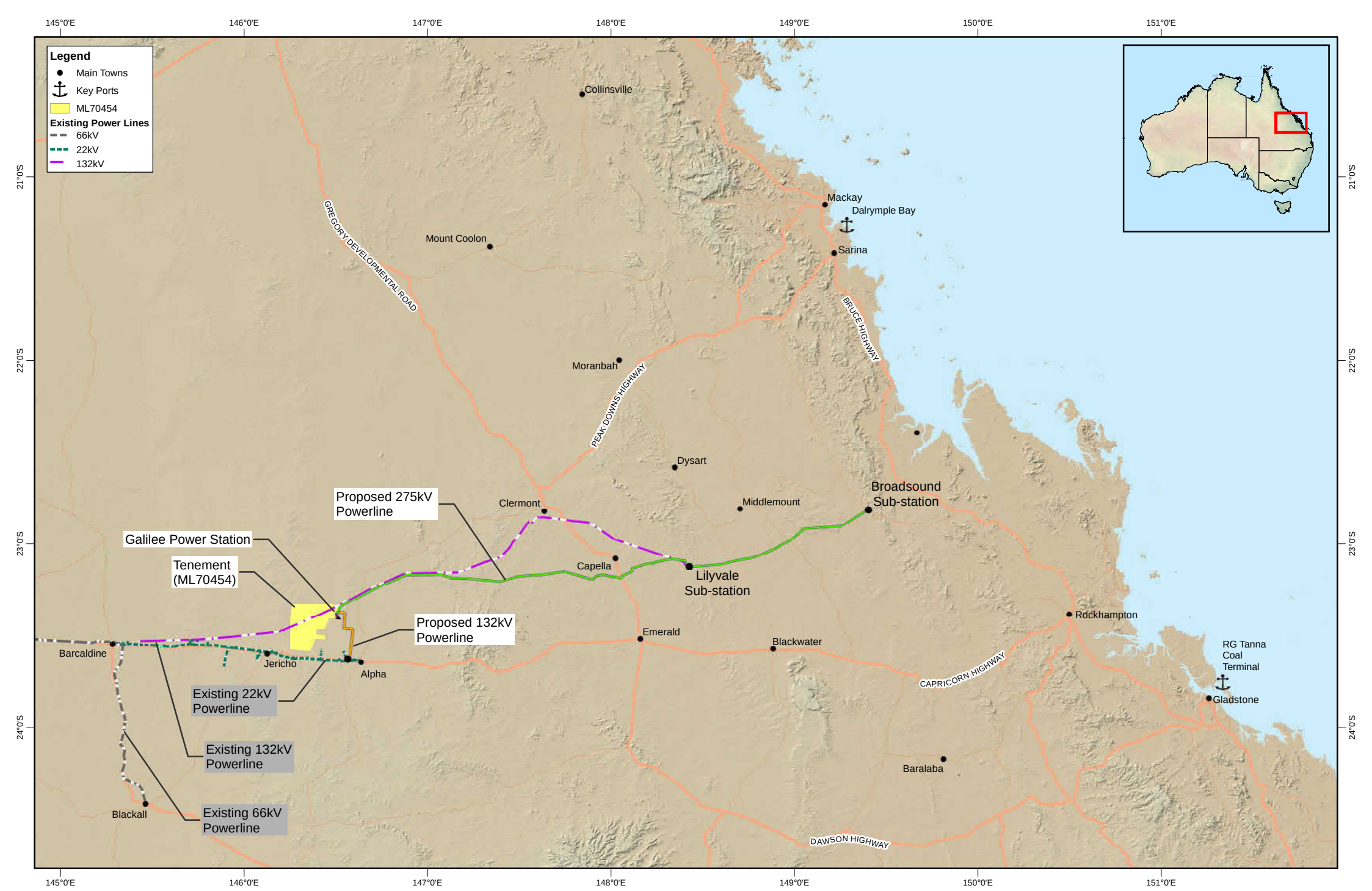
Acronym	Name, Term or Expression
MRA	*Queensland Mineral Resources Act 1989*
Mtpa	Million tonnes per annum
MW	Megawatt
NC Act	Queensland Nature Conservation Act 1992
NO_2	Nitrogen dioxide
pH	Measure of how acidic or alkaline a material, liquid or solid is. pH is presented on a logarithmic scale of 0 to 14. 0 represents the most acid, and 14 the most alkaline and 7 neutrality.
$PM_{2.5}$	Particulate matter with an aerodynamic diameter of up to 2.5 µm
PM_{10}	Particulate matter with an aerodynamic diameter of up to 10 µm
RE	Regional Ecosystem (as defined under the VMA)
REDD	Regional Ecosystem Description Database
ROKAMBA	Republic of Korea-Australia Migratory Bird Agreement
SEWPaC	Former Commonwealth Department of Sustainability, Environment, Water, Population & Communities
SEIS	Supplementary Environment Impact Statement
SPL	Sound production level
SO_x	Sulphur oxide, which refers to many types of sulphur and oxygen containing compounds such as SO, SO_2, SO_3, S_7O_2, S_6O_2, S_2O_2, etc.
SO_2	Sulphur dioxide
sp.	Species (singular)
spp.	Species (plural)
tCO_2-e/MWh	Tonnes of carbon dioxide equivalent per Megawatt-hour
VM Act	*Queensland Vegetation Management Act 1999*
WoN	Weed of National Significance as listed by the Australian Weeds Committee 2012

Table 1-2 Selected Report Terms

Term	Description
Absorption	The solution of one component of a gaseous mixture into a liquid, or the penetration of a gas or liquid into a porous solid.
Acid gas	A gas which, when dissolved in water, forms an acid, e.g.: sulphur dioxide, nitrogen dioxide and carbon dioxide.
Acute exposure	Exposure to a chemical for a short period of time, relative to the organism's life span, e.g. 14 days or less for humans. *cf.* chronic exposure.
Ambient	Refers to environmental conditions in the surrounding air or water, and not to conditions associated with an emission(s) or discharge(s).
Anthropogenic	Made by humans or resulting from human activities.
Bioaccumulation	To accumulate in the tissues of plants and animals to a concentration higher than that of the surrounding environment.
Bioconcentration	To become more concentrated in the tissues of plants and animals than in the surrounding environment.
Biomagnification	The existence of a substance at successively higher concentrations with increasing trophic levels in ecosystem food chains. *cf.* bioconcentration
Chronic exposure	Exposure to a chemical for a relatively long period of time, e.g. 365 days (1 year) or more for humans. *cf.* acute exposure
Critical load	The quantitative estimate of an exposure to one or more pollutants below which significant harmful effects on sensitive elements of the environment do not occur according to present knowledge, i.e. a measure of the damage threshold for pollutants. Critical loads can be set for a range of different habitats and species[3] .
Ecology	The totality or pattern of relations between organisms and their environment. Note that ecology is the study and the science of the interrelations between living organisms and their environment. The term ecology is now frequently misused, usually as "the ecology", when what is meant is a particular ecosystem, a set of ecosystems or the environment.
Ecosystem	A community of living things and the non-living environment functioning together as a system - an ecological system.
Ecosystem resilience	The capacity of an ecosystem to cope with disturbances, such as drought, fire or grazing, without shifting into a qualitatively different state.
Ecosystem services	The collective benefits that society derives from the resources and processes supplied by natural ecosystems. Services can be divided into five categories: provisioning, such as the production of food and water; regulating, such as the control of climate and disease; supporting, such as nutrient cycles and crop pollination; cultural, such as spiritual and recreational benefits; and preserving, which includes guarding against uncertainty through the maintenance of diversity
Emission	Release or discharge of a substance to the environment whether in pure form or contained in other matter and whether in solid, liquid or gaseous form.
Endemic	Native to a particular area and found nowhere else in the wild.
Epithelium	The layer of cells forming the epidermis of the skin and the surface layer of mucous and serous membranes.
Environmental indicators	The physical, chemical, biological or socioeconomic measures that best represent the key elements of a complex ecosystem or environmental issue. Indicators can organise environmental information both spatially and over time.

[3] The concepts of critical loads and critical levels were developed within the United Nation Economic Commission for Europe (UNECE) Convention on Long-Range Transboundary Air Pollution (CLRTAP) for assessing the risk of air pollution impacts to ecosystems and defining emission reductions. This tool is commonly used across Europe to anticipate negative effects of air pollution and, therefore, to protect ecosystems before the changes become irreversible.

Term	Description
Food chain	The transfer of nutrients, and hence energy, from one group of organisms to another in a series or "chain".
Food web	Food chains interconnecting at various levels.
Fossil fuels	Fuels derived from fossilised organic matter such as coal, oil and petroleum.
Fugitive emissions	Substances which escape to air from a source not associated with a specific process but scattered throughout the plant, e.g. leaks from equipment, dust blown from stockpiles.
Greenhouse gases	Carbon dioxide (co_2), carbon dioxide equivalent (indirect), methane (ch_4), nitrous oxide (n_2o), hydrofluorocarbons (hfcs), perfluorocarbons (pfcs), and sulphur hexafluoride (sf_6).
Heavy metals	Metallic elements mainly of high atomic weight, generally toxic to plant and animal life in low concentrations. These elements are often present in the environment in trace concentrations and exhibit biological accumulation. Examples include mercury, cadmium, arsenic and lead.
Hydrocarbon	An organic compound consisting exclusively of the elements carbon and hydrogen.
Inert	A substance which has little or no chemical reactivity.
Invasive species	A species spreading beyond its accepted normal distribution and which threatens valued environmental, agricultural or personal resources by the disruption it causes.
Inversion (temperature inversion)	Reversal of the usual decrease in air temperature with increasing altitude. Under normal conditions, air nearer the ground being warmer and of lower density than cooler air at higher altitudes, rises, carrying up pollutants collected at ground level. In the absence of wind this vertical movement is virtually the only means of pollutant dispersion. On calm, clear, winter nights however, radiation causes rapid cooling of the ground and the air near it and a temperature inversion forms. Pollutants are trapped near the ground in this cooler denser air. If no winds develop and day temperatures are not high enough to heat up the ground and restore the normal thermal gradient, the inversion (and pollution) persists and intensifies
Landscape function	The ability of landscapes to capture, conserve and use scarce water and nutrients.
Necrosis	Changes which are indicative of cell death.
Organic	Substances containing carbon-carbon bonds. Historically, the term referred to substances which are part of or derived from living organisms, although most organic compounds now are synthetic. All living matter on Earth includes carbon as a component. See also inorganic.
Photochemical reactions	Chemical reactions which occur in the presence of ultra-violet or visible light.
Scrubber	As an air-pollution control device, an absorber which uses a liquid in a packed tower or in spray to remove pollutants from a gas stream by absorption or chemical reaction. The packed tower is to provide a very large wetted surface of the absorbent.
Secondary pollutants	Pollutants formed by chemical reactions occurring within the environment. One or more primary pollutants discharged to the environment and possibly one or more naturally occurring substances are the reactants, e.g. ozone is formed by a reaction between oxides of nitrogen, hydrocarbons and oxygen.
Sound attenuation	The process by which all signal components decline equally in intensity due primarily to spherical spread, the dispersion of signal energy over an expanding sphere during transmission.
Sound degradation	The destruction of acoustic signal structure, as a result of reverberation, amplitude fluctuations and differential attenuation at different frequencies.
Tailings	Rock and other waste materials that are separated from crushed ore in the mining process
Threshold limit value	Refers to airborne concentrations of substances, and represents conditions under which it is believed that nearly all workers may be repeatedly exposed for an 8-hour day, 5 days a week for a working lifetime (expressed as parts per million (ppm) for gases and vapours and as milligrams per cubic metre (mg/m^3) for fumes, mists and dusts).
Volatile organic compounds	A general term which refers to a large and diverse group of substances, including hydrocarbons, oxygenates and halocarbons that readily evaporate at room temperature.



GALILEE POWER STATION

Basemap: Shaded relief DNRM 2006
Roads: DNRME 2019
Tenement Boundary: Waratah Coal 2019
Proposed Infrastructure: Waratah Coal 2019

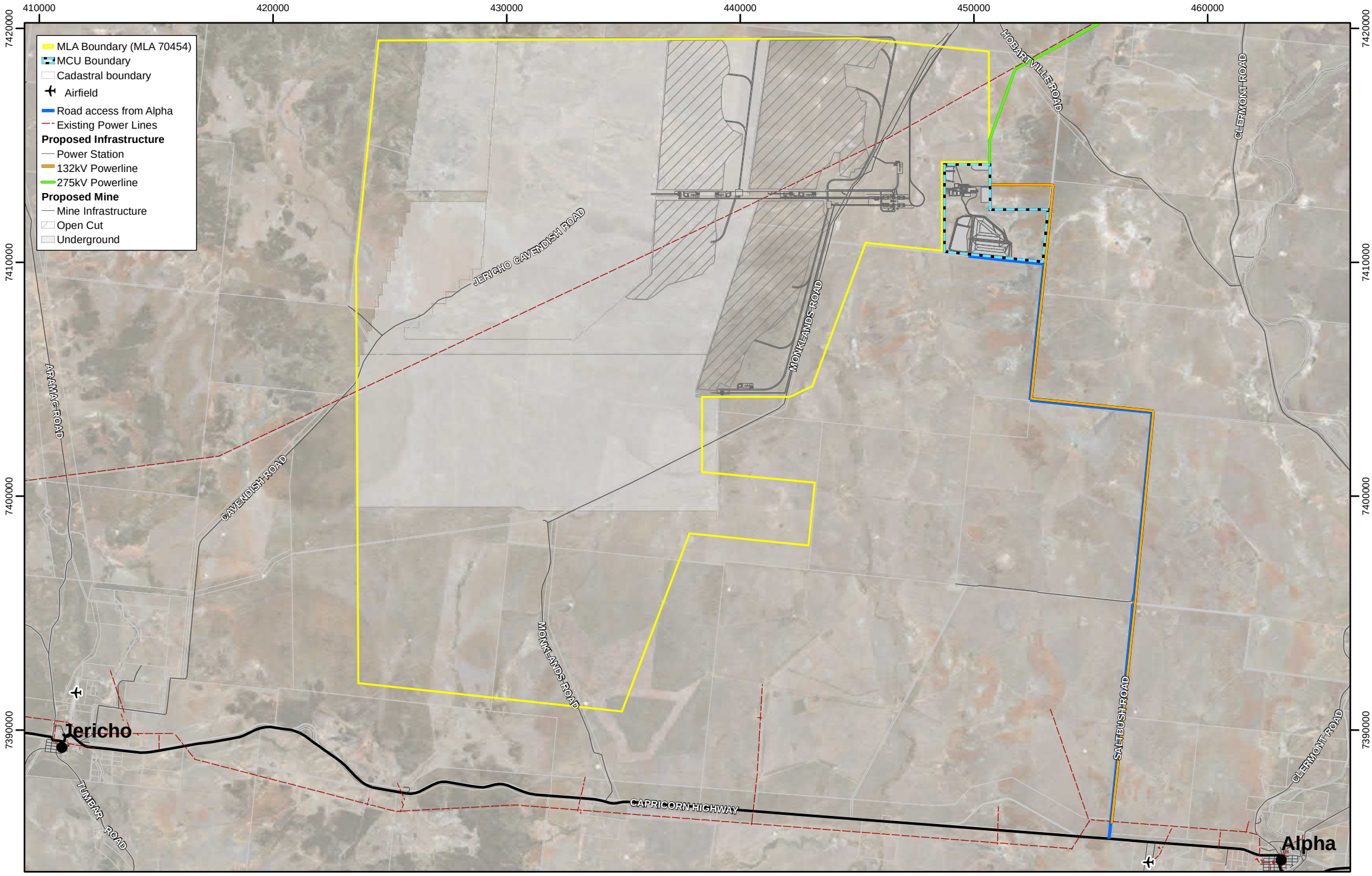
0 50 100 km

A4 Scale 1:2,800,000
GCS GDA 1994

N

Figure 1-1 Project Area and Regional Context

WC-GPS-06-Fig1-RegionalContext-r1-191021, 21 Oct 2019



GALILEE POWER STATION

Roads: DNRME 2018
Tenement Boundary: Waratah Coal 2019
Proposed Infrastructure: Waratah Coal 2018
Cadastre: DNRME 2019
Basemap Image: DigitalGlobe 2016

0 1 2 3 4 5 km

A4 Scale 1:200,000
GDA 1994 MGA Zone 55

N

Figure 1-2 Galilee Power Station and Project Area Context

WC-GPS-06-Fig2-ProjectLayout-r1-191025, 25 Oct 2019

2. Project area Characteristics

2.1. Overview and Land Use Context

The southern extent of the project area is located approximately 20 kilometers north-west of the township of Alpha. The project area encompasses and/or includes part of the following pastoral properties: Spring Creek; Kia Ora; Glen Innes; Lambton Meadows; Cavendish; Hobartville; and Saltbush.

A significant proportion of the project area has been cleared of native vegetation and is maintained as cleared pasture for cattle grazing (e.g. Kia Ora in the north and Hobartville in the east). A large part of this area has been subject to blade ploughing and the introduction of exotic pasture grasses, and Buffel Grass (*Pennisetum ciliare*) is dominant. Whilst the predominant land use across the project area is cattle grazing, it is apparent that grazing management practices differ between properties.

Areas of woodland habitats (including native remnant and native regrowth) has been retained throughout project area, e.g. Glen Innes within the central sector, and parts of Cavendish and Lambton Meadows in the west (**Figure 2-1**). Generally, these areas are also subject to cattle grazing, though it is apparent, that there are differences in grazing management practices implemented throughout these remnant woodland areas (e.g. differences in stocking rates, retention native pasture, and weed control). Woodland habitats are dominated by eucalypts, principally Silver-leaved Ironbark (*Eucalyptus melanophloia*) and Poplar Box (*Eucalyptus populnea*), and support a diversity of native grasses, though also introduced taxa (e.g. Buffel Grass).

Glen Innes station, within the central sector of the project area, supports the Bimblebox Nature Refuge, gazetted in 2003 under the *Nature Conservation (Protected Areas) Regulation 1994* (SL 2003 No. 82). The majority of its 7,912ha supports Silver-leaved Ironbark and Poplar Box woodland.

The project area is located within the Belyando River catchment, which is part of the larger Burdekin River catchment. The project area is transected by a variety of seasonal watercourses. The Spring Creek system drains the north-west sector of EPC1040. This part of the project area supports a variety of mesas and plateaus and vegetation types, including bloodwood open woodlands (dominated by *Corymbia trachyphloia*) and woodlands dominated by Lancewood (*Acacia shirleyi*). The Spring Creek system drains east and north, part of which connects with the Lagoon Creek system (off-site and to the north).

The Lagoon Creek system drains generally northwards through the eastern extent of the project area. The system includes:

- Pebbly Creek - draining east across the central sector of the project area (through the Cavendish and Glen Innes properties);
- Beta Creek - which drains northwards through the southern central part of the project area (through the Lambton Meadows property);
- Tallarenha Creek – draining northwards through the south-eastern part of the project area; and
- Salt Bush Creek - draining north through the eastern areas from the south-eastern sector of the project area.

Both Beta and Tallarenha Creeks join within the central-eastern part of the project area to form Lagoon Creek, where it continues to drain in a northerly direction through the north-western corner of the project area. River Red Gum (*Eucalyptus camaldulensis*) is a relatively common feature along these waterways, particularly from about the confluence of Beta and Tallarenha Creeks and northwards (where *Eucalyptus tessellaris* is often a co-dominant within riparian areas). Within these areas, large hollow-bearing trees can be a relatively common feature.

The project area is embedded within the Desert Uplands Bioregion[4] (**Attachment D**). The Desert Uplands was settled by pastoralists during the 1860s and 1870s (DNRW 2006). The majority of land tenure within the surrounding region is leasehold (about 80%) with the remainder comprising freehold, reserves and other tenures in small land (ANRA 2009).

Accad *et al.* (2017) estimated that approximately 81% of the of the pre-clearing remnant vegetation of the Desert Uplands Bioregion remained in 2015, though rates of retention vary considerably between sub-regions – with only 59% remaining within the Jericho subregion within which the project area is located.

The so-called "Galilee Basin" extends across the eastern part of the region. Coal measures within this area, which includes the project area, are subject to a variety of new mining proposals. This includes the "Alpha Coal" and "Kevins Corner" located adjacent and the north of the project area, the "Carmichael" and "China Stone" projects located approximately 100km to the north and the "South Galilee Coal Project" located adjacent and to the south of the project area.

Approximately 160 kilometers to the east of the project area is Emerald, a regional centre for both coal mining operations of the southern Bowen Basin and significant areas of pastoral and agricultural land uses.

2.2. Ecological Context

As noted previously, Glen Innes station, within the central sector of the project area, supports the Bimblebox Nature Refuge (BBNR)[5]. A nature refuge is a class of protected area under the *Nature Conservation Act 1992.* The BBNR supports at least six REs, including those comprising poplar box and silver-leaved ironbark woodlands.

Other ecological values located within the project area include (**Figure 2-1**):

- A large remnant of eucalypt open woodland and several small open woodland patches located within the south-eastern sector and scattered along sections of the eastern boundary;
- Eucalypt open woodland and lancewood woodland on sandstone plateaus and scarps within the north-west corner; and
- Relatively narrow and linear areas of riparian woodland (where hollow-bearing trees are often common) associated with downstream sections of the Lagoon Creek system - north-eastern parts of the project area.

Regional Ecosystem (RE) mapping by DES (2018a) describes the extent of a variety of REs occurring within the project area (**Attachment C**). There is no discernible difference between that mapping and the previously reviewed DERM (2012c) mapping which was used in previous assessments. Previously, the diversity of REs has been confirmed by previous field assessments, with only relatively minor ground-truthed differences detected in the extent of earlier DERM-mapped remnant vegetation (Worley Parsons 2009; Unidel 2011a; and the SEIS Flora and Vegetation Report).

The project area is contained within the south-eastern part of the Desert Uplands Bioregion (subregion 4: Jericho; Morgan *et al*. 2002). The Desert Uplands Bioregion (DUB) lies within the eastern margin of the Great Artesian Basin. The DUB covers an area equivalent to about 4% of Queensland (6.89 million hectares), has a semi-arid climate, of variable rainfall[6] (though summer dominant), and generally supporting

[4] The Desert Uplands Bioregion (DUB) is one of 13 biogeographical areas of Queensland, and extends between Blackall and Pentland within central northern Queensland (Morgan 1999). It encompasses approximately 7.033 million hectares of semi-arid environments.

[5] *Nature Conservation Legislation Amendment Regulation (N0. 1) 2003.*

[6] Average annual rainfall in the DUB varies from 480 mm in the north-west to 540 mm in the south-east. The rainfall is summer dominant, though with a high annual variability. Shires within the DUB have been drought declared for approximately one year in four since 1964, with the Jericho Shire averaging "drought conditions" one year in five (EPA 2002).

soils of poor structure and low fertility (clay soils, sands and massive earths, and skeletal soils) (Morgan 1999; DERM 2012e).

The sands and massive earths support eucalypt woodlands such as ironbark (*Eucalyptus whitei*, *E. melanophloia*, *E. crebra*), box (*E. populnea*, *E. brownii*), bloodwoods (*Corymbia* spp.) and yellow jacket (*E. similis*), which make up about 86% of the bioregion (ANRA 2009). Vegetation types characteristic of skeletal soils (on ranges, plateaus, scarps, etc.) are dominated by eucalypts, (e.g. narrow-leaved ironbark (*Eucalyptus. crebra*), bendee (*Acacia catenulata*) and lancewood (*A. shirleyi*) (Morgan 1999; ANRA 2009)). Clay soils support brigalow (*Acacia harpophylla*), Dawson River gum (*Eucalyptus cambageana*), gidgee (*A. cambagei*) and blackwood (*A. argyrodendron*) (ANRA 2009). The project area is characterised by vegetation types associated with the sands and massive earths, though comparatively smaller areas of vegetation types are associated with skeletal soils (north-west corner) and clay soils (see Unidel 2011a).

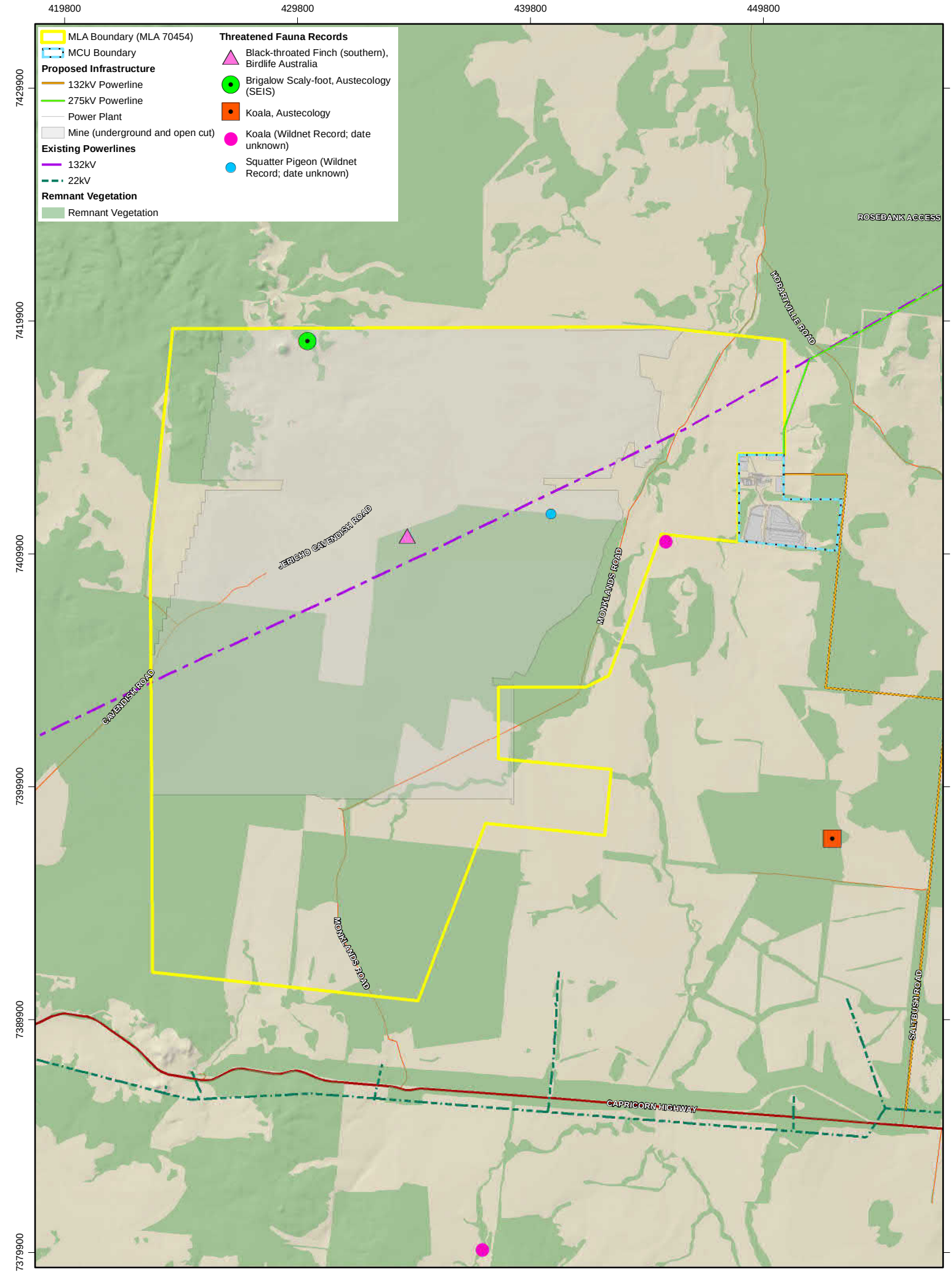
Two significant internal drainage basins in the centre of the region form the catchments of Lake Galilee and Lake Buchanan (respectively 115klms and 190klms to the north of the project area). These brackish lakes fill only as a result of above average wet seasons (ANRA 2009). Both wetlands are large, relatively shallow, and brackish, contained with internal drainage systems, are seasonally important habitat and refuge for water birds, and listed as wetlands of national significance (ANCA 1996[7]).

ANRA (2009) describes the most common threatened vegetation types as eucalypt woodlands with a shrubby understorey, followed by brigalow (*Acacia harpophylla*) forests and woodlands and eucalypt woodlands with a grassy understorey. Approximately 40% of the threatened ecosystems occur on alluvial land types with the majority of the remainder on clay downs (ANRA 2009). The predominant land use of the region is beef cattle grazing, which covers over 90% of the total area (Bastin *et al.* 2008). The major threatening process for threatened ecosystems is grazing followed by broad-scale tree clearing (ANRA 2009). The clearing of approximately 18 per cent of the native vegetation to improve pasture production has had more of an impact on biodiversity in the south of the bioregion (DERM 2012e).

Morgan *et al*. (2002) provides an extensive review of fauna data for the Desert Uplands bioregion[8], and noted that a total of 200 species had been recorded in the Jericho subregion (20 mammals, 54 reptiles, 13 amphibians and 113 birds). The assembled fauna list included a variety of species which were thought to reflect the geographic position of the Jericho subregion, i.e. a significant proportion of the fauna being more commonly distributed to the south-east in the wetter Brigalow Belt North bioregion, and to the west in the lower rainfall Mulga Lands and central Australia. The report also noted that the derived species richness for the subregion may be an underestimate as most fauna surveys had concentrated on the box and ironbark open woodland associations, leaving many regional ecosystems in this subregion under-sampled.

[7] The *Directory of Important Wetlands in Australia* was a cooperative project involving the Australian, state and territory governments and maintained up until 1996. To be considered nationally important, a wetland must meet a set of criteria, including biogeographic representativeness; important ecological or hydrological functions; provision of animal habitat during times of vulnerability or adverse conditions; support for more than 1% of the national population of any taxa; support for threatened taxa or communities; and historical or cultural significance.

[8] Morgan *et al.* (2002) listed 388 vertebrate fauna species from surveys in Desert Upland bioregion. This total comprised 19 mammal species (from 19 families), 116 reptile species (representing 10 families), 24 amphibian species (from three families), and 229 bird species (from 63 families).



GALILEE POWER STATION

Tenement Boundary: Waratah Coal 2019
Receptors: Waratah Coal EIS/CEIS, EMCA 2019
WildNet records: Dept. of Env. and Science 2018
Basemap: Shaded relief DNRM 2006

0 2.5 5 km

A4 Scale 1:200,000
GDA 1994 MGA Zone 55

N

Figure 2-1 Galilee Power Station and Ecological Values Context

WC-GPS-06-Fig5-EcologicalValues-r1-191025, 3 Nov 2019

3. MNES Assessments

3.1. Fauna Survey Programs

There have been wide variety of vertebrate fauna surveys implemented across the project area and within its surrounds. These surveys have all included a strong focus on implementing targeted survey methodologies for threatened fauna. The design and implementation of the majority of the field survey work undertaken across the project area is considered to be consistent with the survey guidelines as provided in DEWHA (2009), DEWHA (2010a), DEWHA (2010b), BBRW (2010), SEWPaC (2011a), SEWPaC (2011b), and Eyre *et al.* (2012)

Collectively, the work demonstrates that the fauna of the project area (and surrounds) is well understood and there has been substantial survey effort that has been undertaken in all seasons during the period 1998 to 2012. Details of the suite of methodologies employed and other survey characteristics were reviewed in detail within Austecology (2011 and 2012). The body of survey work across the project area can be summarised as follows.

3.1.1. Queensland Government Agency Surveys

Fauna surveys, including methodologies targeting threatened species, were implemented by Queensland Government agencies across the project area during the period 1998 to 2011 (e.g. DERM 1998; DERM 1999; QPWS 2000; EPA 2007; and DERM 2011a). Collectively, that work provided a total of 16 fauna survey events with a minimum 90 field-survey and 177 survey-person days. Methodologies included trapping (Elliott, funnel, pitfall, and cage traps), bird surveys, diurnal ground searches, nocturnal surveys, microbat call detection surveys, call playback surveys, harp trapping, and mist-netting.

A total of 304 fauna species were recorded, comprising 28 mammals (including six introduced species), 36 reptiles, eight amphibians (including one introduced species), and 125 bird species. No fauna species listed as threatened under either the EPBCA or NCA were recorded.

3.1.2. Bimblebox Nature Refuge and Birdlife Australia Surveys

The Bimblebox Nature Refuge (BBNR) website notes that a long-term bird monitoring program has been implemented by Birds Australia on the BBNR to monitor trends in avian diversity. A list of birds recorded by Birds Australia during the period 2003 to October 2010 is also provided on the BBNT website[9]. No bird species listed as threatened under either the EPBCA or NCA were recorded. The author is aware of a putative record of BTF from the BBNR (May 2011) and has sought confirmation and record details. At the time of preparing this report, no further information on the BBNR record has been made available to the author.

Bird surveys, with a focus on Black-throated Finch (southern) *Peophila cincta*, were also undertaken throughout the Bimblebox Nature Refuge during 2012 (Birdlife SQ 2012). That work also including the use of acoustic sensors. A total of 96 bird species were recorded. No bird species listed as threatened under either the EPBCA or NCA were recorded.

[9] The 2003-2010 bird list has been incorporated within the bird database included within this report.

3.1.3. China First Project Draft EIS Fauna Survey Program

Fauna surveys, including target threatened species surveys, were implemented across the project area during the period 2009 to 2010 (Unidel 2011a). The survey program provided 30 survey-person days and comprised standardised site-based surveys (pitfall / Elliott / funnel trapping, harp trapping, ultrasonic bat recording, observational bird transects and nocturnal searches) and targeted survey work for threatened fauna.

A total of 130 fauna species were recorded, including 22 mammals (including three introduced species), 15 reptile, five amphibians (including one introduced species), and 88 bird species. No bird species listed as threatened under either the EPBCA or NCA were recorded.

3.1.4. Galilee Coal Project EIS Fauna Survey Program

The survey program was designed to detect threatened avifauna, principally Black-throated Finch (southern) and Squatter Pigeon (southern) *Geophaps scripta*. That work provided 44 survey-person days throughout the period 2011 (Austecology 2011). The program included active roaming searches within potentially suitable habitats, systematic searches for nests, and passive point surveys at potential drinking points. A total of 126 bird species were recorded. No bird species listed as threatened under either the EPBCA or NCA were recorded[10].

3.1.5. Galilee Coal Project SEIS Fauna Survey Program

Fauna surveys (including target threatened species surveys) were undertaken across the project area during 2012 (Austecology 2012). The survey program provided 32 survey-person days and comprised two main survey approaches (and supplementary work). The first primary survey approach comprised a suite of standardised techniques (pitfall / funnel / Elliot / wire cage trapping; bird surveys; active diurnal ground searches; nocturnal ground searching and spotlighting; and microbat call detection surveys), with the second approach dedicated to targeted survey work for threatened fauna (work described in detail within Austecology 2012).

A total of 197 fauna species were recorded on the project area during the SEIS survey program. The recorded assemblage comprised 28 mammals (including six introduced species), 36 reptiles, eight amphibians (including the introduced Cane Toad *Rhinella marina*), and 125 bird species.

A total of nine fauna species, as listed as threatened under the EPBCA and/or NCA at the time, were recorded during that period. Of those, only two remain listed as threatened species under the EPBCA, i.e.: Koala *Phascolarctos cinereus* (Vulnerable, EPBCA) and Squatter Pigeon (southern) *Geophaps scripta* (Vulnerable, EPBCA and NCA)[11].

[10] Black-necked Stork *Ephippiorhynchus asiaticus* (Near Threatened, NCA) was recorded, though has been delisted to Least concern.

[11] Recorded species since delisted: Brigalow Scaly-foot *Paradelma orientalis* (Vulnerable, EPBCA and NCA), Little Pied Bat *Chalinolobus picatus* (Near Threatened, NCA), Cotton Pygmy Goose *Nettapus coromandelianus* (Near Threatened, NCA), Freckled Duck *Stictonetta naevosa* (Near Threatened, NCA), Black-necked Stork *Ephippiorhynchus asiaticus* (Near Threatened, NCA), Square-tailed Kite *Lophoictinia isura* (Near Threatened, NCA), and Black-chinned Honeyeater *Melithreptus gularis* (Near Threatened, NCA).

3.2. Existing Information Reviews

Previous searches of public access databases for the project area were rerun to update information previously reviewed for the project area (Austecology 2012). Database searches and mapping reviews included the Australian Government EPBCA Protected Matters Tool, the Queensland Government Wildlife Online, and the Atlas of Living Australia.

The interrogation of the Wildlife Online (DSITIA 2019) and Atlas of Living Australia databases provided data based on a 100km buffer search area from the centre point of the project area (-23.4434 146.3966) (**Attachment A**). The search of the EPBCA Protected Matters Tool (DEE 2018a) was based on a 50km buffer search area from the centre point of the project area (**Attachment B**).

To provide additional information on threatened and migratory species, a variety of reports, plans and studies were reviewed – and include, but not limited to the following:

- Survey reports forming part of EIS and SEIS for major infrastructure projects, including: AARC 2010; GHD 2010; AARC 2011; Unidel 2011b; AMEC 2012; GHD 2012; Austecology 2013; AMEC 2013; GHD 2013 a & b; QCoal Group 2013; and Cumberland Ecology 2015.
- Regional biodiversity and fauna assessment reports: Morgan *et al.* 2002; EPA 2002; Agnew 2007; and DERM 2012a.
- Australian Government threatened species conservation advice statements, including: TSSC 2005a; TSSC 2005b; SEWPaC 2008; SEWPaC 2012; SEWPaC 2013; DE 2014a; DE 2014b; DE 2014c; DE 2015a; DE 2015b; TSSC 2015a; TSSC 2015b; TSSC 2015c; DE 2015; TSSC 2016a; and TSSC 2016b.
- Threatened species profiles, including: Curtis *et al.* 2012; and DEE 2018 a-n.
- National threatened species recovery plans, including: QPWS 2001; Richardson 2006; BTFRP 2007; Hill & Ward 2010; and DERM 2012b.
- Australian Government threatened species impact assessment and / or referral guidelines, including: DEWHA 2009a; SEWPaC 2011a; and DE 2016.

A number of Geographical Information System (GIS) datasets were integrated to reassess baseline information. The datasets included: rectified aerial photography, cadastre and lease boundaries (supplied by Waratah Coal); Queensland Government Queensland Globe online interactive mapping; and Google Earth imagery.

A series of environmental reports were prepared for the project area (ML 70454) through the Queensland Government online reporting portal. Those reports (DES 2018a and DES 2018b) are provided in **Attachments C and D**. These reports provide current information relevant to threatened fauna habitat, and include the following:

- Regional Ecosystems and vegetation community description and mapping (Version 10);
- Regional Ecosystem Biodiversity Status and known special values associated with a Regional Ecosystem type;
- Pre-clearing remnant vegetation description and mapping;
- Distribution of and description of mapped wetland systems, including those natural wetlands that are of “High Ecological Significance”;
- BioCondition benchmarks for Regional Ecosystems or component vegetation community; and
- Biodiversity Significance of habitats.

4. Assessment Findings

As a result of this assessment, a sub-set of 25 MNES fauna were selected for further assessment in regard to their likelihood of occurrence relevant to the project area and surrounding area, i.e.: those species either known to occur within the area surrounding the project area, or likely to occur, or where occurrence was cautiously regarded as possible.

The assessment of the likelihood of species occurrence within the project area was based on the assignment of one of the following categories.

Known – where the species has been recorded within the project area as part of current surveys or previous surveys within the last five years.

Likely – where there is a medium to high probability of occurrence within in the project area. The species has been recorded as part of current surveys within habitats adjacent to the project area and habitat within the project area is considered to be highly suitable[12] and ecological connectivity between suitable habitat off-site and the project area is not considered to be of notable constraint or where the species is highly mobile, and has been recorded within the extent of desktop searches (as defined in the existing information review) and highly suitable habitat is present within the project area[13].

Possible – where there is a low to medium probability of occurrence within the project area. The species has been recorded within the extent of desktop searches (as defined in the existing information review) though habitat within the project area is considered to be only moderately suitable and/or ecological connectivity between record locations and the project area is considered to be a noteworthy constraint. This category may also apply to species rarely recorded in the bioregion that have been recorded within the wider surrounding area, but whose occurrence in areas of suitable habitat within region is highly erratic and unpredictable (e.g. Australian Painted Snipe).

Highly Unlikely/Negligible – Negligible to very low probability of occurrence within the project area. The species has been recorded from habitats within the region or within an area for which the published modelled species' distribution[14] (e.g. categorised as "may occur") incorporates the project area and the project area supports elements of preferred habitat, though habitat is considered marginal[15] or where the species was historically known from the wider area, though would not be considered to occur due to significant, widespread loss/degradation of habitat and/or other threatening processes (e.g. disease, predation by feral species) or there is simply no suitable habitat present within the project area or immediately adjacent to the project area[16].

Tables 4-1 and 4-2 provide the full list of the species assessed and the assigned likelihood of occurrence.

[12] In terms of characteristics including extent, resources and condition.
[13] This category may include species for which there are historical but no recent records (due to inadequate survey effort), and for which there is highly suitable habitat within the project area.
[14] e.g. as published in DEWHA (2009b), SEWPaC (2011a) or as in Garnett *et al.* (2010) (minimum convex polygon that depicts extant taxon's extent of occurrence), or otherwise provided as distribution maps supporting the EPBCA Protected Matters Search Tool and/or the Species Profile and Threats Database (DEE 2019).
[15] Due to small patch size; condition; threatening processes; and/or fragmented habitat with poor or no connectivity with other potentially suitable habitat
[16] This category could include species known from the project area historically, which are now considered unlikely to occur due to significant loss / degradation of habitat and / or other threatening processes (e.g. disease, predation by feral species).

Table 4-1 Threatened Species Summary Assessment

Notes: EPBCA PMR – EPBC Act Protected Matters Report based on a search area of 50km from the centre of the project area. Records within 100km – Confirmed species records derived from a Queensland Government Wildlife Online extract based on a search area of 100km from the centre of the project area.

Species	Status EPBCA	EPBCA PMR	Records within 100km	Likelihood of Site Occurrence	Comments
Koala *Phascolarctos cinereus*	V	✓	✓	**Known**	Likely to be in very low abundance, with comparatively higher value habitat associated with stands of *Eucalyptus tereticornis* within the south-eastern part of the project area, though also potentially riparian habitat along. **Habitat:** A variety of a range of temperate, sub-tropical and tropical forest, woodland and semi-arid communities dominated by eucalypt species.
Squatter Pigeon *Geophaps scripta*	V	✓	✓	**Likely**	Historical record within or adjacent to northern project area boundary (2010 Alpha Coal surveys). **Habitat:** Ground-dweller of drier eucalypt woodland with sparse grass cover in close proximity to permanent water. Known to use improved pasture, though always near permanent water.
Northern Quoll *Dasyurus hallucatus*	E	✓	✓	**Possible**	**Habitat:** Generally, encompasses some form of rocky area for denning purposes with surrounding vegetated habitats used for foraging and dispersal. Eucalypt forest or woodland habitats which have a high structural diversity containing large diameter trees, termite mounds or hollow logs for denning purposes.
Ornamental Snake *Denisonia maculata*	V	✓	x	**Highly Unlikely**	**Habitat:** Known to prefer woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions in Queensland Regional Ecosystem Land Zone 4 supporting deep cracking clays.
Yakka Skink *Egernia rugosa*	V	✓	✓	**Possible**	**Habitat:** Open dry sclerophyll forest, woodland and scrub. Among dense ground vegetation, fallen timber or rock outcrops, in open and low closed scrub, sandplain areas, woodland (brigalow), open dry sclerophyll (ironbark) and lancewood forest.
Red Goshawk *Erythrotriorchis radiatus*	V	✓	x	**Possible**	**Habitat:** Preference for a mosaic of tall vegetation types, i.e. forest / woodland with permanent water, high bird (prey) density. Often in remote terrain (gorge / escarpment country).

Species	Status EPBCA	EPBCA PMR	Records within 100km	Likelihood of Site Occurrence	Comments
Black-throated Finch *Poephila cincta*	E	✓	x	**Known**	Putative record from Bimblebox Nature Refuge (2011). **Habitat:** Grassy, open woodlands and forests, typically dominated by *Eucalyptus*, *Corymbia* and *Melaleuca*, and occasionally in tussock grasslands or other habitats (e.g. freshwater wetlands), often along or near watercourses, or in the vicinity of water.
Greater Glider *Petauroides volans*	V	✓	x	**Highly Unlikely**	An arboreal, nocturnal, primarily folivorous marsupial, dependent on larger tree hollows for shelter and breeding. **Habitat:** Favours taller forests with a diversity of eucalypt species, with relatively old tress and abundant hollows.
Dunmall's Snake *Furina dunmalli*	V	✓	x	**Highly Unlikely**	**Habitat:** Deeply cracking grey to black clay and clay loam substrates. *Acacia harpophylla* forest, vine scrub and woodland and *Callitris glaucophylla* woodland and dry sclerophyll forest with shrubby or mixed shrub-grass ground cover.
Australian Painted Snipe *Rostratula australis*	E	✓	x	**Possible**	Occurrence erratic and unpredictable, seldom remaining long in any locality. **Habitat:** Well vegetated shallow, permanent or seasonal wetlands where if forages on soft muds & in shallow water.
Star Finch *Neochmia ruficauda*	E	✓	x	**Highly Unlikely**	The total population is estimated to consist of ≤50 breeding birds, in four subpopulations. No permanent populations (or, more specifically, areas of permanently occupied habitat) have been identified. **Habitat:** Grasslands and grassy woodlands that are located close to bodies of fresh water.
Painted Honeyeater *Grantiella picta*	V	✓	x	**Highly Unlikely**	Dispersive habits, exhibiting seasonal north-south movements governed principally by the fruiting of mistletoe, with many birds moving to semi-arid habitats following breeding. **Habitat:** Mistletoes in eucalypt forests / woodlands, riparian woodlands, and trees on farmland. Prefers woodlands which support a higher number of matures trees as these host more mistletoes.

Table 4-2 Migratory Species Summary Assessment

Notes: EPBCA PMR – EPBC Act Protected Matters Report based on a search area of 50km from the centre of the project area. Records within 100km – Confirmed species records derived from a Queensland Government Wildlife Online extract based on a search area of 100km from the centre of the project area.

Species	EPBCA PMR	Records within 100km	Likelihood of Site Occurrence	Comments
Fork-tailed Swift *Apus pacificus*	✓	✓	**Likely**	Non-breeding summer migrant. **Habitat:** An aerial insectivore, spending almost most of the time feeding and sleeping on the wing. Not known to land within Australia.
Oriental Cuckoo *Cuculus optatus*	✓	**x**	**Possible**	Summer migrant (mainly November-March). **Habitat:** Wide range of dense to open timbered habitats (woodland to open forests).
Yellow Wagtail *Motacilla flava*	✓	**x**	**Highly Unlikely**	Summer migrant with a predominately near-coastal distribution, thus highly unlikely to occur in western semi-arid habitats. **Habitat:** Open, moist, grassy or muddy areas associated with wetlands, including sewage treatment plants and sports fields.
Sharp-tailed Sandpiper *Calidris acuminata*	✓	**x**	**Possible**	Mainly a non-breeding summer migrant. **Habitat:** Coastal and inland habitats, feeding for invertebrates in mud or shallow water along edges of shallow wetlands, lagoons, dams and sewage farms.
Pectoral Sandpiper *Caldris melanotos*	✓	**x**	**Highly Unlikely**	Uncommon summer non-breeding migrant. **Habitat:** Grassy edges of freshwater and brackish wetlands. Coastal and near-coastal distribution in northern Australia, and coastal and sub-coastal in south-eastern parts.
Curlew Sandpiper Calidris ferruginea	✓	**x**	**Highly Unlikely**	Non-breeding summer migrant. **Habitat:** Occurs on both coastal & inland wetland habitats, though not as widespread as Sharp-tailed Sandpiper. Prefers bare, wet, muddy surfaces and adjoining shallow water margins of fresh, saline, or brackish open water bodies and wetlands
Common Sandpiper *Actitis hypoleucos*	✓	**x**	**Highly Unlikely**	Non-breeding summer migrant. **Habitat:** Occurs on both coastal & inland wetland habitats. Prefers bare, wet, muddy surfaces and adjoining shallow water margins of fresh, saline, or brackish open water bodies and wetlands.
Latham's Snipe *Gallinago hardwickii*	✓	**x**	**Possible**	Non-breeding summer migrant. **Habitat:** Occurs on a variety of freshwater and brackish wetlands and feeds on soft wet ground or in shallow water. Secretive, usually found close to dense ground cover.
Great Egret *Ardea alba*	✓	✓	**Likely**	**Habitat:** Estuaries and littoral habitats, permanent terrestrial wetlands and nearby flooded grasslands.

Species	EPBCA PMR	Records within 100km	Likelihood of Site Occurrence	Comments
Cattle Egret *Ardea ibis*	✓	x	**Possible**	**Habitat:** Typically associated with grazing cattle. Stock paddocks, pastures, croplands, garbage tips, wetlands, tidal mudflats and drains.
Black-eared Cuckoo *Chrysococyx osculans*	✓	x	**Likely**	Breeding summer migrant. **Habitat:** Open woodland, shrubland, and sparsely treed habitats, including farmland.
White-bellied Sea-Eagle *Haliaeetus leucogaster*	✓	✓	**Likely**	**Habitat:** Prefers to hunt over large open waterbodies, though also over adjacent/nearby terrestrial habitats.
Rainbow Bee-eater *Merops ornatus*	✓	✓	**Known**	**Habitat:** Aerial insectivore in a variety of treed habitats, low woody vegetation and adjacent cleared areas in which they forage aerially for mainly insects.

5. Noise Emissions Assessment

Disturbance can be of an anthropogenic source or natural in its origin (e.g. predator response). Anthropogenic disturbance is of concern as it is a form of disturbance that may be less readily adapted to by species', but potentially can be managed if understood (e.g. Cayford 1993; Beale 2007). The primary source of potential disturbance to fauna arising from the proposed development is likely to be linked to noise generated by both construction and operations (aural stimuli). This may directly affect fauna within a zone of influence, though also more broadly, through an indirect effect from alterations to function, usage patterns and through displacement (with potential associated impacts to existing and displaced communities).

5.1. Existing Information and Guidelines

Effective use of communication contributes immediately to an individual's completion of its daily tasks and ultimately to its survival and reproductive success. Animals participate in communication as a means of finding food, acquiring mates, assessing others, evading predation, and defending resources (Bradbury & Vehrencamp 2017).

In any acoustic signalling environment, differences in humidity, temperature gradients, foliage, and topography do generate certain distorting properties that must be overcome to maintain communication effectiveness (e.g. Marten & Marler 1977; Harris 1966; Rabin *et al.* 2003). In any habitat, masking by the historical noise regime has generally resulted from noise sources such as wind, water, and the signals of conspecifics and heterospecifics (e.g. Wiley & Richards 1978; Sutherland & Daigle 1997; Albert 2004).

In response to these historical noise regimes, populations have evolved strategies that minimize acoustic interference between signal and noise (e.g. Wiley & Richards 1978; Rabin *et al.* 2003; Brumm 2004) and thus, resisting the effects of attenuation and degradation to allow for effective signalling in their given habitat (e.g. Marten & Marler 1977; Wiley & Richards 1982; Bradbury & Vehrencamp 2017)

Modern human societies have generated entirely new patterns of noise that are likely to modify both selection pressures and developmental influences on these communicative systems (Karuse 2001; Brumm 2004). It is often the case that the amplitude of anthropogenic noise exceeds that of historical noise and where the spectral characteristics of anthropogenic noise may be unique when compared with historic noise (e.g. Rabin *et al.* 2003; Bradbury & Vehrencamp 2017).

The potential effects of noise on terrestrial fauna has been previously described as including physiological stress responses, physical damage to hearing organs, increased energy expenditure or physical injury while responding to noise, interference with normal animal activities, and impaired communication (e.g. Workman & Bunch 1991; Patricelli & Bickley 2006; Dooling & Popper 2007; Parris & Schneider 2009; Ortega 2012). The ongoing impacts of these effects can include habitat avoidance, reduced reproductive success and increased mortality (e.g. Forman & Deblinger 2000; Rabin *et al.* 2003; Slabbekoorn & Ripmeester 2008; Francis *et. al.* 2009).

Reactions to noise depend on the type of noise produced, including frequency, loudness, consistency, and duration (Rabin *et al.* 2003; Ortega 2012), with a species' susceptibility to disturbance likely to vary considerably with factors such as age, season, weather, and degree of previous exposure (e.g. Cayford 1993; Yasue *et al.* 2003; Yasue 2006), though also complexed by inter- and intra-species variation in responses to adapt acoustically to human-generated noise (e.g. Blumstein *et al.* 2003; Leonard & Horn 2005; Francis *et al.* 2009; Hoskin & Goosem 2010; Potvin *et al.* 2011).

For species heavily reliant on acoustic communication such as birds and frogs, there can be differential impacts of industrial noise between species (e.g. Goosem *et al.* 2007; Parris *et al.* 2009; Ortega 2012). For example, species with low-pitched songs have been found to be more susceptible to the effects of industrial and transportation noise pollution than species with higher-pitched songs / calls, and ultimately affecting occupancy patterns (e.g. Rheindt 2003; Hoskin & Goosem 2007; Parris *et al.* 2009; Francis *et al.* 2009; Goodwin & Shriver 2011; Read *et al.* 2015; Duarte *et al*. 2018).

Stimuli duration can vary from abrupt and brief point sources such as gunshots or sonic booms to continuous, extended sources such as the drone of transportation or industrial noise (Pater *et al*. 2009). Response durations may also range from brief, immediate behavioural responses, such as alerting or flushing, to long-term responses that affect reproductive success of individual and populations (e.g. Black *et al.* 1984; Delaney *et al.* 1999; Pater *et al*. 2009; Francis *et al*. 2009). For some species, sound-level changes of only a few decibels can result in substantial changes in animal responses, though there is evidence to demonstrate notable differences for each combination of species and type of noise (e.g. Grubb *et al.* 1998; Delaney *et al.* 2011).

Persistence of a species in a high-noise environment (e.g. industrial region) may depend on their specific ability to adapt acoustically to human-generated noise (Potvin *et al.* 2011). In response, some species may rapidly habituate to noises that they learn do not pose a threat (e.g. Black *et al.* 1984; Grubb *et al.* 1992; Brown *et al.* 1999; Krausman *et al.* 2004; Lenoard & Horn 2005), whilst disruption of acoustic communication potentially forces others to significantly alter habitat use or abandon otherwise suitable areas (e.g. Rheindt 2003; Dawe & Goosem 2008; Parris *et al.* 2009; Francis *et al.* 2011; Read *et al.* 2015).

The US Department of Transportation (2004) summarises sensitivities of various groups of wildlife as, follows: mammals (< 10 Hz to 150 kHz; sensitivity at 0-20 dB); birds (more uniform than mammals; 100 Hz to 8-10 kHz; sensitivity at 0-10 dB); reptiles (poorer than birds; 50 Hz to 2 kHz; sensitivity at 40-50 dB); and amphibians (100 Hz to 2 kHz; sensitivity from 10-60 dB).

The body of scientific enquiry into this issue is developing, and there remains a limited understanding. As a result, it is not surprising that there are no current government or other widely accepted guidelines in regard to noise levels or thresholds of relevance to terrestrial fauna.

The body of scientific enquiry into this issue is developing, and there are informative research findings, though with limitations as to how these findings could be applied in an assessment of the effects of noise on different species, species assemblages, and particular environments. Observations and findings from research literature and impact assessments which may provide useful context for the assessment of the potential noise impacts associated with the project are provided in **Table 5-1**.

Table 5-2 provides examples of typical sound pressure levels for noise sources within the context of urban, natural, and construction / industrial environments.

Table 5-1 Acoustic Disturbance Impacts to Fauna – Summary of Selected Studies

Assessment Summary	Issues
Francis *et. al.* (2009) investigated potential noise impacts on terrestrial avifauna associated with gas wells in New Mexico. That work detected species-specific avoidance of noisy areas (gas well pads with noisy compressors), e.g. one species avoided gas-well-compressor noise, several species nested significantly farther from well pads with noisy compressors than from gas well pads without compressors, and several other species were detected significantly more often on sites without compressors. Furthermore, they found 1.5x greater density of breeding birds near noiseless energy facilities than near sites with noisy compressors.	Industrial noise disturbance; terrestrial avifauna.
Dooling and Popper (2007) tested 49 avian species responses (both physiologically and behaviourally) to noise impacts. That study found that physical damage to birds' ears occurs either with short-duration but very loud sounds (>140 db(A) for single impulses or 125 db(A) for multiple impulse noises) or continuous (>72hr) exposure to noise >110 db(A). The study findings also suggested that deleterious effects of chronic noise exposure have been suggested to begin at levels as low as 55–60 dB(A) though data on physiological effects was lacking.	Urban noise disturbance; terrestrial avifauna.
Wright *et al.* (2010) investigated waterbird responses to impulsive noise in relation to ambient noise at a site within the Humber estuary (a large field, close to several industrial power plants, and used by shorebirds as a high tide roost). The study findings included the following: that intentional noise disturbance at very low dB(A) levels was highly unlikely to elicit a behavioural response, while at above 65.5 dB(A) a behavioural response of some kind becomes more likely to occur than no response; and that at levels above 72.2 dB(A), flight with abandonment of the site became the most likely outcome of the disturbance. Wright *et al.* (2010) considered that if a non-response and non-flight response were taken to be relatively harmless, and flight responses potentially costly (in terms of energy expenditure), then for those species studied at the site, a costly outcome becomes more likely at ≥69.9 dB(A). The study concluded that it is unclear whether it is the perceived change in impulsive noise in relation to ambient noise, or simply the level of the impulsive sound itself causes the behavioural responses.	Industrial power plant noise disturbance; wetlands; & waterfowl & waders.
Cutts *et al*. (2009) assessed the flight responses and / or behavioural changes of waterbirds to construction noise associated with a major engineering project on wetlands of the Humber estuary (waterbird habitat of international importance). That research concluded that birds were accepting of a wide range of steady state noise levels between 55dB(A) to 85 dB(A). Furthermore, it was thought probable that the greater the difference between the L_{Amax} (highest recorded level at the site) and the L_{Aeq} equivalent continuous noise level (average of the total sound energy measured over the specified time period), then the greater the possibility of disturbance to avifauna.	Industrial noise disturbance; waterfowl & waders.
Manci *et al*. (1988) investigated the basic characteristics of hearing, communication, and orientation signals in 30 North American species of insectivorous mammals. That work concluded that sound levels above about 90 dB are likely to be adversive to mammals and are associated with a number of behaviours such as retreat from the sound source, freezing, or a strong startle response. Sound level below about 90 dB usually cause much less adversive behaviour. Laboratory studies of domestic mammals have indicated that behavioural	Effects of noise; wildlife and domestic animals.

Assessment Summary	Issues
responses vary with noise types and levels, and that domestic animals appear to acclimate to some sound disturbances, bats, and marine mammals.	
Parris and Schneider (2009) assessed the potential impacts of road noise to avifauna in Victoria. That work showed declines in the abundance of Grey Shrike-thrush and Grey Fantail adjacent to busy roads, with those species absent at sites with road noise levels of 67 dB(A) and 72 dB(A) respectively.	Road noise disturbance; terrestrial avifauna.
Kutt and Pearson (1995) assessed potential impacts of a shipping terminal relocation in regard to an established ibis and egret colony on the Ross River, Townsville. In regard to potential noise impacts, they concluded that given the location of the colony (a busy urban environment), the roosting population must to some degree be tolerant or has adapted to current noise levels, but may be potentially susceptible to increases. That assessment recommended use of temporary construction and permanent site acoustic barriers, particularly for construction activities that would produce levels greater than the acceptable level of noise emissions (i.e. dB(A) for the residential area).	Urban & industrial noise; ibis & egret breeding colonies.
Manci *et al.* (1988) investigated the effects of noise on insects, and in part, related to controlling crop pest insects such as meal-moths and flour beetles. Manci et al. (1988) found that some insects (including bees) stop moving when exposed to high noise levels, and that honey bees suspended movements for periods of up to 20 minutes in response to noise intensities between 107-119dB, and did not appear to habituate to the noise.	Effects of noise; invertebrates.
Brown (1990) examined the influence of pre-recorded aircraft noise (65 to 95 dB(A)) on roosting and breeding terns in the Great Barrier Reef, and indicated that maximum responses were restricted to noises >85 dB(A). No conclusions were made on the effect of this on breeding success, however the study identified that acoustic and visual disturbance combined, increased the level of flight response.	Acoustic & visual disturbance; aircraft overflights; terns - roosting & breeding colonies.
Black *et al.* (1984) assessed the effect of low-level military F-16 training flights over wader breeding colonies (comprising egrets, herons, ibis and darter) over two seasons in Florida. Noise levels recorded during overflights (≤152m AGL) ranged from 55 to 100 dB(A). The study found a minor response (birds looking skyward) as noise levels reached 60-65 dB(A), began changing position (typically to an alert posture) at 70-75 dB(A), and when noise levels were from 75-100 dB(A) birds variously either exhibited no response, looked up, or presumed an alert posture. That work also noted the following: birds typically resumed normal position about 1-2 minutes after an overflight; and observed no differences in adult nest attendance, chick feeding rates, or increase in aggressive encounters, resulting from overflights. The study also noted that noise levels within a breeding colony can reach 64 dB(A) during nest building, feeding sessions, etc. (Wiese 1978 in Black *et al.* 1984) and thus, may equal or surpass noise levels during some overflights.	Aircraft noise; waders; breeding colonies.
Gourdie & Jones (2004) found noise levels exceeding 80dBA generated by military jet flyovers elicited a positive dose response in the alert behaviour of harlequin ducks *Histrionicus histrionicus* at their study sites in Labrador, North America. They conducted a before-after-control-impact (BACI) study design to quantify the effects of low-level military jet over-flights on the behaviour of individual harlequin ducks in a 130,000 km2 Military Training Area. Noise generated from low-level passes (30–100 m above ground level) by military jets was sudden in onset and high in amplitude (>100 dBA), substantially above background sound levels both at the two control sites (40–	Aircraft noise; impacts to waterfowl

Assessment Summary	Issues
50 dBA and 60–70 dBA). Harlequin ducks reacted to noise from military jets with alert behaviour, showing a positive dose-response that especially intensified when noise exceeded 80 dBA. Residual effects, i.e. deviations from normal behaviour patterns after initial responses, were decreased courtship behaviour for up to 1.5 hours after, and increased agonistic behaviour for up to 2 hours after military jet over-flights. Direct behavioural responses to military jet over-flights were of short duration (generally <1 min), and were unlikely to affect critical behaviours such as feeding and resting in the overall time-activity budgets of breeding pairs. However, the presence of residual effects on behaviour implied whole-body stress responses that were potentially more serious; these require further study because they are potentially more detrimental than immediate responses, and may not be detected in studies that focus on readily observed overt responses. A dose-response curve relating particular behaviours of harlequin ducks to associated noise of over-flights could be a valuable conservation tool for the research and mitigation of environmental impacts of aircraft and other noise.	
Dawe & Goosem (2008) investigated frequency shifts in birdsong recorded at the edge of the Kuranda Range Road, Far North Queensland. Songs of fifty-nine bird species were recorded along transects adjacent to the Kuranda Range Road and at control sites adjacent to Black Mountain Road. The dominant frequencies of songs from eighteen of these species recorded at locations adjacent to the highway and at two hundred metres into the interior were analysed for evidence of any acoustic modification over distance. Nine of the eighteen species showed significant differences in dominant song frequencies between individuals recorded at the edge of the forest closest to traffic noise and individuals recorded in the forest interior. Of these, five species were considered to have sufficient replication of the effect between individuals to be attributable to traffic noise and not to other potential confounding factors. At least three of the tested species appear to adjust their songs' dominant frequency in order to overcome traffic noise masking. It was concluded that for at least some species, traffic noise can have deleterious impacts on rainforest bird species through adjustment of song frequency, which has the potential to alter energy budgets, increase predation risk and reduce success in reproduction. Furthermore, that traffic noise at current levels appears to cause modification of bird song with the possibility of altered energy budgets to achieve unnatural pitch adjustments, increased risk of predation and reduced success in mate attraction and therefore reduced fitness of individuals near the road. They postulated that pitch adjustments to songs are likely to have metabolic costs for species because of a possible requirement to use more energy to achieve a different pitch, which may result in less energy available for growth and reproduction. Pitch adjustments may also alter the ability of other birds of the same species to detect the song or alter the likelihood of predators detecting the individual. Such changes could, in turn, reduce the fitness of individuals.	Highway traffic noise; impacts to terrestrial avifauna.
Komenda-Zehnder *et al*. (2003) performed 326 experimental overflights over wetlands situated in three different areas of the Swiss lowlands to assess the behaviour of waterbirds before, during and after those overflights. They analysed the influence of type of aircraft and crossing altitude on the proportion of waterbirds showing a stressed behaviour (alarm posture, swimming, flying). That study found that birds returned to a relaxed behaviour (resting, preening, feeding) within five minutes after the overflights, and no short-term habituation or sensitisation was observed. Furthermore, that: the disturbance effect of helicopters was higher than for aeroplanes and the disturbance effect increased with decreasing flight altitude; and that the behaviour of the birds was not significantly influenced if the aeroplanes flew at 300m above ground level (AGL) and if the helicopter flew at 450 AGL or higher. That study concluded that disturbance by aircraft can be reduced significantly if minimum flight altitudes of 450m AGL are implemented.	Aircraft noise; waterbirds.

Assessment Summary	Issues
Dwyer (2010) investigated waterbird responses to a major bridge construction project across the Forth Estuary. For individual bird species in close proximity to the bridge site, round-the-clock construction work had consequences ranging from neutral to considerably negative. Whilst noise impacts were not assessed as a specific impact issue, that study found that overall waterbird abundance increased within the project surrounds, that habitat usage (feeding, loafing, and roost sites) did not significantly alter, though declines were observed for two species (a cormorant and a migratory shorebird, Redshank). The study postulated that for those species which increased in areas next to the construction site, disturbances may have been common and regular enough in nature for birds to habituate (a conclusion drawn from other studies of waterbird responses to other major engineering projects; e.g. Keller 1989, Marsden 2000).	Industrial construction noise: waterfowl & waders.
Antze and Koper (2018) investigated whether industrial noise from petroleum (oil) wells and shallow natural gas (gas) compressor stations in Alberta Canada, prevent Savannah sparrows (*Passerculus sandwichensis*) from responding appropriately to conspecific (Medowlark) alarm calls at nests. They conducted acoustic playback experiments to determine whether Savannah sparrows responded to conspecific alarm calls by delaying feeding visits, and whether this response was impaired by noise-producing natural gas compressor stations, generator- or grid-powered screw pump oil wells, and noise amplitude. They found that greatest impacts on behaviour were detected at the noisiest treatment (compressor stations) where feeding latency was shortened compared with control sites, and proposed that the effect may expose nests to greater predation risk. As noise amplitudes increased, Savannah sparrows took longer to feed following meadowlark playbacks, potentially because noise interfered with interpretation of acoustic cues. The effects of compressor stations on anti-predator behaviour may be best explained by the distracting effects of anthropogenic noise, while increases in feeding latency following meadowlark playbacks may be explained by a heightened response threshold caused by acoustic masking. Industrial infrastructure can influence the reproductive success of wildlife through its impact on perception and interpretation of conspecific signals, but these effects are complex.	Industrial noise; grassland birds.
Duarte *et al.* (2018) studied the acoustic parameters of loud calls and their diurnal pattern in the black-fronted titi monkey (*Callicebus nigrifrons*) to assess if they were affected by noise produced by mining activity in a fragment of Atlantic Forest in Brazil. They installed two passive acoustic monitoring devices to record sound 24 h/day, 7 days every 2 months, for a year. One unit was close to an opencast mine and the other 2.5 km away from it. Both sites presented similar habitat structures and were inhabited by groups of black-fronted titi monkeys. They quantified the noise at both sites by measuring the equivalent continuous sound level every 2 months for 1 year and quantified the emission of loud calls by titi monkeys through visual inspection of the recordings. The close site presented higher ambient noise levels than the far site. The quantitative comparison of loud calls of black-fronted titi monkeys between the two sites showed less calling activity in the site close to the mine than in the site further away. Approximately 20 % of the calls detected at the site close to the mine were masked by noise from truck traffic. Loud calls were longer at the site far from the mine and the diurnal patterns of vocal activity differed in the amount of calling as well as in the timing of peak calling activity between the two sites. The results indicate that mining noise may constrain titi monkeys' long-distance vocal communication. Loud calls occupy a similar frequency band to mining noise, and an increase in ambient noise may be triggering black-fronted titi monkeys to adjust their long-distance communication patterns to avoid masking of their calls. Given that vocalizations are an important means of social interaction in this species, there are concerns about the impact of mining noise on populations exposed to this human activity.	Mining and industrial noise: primates.

Assessment Summary	Issues
Delaney *et al.* (2011) undertook an assessment of the impacts of military training noise (i.e., artillery, small arms, helicopter, and manoeuvre noise) impacts on the Red-cockaded Woodpecker. Dose-response relationships were measured by recording the in-situ response of the red-cockaded woodpecker to actual military training noise events. Proximate response measures included: flushing from nest, recovery time, nest attentiveness, and provisioning of young. Proximate responses were correlated with individual fitness measures such as reproductive success data. Noise levels were characterized by metrics appropriate for each type of noise. That involved frequency weighting that included only noise energy at frequencies that the woodpecker could hear. Overall, woodpeckers had a reduced auditory sensitivity relative to human hearing sensitivity and other species of small birds, especially in the frequency range >4 kHz. Woodpeckers were most sensitive in the 1.5- to 4.0-kHz range. Hearing threshold audiograms for a closely-related species were used to estimate the hearing ability of the red-cockaded woodpecker. These data were integrated into population models to assess impacts at the population level. Three seasons of noise and behavioural data were collected to develop dose-response relationships and to assess noise impacts on individual fitness and at the population level. Over ten thousand hours of video surveillance tapes were obtained at disturbed and undisturbed sites. Data collected from these sites substantially augmented the existing data especially for large calibre fire at close proximity to the source of the noise. Correlation of noise level with RCW productivity was examined using noise contours generated by the BNOISE and SARNAM noise models and training data supplied by Fort Stewart. Data indicate that training noise has no significant impact on the reproductive success of the red-cockaded woodpecker.	Military training noise; avifauna

Table 5-2 Examples of Typical Sound Pressure Levels

Sources: Department of Transportation USA (FTA 2006); European Commission (SCENIHR 2008); Center for Hearing and Communication (CHC 2018); and WorkSafe Queensland (2019).

Noise Source / Observing Situation	Typical Sound Pressure Level (dB SPL)
Normal breathing	10
Leaves rustling in distance / leaves fluttering	10-20
Whisper in an ear	30
Quiet residential area / rural environment with light breezes and some noise from insects, birds and distant traffic / bird calls (distant)	40
Rainfall	50
Normal speech at 1m	60
Passenger car at 10m	60-80
Hair dryer	60-85
Cicadas at 1m / tractor idling	80
Diesel truck at 60kph at 15m / diesel train at 70kmh at 30m	85
Dog bark at 1m / chainsaw idling at 1m	90
Traffic on a busy roadway (freeway traffic) at 10m	80-90
Non-electric lawn mower	65-95
Motor cycle at 10m / angle grinder / car horn at 10m	95-110
Tractor operating under load without a cab / ambulance siren at 30m	100
Shouting in ear / Non-electric chainsaw at 1m	110
Thunder clap	120-125
Jack hammer at 1m	100-130
Jet engine at 100m	110-140
Jet aircraft at 50m	140
Shotgun	170
Construction Equipment	
Generator (<25kva) / pump at 15m	70-76
Air compressor / generator at 15m	81
Concrete mixer / Flatbed truck / dump truck at 15m	85
Jack hammer / rock drill at 15m	88
Small track-type bulldozer (e.g. Caterpillar D5) at 15m	83
Large track-type bulldozer (e.g. Caterpillar D9) at 15m	92
Graders (e.g. Caterpillar models 12F to 16) at 15m	72-92
Backhoe / loader (e.g. Caterpillar 426F2) at 15m	82-92
Wheel front loader (e.g. Caterpillar 980) at 15m	84-96
Overhead Cranes (e.g. Grove GMK5120B) at 15m	84-94
Pile driver (impact) at 15m	110

Notes: According to Anderson *et al.* (1973), a sound level change of 1 dB can barely be detected by humans, while changes of 2 to 3 dB are barely noticeable. Also, that: a change of 5 dB (is readily noticeable), a change of 10 dB (perceived as a doubling in loudness); a change of 20 dB (represents a dramatic change); and a change of 40 dB (represents the difference between a faintly audible sound and a very load sound).

5.2. Impact Assessment and Mitigation

A noise impact assessment for the project has been undertaken (Acoustics RB 2019). For all aspects of the project activities, the potential noise impact on the surrounding area has been subject to modelling. Noise producing activities, locations and anticipated equipment requirements are summarised in the Acoustics RB (2019) report. **Table 5-2** also provides examples of typical sound pressure levels for noise sources within the context of urban, natural, and construction / industrial environments.

Numerous sensitive receptors were identified as part of the noise assessment undertaken as part of the Galilee Coal Project EIAs, and employed within the current modelling. The suite of sensitive receptors employed for the current modelling also includes a subset specifically located within all representative fauna habitats (ecologically sensitive receptor sites), including remnant and non-remnant vegetation, wetland[17], and riparian habitats[18] (**Figure 6-1**).

Operational noise levels were predicted for the "worst-case" situation (i.e. most adverse atmospheric conditions generating the likely highest level of noise emission under 2x700MW output) but no attenuation applied to the power station noise sources to achieve noise level limits specific to a variety of affected receptors, including residential premises (e.g. Glen Innes on Bimblebox).

The SoundPLAN model outputs for the "worst-case" situation[19] shows that the highest predicted noise level within the development footprint reduces to below 65 dBA[20] within approximately 1 km from the power plant (**Figure 5-1**). The distal ends of two relatively narrow linear bands of remnant vegetation occur within 1 km of the power plant (and within the industrial precinct), though this vegetation, and the remainder of these bands of vegetation do not represent quality habitat any of the threatened fauna species considered in this report (**Figure 2-1** and **Figure 6-1**).

The SoundPLAN model outputs for the "worst-case" situation also show that mapped remnant vegetation, mostly narrow bands of riparian vegetation, occur within about 3 km the center of the power plant infrastructure footprint, and could be subject to noise levels of ranging from 45 dBA to 55 dBA (**Figure 2-1** and **Figure 5-1**). These relatively small remnant patches and linear bands, and the power plant infrastructure itself, are located within an extensive area of cleared pastoral land which does not support suitable remnant habitat for any of the threatened fauna species considered in this report (**Figure 2-1**).

Larger areas of remnant vegetation habitat, approximately 6 km to the south-west of the power plant, have potential to support several of the threatened species discussed with this report, though the closest record (Squatter Pigeon southern) is approximately 8.5 km from the power plant (**Figure 6-1**). The SoundPLAN model outputs for the "worst-case" situation show that the highest predicted noise level at

[17] The Queensland Government biodiversity and conservation values report (**Attachment D**) maps a variety of very small Palustrine Waterbodies (Map 4), with several mapped as "wetlands of high ecological significance" (Map 6) – one to the north of MLA 70454, four to the east of the MLA, one to the south of the MLA, and three within the MLA (the closest being two very small wetlands approximately 6 km to the south-west of the project area). The majority of the wetlands on Map 6 are categorised as medium to very low significance.

[18] Noting that the Queensland Government Aquatic Conservation Assessment of riverine values shows that the significance of those ecosystems across the majority of the site (project area and wider surrounding area) were considered to be low to very low significance (**Attachment D**).

[19] i.e. 2x700 MW operations (all noise sources), at night, with a temperature inversion (Class G), and no attenuation.

[20] Collectively, research findings reviewed for this assessment indicate that intentional noise disturbance below 65.5 dB(A) was less likely to elicit strong behavioural responses (e.g. Black *et al.* 1984*;* Dooling & Popper 2007; Parris & Schneider 2009; Wright *et al.* 2010).

approximately 6 km from the power plant (an area including potential and / or known habitat for threatened MNES) reduces to between 35 to 40 dBA and reducing to below 30 dBA at approximately 8.5 km from the power plant, being noise levels well below those associated with negative impacts to fauna (**Figure 5-1**).

As noted previously, there is a mapped wetland protection area within MLA 70454 (approximately 8 km to the south-west of the proposed power plant), with others located 9 to 14 km to the south, and 12 km to the north of the proposed power plant (**Figure 6-1**). Wetlands, and their protection areas, within the Great Barrier Reef catchments are subject to Queensland State Development Assessment Provisions (SDAP) through the State Code 9[21]. The State Code 9 is supported by non-statutory guideline to determine compliance with environmental requirements of the Code for development in a GBR wetland protection area.

The non-statutory guideline's Performance Outcome 8 (PO8) requires that development protects wetland fauna form impacts including noise disturbance. Noise modelling outputs clearly show that predicted noise levels relevant to all GBR wetland protection areas are between 20 to 30 dBA, being well below those associated with reported negative impacts to fauna (**Figure 2-1**, **Figure 5-1**, and **Table 5-1**)[22].

Collectively, research findings reviewed for this assessment indicate that intentional noise disturbance below 65.5 dB(A) was less likely to elicit strong behavioural responses (e.g. Black *et al.* 1984*;* Dooling & Popper 2007; Parris & Schneider 2009; Wright *et al.* 2010). It is clear that there is no suitable habitat for threatened MNES within the predicted footprint of noise levels above 65.5 dBA (**Figure 5-1** and **Figure 6-1**).

SoundPLAN model outputs for the "worst-case" situation also demonstrate that potential and / or known habitat for threatened MNES are subject to comparatively low predicted noise levels (e.g. from 20 to 40 dBA) which have not been associated with negative impacts to fauna within the existing scientific research (**Figure 2-1**, **Figure 5-1**, and **Table 5-1**).

It is concluded that the predicted noise levels generated by construction activities and the operations would not generate a significant impact to threatened or migratory fauna species assessed in this report. This conclusion is underpinned by the successful implementation of the regime of noise mitigation measures described in Acoustics RB (2019).

[21] *State Code 9: Great Barrier Reef wetland protection areas*

[22] Collectively, research findings reviewed for this assessment indicate that intentional noise disturbance below 65.5 dB(A) was less likely to elicit strong behavioural responses (e.g. Black *et al.* 1984; Dooling & Popper 2007; Parris & Schneider 2009; Wright *et al.* 2010).

Acoustics RB Pty Ltd

Figure 5-1 SoundPlan Noise Model Outputs - Worst Case Scenario

$L_{Aeq,T}$ Noise Levels

Proposed Galilee Power Project
2x700MW All Noise Sources
Night Time Temperature Inversion (Class G)
No Attenuation

N

Hoparivile Homestead
R20
Alpha Coal Project (URS, 2011)

Kia Ora Homestead
R2
Waratah Coal (Galilee Coal Project)

Tressillian Homestead
R19

Monklands
R8
Waratah Coal (Galilee Coal Project)

Workers Camp

Bimblebox Nature Refuge

Glen Innes Homestead
R12
Waratah Coal (Galilee Coal Project)

Mentmore Homestead
R11

Gadwell Homestead
R10

Salt Bush Homestead
R9

$L_{Aeq,T}$ Noise Level (dBA)

= 0
= 5
= 10
= 15
= 20
= 25
= 30
= 35
= 40
= 45
= 50
= 55
= 60
= 65
= 70

A3 Scale 1:100000

0 500 1000 2000 3000 4000 5000 6000 7000 8000 9000 10000 m

6. Air Emissions Assessment

6.1. Existing Information, Guidelines and Legislation

The ecological impacts of air pollution (derived from sources including coal-fired power plants) on natural and semi-natural ecosystems have been primarily studied in the temperate and boreal regions of Europe and North America and, more recently, in steppe and sub- tropical areas of China, and on Mediterranean Basin ecosystems (Paoletti, 2006; Xia & Wan 2008; Bobbink *et al.* 2010; Dudley & Stolton 2011; Ochoa-Hueso *et al.* 2017; and Yue *et al.* 2017). A key focus of such studies, in regard to coal-fired power stations, relates to deposition of nitrogen oxides (SO_2 and NO_x)[23], hydrocarbons, and the formation of ozone pollutants.

In contrast, there is a paucity of research on air pollution impacts to biodiversity for environments of the southern hemisphere. It is expected that these environments will differ from the better-studied ecosystems of the northern hemisphere (particularly in Australia) in critical aspects that justify their separate consideration, such as their much-higher levels of biodiversity (particularly for plants) and their higher-than-average levels of biologically-relevant spatial and temporal environmental heterogeneity, including the characteristic summer drought period.

Animals are exposed to air pollutants via three pathways: 1) inhalation of gases or small particles; 2) ingestion of particles suspended in food or water; or 3) absorption of gases through the skin. In general, only soft-bodied invertebrates (e.g. earthworms), or animals with thin, moist skin (e.g. amphibians) are affected by the absorption of pollutants (US EPA 2018).

An individual's response to a pollutant varies greatly and depends on the type of pollutant involved, the duration and time of exposure, and the amount taken up by the animal (e.g. Llacuna *et al.* 1995; European Commission 2013; Dutta 2017). The individual's age, sex, health, and reproductive condition also play a role in its response (e.g. Isaksson 2010; US EPA 2018), as does its ability to adapt by implementing behavioural responses to changing conditions (e.g. Newman *et al.* 1985; Ormerod & Tyler 1986; Eriksson 1986; Alvo 1986; Eeva *et al.* 2005). There is a great deal of variability between animal classes, species, and even genotypes, in terms of the level of tolerance to a particular pollutant (e.g. Richkind & Hacker 1980; Mallinowski 1992; Llacuna *et al.* 1995; Dudley & Stolton 2011).

Measurable effects on wild animals, when they do occur, are generally due to either loss of food or loss of ability to reproduce (e.g. US F&WS 1982; Dudley & Stolton 2011; Eva & Lehikoimen 2015). For example, studies on mammals and birds have found the strongest links between declines and loss of food species, whereas animals of slightly lower orders, including particularly amphibians and fish, impacts are more commonly related to loss of reproductive capacity and often through freshwater acidification (e.g. Jap 1979; Hagstrom 1980; Lechowicz 1981; Grodzinka 1983; Berlekam 1985; US EPA 2018).

Studies have also shown that exposure to air pollutants (particularly O_3, SO_2, and NO_x) cause morphological and physiological changes (e.g. Isaksson 2010; Cruz-Martinez *et al.* 2015; Sanderfoot & Holloway 2017). For example, exposure to air pollution, has been shown to cause respiratory distress in birds, impair immune response, and increases their susceptibility to respiratory infection (e.g. Llacuna *et al.* 1993; Gorriz *et al.* 1994; Cuesta *et al.* 2005), and has been linked to genotoxic effects in birds, including higher rates of heritable genetic mutations (e.g. Baesse *et al.* 2015; Sanderfoot & Holloway 2017). Both

[23] Acid rain, being precipitation, whether rain or snow, where the water has an acidity greater than normal (effectively a pH of less than 5.7). It derives from interaction of water vapour in air with sulphur and nitrogen oxides formed by combustion of fossil fuels. Acidification can also result from “dry deposition” where sulphur and nitrogen oxides fall to the earth as dry gases and are converted to acids through the action of rainwater.

the direct, toxic effects of exposure to atmospheric contaminants as well as the indirect effects of air pollution on avifauna (i.e. shifts in food availability) have been linked to impaired reproductive success (e.g. Belskii *et al.* 2005; Eva & Lehikoimen 2015) and that species-specific differences in reproductive success following exposure to air pollution could lead to shifts in the composition of avian communities (e.g. Eeva *et al.* 2012; Sanderfoot & Holloway 2017).

Observations and findings from research literature and impact assessments, which provide useful context to the assessment of the potential gaseous emission impacts associated with the project and key fauna of relevance to the project area, are provided in **Table 6-1.** Whilst these investigations are useful in helping to identify the existence and scale of the problem relating to biodiversity and air pollution in the Northern Hemisphere, there is an absence of parallel research relevant to Australian conditions.

In Australia, there are four air pollutants that have been monitored most extensively and have well-established regulations and standards, i.e. coarse and fine particulate matter (PM_{10} and $PM_{2.5}$), sulphur dioxide (SO_2) and oxides of nitrogen (NO_x) (NPI data 2019)[24]. Coal-fired power stations are the biggest source of $PM_{2.5}$, SO_2 and NO_x in Australia (NPI data 2019).

The *National Environment Protection (National Pollutant Inventory) Measure* (NPI NEPM) sets out agreed National objectives for protecting or managing particular aspects of the environment, with regulation implemented by State governments. In Queensland, the NPI NEPM, as it relates to gaseous emissions, is implemented under the *Environmental Protection (Air) Policy 2008*. There are no national standards for power station emission, with emission limits set by each State government.

The *Environmental Protection (Air) Policy 2008* is the only emissions regulation in Australia that sets standards in regard to biodiversity, with one of the key environmental values to be protected, being *the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems* (section 7 (a)). Air quality objectives, relevant to biodiversity, are identified for the following indicators: Fluoride; NO_2, Ozone, and SO_2.

[24] National Pollution Inventory, Department of the Environment and Energy, Australian Government. www.npi.gov.au/npi-data/search-npi-data

Table 6-1 Emission Impacts to Biodiversity – Summary of Selected Studies

Assessment Summary	Issues
Singh *et al.* (1994) investigated emission impacts of two coal-fired super thermal power plants (2,000 MW and 285MW capacities) on the structure of herbaceous communities in a dry tropical region of India. The higher capacity plant was fitted with efficient electrostatic precipitators, whilst the other, was not equipped with efficient control devices. That work found a significant correlation between ambient SO_2 concentration and species diversity, suggesting selective elimination of sensitive species form heavily polluted study sites. That work concluded that differences in the sensitivity of species may be due to their different strategies and life forms. The most sensitive species were found to be annual herbs with hygromorphic or mesomorphic leaves requiring a higher moisture content, whilst grasses were regarded as mostly resistant to the thermal power plant emissions. The study did not identify any critical pollutant loads or thresholds for consideration of impact mitigation.	Coal-fired thermal power plants; impacts to herbaceous community structure.
Rosenberg *et al.* (1979) investigated the effects of sulphurous emissions from a coal-burning power plant on the vegetation of a mixed pine-oak forest in North America. That work found that species diversity and importance values of certain species were inversely related to distance from the source of emission. Differences with distance were greater downwind than upwind. That study concluded that species richness and diversity were more sensitive indicators of pollution damage than growth assessments of individual overstorey species or groups of species. The study did not identify any critical pollutant loads or thresholds for consideration of impact mitigation.	Coal-fired TPP emissions; impacts to plant species richness and forest community structure.
Pandey *et al.* (2014) investigated the effects of coal mining activities on the community structures of woody and herbaceous plants. Air monitoring, soil physico-chemical and phytosociological analyses was undertaken in two regions within the eastern part of India. The study recorded distinct changes in the community structure at both coal mining areas. The changes in species diversity observed at mining areas indicated an increase in the pro- portion of resistant herbs and grasses showing a tendency towards a definite selection strategy of ecosystem in response to air pollution and altered soil characteristics. The findings indicated that sulphate, phosphate, total N and total organic carbon concentrations in soil and TSP, SO_2 and NO_2 in ambient air were major factors governing the community structure at the coal mining areas. The study did not identify any critical pollutant loads or thresholds for consideration of impact mitigation.	Coal mining emissions; impacts to plant species richness and community structure.
Llacuna *et al.* (1993) investigated the effects produced by emissions from Spanish coal-fired power plants, including mainly SO_2, NO_x and particulates, on natural populations and caged specimens of birds and small mammals. The field-captured species used to evaluate these effects were passerine birds *Parus major* (coal tit) and *Emberiza cia* (rock bunting)), and the rodent *Apodemus sylvaticus* (wood mouse). In parallel to this study on animals captured in the field, they used other animals, *Mus musculus* (house mouse) and *Carduelis* (goldfinch) which were placed in cages near the source of pollution. Some of the animals were killed and their tracheas were removed and prepared for conventional optic studies (1000x) and electron microscopy (TEM and SEM). The results showed that atmospheric air pollutants from coal-fired power plants produce alterations in the tracheal epithelium. In passerine birds, an increase in the mucus which covers the tracheal epithelium, shortening of the cilia, and increase in the number of secretory granules and vesicles were observed. In mammals, variation of the uniformity of the pseudostratified epithelium with a wide stratum of mucus, shortening of the cilia, and increase in the number of secretory granules were observed. The study did not identify any critical pollutant loads or thresholds for consideration of impact mitigation.	Coal mining emissions; impacts to birds & mammals.

Assessment Summary	Issues
Belskii *et al.* (1995a, 1995b, 2005) undertook a series of studies of the impacts of heavy metal and SO_2 emissions from a copper-smelting plant on pied flycatchers in Russia. Results from these studies indicate that reproductive success was impaired at nesting sites closest to point sources of industrial emissions. At nests more than 15 km from the copper smelter, clutch size increased by a factor of 1.5, and both the number of hatched chicks and the number of fledglings per nest doubled compared to nests located in the nearby vicinity of the plant. At those sites closest to the plant, egg mortality was also 3.5 times greater. In addition, the results showed that the proportion of nestlings infested by parasitic fly larvae as well as the severity of infestation (as measured by the average number of fly larvae per infested chick) increased with decreasing distance to the plant. Higher liver indices, reduced haemoglobin concentrations, and greater proportions of immature erythrocytes in nestlings were linked to both the direct toxic effect of air pollutants and greater incidence and severity of parasitic infestation, leading the authors to suggest that exposure to industrial air pollution leads to a general weakening in nestlings, rendering them more susceptible to infestation and subsequent infection.	Copper-smelting plant emissions; impacts to avian health.
Gorriz *et al*. (1994) studied the effects of the ciliar tracheal epithelium of passerine birds and small mammals subjected to NO_2 and SO_2 emissions from a coal-fired power plant in the northeast of Spain. Emission of NO_x, SO_2 and particulates from such plants has led to variation in the percentage of ciliated and non-ciliated cells, as well as the organisation, orientation and morphology of cilia in the tracheal epithelium of goldfinch (*Carduelis carduelis*), rock bunting (*Emberiza cia*), great tit (*Parus major*) and blackbird (*Turdus merula*). The study did not identify any critical pollutant loads or thresholds for consideration of impact mitigation.	Coal-fired thermal power plants; impacts to birds & small mammals.
Harmens *et al.* (2013) reviewed a wide variety of examples of how air pollution control is of benefit to biodiversity and ecosystem services across Europe. A key focus was investigating the benefits of reducing nitrogen enrichment of the environment and the formation of ground-level ozone for biodiversity, particularly plant diversity. The review showed that deposition of reactive nitrogen remains a threat for plant diversity in the future. Particularly so as the effects of excessive nitrogen deposition on the structure and functioning of ecosystems and its biodiversity may not occur instantly, in some instances it may take several decades over which the resilience of soils and vegetation is weakened and impacts become apparent. Large areas in Europe still show exceedance of the nutrient nitrogen critical load and in acids grasslands a reduction in plant diversity due to elevated nitrogen deposition has been shown. So far, little is known about the recovery from historic nitrogen pollution; full recovery might not occur in the future, especially in areas where nitrogen-sensitive plant species have disappeared. Assessments should be extended to other ecosystems and biodiversity indicators (e.g. presence of red list species, soil organisms) for a comprehensive analysis of impacts of excessive nitrogen deposition on biodiversity. Impacts of other atmospheric pollutants also need to be considered. For example, there is a trend towards an increase in the number of benthic invertebrates since the beginning of the 1980's that might be related to a recovery from acidification in fresh water systems across Europe. Also, experiments at different scales have shown that a shift in plant species composition can occur due to ozone exposure. Ozone-sensitive plant species might be outcompeted by more ozone-resistant plant species in areas where the 'uptake' of ozone by vegetation is high (i.e. high phytotoxic ozone dose). However, these observations need to be confirmed by further field-based evidence for impacts of ozone on plant species diversity.	Industrial emissions; impacts of ground level ozone and nitrogen deposition on biodiversity

Assessment Summary	Issues
Yilman *et al.* (2004) investigated the possible effects of the Afsin-Elbistan Coal Power Plant (AECPP) on the environment in Turkey. Soil and plant samples were collected, based on the dominant wind direction, which is from northeast to southwest and they defined the northeast part of the plant as the less contaminated direction (LCD) and the southwest part as the more contaminated direction (MCD). The results indicated that the AECPP created environmental problems and caused contaminations especially in the MCD. The results of the statistical analysis for the measured attributes between the LCD and the MCD showed that there were significant differences for pH, SO_4(-2)-S, Ni and Pb. Significant correlations were found between the distance from the AECPP and some of the measured soil and plant parameters in the MCD. The concentrations of SO_4(-2)-S, Ni and Pb decreased as the distance increased. The AECPP discharge water was also found to support a potential risk for the aquatic life and soil health in the area. The honey quality was also affected negatively by fly ash and emissions.	Coal Power Plant emissions; impacts to soil & plants.
Cruz-Martinez *et al*. (2015) assessed the biological costs of natural exposure to oil sands-related air emissions on birds in Alberta, Canada. Nest boxes for tree swallows (*Tachycineta bicolor*) were erected at sites within 5km of active oil sands mining and extraction, and ≥60km away at one reference site. Passive air monitors were deployed at the nest boxes to measure the impact of pollutants including NO_2, SO_2, O_3, volatile organic compounds, and polycyclic aromatic hydrocarbons (PAHs). That study concluded that exposure to elevated concentrations of ambient air pollutants associated with oil sands activity was linked to increased detoxification effort and suppression of cell-mediated immunity of tree swallows.	Oil sands emissions; immune responses of birds
Dudley and Stolton (2011a) undertook a wide-ranging review of research in regard to the impact of air pollution on biodiversity for the World Wildlife Fund. That work focused on environments and species of the northern hemisphere, and the effects of SO_2 and acidification of terrestrial and aquatic ecosystems. A variety of broad conclusions were proffered, i.e.: air pollution tends to reduce biodiversity, but not necessarily biomass or primary productivity, with losses usually represented by a decline in rarer, more sensitive species, and their places are, on the whole, taken over by commoner and more robust species; that research to date, suggests that air pollution has been involved in decline and extirpation of species, rather than in their extinction; lower life forms are usually more affected by air pollution than higher life-forms; in general, plants are more affected by air pollution than animals on land, but not in freshwater; most affected species decline due to pollution, but a minority increase; impacts on higher animals (mammals) are most commonly linked with food loss and reproductive effects, rather than to direct toxic effects on adults; impacts to animals of lower life orders (amphibians, fish) were more commonly related to loss of reproductive capacity; responses to air pollution differed markedly within many animal groups where each combination has a slightly different effect and combinations can sometimes produce a joint effect greater than the sum of individual effects (synergism) and on other occasions effectively cancel each other out; pollution impacts are further complicated by the fact that in most situations pollutants are acting in the presence of other factors which themselves have an impact on ecosystems;.	Air pollution; impacts to biodiversity

Assessment Summary	Issues
Dudley and Stolton (2011b) A summary of biodiversity impacts from air pollution was as follows: Blue-green algae are particularly susceptible to a range of air pollutants, and some species are at risk in polluted areas; lichens were probably the single group showing the strongest responses to pollution, both from dry deposited SO_2 and from wet acid deposition (with many local and some national extirpations); bryophytes were similarly highly sensitive to many air pollutants, particularly for tree-living or bog mosses; many mycorrhizal fungi decline in acidified environments; increasing body of evidence for decline of herbaceous flowering plants, both through SO_2 pollution and on acidified soils; broad leaved and conifer trees declining in polluted environments, due to the impacts of both air pollution and other stress factors (the multiple stress problem); micro-organisms such as zooplankton decline in diversity in acidified waters, and soil micro-organisms decline in acid soils; almost all lower soft-bodied invertebrates in decline in acid waters, with a decline in many species, such as earthworms in acidic soils; many crustaceans and insects decline in acid waters, although a minority of insect species thrive in the absence of competition, with fragmentary information suggesting that many species are likely to decline on land due to air pollution; fish species show a range of responses to acidification, with some disappearing in slightly acid waters and others able to withstand even fairly severe acidification; many amphibian species decline in acidified waters, primarily due to reproductive failure; no information has been found on reactions of reptiles to acidification or air pollution; a minority of bird species decline due to food chain effects from losses, particularly in acidified waters, while other species have proved adaptable enough to cope with any changes, with others are apparently directly affected by SO_2; and whilst there was much evidence for build-up of heavy metals and sulphur in mammals in polluted environments, the main effects noted for mammals come from food chain effects in species such as the otter and elk.	Air pollution; impacts to biodiversity
Carlson and Adriano (1993) reviewed a wide variety of studies concerning impacts of coal combustion residues, including fly ash, bottom ash, flue gas desulfurization waste (scrubber sludge), fluidized bed boiler waste, and coal gasification ash, which account for 90% of all fossil fuel combustion wastes produced in the USA. The major potential impacts of ash disposal on terrestrial ecosystems include: leaching of potentially toxic substances from the ash into soils and groundwater; reductions in plant establishment and growth on the ash; changes in the elemental composition of vegetation inhabiting the ash; and increased transfer of elements through the food chain. The potential for groundwater contamination due to leachate from ash disposal sites is the primary area of concern regarding the disposal of these wastes due to the elevated concentrations of soluble salts and potentially toxic trace elements, including As, Ba, Cd, Cr, Pb, Hg, and Se, present in many fly and bottom ashes. Leachate pH varies depending on the composition of the ash, with ash from high-S coals generally producing acidic leachate and ash from low-S coals producing alkaline leachate. The major factors limiting vegetation establishment on ash disposal sites are: (i) deficient supplies of essential nutrients, usually N and P; (ii) toxicity caused by high pH and/or high soluble salt concentrations, high B, and high concentrations of other potentially toxic trace elements; and (iii) the presence of compacted and/or cemented layers in the ash.	Environmental impacts of coal combustion residues
Isaksson (2010) undertook a review of the published data on wild terrestrial animals to reveal general trends regarding the effects of pollution on oxidative stress. The main findings of this meta-analysis reveal that: there was an overall significant increase in oxidative stress in animals living in polluted environments; this significant increase in oxidative stress was driven by a tendency to an overall accumulation of oxidative damages, although, birds specifically, showed significantly upregulated antioxidant defence in polluted environments, which may have protected them against increased damage; the impact of the significantly increased oxidative stress in adults, but not in juveniles, was difficult to interpret, with studies needed to link physiology to population dynamics (e.g. reproduction and mortality) to evaluate if oxidative stress is the unifying feature underlying the effects.	anthropogenic pollution; oxidative stress to wildlife.

Assessment Summary	Issues
Sanderfoot & Holloway (2017) implemented a major review of the published scientific literature in regard to the potential impact of reactive atmospheric gases and aerosols on avian species. The study found consistent evidence for adverse health impacts on birds attributable to exposure to gas-phase and particulate air pollutants, including carbon monoxide (CO), ozone (O_3), sulphur dioxide (SO_2), smoke, and heavy metals, as well as mixtures of urban and industrial emissions. Avian responses to air pollution include respiratory distress and illness, increased detoxification effort, elevated stress levels, immunosuppression, behavioural changes, and impaired reproductive success. Exposure to air pollution may furthermore reduce population density, species diversity, and species richness in bird communities.	Industrial and urban air pollution: impacts to avifauna.

6.2. Impact Assessment and Mitigation

The *Environmental Protection (Air) Policy 2008* is the only emissions regulation in Australia that sets standards in regard to biodiversity, with one of the key environmental values to be protected, being *the qualities of the air environment that are conducive to protecting the health and biodiversity of ecosystems* (section 7 (a)).

Air quality objectives, relevant to biodiversity, are identified for the following indicators: Fluoride; NO_2, Ozone, and SO_2.

The specific air quality objectives for these are as follows:

- Fluoride – 2.9 µg/m^3 over a 24hr-period; 0.84 µg/m^3 over a 30-day period; and 0.5 µg/m^3 over a 90-day period[25].
- Nitrogen dioxide- 33 µg/m^3 over a one-year period; or 0.016 ppm over a one-year period[26].
- Ozone – 3 ppm-hr over a three-month period[27]; or 10ppm-hr over a six-month period[28].
- Sulphur dioxide - 22 µg/m^3 over a one-year period; or 0.0075 ppm over a one-year period[29].

Numerous ecological sensitive receptors were identified as part of the air quality assessment undertaken as part of the Galilee Coal Project EIAs. The suite of sensitive receptors has included those set within all representative fauna habitats, including remnant and non-remnant vegetation, wetland, and riparian habitats (**Figure 6-1**).

Air quality modelling has been developed to assess predicted levels of a wide variety of air pollutants at those sensitive receptors from the power plant operations, including Fluoride, NO_2, Ozone, and SO_2. That modelling has also taken into account cumulative impacts to the airshed as a result of the mining activities, both on the Galilee Coal Project Mining Lease and on those of adjacent mines (Katestone 2019)[30]. Modelled levels have been referenced against the relevant air quality objectives specified in the *Environmental Protection (Air) Policy 2008*.

The modelling demonstrates that concentrations of Fluoride[31], NO_2[32], Ozone[33], and SO_2[34] in the emissions from the proposed power plant and background, even under worst case scenarios, are well below nominated thresholds and thus, are not expected to exceed the threshold air quality objectives (see **Figures 6-2** to **6-5**).

The air quality modelling assessments also show that standards (thresholds for a wide variety of other pollutants) intended to prevent health effects in sensitive humans are not exceeded (Katestone 2019), and in the absence of evidence that wildlife is substantially more sensitive than humans, it is assumed that no effects on wildlife populations would occur during plant operation due to respiring those gases.

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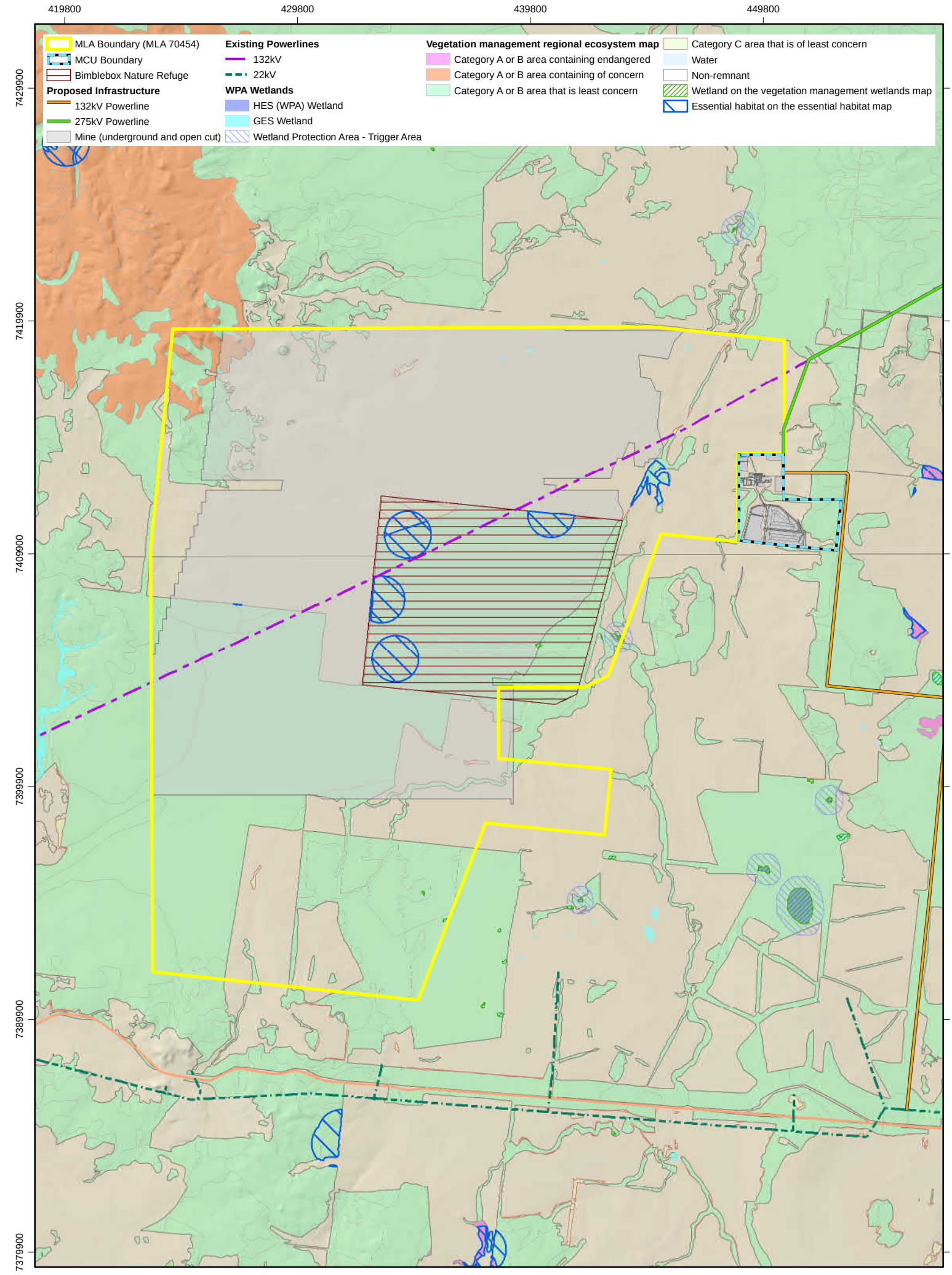
[25] *Environmental value: health and biodiversity of ecosystems other that protected areas.*
[26] *Environmental value: health and biodiversity of ecosystems.*
[27] *Environmental value: health and biodiversity of ecosystems for semi-natural vegetation.*
[28] *Environmental value: health and biodiversity of ecosystems for natural or uncultivated areas.*
[29] *Environmental value: health and biodiversity of ecosystems for forests and natural vegetation.*
[30] A site-specific meteorological data file was developed using TAPM and CALMET models, with modelling accounting for local terrain and land use features of the surrounding region. Emission rates and stack characteristics were determined from the manufacturer's specifications, emission limits, and emissions information provided by Waratah.
[31] i.e. worst-case scenario of 0.0001 to 0.00006 µg/m^3 (over a 30-day period) and 0.0001 to 0.00005 µg/m^3 (over a 90-day period) *cf. Environmental Protection (Air) Policy 2008* thresholds of 0.84 µg/m^3 (over a 30-day period) and 0.5 µg/m^3 (over a 90-day period).
[32] i.e. worst-case scenario 10.8 to 11 µg/m^3, *cf. Environmental Protection (Air) Policy 2008* threshold of 33 µg/m^3 over a one-year period.
[33] As detailed in Katestone (2019), the maximum predicted contribution of the Galilee Power Project to levels of NO_2 at 10km from the site are predicted to be between 60 and 105 ug/m^3 (29 - 51 ppb), depending on load. As an extremely conservative assessment, the total amount of NO_2 emitted could react to produce ozone, resulting in an additional 29 - 51 ppb (62 to 110 ug/m^3) of ozone. Typical ambient background levels of ozone for rural areas area 35 ppb (75 ug/m^3). The maximum predicted cumulative 1-hour average concentrations of ozone would be 185 ug/m^3 which is below the *Environmental Protection (Air) Policy 2008* threshold of 210 ug/m^3 for ozone.
[34] i.e. worst-case scenario 3.65 to 3.8 µg/m^3, *cf. Environmental Protection (Air) Policy 2008* threshold of 22 µg/m^3 over a one-year period.

It is concluded that the predicted emission levels generated by the proposed operations would not generate a significant impact to threatened or migratory fauna species assessed in this report. There are no specific emission management strategies relating to the protection of wildlife in addition to the project environment management and monitoring plan which will be established to ensure that air quality objectives of the *Environmental Protection (Air) Policy 2008* are met, including those for Fluoride, NO_2, Ozone, and SO_2 as described above, and founded on the management / monitoring strategies described in Katestone (2019).



GALILEE POWER STATION

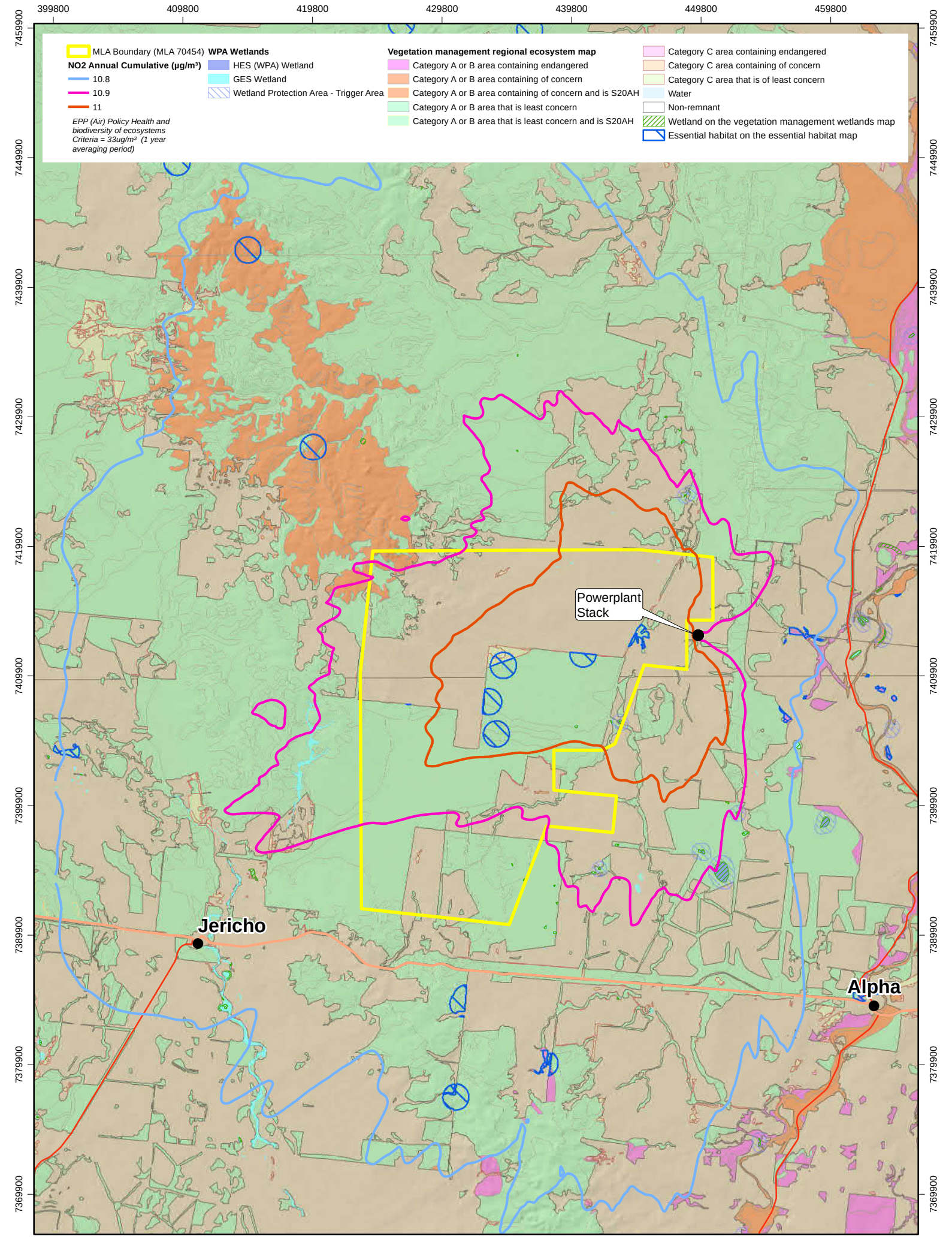
Tenement Boundary: Waratah Coal 2019
Proposed Infrastructure: Waratah Coal 2019
HES (WPA) Wetland / GES Wetland / Trigger Area: DES 2011
Essential Habitat: DNRME 2019
Regional Ecosystems: DNRME 2019
Basemap: Shaded relief DNRM 2006

0 2.5 5 km

A4 Scale 1:200,000
GDA 1994 MGA Zone 55

N

Figure 6-1 Wildlife Habitat Sensitive Receptors - Air and Noise Assessments



GALILEE POWER STATION

Tenement Boundary: Waratah Coal 2019
Proposed Infrastructure: Waratah Coal 2019
HES (WPA) Wetland / GES Wetland / Trigger Area: Dept. of Env. and Science 2011
Essential Habitat: DNRME 2019
Regional Ecosystems: DNRME 2019
Basemap: Shaded relief DNRM 2006

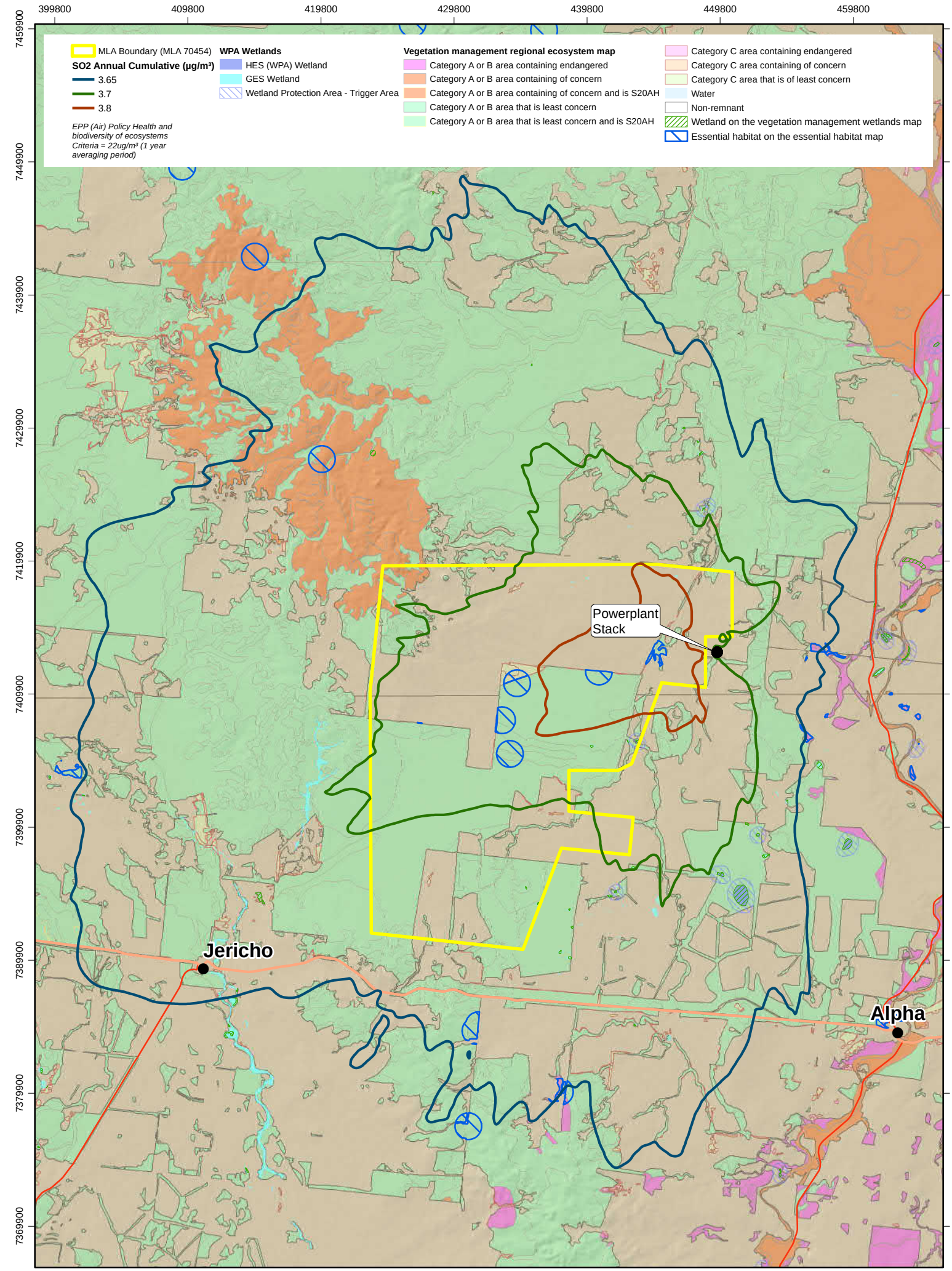
0 5 10 km

A4 Scale 1:350,000
GDA 1994 MGA Zone 55

N

Figure 6-2 Emissions Modelling – Worst Case Scenario for NO2

WC-GPS-06-Fig7-WorstCaseNO2-r1-191025, 25 Oct 2019



GALILEE POWER STATION

Tenement Boundary: Waratah Coal 2019
Proposed Infrastructure: Waratah Coal 2018
HES (WPA) Wetland / GES Wetland / Trigger Area: Dept. of Env. and Science 2011
Essential Habitat: DNRME 2019
Regional Ecosystems: DNRME 2019
Basemap: Shaded relief DNRM 2006

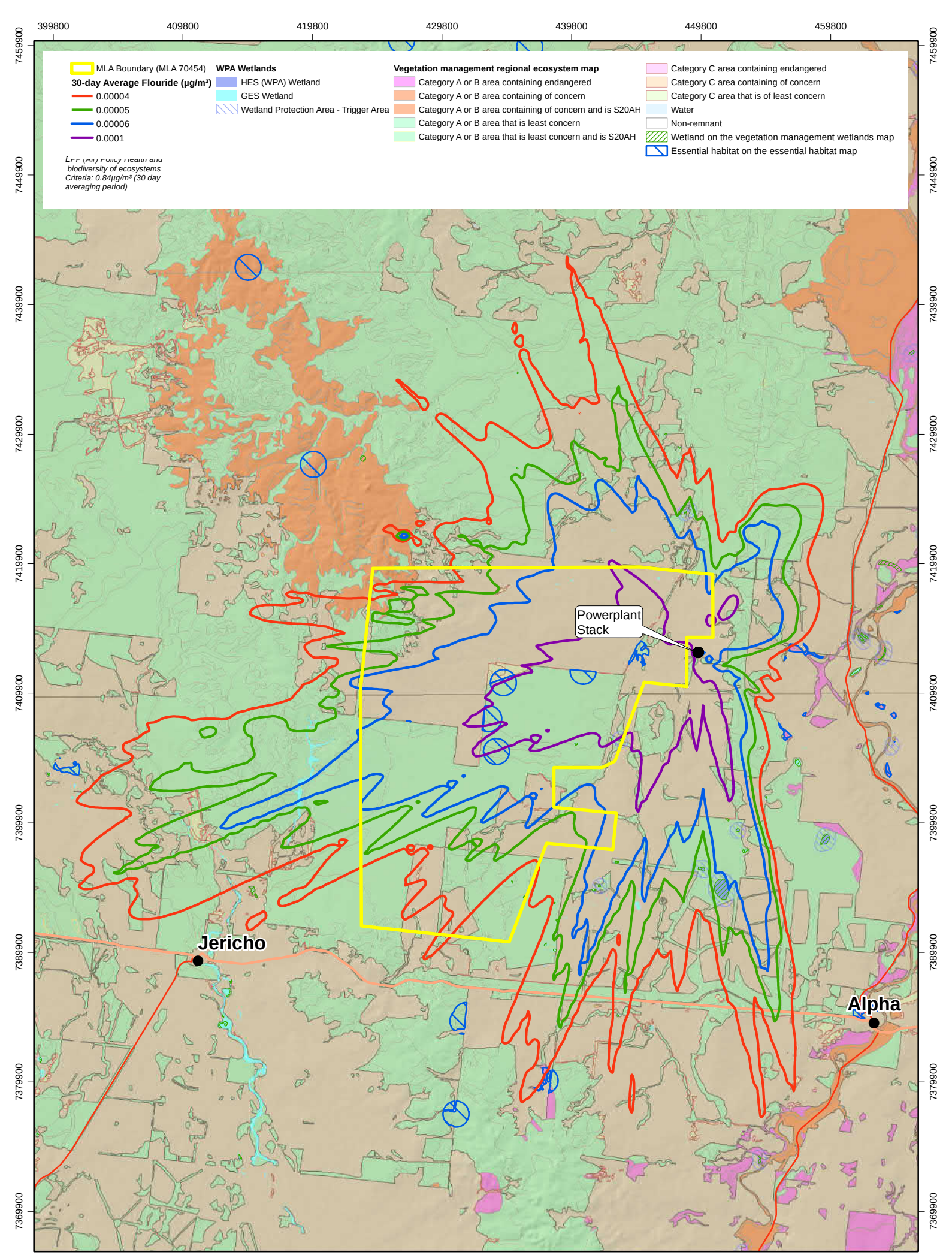
0 4.5 9 km

A4 Scale 1:350,000
GDA 1994 MGA Zone 55

N

Figure 6-3 Emissions Modelling – Worst Case Scenario for SO2

WC-GPS-06-Fig8-WorstCaseSO2-r1-191025, 25 Oct 2019



GALILEE POWER STATION

Tenement Boundary: Waratah Coal 2019
Proposed Infrastructure: Waratah Coal 2018
HES (WPA) Wetland / GES Wetland / Trigger Area: Dept. of Env. and Science 2011
Essential Habitat: DNRME 2019
Regional Ecosystems: DNRME 2019
Basemap: Shaded relief DNRM 2006

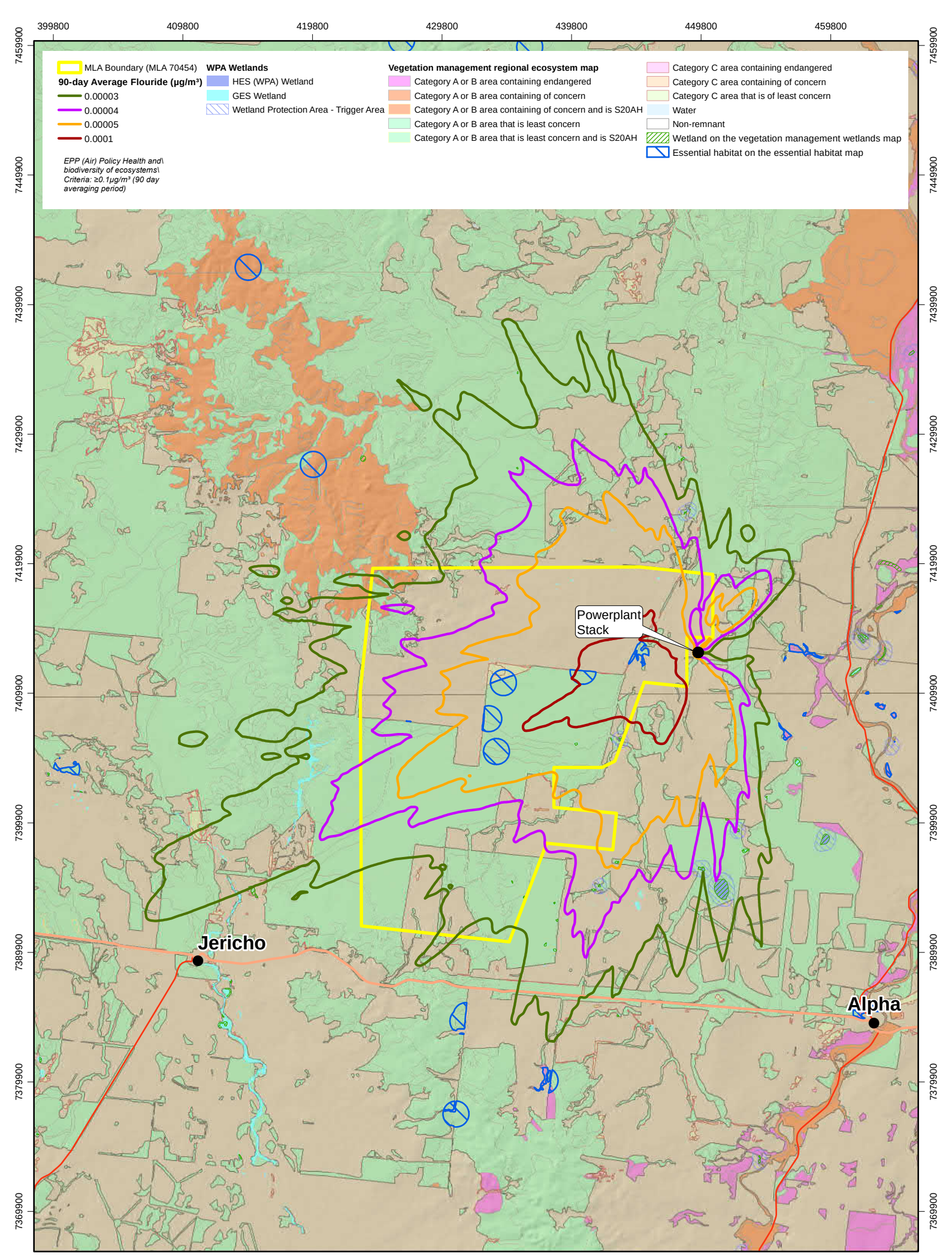
0 5 10 km

A4 Scale 1:350,000
GDA 1994 MGA Zone 55

N

Figure 6-4 Emissions Modelling – Worst Case Scenario for Fluoride (30-day period)

WC-GPS-06-Fig9-WorstCaseFlouride30day-r1-191025, 25 Oct 2019



GALILEE POWER STATION

Tenement Boundary: Waratah Coal 2019
Proposed Infrastructure: Waratah Coal 2019
HES (WPA) Wetland / GES Wetland / Trigger Area: Dept. of Env. and Science 2011
Essential Habitat: DNRME 2019
Regional Ecosystems: DNRME 2019
Basemap: Shaded relief DNRM 2006

0 5 10 km

A4 Scale 1:350,000
GDA 1994 MGA Zone 55

N

Figure 6-5 Emissions Modelling – Worst Case Scenario for Fluoride (90-day period)

WC-GPS-06-Fig10-WorstCaseFlouride30day-r1-191025, 25 Oct 2019

7. Conclusions

The Galilee Power Station is contingent upon the development of the Galilee Coal Project, and areas of habitat assessed as part of this report will be removed or modified as part of the approved the Galilee Coal Project. A suite of potential direct and indirect impacts to fauna (including MNES) was identified within the approved Galilee Coal Project environmental impact assessments. These included:

- Direct loss of habitat and resources as a result of vegetation clearing;
- Habitat fragmentation as a result of vegetation clearing which results in direct loss of fauna movement opportunities, though also indirect degradation of retained habitats;
- Habitat degradation associated with land subsidence following underground mining;
- Direct mortality impacts to terrestrial fauna;
- Alteration of fauna behaviour and habitat use resulting from disturbances associated with construction and operational activities (e.g. impacts associated with light, dust, noise and vibration);
- Introduction of exotic weed and pest species to retained habitats; and
- Alteration to fire regimes to retained habitats.

In support of the approved Galilee Coal Project, a Biodiversity Offset Strategy (BOS) and Fauna Management Plan (FMP) were prepared in order to mitigate impacts to fauna and offset habitat loss, and specifically in regard to MNES fauna (Austecology 2012; Ecofund 2013).

Ecofund (2013) determined the offset requirements of the project based on an assessment of project impacts against the *Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) Environmental Offsets Policy, 2012* (EOP). The total offset proposal accounted for all of the remnant vegetation to be removed, and also for damage remnant vegetation caused by underground mining, commensurate with the level of damage to that vegetation.

The current assessment concludes that, in regard to noise emissions, that the predicted noise levels generated by construction activities and the operations were not expected to have a significant impact to threatened or migratory fauna species assessed in this report. Furthermore, that the predicted emission levels generated by the proposed operations would not generate a significant impact to threatened or migratory fauna species assessed in this report. These conclusions are based on the operational / management / monitoring strategies as described in Acoustics RB (2019) and Katestone (2019).

Thus, in the event that any remnant vegetation previously approved to be cleared, being habitat for MNES fauna, was instead retained on the Galilee Coal Project site, it is concluded that there would not be a significant impact to MNES fauna. Further, the modelled results for both the noise and emissions assessments demonstrate that operations would not generate a significant impact to threatened or migratory fauna species within the surrounding habitats, external to the Galilee Coal Project site.

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Attachment A Queensland Government Wildlife Online Extract

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Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Specified Point
Species: Animals
Type: Native
Status: Rare and threatened species
Records: Confirmed
Date: Since 1980
Latitude: -23.4430
Longitude: 146.3980
Distance: 20
Email: lindsay@austecology.com.au
Date submitted: Wednesday 25 Sep 2019 09:07:41
Date extracted: Wednesday 25 Sep 2019 09:10:13

The number of records retrieved = 2

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	2
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		V	V	1

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Queensland Government

Wildlife Online Extract

Search Criteria: Species List for a Specified Point
Species: Animals
Type: Native
Status: Rare and threatened species
Records: Confirmed
Date: Since 1980
Latitude: -23.4430
Longitude: 146.3980
Distance: 100
Email: lindsay@austecology.com.au
Date submitted: Wednesday 25 Sep 2019 13:50:55
Date extracted: Wednesday 25 Sep 2019 14:00:02

The number of records retrieved = 9

Kingdom	Class	Family	Scientific Name	Common Name	I	Q	A	Records
animals	birds	Columbidae	*Geophaps scripta scripta*	squatter pigeon (southern subspecies)		V	V	24
animals	mammals	Phascolarctidae	*Phascolarctos cinereus*	koala		V	V	5
animals	mammals	Pseudocheiridae	*Petauroides volans*	greater glider		V	V	1
animals	mammals	Pseudocheiridae	*Petauroides volans volans*	southern greater glider		V	V	1
animals	ray-finned fishes	Gobiidae	*Chlamydogobius squamigenus*	Edgbaston goby		E	V	8/7
animals	ray-finned fishes	Pseudomugilidae	*Scaturiginichthys vermeilipinnis*	redfin blue eye		E	E	1/1
animals	reptiles	Elapidae	*Acanthophis antarcticus*	common death adder		V		2
animals	reptiles	Scincidae	*Egernia rugosa*	yakka skink		V	V	1
animals	reptiles	Scincidae	*Ctenotus capricorni*	Capricorn ctenotus		NT		2/2

CODES

I - Y indicates that the taxon is introduced to Queensland and has naturalised.

Q - Indicates the Queensland conservation status of each taxon under the *Nature Conservation Act 1992.* The codes are Extinct in the Wild (PE), Endangered (E), Vulnerable (V), Near Threatened (NT), Least Concern (C) or Not Protected ( ).

A - Indicates the Australian conservation status of each taxon under the *Environment Protection and Biodiversity Conservation Act 1999.* The values of EPBC are Conservation Dependent (CD), Critically Endangered (CE), Endangered (E), Extinct (EX), Extinct in the Wild (XW) and Vulnerable (V).

Records – The first number indicates the total number of records of the taxon for the record option selected (i.e. All, Confirmed or Specimens).
This number is output as 99999 if it equals or exceeds this value. The second number located after the / indicates the number of specimen records for the taxon.
This number is output as 999 if it equals or exceeds this value.

Attachment B EPBC Act Protected Matters Report

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Australian Government
Department of the Environment and Energy

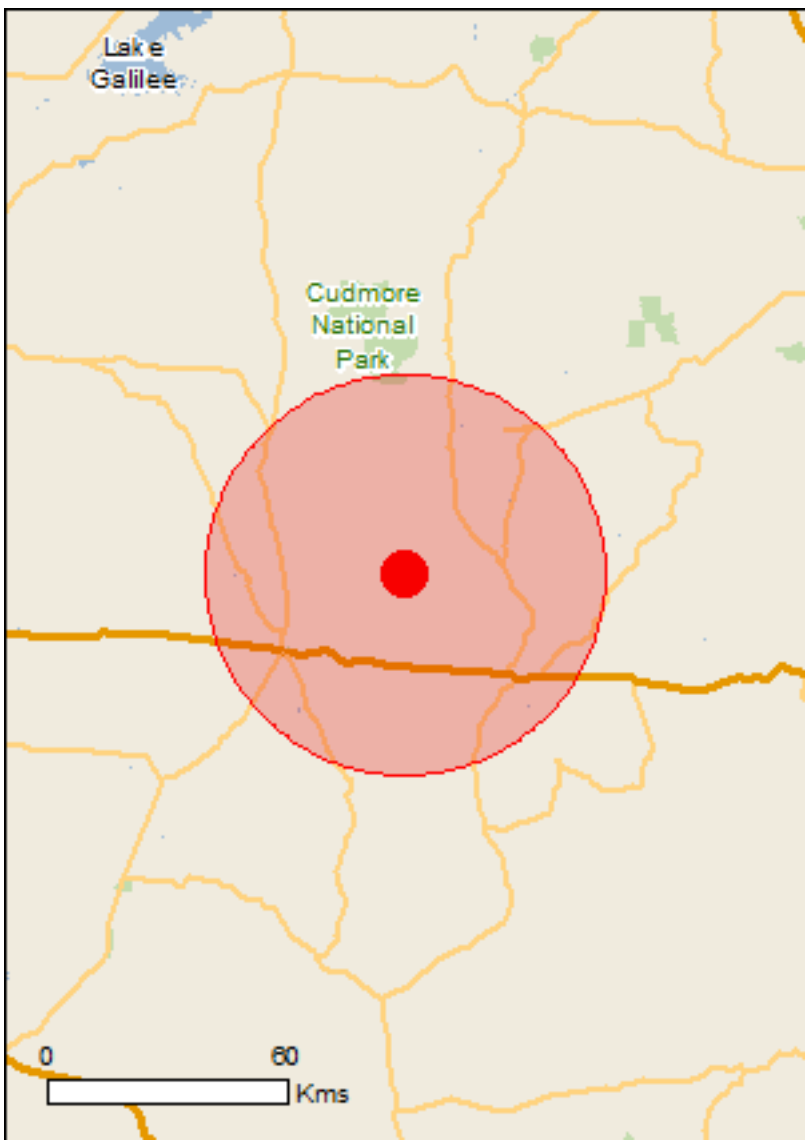
EPBC Act Protected Matters Report

This report provides general guidance on matters of national environmental significance and other matters protected by the EPBC Act in the area you have selected.

Information on the coverage of this report and qualifications on data supporting this report are contained in the caveat at the end of the report.

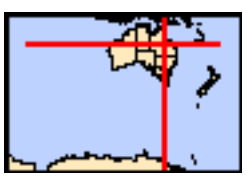
Information is available about Environment Assessments and the EPBC Act including significance guidelines, forms and application process details.

Report created: 17/12/18 18:20:03



This map may contain data which are ©Commonwealth of Australia (Geoscience Australia), ©PSMA 2010

Coordinates
Buffer: 50.0Km



Summary

Matters of National Environmental Significance

This part of the report summarises the matters of national environmental significance that may occur in, or may relate to, the area you nominated. Further information is available in the detail part of the report, which can be accessed by scrolling or following the links below. If you are proposing to undertake an activity that may have a significant impact on one or more matters of national environmental significance then you should consider the Administrative Guidelines on Significance.

World Heritage Properties:	None
National Heritage Places:	None
Wetlands of International Importance:	1
Great Barrier Reef Marine Park:	None
Commonwealth Marine Area:	None
Listed Threatened Ecological Communities:	4
Listed Threatened Species:	17
Listed Migratory Species:	8

Other Matters Protected by the EPBC Act

This part of the report summarises other matters protected under the Act that may relate to the area you nominated. Approval may be required for a proposed activity that significantly affects the environment on Commonwealth land, when the action is outside the Commonwealth land, or the environment anywhere when the action is taken on Commonwealth land. Approval may also be required for the Commonwealth or Commonwealth agencies proposing to take an action that is likely to have a significant impact on the environment anywhere.

The EPBC Act protects the environment on Commonwealth land, the environment from the actions taken on Commonwealth land, and the environment from actions taken by Commonwealth agencies. As heritage values of a place are part of the 'environment', these aspects of the EPBC Act protect the Commonwealth Heritage values of a Commonwealth Heritage place. Information on the new heritage laws can be found at http://www.environment.gov.au/heritage

A permit may be required for activities in or on a Commonwealth area that may affect a member of a listed threatened species or ecological community, a member of a listed migratory species, whales and other cetaceans, or a member of a listed marine species.

Commonwealth Land:	None
Commonwealth Heritage Places:	None
Listed Marine Species:	13
Whales and Other Cetaceans:	None
Critical Habitats:	None
Commonwealth Reserves Terrestrial:	None
Australian Marine Parks:	None

Extra Information

This part of the report provides information that may also be relevant to the area you have nominated.

State and Territory Reserves:	3
Regional Forest Agreements:	None
Invasive Species:	21
Nationally Important Wetlands:	None
Key Ecological Features (Marine)	None

Details

Matters of National Environmental Significance

Wetlands of International Importance (Ramsar) [Resource Information]

Name	Proximity
Coongie lakes	600 - 700km upstream

Listed Threatened Ecological Communities [Resource Information]

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Name	Status	Type of Presence
Brigalow (Acacia harpophylla dominant and co-dominant)	Endangered	Community known to occur within area
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South Bioregions	Endangered	Community may occur within area
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin	Endangered	Community may occur within area
Weeping Myall Woodlands	Endangered	Community likely to occur within area

Listed Threatened Species [Resource Information]

Name	Status	Type of Presence
Birds		
Calidris ferruginea Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Erythrotriorchis radiatus Red Goshawk [942]	Vulnerable	Species or species habitat likely to occur within area
Geophaps scripta scripta Squatter Pigeon (southern) [64440]	Vulnerable	Species or species habitat likely to occur within area
Grantiella picta Painted Honeyeater [470]	Vulnerable	Species or species habitat may occur within area
Neochmia ruficauda ruficauda Star Finch (eastern), Star Finch (southern) [26027]	Endangered	Species or species habitat likely to occur within area
Poephila cincta cincta Southern Black-throated Finch [64447]	Endangered	Species or species habitat may occur within area
Rostratula australis Australian Painted-snipe, Australian Painted Snipe [77037]	Endangered	Species or species habitat may occur within area
Fish		
Maccullochella peelii Murray Cod [66633]	Vulnerable	Species or species habitat may occur within area
Mammals		

Name	Status	Type of Presence
Dasyurus hallucatus		
Northern Quoll, Digul [Gogo-Yimidir], Wijingadda [Dambimangari], Wiminji [Martu] [331]	Endangered	Species or species habitat may occur within area
Macrotis lagotis		
Greater Bilby [282]	Vulnerable	Species or species habitat may occur within area
Petauroides volans		
Greater Glider [254]	Vulnerable	Species or species habitat known to occur within area
Phascolarctos cinereus (combined populations of Qld, NSW and the ACT)		
Koala (combined populations of Queensland, New South Wales and the Australian Capital Territory) [85104]	Vulnerable	Species or species habitat known to occur within area
Plants		
Cadellia pentastylis		
Ooline [9828]	Vulnerable	Species or species habitat may occur within area
Marsdenia brevifolia		
[64585]	Vulnerable	Species or species habitat may occur within area
Reptiles		
Denisonia maculata		
Ornamental Snake [1193]	Vulnerable	Species or species habitat known to occur within area
Egernia rugosa		
Yakka Skink [1420]	Vulnerable	Species or species habitat likely to occur within area
Furina dunmalli		
Dunmall's Snake [59254]	Vulnerable	Species or species habitat may occur within area

Listed Migratory Species [Resource Information]

* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.

Name	Threatened	Type of Presence
Migratory Marine Birds		
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Migratory Terrestrial Species		
Cuculus optatus		
Oriental Cuckoo, Horsfield's Cuckoo [86651]		Species or species habitat may occur within area
Motacilla flava		
Yellow Wagtail [644]		Species or species habitat may occur within area
Migratory Wetlands Species		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within

Name	Threatened	Type of Presence
		area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area

Other Matters Protected by the EPBC Act

Listed Marine Species		[Resource Information]
* Species is listed under a different scientific name on the EPBC Act - Threatened Species list.		
Name	Threatened	Type of Presence
Birds		
Actitis hypoleucos		
Common Sandpiper [59309]		Species or species habitat may occur within area
Apus pacificus		
Fork-tailed Swift [678]		Species or species habitat likely to occur within area
Ardea alba		
Great Egret, White Egret [59541]		Species or species habitat known to occur within area
Ardea ibis		
Cattle Egret [59542]		Species or species habitat may occur within area
Calidris acuminata		
Sharp-tailed Sandpiper [874]		Species or species habitat likely to occur within area
Calidris ferruginea		
Curlew Sandpiper [856]	Critically Endangered	Species or species habitat may occur within area
Calidris melanotos		
Pectoral Sandpiper [858]		Species or species habitat may occur within area
Chrysococcyx osculans		
Black-eared Cuckoo [705]		Species or species habitat known to occur within area
Gallinago hardwickii		
Latham's Snipe, Japanese Snipe [863]		Species or species habitat may occur within area
Haliaeetus leucogaster		
White-bellied Sea-Eagle [943]		Species or species habitat likely to occur within area

Name	Threatened	Type of Presence
Merops ornatus Rainbow Bee-eater [670]		Species or species habitat may occur within area
Motacilla flava Yellow Wagtail [644]		Species or species habitat may occur within area
Rostratula benghalensis (sensu lato) Painted Snipe [889]	Endangered*	Species or species habitat may occur within area

Extra Information

State and Territory Reserves	[Resource Information]
Name	State
Bimblebox	QLD
Cudmore	QLD
Cudmore (Limited Depth)	QLD

Invasive Species	[Resource Information]

Weeds reported here are the 20 species of national significance (WoNS), along with other introduced plants that are considered by the States and Territories to pose a particularly significant threat to biodiversity. The following feral animals are reported: Goat, Red Fox, Cat, Rabbit, Pig, Water Buffalo and Cane Toad. Maps from Landscape Health Project, National Land and Water Resouces Audit, 2001.

Name	Status	Type of Presence
Birds		
Anas platyrhynchos Mallard [974]		Species or species habitat likely to occur within area
Columba livia Rock Pigeon, Rock Dove, Domestic Pigeon [803]		Species or species habitat likely to occur within area
Passer domesticus House Sparrow [405]		Species or species habitat likely to occur within area
Frogs		
Rhinella marina Cane Toad [83218]		Species or species habitat known to occur within area
Mammals		
Bos taurus Domestic Cattle [16]		Species or species habitat likely to occur within area
Canis lupus familiaris Domestic Dog [82654]		Species or species habitat likely to occur within area
Capra hircus Goat [2]		Species or species habitat likely to occur within area
Felis catus Cat, House Cat, Domestic Cat [19]		Species or species

Name	Status	Type of Presence
		habitat likely to occur within area
Feral deer Feral deer species in Australia [85733]		Species or species habitat likely to occur within area
Mus musculus House Mouse [120]		Species or species habitat likely to occur within area
Oryctolagus cuniculus Rabbit, European Rabbit [128]		Species or species habitat likely to occur within area
Sus scrofa Pig [6]		Species or species habitat likely to occur within area
Vulpes vulpes Red Fox, Fox [18]		Species or species habitat likely to occur within area
Plants		
Acacia nilotica subsp. indica Prickly Acacia [6196]		Species or species habitat may occur within area
Cryptostegia grandiflora Rubber Vine, Rubbervine, India Rubber Vine, India Rubbervine, Palay Rubbervine, Purple Allamanda [18913]		Species or species habitat likely to occur within area
Jatropha gossypifolia Cotton-leaved Physic-Nut, Bellyache Bush, Cotton-leaf Physic Nut, Cotton-leaf Jatropha, Black Physic Nut [7507]		Species or species habitat likely to occur within area
Lantana camara Lantana, Common Lantana, Kamara Lantana, Large-leaf Lantana, Pink Flowered Lantana, Red Flowered Lantana, Red-Flowered Sage, White Sage, Wild Sage [10892]		Species or species habitat likely to occur within area
Opuntia spp. Prickly Pears [82753]		Species or species habitat likely to occur within area
Parkinsonia aculeata Parkinsonia, Jerusalem Thorn, Jelly Bean Tree, Horse Bean [12301]		Species or species habitat likely to occur within area
Parthenium hysterophorus Parthenium Weed, Bitter Weed, Carrot Grass, False Ragweed [19566]		Species or species habitat likely to occur within area
Vachellia nilotica Prickly Acacia, Blackthorn, Prickly Mimosa, Black Piquant, Babul [84351]		Species or species habitat likely to occur within area

Caveat

The information presented in this report has been provided by a range of data sources as acknowledged at the end of the report.

This report is designed to assist in identifying the locations of places which may be relevant in determining obligations under the Environment Protection and Biodiversity Conservation Act 1999. It holds mapped locations of World and National Heritage properties, Wetlands of International and National Importance, Commonwealth and State/Territory reserves, listed threatened, migratory and marine species and listed threatened ecological communities. Mapping of Commonwealth land is not complete at this stage. Maps have been collated from a range of sources at various resolutions.

Not all species listed under the EPBC Act have been mapped (see below) and therefore a report is a general guide only. Where available data supports mapping, the type of presence that can be determined from the data is indicated in general terms. People using this information in making a referral may need to consider the qualifications below and may need to seek and consider other information sources.

For threatened ecological communities where the distribution is well known, maps are derived from recovery plans, State vegetation maps, remote sensing imagery and other sources. Where threatened ecological community distributions are less well known, existing vegetation maps and point location data are used to produce indicative distribution maps.

Threatened, migratory and marine species distributions have been derived through a variety of methods. Where distributions are well known and if time permits, maps are derived using either thematic spatial data (i.e. vegetation, soils, geology, elevation, aspect, terrain, etc) together with point locations and described habitat; or environmental modelling (MAXENT or BIOCLIM habitat modelling) using point locations and environmental data layers.

Where very little information is available for species or large number of maps are required in a short time-frame, maps are derived either from 0.04 or 0.02 decimal degree cells; by an automated process using polygon capture techniques (static two kilometre grid cells, alpha-hull and convex hull); or captured manually or by using topographic features (national park boundaries, islands, etc). In the early stages of the distribution mapping process (1999-early 2000s) distributions were defined by degree blocks, 100K or 250K map sheets to rapidly create distribution maps. More reliable distribution mapping methods are used to update these distributions as time permits.

Only selected species covered by the following provisions of the EPBC Act have been mapped:

- migratory and
- marine

The following species and ecological communities have not been mapped and do not appear in reports produced from this database:

- threatened species listed as extinct or considered as vagrants
- some species and ecological communities that have only recently been listed
- some terrestrial species that overfly the Commonwealth marine area
- migratory species that are very widespread, vagrant, or only occur in small numbers

The following groups have been mapped, but may not cover the complete distribution of the species:

- non-threatened seabirds which have only been mapped for recorded breeding sites
- seals which have only been mapped for breeding sites near the Australian continent

Such breeding sites may be important for the protection of the Commonwealth Marine environment.

Coordinates

-23.44335 146.39671

Acknowledgements

This database has been compiled from a range of data sources. The department acknowledges the following custodians who have contributed valuable data and advice:

-Office of Environment and Heritage, New South Wales
-Department of Environment and Primary Industries, Victoria
-Department of Primary Industries, Parks, Water and Environment, Tasmania
-Department of Environment, Water and Natural Resources, South Australia
-Department of Land and Resource Management, Northern Territory
-Department of Environmental and Heritage Protection, Queensland
-Department of Parks and Wildlife, Western Australia
-Environment and Planning Directorate, ACT
-Birdlife Australia
-Australian Bird and Bat Banding Scheme
-Australian National Wildlife Collection
-Natural history museums of Australia
-Museum Victoria
-Australian Museum
-South Australian Museum
-Queensland Museum
-Online Zoological Collections of Australian Museums
-Queensland Herbarium
-National Herbarium of NSW
-Royal Botanic Gardens and National Herbarium of Victoria
-Tasmanian Herbarium
-State Herbarium of South Australia
-Northern Territory Herbarium
-Western Australian Herbarium
-Australian National Herbarium, Canberra
-University of New England
-Ocean Biogeographic Information System
-Australian Government, Department of Defence
Forestry Corporation, NSW
-Geoscience Australia
-CSIRO
-Australian Tropical Herbarium, Cairns
-eBird Australia
-Australian Government – Australian Antarctic Data Centre
-Museum and Art Gallery of the Northern Territory
-Australian Government National Environmental Science Program
-Australian Institute of Marine Science
-Reef Life Survey Australia
-American Museum of Natural History
-Queen Victoria Museum and Art Gallery, Inveresk, Tasmania
-Tasmanian Museum and Art Gallery, Hobart, Tasmania
-Other groups and individuals

The Department is extremely grateful to the many organisations and individuals who provided expert advice and information on numerous draft distributions.

Please feel free to provide feedback via the Contact Us page.

Department of the Environment
GPO Box 787
Canberra ACT 2601 Australia
+61 2 6274 1111

Attachment C Queensland Government Regional Ecosystems Biodiversity Status Report

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Queensland Government

Department of Environment and Science

Environmental Reports

Regional Ecosystems

Biodiversity Status

For the selected area of interest
ml: 70454

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or area of interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "central coordinates" option, the resulting assessment area encompasses an area extending for a 2km radius from the input coordinates.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no matters of interest have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Important Note to User

Information presented in this report is based upon the Queensland Herbarium's Regional Ecosystem framework. The Biodiversity Status has been used to depict the extent of "Endangered", "Of Concern" and "No Concern at Present" regional ecosystems in all cases, rather than the classes used for the purposes of the *Vegetation Management Act 1999* (VMA). Mapping and figures presented in this document reflect the Queensland Herbarium's Remnant and Pre-clearing Regional Ecosystem Datasets, and not the certified mapping used for the purpose of the VMA.

For matters relevant to vegetation management under the VMA, please refer to the Department of Natural Resources, Mines and Energy website

https://www.dnrme.qld.gov.au/

Please direct queries about these reports to: Queensland.Herbarium@dsiti.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.

Table of Contents

Summary Information

The following table provides an overview of the AOI with respect to selected topographic and environmental themes. Refer to **Map 1** for locality information.

Table 1: Area of interest details: ml: 70454

Size (ha)	55,623.46
Local Government(s)	Barcaldine Regional
Bioregion(s)	Desert Uplands
Subregion(s)	Jericho
Catchment(s)	Cooper Creek, Burdekin

The table below summarizes the extent of remnant vegetation classed as "Endangered", "Of concern" and "No concern at present" regional ecosystems classified by Biodiversity Status within the area of interest (AOI).

Table 2: Summary table, biodiversity status of regional ecosystems within the AOI

Biodiversity Status	Area (Ha)	% of AOI
Endangered	46.23	0.08
Of concern	2,810.49	5.05
No concern at present	19,726.90	35.47
Total remnant vegetation	22,583.62	40.6

Refer to **Map 2** for further information.

Regional Ecosystems

1. Introduction

Regional ecosystems are vegetation communities in a bioregion that are consistently associated with particular combinations of geology, landform and soil (Sattler and Williams 1999). Descriptions of Queensland's Regional ecosystems are available online from the Regional Ecosystem Description Database (REDD). Descriptions are compiled from a broad range of information sources including vegetation, land system and geology survey and mapping and detailed vegetation site data. The regional ecosystem classification and descriptions are reviewed as new information becomes available. A number of vegetation communities may form a single regional ecosystem and are usually distinguished by differences in dominant species, frequently in the shrub or ground layers and are denoted by a letter following the regional ecosystem code (e.g. a, b, c). Vegetation communities and regional ecosystems are amalgamated into a higher level classification of broad vegetation groups (BVGs).

A published methodology for survey and mapping of regional ecosystems across Queensland (Neldner et al 2017) provides further details on regional ecosystem concepts and terminology.

This report provides information on the type, status, and extent of vegetation communities, regional ecosystems and broad vegetation groups present within a user specified area of interest. Please note, for the purpose of this report, the Biodiversity Status is used. This report has not been developed for application of the *Vegetation Management Act 1999* (VMA). Additionally, information generated in this report has been derived from the Queensland Herbarium's Regional Ecosystem Mapping, and not the regulated mapping certified for the purposes of the VMA. If your interest/matter relates to regional ecosystems and the VMA, users should refer to the Department of Natural Resources, Mines and Energy website.

https://www.dnrme.qld.gov.au/

With respect to the Queensland Biodiversity Status,

"Endangered" regional ecosystems are described as those where:

- remnant vegetation is less than 10 per cent of its pre-clearing extent across the bioregion; or 10-30% of its pre-clearing extent remains and the remnant vegetation is less than 10,000 hectares, or
- less than 10 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss*, or
- 10-30 per cent of its pre-clearing extent remains unaffected by severe degradation and/or biodiversity loss and the remnant vegetation is less than 10,000 hectares; or
- it is a rare** regional ecosystem subject to a threatening process.***

"Of concern" regional ecosystems are described as those where:

- the degradation criteria listed above for 'Endangered' regional ecosystems are not met and,
- remnant vegetation is 10-30 per cent of its pre-clearing extent across the bioregion; or more than 20 per cent of its pre-clearing extent remains and the remnant extent is less than 10,000 hectares, or
- 10-30 percent of its pre-clearing extent remains unaffected by moderate degradation and/or biodiversity loss.****

and "No concern at present" regional ecosystems are described as those where:

- remnant vegetation is over 30 per cent of its pre-clearing extent across the bioregion, and the remnant area is greater than 10,000 hectares, and
- the degradation criteria listed above for 'Endangered' or 'Of concern' regional ecosystems are not met.

**Severe degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 50 years even with the removal of threatening processes; or soil surface is severely degraded, for example, by loss of A horizon, surface expression of salinity; surface compaction, loss of organic matter or sheet erosion.*

***Rare regional ecosystem: pre-clearing extent (1000 ha); or patch size (100 ha and of limited total extent across its range).*

****Threatening processes are those that are reducing or will reduce the biodiversity and ecological integrity of a regional ecosystem. For example, clearing, weed invasion, fragmentation, inappropriate fire regime or grazing pressure, or infrastructure development.*

*****Moderate degradation and/or biodiversity loss is defined as: floristic and/or faunal diversity is greatly reduced but unlikely to recover within the next 20 years even with the removal of threatening processes; or soil surface is moderately degraded.*

2. Remnant Regional Ecosystems

The following table identifies the remnant regional ecosystems and vegetation communities mapped within the AOI and provides their short descriptions, Biodiversity Status, and remnant extent within the selected AOI. Please note, where heterogeneous vegetated patches (mixed patches of remnant vegetation mapped as containing multiple regional ecosystems) occur within the AOI, they have been split and listed as individual regional ecosystems (or vegetation communities where present) for the purposes of the table below. In such instances, associated area figures have been generated based upon the estimated proportion of each regional ecosystem (or vegetation community) predicted to be present within the larger mixed patch.

Table 3: Remnant regional ecosystems, description and status within the AOI

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
10.10.1a	Acacia shirleyi woodland or A. catenulata low open woodland on sandstone ranges	No concern at present	359.92	0.65
10.10.3	Eucalyptus drepanophylla woodland on sandstone ranges	Of concern	40.34	0.07
10.10.4a	Eucalyptus exilipes and/or Corymbia leichhardtii open woodland on sandstone ranges	No concern at present	935.9	1.68
10.10.5c	Corymbia trachyphloia and/or C. lamprophylla or Eucalyptus mediocris open woodland on sandstone ranges	No concern at present	38.67	0.07
10.10.7	Eucalyptus cloeziana open woodland on sandstone ranges	Of concern	19.33	0.03
10.3.12a	Corymbia dallachiana and C. plena or C. terminalis woodland to open woodland on sandy alluvial terraces (eastern)	No concern at present	77.57	0.14
10.3.14d	Eucalyptus camaldulensis and/or E. coolabah woodland to open woodland along channels and on floodplains	Of concern	20.78	0.04
10.3.25	Eremophila mitchellii tall open shrubland on alluvial plains	Endangered	1.16	less than 0.01
10.3.27a	Eucalyptus populnea woodland to open woodland on alluvial plains	Of concern	2,556.87	4.6
10.3.28a	Eucalyptus melanophloia or E. crebra woodland to open woodland on sandy alluvial fans	No concern at present	720.09	1.29
10.3.3a	Acacia harpophylla and/or Eucalyptus cambageana low open woodland to open woodland on alluvial plains	No concern at present	25.3	0.05
10.3.3b	Acacia harpophylla and/or Eucalyptus cambageana low open woodland to open woodland on alluvial plains	No concern at present	49.13	0.09
10.3.4b	Acacia cambagei low open woodland to low woodland on alluvial plains	Of concern	17.42	0.03
10.4.3a	Acacia harpophylla and/or Eucalyptus cambageana open woodland on Cainozoic lake beds	Endangered	45.07	0.08
10.5.10	Corymbia leichhardtii open woodland on sand plains	No concern at present	515.61	0.93
10.5.12	Eucalyptus populnea open woodland on sand plains	No concern at present	1,533.16	2.76

Regional Ecosystem	Short Description	BD Status	Area (Ha)	% of AOI
10.5.1a	Eucalyptus similis and/or Corymbia brachycarpa and/or Corymbia setosa low open woodland on sand plains	No concern at present	159.32	0.29
10.5.1b	Eucalyptus similis and/or Corymbia brachycarpa and/or Corymbia setosa low open woodland on sand plains	No concern at present	1,170.48	2.1
10.5.4a	Eucalyptus crebra or E. drepanophylla woodland on sand plains	No concern at present	4.16	0.01
10.5.5a	Eucalyptus melanophloia woodland to open woodland on sand plains	No concern at present	13,787.22	24.79
10.7.3a	Acacia shirleyi woodland or A. catenulata low woodland at margins of plateaus	No concern at present	249.61	0.45
10.7.3b	Acacia shirleyi woodland or A. catenulata low woodland at margins of plateaus	No concern at present	93.02	0.17
10.7.3c	Acacia shirleyi woodland or A. catenulata low woodland at margins of plateaus	No concern at present	4.16	0.01
10.7.5	Eucalyptus thozetiana open woodland on scarps and on pediments below scarps	Of concern	155.76	0.28
11.5.5	Eucalyptus melanophloia, Callitris glaucophylla woodland on Cainozoic sand plains and/or remnant surfaces. Deep red sands	No concern at present	3.57	0.01
non-rem	None	None	33,042.45	59.4

Refer to **Map 2** for further information. **Map 3** also provides a visual estimate of the distribution of regional ecosystems present before clearing.

Table 4 provides further information in regards to the remnant regional ecosystems present within the SOI. Specifically, the extent of remnant vegetation remaining within the bioregion, the 1:1,000,000 broad vegetation group (BVG) classification, whether the regional ecosystem is identified as a wetland, and extent of representation in Queensland's Protected Area Estate. For a description of the vegetation communities within the AOI and classified according to the 1:1,000,000 BVG, refer to **Table 6**.

Table 4: Remnant regional ecosystems within the AOI, additional information

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
10.10.1a	Pre-clearing 93000 ha; Remnant 2017 92000 ha	24a	None	High
10.10.3	Pre-clearing 2000 ha; Remnant 2017 2000 ha	12a	None	Low
10.10.4a	Pre-clearing 71000 ha; Remnant 2017 71000 ha	12a	None	High
10.10.5c	Pre-clearing 59000 ha; Remnant 2017 59000 ha	12a	None	High
10.10.7	Pre-clearing 3000 ha; Remnant 2017 3000 ha	12a	None	No representation
10.3.12a	Pre-clearing 34000 ha; Remnant 2017 25000 ha	18a	Floodplain (other than floodplain wetlands).	Low
10.3.14d	Pre-clearing 166000 ha; Remnant 2017 143000 ha	16a	Riverine wetland or fringing riverine wetland.	Low

Regional Ecosystem	Remnant Extent	BVG (1 Million)	Wetland	Representation in protected estate
10.3.25	Pre-clearing 32000 ha; Remnant 2017 29000 ha	27c	None	Low
10.3.27a	Pre-clearing 159000 ha; Remnant 2017 65000 ha	17a	None	Low
10.3.28a	Pre-clearing 327000 ha; Remnant 2017 255000 ha	17b	None	Low
10.3.3a	Pre-clearing 60000 ha; Remnant 2017 25000 ha	25a	None	Low
10.3.3b	Pre-clearing 60000 ha; Remnant 2017 25000 ha	25a	Contains palustrine wetland (e.g. in swales).	Low
10.3.4b	Pre-clearing 83000 ha; Remnant 2017 36000 ha	26a	Contains palustrine wetland (e.g. in swales).	Low
10.4.3a	Pre-clearing 36000 ha; Remnant 2017 15000 ha	25a	None	No representation
10.5.10	Pre-clearing 43000 ha; Remnant 2017 39000 ha	18a	None	Medium
10.5.12	Pre-clearing 237000 ha; Remnant 2017 140000 ha	17a	None	Low
10.5.1a	Pre-clearing 914000 ha; Remnant 2017 886000 ha	17c	None	Low
10.5.1b	Pre-clearing 914000 ha; Remnant 2017 886000 ha	18b	None	Low
10.5.4a	Pre-clearing 126000 ha; Remnant 2017 103000 ha	18b	None	Low
10.5.5a	Pre-clearing 1242000 ha; Remnant 2017 936000 ha	17b	None	Low
10.7.3a	Pre-clearing 109000 ha; Remnant 2017 103000 ha	24a	None	Medium
10.7.3b	Pre-clearing 109000 ha; Remnant 2017 103000 ha	24a	None	Medium
10.7.3c	Pre-clearing 109000 ha; Remnant 2017 103000 ha	12a	None	Medium
10.7.5	Pre-clearing 30000 ha; Remnant 2017 26000 ha	12a	None	Low
11.5.5	Pre-clearing 386000 ha; Remnant 2017 134000 ha	17b	None	Low
non-rem	None	None	None	None

Representation in Protected Area Estate: High greater than 10% of pre-clearing extent is represented; Medium 4 - 10% is represented; Low less than 4% is represented, No representation.

The distribution of mapped wetland systems within the area of interest is displayed in **Map 6**.

The following table lists known special values associated with a regional ecosystem type.

Table 5: Remnant regional ecosystems within the AOI, special values

Regional Ecosystem	Special Values
10.10.1a	Habitat for vulnerable plant species Kardomia squarrulosa and near threatened species, Aristida burraensis, Bertya pedicellata, and Boronia eriantha. Solanum crassitomentosum is endemic to the White Mountains and occurs in this ecosystem.
10.10.3	None
10.10.4a	Potential habitat for the vulnerable species Kardomia squarrulosa and Micromyrtus rotundifolia. Goodenia splendida occurs in this habitat and is known from only ten Herbarium records. Calytrix microcoma is occurs mostly in the DEU and is common in this ecosystem. Also habitat for poorly known species Coronidium lanosum and Tephrosia sp. (Lake Buchanan E.J.Thompson+ BUC2128). Eucalyptus chartaboma occurs near its southern most known location in this ecosystem.
10.10.5c	Potential habitat for the vulnerable plant species Kardomia squarrulosa and near threatened plant species including Acacia spania. A disjunct population of Zieria tenuis occurs in this ecosystem in the White Mountains. 10.10.5c: The near threatened species, Acacia spania recorded at a single location in this vegetation community. Potential habitat for the vulnerable species Kardomia squarrulosa.
10.10.7	None
10.3.12a	Habitat values for arboreal fauna is high. As for other riparian zones, this ecosystem has important values for stabilising stream banks and top soils, providing corridors for wildlife, and for trapping soil and maintaining water quality.
10.3.14d	High habitat and faunal corridor values. Seasonal wetlands important for water bird nesting and aquatic species, and potential habitat for the endangered species Eriocaulon aloefolium and Ammannia robertsii. Habitat for vulnerable plant species, Livistona lanuginosa and near threatened species, Acacia armitii. The seasonal wetlands are in this ecosystem are important for water bird nesting and aquatic species. As for other riparian zones, this ecosystem has important values for stabilising top soils, providing corridors for wildlife, and for trapping soil and maintaining water quality.
10.3.25	None
10.3.27a	Only known record for the new species Eragrostis jerichoensis is from this regional ecosystem.
10.3.28a	Habitat for relatively uncommon species Velleia macrocalyx known from only seven Herbarium records in the DEU (total of 14 records for Queensland).
10.3.3a	Potential habitat for NCA listed species: Ammannia robertsii
10.3.3b	Potential habitat for NCA listed species: Ammannia robertsii
10.3.4b	Habitat for endangered species Ammannia robertsii. Larger gilgai may provide ephemeral wetland habitat. Associated with gilgais that may support ephermal wetlands. 10.3.4c: Provides habitat for wetlands species in gilgai depressions.
10.4.3a	Associated with gilgais that may support ephermal wetlands.
10.5.10	Habitat for near threatened plant species Acacia spania.
10.5.12	Potential habitat for NCA listed species: Cerbera dumicola

Regional Ecosystem	Special Values
10.5.1a	High faunal values as extensive areas have historically been only lightly grazed, due to presence of poison heartleaf Gastrolobium grandiflorum and absence of surface water. Habitat for. Also habitat for Calytrix microcoma and Solanum crassitomentosum, endemic to the Desert Uplands. Habitat for Goodenia splendida known from ten Herbarium records. Eucalyptus tetrodonta and E. chartaboma occur at or near their most southerly know limits in this ecosystem. Poorly known species Polygala difficilis occurs in this ecosystemt. Hakea purpurea occurs near its most northerly known location in this ecosystem. The ecosystem is an intake area for Great Artesian Basin aquifers. 10.5.1f: Most southerly known location of E. tetrodonta near White Mountains National Park.
10.5.1b	High faunal values as extensive areas have historically been only lightly grazed, due to presence of poison heartleaf Gastrolobium grandiflorum and absence of surface water. Habitat for. Also habitat for Calytrix microcoma and Solanum crassitomentosum, endemic to the Desert Uplands. Habitat for Goodenia splendida known from ten Herbarium records. Eucalyptus tetrodonta and E. chartaboma occur at or near their most southerly know limits in this ecosystem. Poorly known species Polygala difficilis occurs in this ecosystemt. Hakea purpurea occurs near its most northerly known location in this ecosystem. The ecosystem is an intake area for Great Artesian Basin aquifers. 10.5.1f: Most southerly known location of E. tetrodonta near White Mountains National Park.
10.5.4a	Eucalyptus tetrodonta occurs in this ecosystem near its southern limit in Queensland.
10.5.5a	Habitat for near threatened plant species Cerbera dumicola.
10.7.3a	Habitat for vulnerable plant species, Micromyrtus rotundifolia and near threatened species including Cerber dumicola. Habita for Solanum crassitomentosum that is endemic to the White Mountains and occurs in this ecosystem. Recently discovered grass species Dimorphochloa sp. (Charters Towers E.J.Thompson+ CHA554) is known from only two locations in this ecosystem near Charters Towers. Eucalyptus bakeri occurs at its most northerly known location in this ecosystem in the White Mountains. A disjunct population of Triodia triaristata occurs in this ecosystem in the White Mountains. 10.7.3f: Indigofera haematica has been recorded in this ecosystem and is of biogeographical significance with restricted distribution (known from only 14 herbarium records in Queensland).
10.7.3b	Habitat for vulnerable plant species, Micromyrtus rotundifolia and near threatened species including Cerber dumicola. Habita for Solanum crassitomentosum that is endemic to the White Mountains and occurs in this ecosystem. Recently discovered grass species Dimorphochloa sp. (Charters Towers E.J.Thompson+ CHA554) is known from only two locations in this ecosystem near Charters Towers. Eucalyptus bakeri occurs at its most northerly known location in this ecosystem in the White Mountains. A disjunct population of Triodia triaristata occurs in this ecosystem in the White Mountains. 10.7.3f: Indigofera haematica has been recorded in this ecosystem and is of biogeographical significance with restricted distribution (known from only 14 herbarium records in Queensland).

Regional Ecosystem	Special Values
10.7.3c	Habitat for vulnerable plant species, Micromyrtus rotundifolia and near threatened species including Cerber dumicola. Habita for Solanum crassitomentosum that is endemic to the White Mountains and occurs in this ecosystem. Recently discovered grass species Dimorphochloa sp. (Charters Towers E.J.Thompson+ CHA554) is known from only two locations in this ecosystem near Charters Towers. Eucalyptus bakeri occurs at its most northerly known location in this ecosystem in the White Mountains. A disjunct population of Triodia triaristata occurs in this ecosystem in the White Mountains. 10.7.3f: Indigofera haematica has been recorded in this ecosystem and is of biogeographical significance with restricted distribution (known from only 14 herbarium records in Queensland).
10.7.5	None
11.5.5	Potential habitat for NCA listed species: Tylophora linearis
non-rem	None

3. Remnant Regional Ecosystems by Broad Vegetation Group

BVGs are a higher-level grouping of vegetation communities. Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid climatic zones. BVGs provide an overview of vegetation communities across the state or a bioregion and allow comparison with other states. There are three levels of BVGs which reflect the approximate scale at which they are designed to be used: the 1:5,000,000 (national), 1:2,000,000 (state) and 1:1,000,000 (regional) scales.

A comprehensive description of BVGs is available at:

https://publications.qld.gov.au/dataset/redd/resource/

The following table provides a description of the 1:1,000,000 BVGs present and their associated extent within the AOI.

Table 6: Broad vegetation groups (1 million) within the AOI

BVG (1 Million)	Description	Area (Ha)	% of AOI
None	None	33,042.45	59.4
12a	Dry woodlands to open woodlands dominated by ironbarks such as Eucalyptus decorticans (gum-topped ironbark), E. fibrosa subsp. nubila (blue-leaved ironbark), or E. crebra (narrow-leaved red ironbark) and/or bloodwoods such as Corymbia trachyphloia (yellow bloodwood), C. leichhardtii (rustyjacket), C. watsoniana (Watson's yellow bloodwood), C. lamprophylla, C. peltata (yellowjacket). Occasionally E. thozetiana (mountain yapunyah), E. cloeziana (Gympie messmate) or E. mediocris are dominant. Mostly on sub-coastal/inland hills with shallow soils. (land zones 10, 7, 9) (BRB, DEU, SEQ, GUP)	1,194.16	2.15
16a	Open forest and woodlands dominated by Eucalyptus camaldulensis (river red gum) (or E. tereticornis (blue gum)) and/or E. coolabah (coolabah) (or E. microtheca (coolabah)) fringing drainage lines. Associated species may include Melaleuca spp., Corymbia tessellaris (carbeen), Angophora spp., Casuarina cunninghamiana (riveroak). Does not include alluvial areas dominated by herb and grasslands or alluvial plains that are not flooded. (land zone 3) (MGD, BRB, GUP, CHC, MUL, DEU, EIU, NWH, SEQ, [NET, WET]) (All bioregions except CYP and CQC)	20.78	0.04

BVG (1 Million)	Description	Area (Ha)	% of AOI
17a	Woodlands dominated by Eucalyptus populnea (poplar box) (or E. brownii (Reid River box)) on alluvium, sand plains and footslopes of hills and ranges. (land zones 3, 5, 10, 9, 4, 11, 12, [8]) (BRB, MUL, DEU, MUL, EIU)	4,090.02	7.35
17b	Woodlands to open woodlands dominated by Eucalyptus melanophloia (silver-leaved ironbark) (or E. shirleyi (shirley's silver-leaved ironbark)) on sand plains and footslopes of hills and ranges. (land zones 5, 12, 3, 11, 9, 7) (BRB, DEU, EIU, SEQ, NET, GUP, NWH)	14,510.88	26.09
17c	Eucalyptus whitei (White's ironbark) or E. similis (Queensland yellowjacket) on sand sheets. (land zones 5, 7, 3, 10) (DEU, GUP, EIU)	159.32	0.29
18a	Dry woodlands to open woodlands, dominated by bloodwoods (Corymbia dallachiana, C. terminalis (long-fruited bloodwood), C. plena, or C. leichhardtii (rustyjacket)) or ironbarks (Eucalyptus quadricostata (Pentland ironbark), E. crebra (narrow-leaved red ironbark) or E. exilipes (fine-leaved ironbark)), often with E. acmenoides (narrow-leaved white stringybark), Angophora leiocarpa (rusty gum) and Callitris glaucophylla (white cypress pine) in the Brigalow Belt, on sandy plateaus and plains. (land zones 5, 3, 7) (GUP, DEU, BRB)	593.18	1.07
18b	Woodlands dominated Eucalyptus crebra (sens. lat.) (narrow-leaved red ironbark) frequently with Corymbia spp. or Callitris spp. on flat to undulating plains. (land zones 5, 3) (BRB, DEU, EIU, GUP, CYP)	1,174.64	2.11
24a	Low woodlands to tall shrublands dominated by Acacia spp. on residuals. Species include A. shirleyi (lancewood), A. catenulata (bendee), A. microsperma (bowyakka), A. clivicola, A. sibirica, A. rhodoxylon (rosewood) and A. leptostachya (Townsville wattle). (land zones 7, 10, 5, 12, 11, [9, 3]) (MUL, CHC, BRB, GUP, EIU, MGD, DEU, NWH, [CYP])	702.55	1.26
25a	Open forests to woodlands dominated by Acacia harpophylla (brigalow) sometimes with Casuarina cristata (belah) on heavy clay soils. Includes areas co-dominated with A. cambagei (gidgee) and/or emergent eucalypts (land zones 4, 9, 3, 11, 7, 12, [5, 8]) (BRB, MUL, MGD, DEU, [SEQ])	119.5	0.21
26a	Open forests to tall shrublands dominated by Acacia cambagei (gidgee) or A. georginae (Georgina gidgee) or A. argyrodendron (blackwood). (land zones 9, 3, 4, 6, 5, 7, [8, 11]) (MGD, MUL, CHC, BRB, DEU, GUP, NWH, [EIU])	17.42	0.03
27c	Low open woodlands dominated by a variety of species including Grevillea striata (beefwood), Acacia spp., Terminalia spp. or Cochlospermum spp. (land zones 9, 12, 3, 11, 5) (NWH, EIU, DEU, GUP, [BRB])	1.16	less than 0.01

Refer to **Map 4** for further information. **Map 5** also provides a representation of the distribution of vegetation communities as per the 1:5,000,000 BVG believed to be present prior to European settlement.

4. Technical and BioCondition Benchmark Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 11.3.1) and their component vegetation communities (e.g. 11.3.1a, 11.3.1b). See:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

The descriptions are compiled using site survey data from the Queensland Herbarium's CORVEG database. Distribution maps, representative images (if available) and the pre-clearing and remnant extent (hectares) of each vegetation community

derived from the regional ecosystem mapping data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem.

Technical descriptions include data on canopy height, canopy cover and native plant species composition of the predominant layer, which are attributes relevant to assessment of the remnant status of vegetation under the *Vegetation Management Act 1999*. However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used for remnant assessment where possible (Neldner et al. 2012 (PDF)* section 3.3.1 of:

https://publications.qld.gov.au/dataset/redd/resource/

The technical descriptions are subject to review and are updated as additional data becomes available.

When conducting a BioCondition assessment, these technical descriptions should be used in conjunction with BioCondition benchmarks for the specific regional ecosystem, or component vegetation community.

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

Benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. Benchmarks are specific to one regional ecosystem vegetation community, however, the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes has been considered throughout the geographic extent of the regional ecosystem. Local reference sites should be used for this spatial and temporal (seasonal and annual) variability.

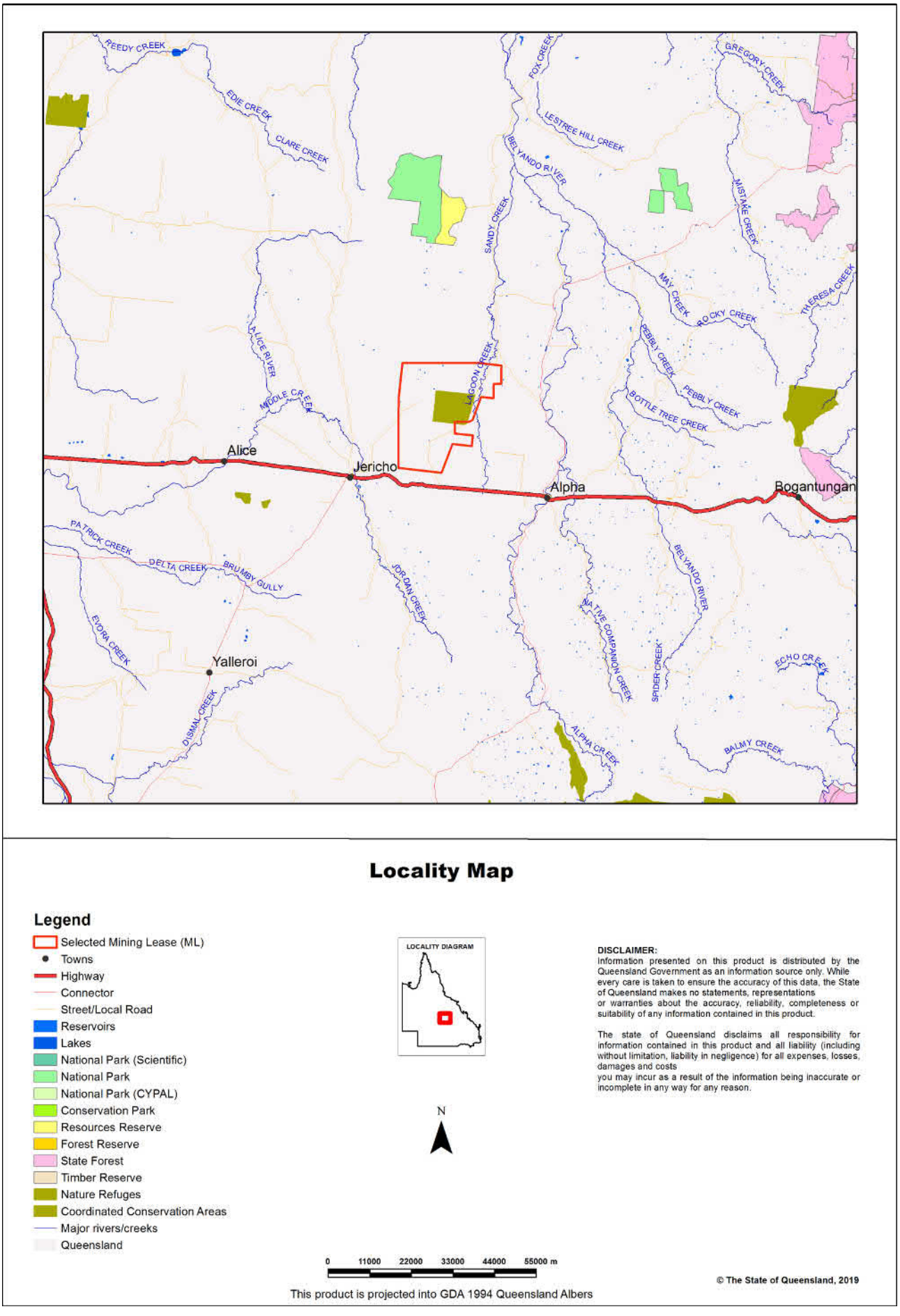
Table 7: List of remnant regional ecosystems within the AOI for which technical and biocondition benchmark descriptions are available

Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
10.10.1a	Not currently available	Not currently available
10.10.3	Not currently available	Not currently available
10.10.4a	Not currently available	Not currently available
10.10.5c	Not currently available	Not currently available
10.10.7	Not currently available	Not currently available
10.3.12a	Not currently available	Not currently available
10.3.14d	Not currently available	Not currently available
10.3.25	Not currently available	Not currently available
10.3.27a	Not currently available	Not currently available
10.3.28a	Not currently available	Not currently available
10.3.3a	Not currently available	Not currently available
10.3.3b	Not currently available	Not currently available
10.3.4b	Not currently available	Not currently available
10.4.3a	Not currently available	Not currently available
10.5.10	Not currently available	Not currently available
10.5.12	Not currently available	Not currently available
10.5.1a	Not currently available	Not currently available
10.5.1b	Not currently available	Not currently available
10.5.4a	Not currently available	Not currently available
10.5.5a	Not currently available	Not currently available
10.7.3a	Not currently available	Not currently available
10.7.3b	Not currently available	Not currently available
10.7.3c	Not currently available	Not currently available

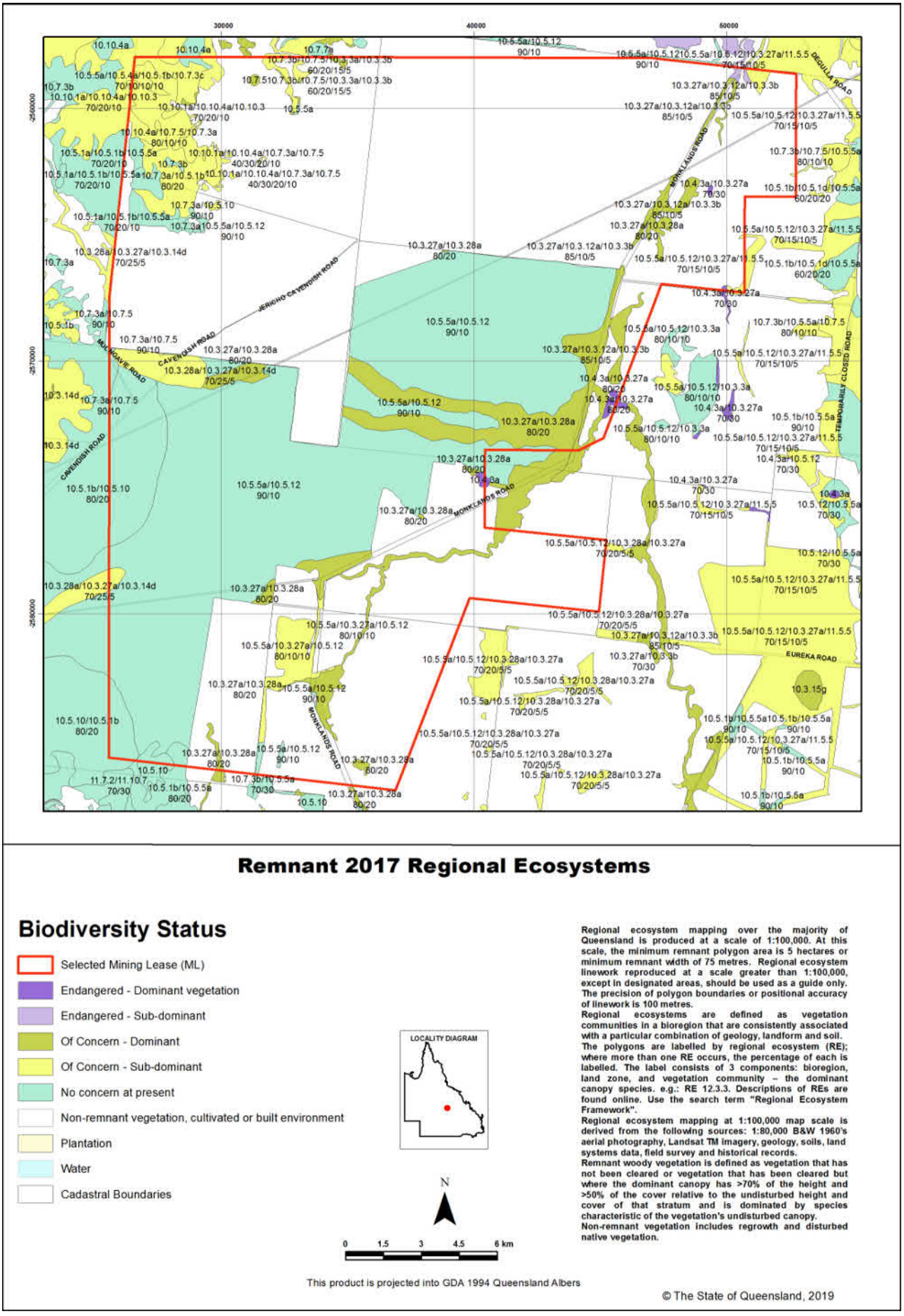
Regional ecosystems mapped as within the AOI	Technical Descriptions	Biocondition Benchmarks
10.7.5	Not currently available	Not currently available
11.5.5	Available	Not currently available
non-rem	Not currently available	Not currently available

Maps

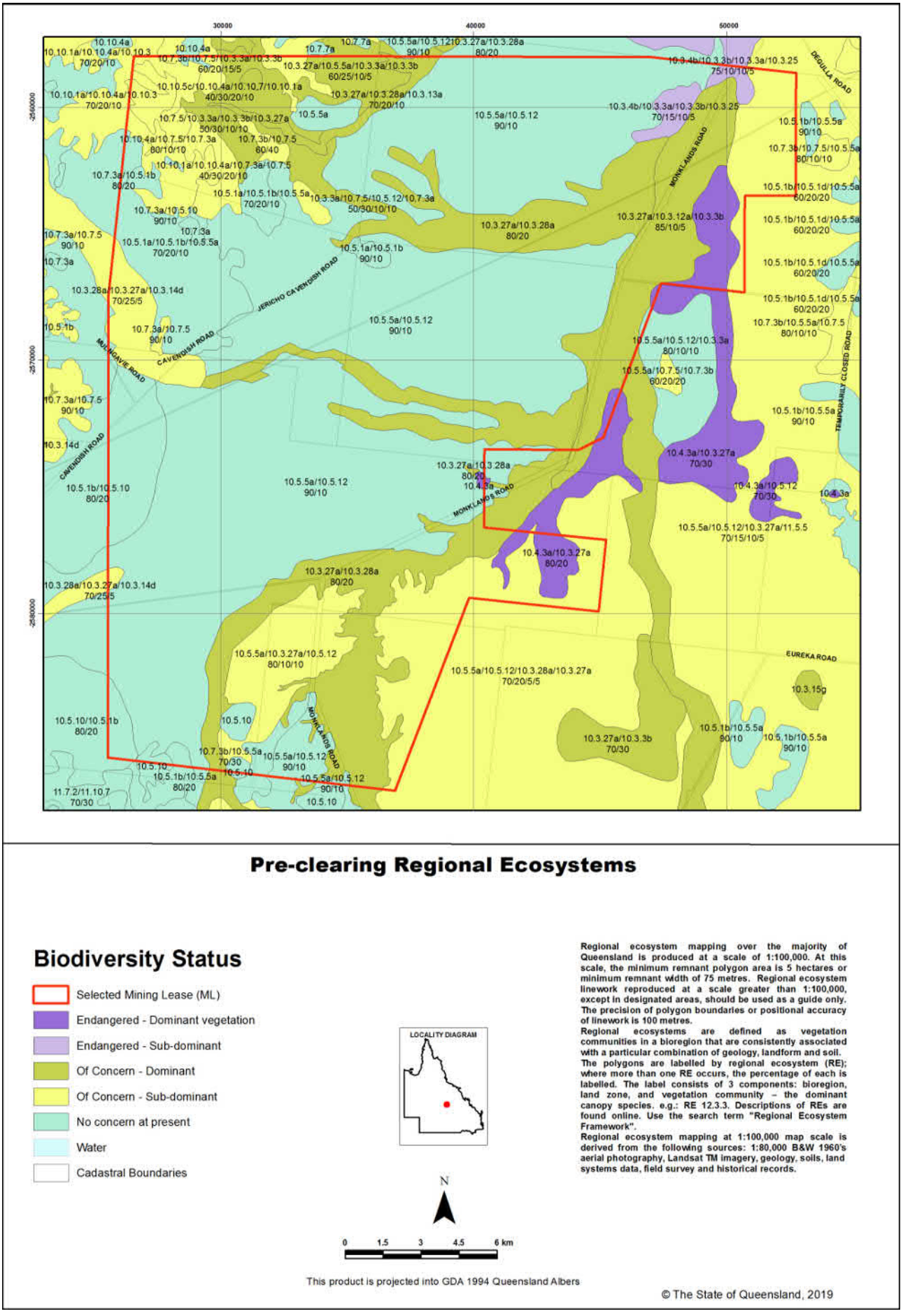
Map 1 - Location



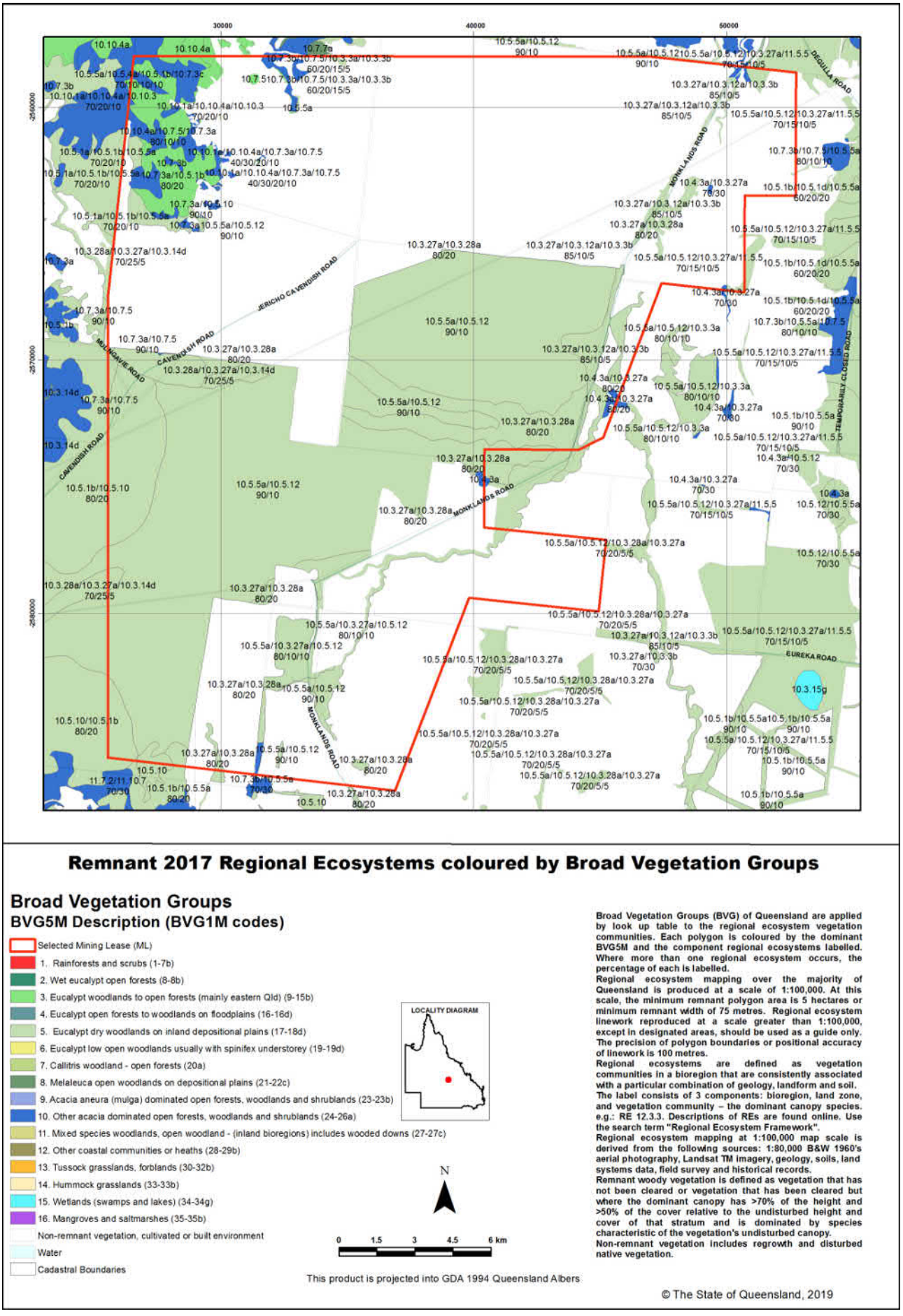
Map 2 - Remnant 2017 regional ecosystems



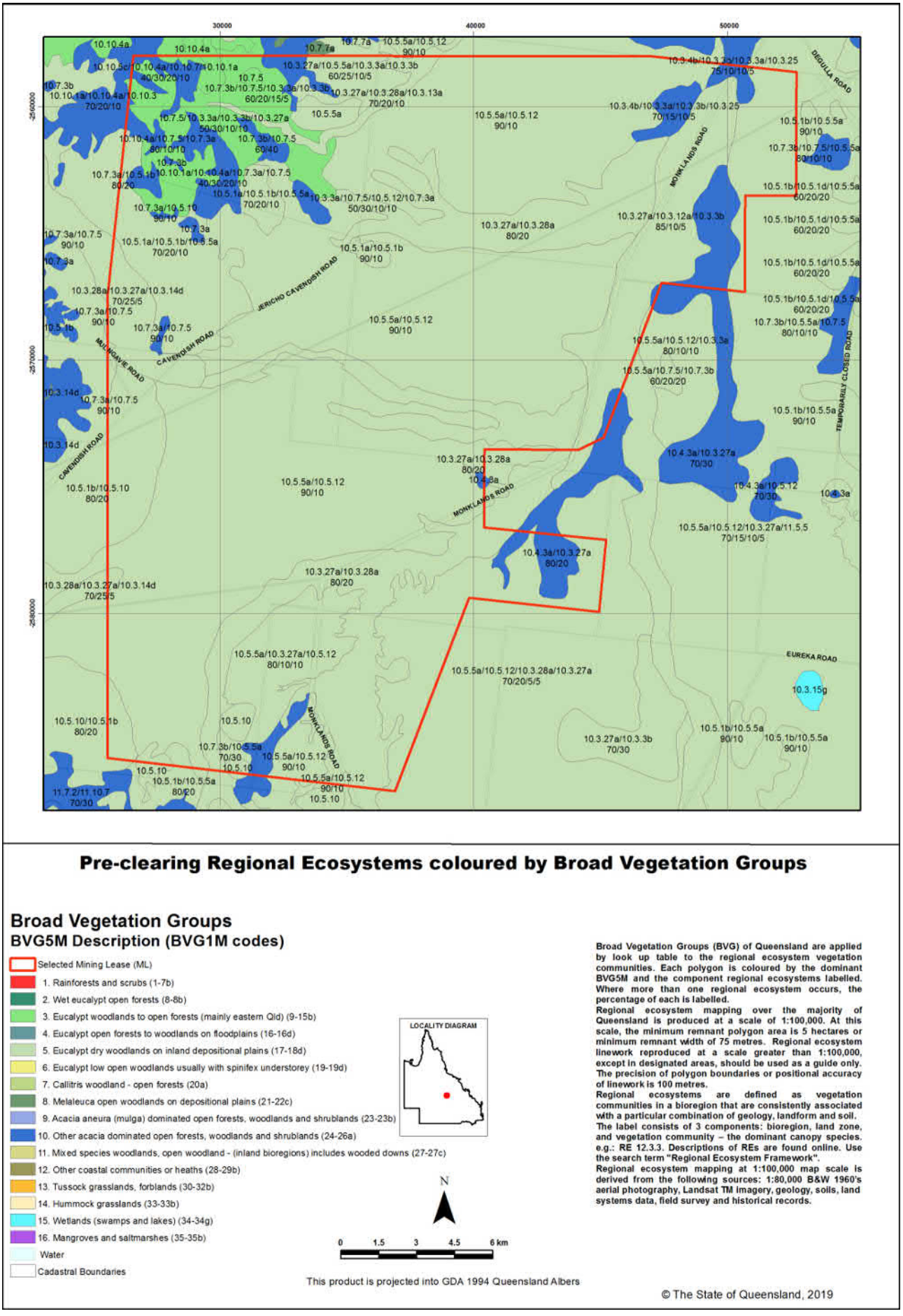
Map 3 - Pre-clearing regional ecosystems



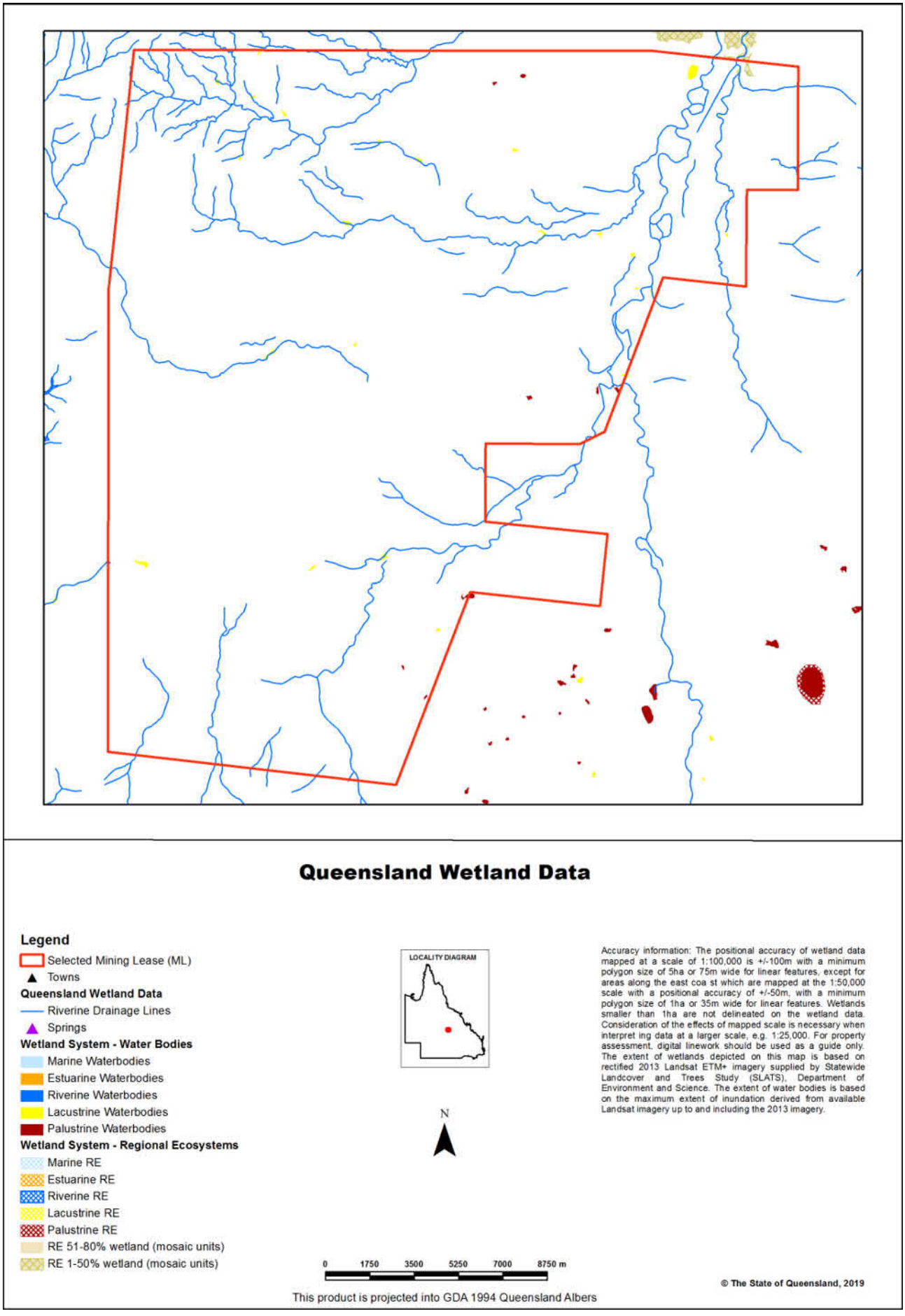
Map 4 - Remnant 2017 regional ecosystems by BVG (5M)



Map 5 - Pre-clearing regional ecosystems by BVG (5M)



Map 6 - Wetlands and waterways



Links and Other Information Sources

The Department of Environment and Science's Website -

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/

provides further information on the regional ecosystem framework, including access to links to the Regional Ecosystem Database, Broad Vegetation Group Definitions, Regional Ecosystem and Land zone descriptions.

Descriptions of the broad vegetation groups of Queensland can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

The methodology for mapping regional ecosystems can be downloaded from:

https://publications.qld.gov.au/dataset/redd/resource/

Technical descriptions for regional ecosystems can be obtained from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/technical-descriptions/

Benchmarks can be obtained from:

http://www.qld.gov.au/environment/plants-animals/biodiversity/benchmarks/

For further information associated with the remnant regional ecosystem dataset used by this report, refer to the metadata associated with the Biodiversity status of pre-clearing and Remnant Regional Ecosystems of Queensland dataset (version listed in **Appendix 1**) which is available through the Queensland Government Information System portal,

http://dds.information.qld.gov.au/dds/

The Queensland Globe is a mapping and data application. As an interactive online tool, Queensland Globe allows you to view and explore Queensland maps, imagery (including up-to-date satellite images) and other spatial data, including regional ecosystem mapping. To further view and explore regional ecosystems over an area of interest, access the Biota Globe (a component of the Queensland Globe). The Queensland Globe can be accessed via the following link:

http://www.dnrm.qld.gov.au/mapping-data/queensland-globe

References

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(https://publications.qld.gov.au/dataset/redd/resource/78209e74-c7f2-4589-90c1-c33188359086)

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Sattler, P.S. and Williams, R.D. (eds) (1999). *The Conservation Status of Queensland's Bioregional Ecosystems*. Environmental Protection Agency, Brisbane.

Appendices

Appendix 1 - Source Data

The dataset listed below is available for download from:

http://www.qld.gov.au/environment/plants-animals/plants/ecosystems/download/

- Regional Ecosystem Description Database

The datasets listed below are available for download from:

http://dds.information.qld.gov.au/dds/

- Biodiversity status of pre-clearing and 2017 remnant regional ecosystems of Queensland
- Pre-clearing Vegetation Communities and Regional Ecosystems of Queensland
- Queensland Wetland Data Version - Wetland lines
- Queensland Wetland Data Version - Wetland points
- Queensland Wetland Data Version - Wetland areas

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
VMA	- *Vegetation Management Act 1999*

Attachment D Queensland Government Biodiversity and Conservation Values Report

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Queensland Government

Department of Environment and Science

Environmental Reports

Biodiversity and Conservation Values

Biodiversity Planning Assessments and Aquatic Conservation Assessments

For the selected area of interest
ml: 70454

Environmental Reports - General Information

The Environmental Reports portal provides for the assessment of selected matters of interest relevant to a user specified location, or Area of Interest (AOI). All area and derivative figures are relevant to the extent of matters of interest contained within the AOI unless otherwise stated. Please note, if a user selects an AOI via the "Central co-ordinates" option, the resulting assessment area encompasses an area extending from 2km radius from the point of interest.

All area and area derived figures included in this report have been calculated via reprojecting relevant spatial features to Albers equal-area conic projection (central meridian = 146, datum Geocentric Datum of Australia 1994). As a result, area figures may differ slightly if calculated for the same features using a different co-ordinate system.

Figures in tables may be affected by rounding.

The matters of interest reported on in this document are based upon available state mapped datasets. Where the report indicates that a matter of interest is not present within the AOI (e.g. where area related calculations are equal to zero, or no values are listed), this may be due either to the fact that state mapping has not been undertaken for the AOI, that state mapping is incomplete for the AOI, or that no values have been identified within the site.

The information presented in this report should be considered as a guide only and field survey may be required to validate values on the ground.

Please direct queries about these reports to: biodiversity.planning@des.qld.gov.au

Disclaimer

Whilst every care is taken to ensure the accuracy of the information provided in this report, the Queensland Government makes no representations or warranties about its accuracy, reliability, completeness, or suitability, for any particular purpose and disclaims all responsibility and all liability (including without limitation, liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which the user may incur as a consequence of the information being inaccurate or incomplete in any way and for any reason.

Table of Contents

Summary Information

Tables 1 to 8 provide an overview of the AOI with respect to selected topographic and environmental values.

Table 1: Area of interest details: ml: 70454

Size (ha)	55,623.46
Local Government(s)	Barcaldine Regional
Bioregion(s)	Desert Uplands
Subregion(s)	Jericho
Catchment(s)	Cooper Creek, Burdekin

The following table identifies available Biodiversity Planning Assessments (BPAs) and Aquatic Conservation Assessments (ACAs) with respect to the AOI.

Table 2: Available Biodiversity Planning and Aquatic Conservation Assessments

Assessment Type	Assessment Area and Version
Biodiversity Planning Assessment(s)	Desert Uplands v1.3
Aquatic Conservation Assessment(s) (riverine)	Lake Eyre and Bulloo Basins v1.1, Great Barrier Reef Catchments v1.3
Aquatic Conservation Assessment(s) (non-riverine)	Lake Eyre and Bulloo Basins v1.1, Great Barrier Reef Catchments v1.3

Table 3: Remnant regional ecosystems within the AOI as per the Qld Herbarium's 'biodiversity status'

Biodiversity Status	Area (Ha)	% of AOI
Endangered	46.23	0.08
Of concern	2,810.49	5.05
No concern at present	19,726.90	35.47

The following table identifies the extent and proportion of the user specified area of interest (AOI) which is mapped as being of "State", "Regional" or "Local" significance via application of the Queensland Department of Environment and Science's *Biodiversity Assessment and Mapping Methodology* (BAMM).

Table 4: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
State Habitat for EVNT taxa	0.0	0.0
State	25,818.16	46.42
Regional	4,138.94	7.44
Local or Other Values	276.89	0.5

Table 5: Non-riverine wetlands intersecting the AOI

Non-riverine wetland types intersecting the area of interest	#
Number of Palustrine wetlands	9
Number of Lacustrine wetlands	2
Total number of non-riverine wetlands	11

NB. The figures presented in the table above are derived from the relevant non-riverine Aquatic Conservation Assessment(s). Later releases of wetland mapping produced via the Queensland Wetland Mapping Program may provide more recent information in regards to wetland extent.

Table 6: Named waterways intersecting the AOI

Name	Permanency
BETA CREEK	Non-perennial
CAMP CREEK	Non-perennial
LAGOON CREEK	Non-perennial
MALCOLM CREEK	Non-perennial
PEBBLY CREEK	Non-perennial
SALTBUSH CREEK	Non-perennial
SPRING CREEK	Non-perennial
TALLARENHA CREEK	Non-perennial

Refer to **Map 1** for general locality information.

The following two tables identify the extent and proportion of the user specified AOI which is mapped as being of "Very High", "High", "Medium", "Low", or "Very Low" aquatic conservation value for riverine and non-riverine wetlands via application of the Queensland Department of Environment and Science's *Aquatic Biodiversity Assessment and Mapping Method* (AquaBAMM).

Table 7: Summary table, aquatic conservation significance (riverine)

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	0.0	0.0
Medium	6,860.29	12.33
Low	46,303.66	83.24
Very Low	2,461.70	4.43

Table 8: Summary table, aquatic conservation significance (non-riverine)

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	7.7	0.01
Medium	12.94	0.02
Low	0.0	0.0
Very Low	6.76	0.01

Biodiversity Planning Assessments

Introduction

The Department of Environment and Science (DES) attributes biodiversity significance on a bioregional scale through a Biodiversity Planning Assessment (BPA). A BPA involves the integration of ecological criteria using the *Biodiversity assessment and Mapping Methodology* (BAMM) and is developed in two stages: 1) **diagnostic criteria**, and 2) **expert panel criteria**. The diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion, while the expert panel criteria allows for the refinement of the mapped information from the diagnostic output by incorporating local knowledge and expert opinion.

The BAMM methodology has application for identifying areas with various levels of significance solely for biodiversity reasons. These include threatened ecosystems or taxa, large tracts of habitat in good condition, ecosystem diversity, landscape context and connection, and buffers to wetlands or other types of habitat important for the maintenance of biodiversity or ecological processes. While natural resource values such as dryland salinity, soil erosion potential or land capability are not dealt with explicitly, they are included to some extent within the biodiversity status of regional ecosystems recognised by the DES.

Biodiversity Planning Assessments (BPAs) assign three levels of overall biodiversity significance.

- **State significance** - areas assessed as being significant for biodiversity at the bioregional or state scales. They also include areas assessed by other studies/processes as being significant at national or international scales. In addition, areas flagged as being of State significance due to the presence of endangered, vulnerable and/or near threatened taxa, are identified as "State Habitat for EVNT taxa".
- **Regional significance** - areas assessed as being significant for biodiversity at the subregional scale. These areas have lower significance for biodiversity than areas assessed as being of State significance.
- **Local significance and/or other values** - areas assessed as not being significant for biodiversity at state or regional scales. Local values are of significance at the local government scale.

For further information on released BPAs and a copy of the underlying methodology, go to:

http://www.qld.gov.au/environment/plants-animals/biodiversity/planning/

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

The following table identifies the extent and proportion of the user specified AOI which is mapped as being of "State", "Regional" or "Local" significance via application of the BAMM.

Table 9: Summary table, biodiversity significance

Biodiversity significance	Area (Ha)	% of AOI
State Habitat for EVNT taxa	0.0	0.0
State	25,818.16	46.42
Regional	4,138.94	7.44
Local or Other Values	276.89	0.5

Refer to **Map 2** for further information.

Diagnostic Criteria

Diagnostic criteria are based on existing data which is reliable and uniformly available across a bioregion. These criteria are diagnostic in that they are used to filter the available data and provide a "first-cut" or initial determination of biodiversity significance. This initial assessment is then combined through a second group of other essential criteria.

A description of the individual diagnostic criteria is provided in the following sections.

Criteria A. Habitat for EVNT taxa: Classifies areas according to their significance based on the presence of endangered, vulnerable and/or rare (EVNT) taxa. EVNT taxa are those scheduled under the *Nature Conservation Act 1992* and/or the

Environment Protection and Biodiversity Conservation Act 1999. It excludes highly mobile fauna taxa which are instead considered in Criterion H and brings together information on EVNT taxa using buffering of recorded sites or habitat suitability models (HSM) where available.

Criteria B. Ecosystem value: Classifies on the basis of biodiversity status of regional ecosystems, their extent in protected areas (presence of poorly conserved regional ecosystems), the presence of significant wetlands; and areas of national importance such as the presence of Threatened Ecological Communities, World Heritage areas and Ramsar sites. Ecosystem value is applied at a bioregional (**B1**) and regional (**B2**) scale.

Criteria C. Tract size: Measures the relative size of tracts of vegetation in the landscape. The size of any tract is a major indicator of ecological significance, and is also strongly correlated with the long-term viability of biodiversity values. Larger tracts are less susceptible to ecological edge effects and are more likely to sustain viable populations of native flora and fauna than smaller tracts.

Criteria D. Relative size of regional ecosystems: Classifies the relative size of each regional ecosystem unit within its bioregion (**D1**) and its subregion (**D2**). Remnant units are compared with all other occurrences with the same regional ecosystem. Large examples of a regional ecosystem are more significant than smaller examples of the same regional ecosystem because they are more representative of the biodiversity values particular to the regional ecosystem, are more resilient to the effects of disturbance, and constitute a significant proportion of the total area of the regional ecosystem.

Criteria F. Ecosystem diversity: Is an indicator of the number of regional ecosystems occurring within an area. An area with high ecosystem diversity will have many regional ecosystems and ecotones relative to other areas within the bioregion.

Criteria G. Context and connection: Represents the extent to which a remnant unit incorporates, borders or buffers areas such as significant wetlands, endangered ecosystems; and the degree to which it is connected to other vegetation.

A summary of the biodiversity status based upon the diagnostic criteria is provided in the following table.

Table 10: Summary of biodiversity significance based upon diagnostic criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
State	Remnant contains an RE that is one of the largest of its type in the bioregion (D1) & Remnant has Ecosystem diversity in the top quartile (F)	99.11	0.18
State	Remnant contains an RE that is one of the largest of its type in the bioregion (D1) & Remnant has high connectivity or buffers an endangered RE or Sig. Wetland (G)	258.43	0.46
State	Remnant contains at least 1 Endangered RE (B1)	54.11	0.1
State	Remnant contains at least one Of Concern RE (B1) & Remnant contains an RE that is one of the largest of its type in the bioregion (D1)	3,041.86	5.47
Regional	Remnant contains an RE that is one of the largest of its type in the subregion (D2)	9,319.37	16.75
Regional	Remnant contains at least one Of Concern RE (B1)	1,244.04	2.24
Local or Other Values	Refer to diagnostic data for additional information	11,479.36	20.64

Assessment of diagnostic criteria with respect to the AOI

The following table reflects an assessment of the individual diagnostic criteria noted above in regards to the AOI.

Table 11: Assessment of individual diagnostic criteria with respect to the AOI

Diagnostic Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
A: Habitat for EVNT Taxa					17,818.60	32.0	7,677.65	13.8
B1: Ecosystem Value (Bioregion)	54.11	0.1	4,285.91	7.7	21,124.83	38.0	31.4	0.1
B2: Ecosystem Value (Subregion)			65.12	0.1	23,779.97	42.8	1,651.16	3.0
C: Tract Size	24,935.10	44.8					561.15	1.0
D1: Relative RE Size (Bioregion)	12,718.78	22.9			5,953.21	10.7	6,824.26	12.3
D2: Relative RE Size (Subregion)	12,718.78	22.9			7,631.57	13.7	5,145.90	9.3
F: Ecosystem Diversity	1,341.36	2.4	9,494.08	17.1	14,599.33	26.2	61.48	0.1
G: Context and Connection	3,649.83	6.6	18,315.23	32.9	3,053.88	5.5	477.31	0.9

Other Essential Criteria

Other essential criteria (also known as expert panel criteria) are based on non-uniform information sources and which may rely more upon expert opinion than on quantitative data. These criteria are used to provide a "second-cut" determination of biodiversity significance, which is then combined with the diagnostic criteria for an overall assessment of relative biodiversity significance. A summary of the biodiversity status based upon the other essential criteria is provided in the following table.

Table 12: Summary of biodiversity significance based upon other essential criteria with respect to the AOI

Biodiversity significance	Description	Area (Ha)	% of AOI
State	Remnant contains Core Habitat for Priority Taxa (H) & Remnant contains Special Biodiversity Values (view Expert Panel data for further information) (I) & Remnant forms part of a bioregional corridor (J)	295.04	0.53
State	Remnant contains Core Habitat for Priority Taxa (H) & Remnant forms part of a bioregional corridor (J)	7.98	0.01
State	Remnant contains Special Biodiversity Values (view Expert Panel data for further information) (I)	17,695.78	31.81
State	Remnant contains Special Biodiversity Values (view Expert Panel data for further information) (I) & Remnant forms part of a bioregional corridor (J)	5,187.89	9.33
State	Remnant forms part of a bioregional corridor (J)	2,488.59	4.47
Regional	Refer to Expert Panel data for additional information	2,579.61	4.64
Regional	Remnant contains Special Biodiversity Values (view Expert Panel data for further information) (I)	1,636.40	2.94

A description of each of the other essential criteria and associated assessment in regards to the AOI is provided in the following sections.

Criteria H. Essential and general habitat for priority taxa: Priority taxa are those which are at risk or of management concern, taxa of scientific interest as relictual (ancient or primitive), endemic taxa or locally significant populations (such as a flying fox camp or heronry), highly specialised taxa whose habitat requirements are complex and distributions are not well correlated with any particular regional ecosystem, taxa important for maintaining genetic diversity (such as complex spatial patterns of genetic variation, geographic range limits, highly disjunct populations), taxa critical for management or monitoring of biodiversity (functionally important or ecological indicators), or economic and culturally important taxa.

Criteria I. Special biodiversity values: areas with special biodiversity values are important because they contain multiple taxa in a unique ecological and often highly biodiverse environment. Areas with special biodiversity values can include the following:

- Ia - centres of endemism - areas where concentrations of taxa are endemic to a bioregion or subregion are found.
- Ib - wildlife refugia (Morton *et al*. 1995), for example, islands, mound springs, caves, wetlands, gorges, mountain ranges and topographic isolates, ecological refuges, refuges from exotic animals, and refuges from clearing. The latter may include large areas that are not suitable for clearing because of land suitability/capability.
- Ic - areas with concentrations of disjunct populations.
- Id - areas with concentrations of taxa at the limits of their geographic ranges.
- Ie - areas with high species richness.
- If - areas with concentrations of relictual populations (ancient and primitive taxa).
- Ig - areas containing REs with distinct variation in species composition associated with geomorphology and other environmental variables.
- Ih - an artificial waterbody or managed/manipulated wetland considered by the panel/s to be of ecological significance.
- Ii - areas with a high density of hollow-bearing trees that provide habitat for animals.
- Ij - breeding or roosting sites used by a significant number of individuals.
- Ik - climate change refuge.

The following table identifies the value and extent area of the Other Essential Criteria H and I within the AOI.

Table 13: Relative importance of expert panel criteria (H and I) used to access overall biodiversity significance with respect to the AOI

Expert Panel	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
H: Core Habitat Priority Taxa			8,656.56	15.6	59.75	0.1		
Ia: Centres of Endemism			60.94	0.1				
Ib: Wildlife Refugia	21,927.34	39.4	2,887.74	5.2				
Ic: Disjunct Populations	289.75	0.5	18,643.34	33.5				
Id: Limits of Geographic Ranges	289.75	0.5	22,055.76	39.7				
Ie: High Species Richness	17,392.00	31.3	6,589.91	11.8				
If: Relictual Populations								
Ig: Variation in Species Composition	4,245.59	7.6						
Ih: Artificial Wetland								
Ii: Hollow Bearing Trees	20,743.48	37.3	60.94	0.1				
Ij: Breeding or Roosting Site	289.75	0.5						
Ik: Climate Refugia								

NB. Whilst biodiversity values associated with Criteria I may be present within the site (refer to tables 12 and 15), for the New England Tableland and Central Queensland Coast BPAs, area and % area figures associated with Criteria Ia through to Ij cannot be listed in the table above (due to slight variations in data formats between BPAs).

Criteria J. Corridors: areas identified under this criterion qualify either because they are existing vegetated corridors important for contiguity, or cleared areas that could serve this purpose if revegetated. Some examples of corridors include riparian habitats, transport corridors and "stepping stones".

Bioregional and subregional conservation corridors have been identified in the more developed bioregions of Queensland through the BPAs, using an intensive process involving expert panels. Map 3 displays the location of corridors as identified under the Statewide Corridor network. The Statewide Corridor network incorporates BPA derived corridors and for bioregions where no BPA has been assessed yet, corridors derived under other planning processes. *Note: as a result of updating and developing a statewide network, the alignment of corridors may differ slightly in some instances when compared to those used in individual BPAs.*

The functions of these corridors are:

- **Terrestrial** Bioregional corridors, in conjunction with large tracts of remnant vegetation, maintain ecological and evolutionary processes at a landscape scale, by:

  • Maintaining long term evolutionary/genetic processes that allow the natural change in distributions of species and connectivity between populations of species over long periods of time;

  • Maintaining landscape/ecosystems processes associated with geological, altitudinal and climatic gradients, to allow for ecological responses to climate change;

- Maintaining large scale seasonal/migratory species processes and movement of fauna;
- Maximising connectivity between large tracts/patches of remnant vegetation;
- Identifying key areas for rehabilitation and offsets; and

- **Riparian** Bioregional Corridors also maintain and encourage connectivity of riparian and associated ecosystems.

The location of the corridors is determined by the following principles:

- Terrestrial
  - Complement riparian landscape corridors (i.e. minimise overlap and maximise connectivity);
  - Follow major watershed/catchment and/or coastal boundaries;
  - Incorporate major altitudinal/geological/climatic gradients;
  - Include and maximise connectivity between large tracts/patches of remnant vegetation;
  - Include and maximise connectivity between remnant vegetation in good condition; and

- Riparian
  - Located on the major river or creek systems within the bioregion in question.

The total extent of remnant vegetation triggered as being of "State", "Regional" or "Local" significance due to the presence of an overlying BPA derived terrestrial or riparian corridor within the AOI, is provided in the following table. For further information on how remnant vegetation is triggered due to the presence of an overlying BPA derived corridor, refer to the relevant landscape BPA expert panel report(s).

Table 14: Extent of triggered remnant vegetation due to the presence of BPA derived corridors with respect to the AOI

Biodiversity Significance	Area (Ha)	% of AOI
State	7,979.49	14.35
Regional	0.0	0.0
Local	0.0	0.0

NB: area figures associated with the extent of corridor triggered remnant vegetation are only available for those bioregions where a BPA has been undertaken.

Refer to **Map 3** for further information.

Threatening process/condition (Criteria K) - areas identified by experts under this criterion may be used to amend (upgrade or downgrade) biodiversity significance arising from the "first-cut" analysis. The condition of remnant vegetation is affected by threatening processes such as weeds, ferals, grazing and burning regime, selective timber harvesting/removal, salinity, soil erosion, and climate change.

Assessment of Criteria K with respect to the AOI is not currently included in the "Biodiversity and Conservation Values" report, as it has not been applied to the majority of Queensland due to data/information limitations and availability.

Special Area Decisions

Expert panel derived "Special Area Decisions" are used to assign values to Other Essential Criteria. The specific decisions which relate to the AOI in question are listed in the table below.

Table 15: Expert panel decisions for assigning levels of biodiversity significance with respect to the AOI

Decision Number	Description	Panel Recommended Significance	Criteria Values
deu_fa_09	The special biodiversity value of occurrences of 10.5.1 is very high in areas with very high condition rating.	State	Ia (centre of endemism): HIGH Ib (Wildlife refugia): VERY HIGH Ic (Areas with concentrations of disjunct populations): HIGH Id (Areas with concentrations of taxa at the limits of their geographic range): HIGH Ie (Areas with high species richness): VERY HIGH Ii (Areas with a high density of hollow-bearing trees that provide habitat for animals): HIGH
deu_fa_10	The special biodiversity value of occurrences of 10.5.5 is very high in areas: With very high condition rating; Within or directly adjacent to significant wetlands; or With a D2 rating of very high (largest examples of this RE in the subregion).	State	Ib (Wildlife refugia): VERY HIGH Ic (Areas with concentrations of disjunct populations): HIGH Id (Areas with concentrations of taxa at the limits of their geographic range): HIGH Ie (Areas with high species richness): VERY HIGH Ii (Areas with a high density of hollow-bearing trees that provide habitat for animals): VERY HIGH
deu_fa_13	The special biodiversity value of occurrences of 10.7.3 mapped in the 'sandstone ranges and escarpments' coverage as mentioned in The conservation of biodiversity in the Desert Uplands (Morgan *et al*. 2002) section 4.2.6 Areas of greatest significance for the conservation of faunal biodiversity, is very high.	State	Ib (Wildlife refugia): VERY HIGH Ic (Areas with concentrations of disjunct populations: VERY HIGH Id (Areas with concentrations of taxa at the limits of their geographic range): VERY HIGH Ie (Areas with high species richness): HIGH Ij (Breeding or roosting sites used by a significant number of individuals): VERY HIGH
deu_fa_19	The special biodiversity value of occurrences of 10.3.27 Poplar box is very high in areas: With very high condition rating; Within or directly adjacent to significant wetlands; or With a D2 rating of very high (largest examples of this RE in the subregion.	State	Ib (Wildlife refugia): VERY HIGH Id (Areas with concentrations of taxa at the limits of their geographic range): HIGH Ie (Areas with high species richness): HIGH Ii (Areas with a high density of hollow-bearing trees that provide habitat for animals): VERY HIGH
deu_fa_20	The special biodiversity value of occurrences of 10.3.28 alluvials (narrow-leaf ironbark and silver-leaf ironbark) is very high in areas: With very high condition rating; Within or directly adjacent to significant wetlands; or With a D2 rating of very high (largest examples of this RE in the subregion.	State	Ib (Wildlife refugia): VERY HIGH Ic (Areas with concentrations of disjunct populations: HIGH Id (Areas with concentrations of taxa at the limits of their geographic range): HIGH Ie (Areas with high species richness): VERY HIGH Ii (Areas with a high density of hollow-bearing trees that provide habitat for animals): VERY HIGH
deu_fa_22	The special biodiversity values of all land zone 10 is high.	Regional	Ib (wildlife refugia): HIGH, Ie (high species diversity): HIGH
deu_fa_25	High precision records for priority taxa of Regional significance are contained within the remnant.	Regional	Criteria H: HIGH
deu_fa_26	Low precision records for priority taxa of Regional significance are contained within the remnant.	Regional	Criteria H: MEDIUM
deu_fl_09	10.5.1 RE sub-types with EVNT/priority taxa-a,b and d.	Regional	Ib (wildlife refugia): HIGH Ic (disjunct populations): HIGH Id (species at geographic range limit): HIGH Ie (high species diversity): HIGH

Decision Number	Description	Panel Recommended Significance	Criteria Values
deu_l_02	Threatened REs The conservation of biodiversity in the Desert Uplands (Morgan *et al* 2002) section 3.2 outlines the special biodiversity values associated with endemic REs that only occur in one sub-region and vegetation units. Where these endemic ecosystems cover an extent of less than 10 000 hectares, the vegetation units are rated as having very high special biodiversity value because of the likelihood of distinct variation in species composition associated with geomorphology and other environmental variables.	State	Ib (wildlife refugia): VERY HIGH Ig (REs show distinct variation in species composition): VERY HIGH
deu_l_22	Ground Cover Disturbance Index (GCDI) REs with GCDI values of high or very high over 25 per cent or more of the discrete mapped area have significance in that they are assumed to have very low disturbance to the ground layer.	Regional	K (threatening processes/condition): Regional
deu_l_25	Terrestrial corridors and remnant linkages	State	J (corridors): State

Expert panel decision descriptions:

deu_fa_09

Values:

High species richness for all taxa

Very high species richness for priority and EVNT species.

This RE represents some of the best remaining intact sub-tropical woodlands in Central and South East Queensland. Extremely high habitat condition in most of this region due to lack of disturbance, low levels of grazing (including areas where it is entirely absent due to poison bush), low levels of infrastructure, watering points and weeds.

The presence of at least two endemic species.

The presence of a number of sibling or related species, indicated this region has biogeographic significance as a zone of species turnover between the wetter coastal regions and the arid interior of Australia.

The presence of a number of disjunct species, and in the case of Pseudomys desertor, extremely high abundances, further evidence of this regions value as good quality habitat and as an area of significant habitat refuge.

This RE forms the core of the Alice Tableland a biogeographically significant landscape, which represents a substantial area of species turnover, refuge and disjunction. Being situated on the Great Dividing Range, this area forms continuous north-south woodland corridor, linking the woodlands and forests of the Einasleigh Uplands and Cape York Peninsula with the woodlands of the Carnarvon ranges, and ultimately with the woodlands and forests of the Great Dividing Range in New South Wales and Victoria.

Species:

Accipiter novaehollandiae, grey goshawk; Aepyprymnus rufescens, rufous bettong; Chthonicola sagittata, speckled warbler; Climacteris picumnus, brown tree-creeper; Ctenotus rosarium, Desert Uplands ctenotus; Lagorchestes conspicillatus, spectacled hare-wallaby.

deu_fa_10

Values:

Very high species richness for all taxa.

Very high species richness for priority and EVNT species.

Complex, well-formed woodlands with many hollow-bearing trees of high fertility is one of the most significant habitats for fauna in the DEU bioregion.

Refugial habitat for woodland species in areas where clearing is extensive, and important habitat for bird species, many of which have declined further south.

Biogeographically significant habitat as it allows inland incursions of many east coast species into the semi-arid zone which are on edge of their geographic range.

Species:

Ctenotus capricorni, Capricorn ctenotus; Ephippiorhynchus asiaticus, black-necked stork;Geophaps scripta scripta, squatter pigeon; Heteromunia pectoralis, pictorella mannikin; Lewinia pectoralis, Lewin's rail; Lophoictinia isura, square-tailed kite; Melithreptus gularis, black-chinned honeyeater; Poephila cincta cincta, black-throated finch; Rostratula australis, Australian painted snipe; Aepyprymnus rufescens, rufous bettong; Climacteris picumnus, brown tree-creeper; Diplodactylus vittatus, wood gecko; Lagorchestes conspicillatus, spectacled hare-wallaby; Lichenostomus leucotis, white-eared honeyeater; Petroica goodenovii, red-capped robin; Climacteris picumnus, brown tree-creeper; Pseudomys desertor, desert mouse.

deu_fa_13

Values:

High species richness for mammals.

High species richness for priority species.

The sandstone ranges, escarpments and cave habitats are of limited areal extent in the DEU bioregion, but many species are specialised to these environments, being associated with bare stony ground, the mesic gorges or the caves and crevices in the sandstone rock. These habitats are refugial and support disjunct species.

The caves and escarpment provide significant roosting habitat for many bats species including significant species as well as roosts for owls in environments that may not otherwise have tall hollow-bearing trees.

Species:

Chalinolobus picatus, little pied bat; Diplodactylus vittatus, wood gecko; Lagorchestes conspicillatus, spectacled hare-wallaby; Lichenostomus leucotis, white-eared honeyeater; Petroica goodenovii, red-capped robin.

deu_fa_19

Values:

High species richness for birds, frogs and reptiles.

Very high species richness for priority species.

Complex, well-formed woodlands with many hollow-bearing trees of high fertility is one of the most significant habitats for fauna in the DEU bioregion.

Refugial habitat for woodland species in areas where clearing is extensive, and important habitat for bird species, many of which have declined further south.

Biogeographically significant habitat as it allows inland incursions of many east coast species into the semi-arid zone which are on edge of their geographic range.

Species:

Lophoictinia isura, square-tailed kite; Melithreptus gularis, black-chinned honeyeater; Aepyprymnus rufescens, rufous bettong; Burhinus grallarius, bush stone-curlew; Chthonicola sagittata, speckled warbler; Climacteris picumnus, brown treecreeper; Melanodryas cucullata, hooded robin; Petroica goodenovii, red-capped robin; Pomatostomus temporalis, grey-crowned babbler; Pseudomys desertor, desert mouse.

deu_fa_20

Values:

High species richness for reptiles, frogs and mammals, very high for birds.

Very high species richness for priority and EVNT species.

Complex, well-formed woodlands with many hollow-bearing trees of high fertility is one of the most significant habitats for fauna in the DEU bioregion.

Refugial habitat for woodland species in areas where clearing is extensive, and important habitat for bird species, many of which have declined further south.

Biogeographically significant habitat as it allows inland incursions of many east coast species into the semi-arid zone which are on edge of their geographic range.

Species:

Geophaps scripta scripta, squatter pigeon.

deu_fa_22

Values:

The sandstone ranges, escarpments and cave habitats support many species specialised to bare stony ground, mesic gorges or the cave habitats and crevices in the sandstone rock. The special biodiversity value of these areas is very high for the conservation of the faunal diversity of the bioregion. These values are described in The conservation of biodiversity in the Desert Uplands (Morgan **et al**. 2002) section 4.2.6 Areas of greatest significance for the conservation of faunal biodiversity.

Species:

Poephila cincta cincta, black-throated finch; Melithreptus gularis, black-chinned honeyeater; Lophoictinia isura, square-tailed kite; Acanthophis antarcticus, common death adder; Accipiter novaehollandiae, grey goshawk; Falco hypoleucos, grey falcon; Aepyprymnus rufescens, rufous bettong; Burhinus grallarius, bush stone-curlew; Climacteris picumnus, brown treecreeper; Ctenotus rosarium, red earth skink; Diplodactylus vittatus, wood gecko; Lichenostomus leucotis, white-eared honeyeater; Melanodryas cucullata, hooded robin; Petauroides volans, greater glider; Petroica goodenovii, red-capped robin; Pomatostomus temporalis, grey-crowned babbler; Turnix varius, painted button quail; Zygomys argurus, common rock-rat.

deu_fa_25

Remnant contains habitat for priority taxa with high precision records

deu_fa_26

Remnant contains habitat for priority taxa with low precision records

deu_fl_09

Values:

Very high overall species diversity of DEU bioregion species

Area of concentration of EVNT flora and flora with biogeographic interest and other priority species (Morgan **et al** 2002; section 4.1).

Species:

Acacia ramiflora (E); Aristida burraensis (NT); Calytrix microcoma; Desmodium macrocarpum (NT); Eucalyptus miniata; Eucalyptus tetrodonta; Goodenia splendida; Hakea purpurea; Hibbertia exutiacies; Keraudrenia sp. (Pentland S.T.Blake 9922); Polygala sp. (White Mountains M.B.Thomas+ 1738); Solanum crassitomentosum; Corymbia clandestina (V); Micromyrtus rotundifolia (V); Desmodium macrocarpum (NT); Acacia ramiflora; Eucalyptus similis, yellow jacket

deu_l_02

A number of threatened REs have their status because of their naturally restricted distribution, but others due largely due to widespread degradation resulting from a history of high grazing pressure. Those REs are included here along with those that are endemic with restricted extents.

Threatened ecosystems that have been the target of extensive clearing are, in general, those associated with the more productive and better watered landscapes.

28 REs included:

1 'endangered' RE occurs (<10 000 hectares): 10.3.19.

25 'of concern' REs (<10 000 hectares or <1000 hectares pre-clearing).

2 'least concern' REs (>10 000 hectares) subject to 'high grazing pressure' (REDD): 10.3.25, 10.3.27.

3 REs 'subject to high grazing pressure' excluded due to there being

>10 000 hectares: 10.9.1, 10.3.4, 10.7.5.

deu_l_22

Using a 1988-2009 Landsat TM derived bare ground index time series, a disturbance classification (LOW, MEDIUM, HIGH, VERY HIGH) was developed for all areas in the DEU bioregion with less than 20 per cent foliage projective cover. This disturbance classification was then used to incorporate the 'disturbance/condition' data into the DEU bioregion BPA in the following way: 1) Occurrences of REs that have VERY LOW disturbance are elevated to Regional significance through criteria K.

Discrete areas of High and Very High GCDI ratings incorporated 65 REs. Those with >10 000 hectares represented are:

10.5.11-Eucalyptus melanophloia/whitei open woodland.

10.5.5-E.melanophloia open woodland.

10.7.10-E. whitei open woodland.

10.4.8-Dichanthium sericeum grassland.

10.5.2- Corymbia plena open woodland.

10.9.1- Acacia argyrodendron open woodland.

10.9.2-A. cambagei low woodland.

10.7.11-E. melanophloia open woodland.

10.7.1-E. whitei open woodland.

10.7.2-E. persistens open woodland.

10.3.6-E. brownie open woodland.

10.3.14-E. camaldulensis open woodland.

10.3.9-E. whitei open woodland.

10.4.1-A. argyrodendron open woodland.

10.3.8-Aristida latifolia tussock grassland.

10.7.8-Melaleuca spp. shrubland.

10.3.15-E. camaldulensis open woodland to grasslands

10.5.7-Grevillea striata low open woodland.

deu_l_25

Natural vegetation corridors are the norm in the DEU bioregion because the extent of clearing of vegetation has been limited particularly along the spines of old weathered range systems and in the north of the region. Where clearing has broken or narrowed vegetation corridors in the south these areas have been identified as having very high value for landscape connectivity. A buffer 2.5 kilometres wide either side of the centre line of the corridor has been used and both remnant and cleared areas in these corridors have been attributed.

Aquatic Conservation Assessments

Introduction

The Aquatic Biodiversity Assessment and Mapping Method or AquaBAMM (Clayton *et al.* 2006), was developed to assess conservation values of wetlands in queensland, and may also have application in broader geographical contexts. It is a comprehensive method that uses available data, including data resulting from expert opinion, to identify relative wetland conservation/ecological values within a specified study area (usually a catchment). The product of applying this method is an Aquatic Conservation Assessment (ACA) for the study area.

An ACA using AquaBAMM is non-social, non-economic and identifies the conservation/ecological values of wetlands at a user-defined scale. It provides a robust and objective conservation assessment using criteria, indicators and measures that are founded upon a large body of national and international literature. The criteria, each of which may have variable numbers of indicators and measures, are naturalness (aquatic), naturalness (catchment), diversity and richness, threatened species and ecosystems, priority species and ecosystems, special features, connectivity and representativeness. An ACA using AquaBAMM is a powerful decision support tool that is easily updated and simply interrogated through a geographic information system (GIS).

Where they have been conducted, ACAs can provide a source of baseline wetland conservation/ecological information to support natural resource management and planning processes. They are useful as an independent product or as an important foundation upon which a variety of additional environmental and socio-economic elements can be added and considered (i.e. an early input to broader 'triple-bottom-line' decision-making processes). An ACA can have application in:

- determining priorities for protection, regulation or rehabilitation of wetlands and other aquatic ecosystems
- on-ground investment in wetlands and other aquatic ecosystems
- contributing to impact assessment of large-scale development (e.g. dams)
- water resource and strategic regional planning prcesses

For a detailed explanation of the methodology please refer to the summary and expert panel reports relevant to the ACA utilised in this assessment. These reports can be accessed at Wetland *Info*:

http://wetlandinfo.des.qld.gov.au/wetlands/assessment/assessment-methods/aca

The GIS results can be downloaded from the Queensland Spatial Catalogue at:

http://qspatial.information.qld.gov.au/geoportal/

Explanation of Criteria

Under the AquaBAMM, eight criteria are assessed to derive an overall conservation value. Similar to the Biodiversity Assessment and Mapping Methodology, the criteria may be primarily diagnostic (quantitative) or primarily expert opinion (qualitative) in nature. The following sections provide a brief description of each of the 8 criteria.

Criteria 1. Naturalness - Aquatic: This attribute reflects the extent to which a wetland's (riverine, non-riverine, estuarine) aquatic state of naturalness is affected through relevant influencing indicators which include: presence of exotic flora and fauna; presence of aquatic communities; degree of habitat modification and degree of hydrological modification.

Criteria 2. Naturalness - Catchment: The naturalness of the terrestrial systems of a catchment can have an influence on many wetland characteristics including: natural ecological processes e.g. nutrient cycling, riparian vegetation, water chemistry, and flow. The indicators utilised to assess this criterion include: presence of exotic flora and/or fauna; riparian, catchment and flow modification.

Criteria 3. Naturalness - Diversity and Richness: This criterion is common to many ecological assessment methods and can include both physical and biological features. It includes such indicators as species richness, riparian ecosystem richness and geomorphological diversity.

Criteria 4. Threatened Species and Ecosystems: This criterion evaluates ecological rarity characteristics of a wetland. This includes both species rarity and rarity of communities / assemblages. The communities and assemblages are best represented by regional ecosystems. Species rarity is determined by NCA and EPBC status with Endangered, Vulnerable or Near-threatened species being included in the evaluation. Ecosystem rarity is determined by regional ecosystem biodiversity status i.e. Endangered, Of Concern, or Not of Concern.

Criteria 5. Priority Species and Ecosystems: Priority flora and fauna species lists are expert panel derived. These are aquatic, semi-aquatic and riparian species which exhibit at least 1 particular trait in order to be eligible for consideration. For

flora species the traits included:

- It forms significant macrophyte beds (in shallow or deep water).
- It is an important food source.
- It is important/critical habitat.
- It is implicated in spawning or reproduction for other fauna and/or flora species.
- It is at its distributional limit or is a disjunct population.
- It provides stream bank or bed stabilisation or has soil binding properties.
- It is a small population and subject to threatening processes.

Fauna species are included if they meet at least one of the following traits:

- It is endemic to the study area (>75 per cent of its distribution is in the study area/catchment).
- It has experienced, or is suspected of experiencing, a serious population decline.
- It has experienced a significant reduction in its distribution and has a naturally restricted distribution in the study area/catchment.
- It is currently a small population and threatened by loss of habitat.
- It is a significant disjunct population.
- It is a migratory species (other than birds).
- A significant proportion of the breeding population (>one per cent for waterbirds, >75 per cent other species) occurs in the waterbody (see Ramsar criterion 6 for waterbirds).
- Limit of species range.

See the individual expert panel reports for the priority species traits specific to an ACA.

Criteria 6. Special Features: Special features are areas identified by flora, fauna and ecology expert panels which exhibit characteristics beyond those identified in other criteria and which the expert panels consider to be of the highest ecological importance. Special feature traits can relate to, but are not solely restricted to geomorphic features, unique ecological processes, presence of unique or distinct habitat, presence of unique or special hydrological regimes e.g. spring-fed streams. Special features are rated on a 1 - 4 scale (4 being the highest).

Criteria 7. Connectivity: This criterion is based on the concept that appropriately connected aquatic ecosystems are healthy and resilient, with maximum potential biodiversity and delivery of ecosystem services.

Criteria 8. Representativeness: This criterion applies primarily to non-riverine assessments, evaluates the rarity and uniqueness of a wetland type in relation to specific geographic areas. Rarity is determined by the degree of wetland protection within "protected Areas" estate or within an area subject to the *Fisheries Act 1994*, *Coastal Protection and Management Act 1995*, or *Marine Parks Act 2004*. Wetland uniqueness evaluates the relative abundance and size of a wetland or wetland management group within geographic areas such as catchment and subcatchment.

Riverine Wetlands

Riverine wetlands are all wetlands and deepwater habitats within a channel. The channels are naturally or artificially created, periodically or continuously contain moving water, or connecting two bodies of standing water. AquaBAMM, when applied to riverine wetlands uses a discrete spatial unit termed subsections. A subsection can be considered as an area which encompasses discrete homogeneous stream sections in terms of their natural attributes (i.e. physical, chemical, biological and utilitarian values) and natural resources. Thus in an ACA, an aquatic conservation significance score is calculated for each subsection and applies to all streams within a subsection, rather than individual streams as such.

Please note, the area figures provided in Tables 16 and 17, are derived using the extent of riverine subsections within the AOI. Refer to **Map 5** for further information. A summary of the conservation significance of riverine wetlands within the AOI is provided in the following table.

Table 16: Overall level/s of riverine aquatic conservation significance

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0

Aquatic conservation significance (riverine wetlands)	Area (Ha)	% of AOI
High	0.0	0.0
Medium	6,860.29	12.33
Low	46,303.66	83.24
Very Low	2,461.70	4.43

The individual aquatic conservation criteria ratings for riverine wetlands within the AOI are listed below.

Table 17: Level/s of riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
1. Naturalness aquatic	33,872.88	60.9			2,110.27	3.8	19,642.49	35.3
2. Naturalness catchment	29,204.86	52.5	20,901.32	37.6	3,409.19	6.1	2,110.27	3.8
3. Diversity and richness					14,397.07	25.9	41,228.57	74.1
4. Threatened species and ecosystems			2,110.27	3.8				
5. Priority species and ecosystems			2,110.27	3.8				
6. Special features								
7. Connectivity			6,042.45	10.9	15,848.23	28.5	33,734.96	60.6
8. Representative-ness								

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to riverine wetlands within the AOI.

Table 18: Expert panel decisions for assigning overall levels of riverine aquatic conservation significance

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Non-riverine Wetlands

Non-riverine wetlands include both lacustrine and palustrine wetlands, however, do not currently incorporate estuarine, marine or subterranean wetland types. A summary of the conservation significance of non-riverine wetlands within the AOI is provided in the following table. Refer to **Map 6** for further information.

Table 19: Overall level/s of non-riverine aquatic conservation significance

Aquatic conservation significance (non-riverine wetlands)	Area (Ha)	% of AOI
Very High	0.0	0.0
High	7.7	0.01
Medium	12.94	0.02
Low	0.0	0.0
Very Low	6.76	0.01

The following table provides an assessment of non-riverine wetlands within the AOI and associated aquatic conservation criteria values.

Table 20: Level/s of non-riverine aquatic conservation significance based on selected criteria

Criteria	Very High Rating - Area (Ha)	Very High Rating - % of AOI	High Rating - Area (Ha)	High Rating - % of AOI	Medium Rating - Area (Ha)	Medium Rating - % of AOI	Low Rating - Area (Ha)	Low Rating - % of AOI
1. Naturalness aquatic	9.38		11.26				6.76	
2. Naturalness catchment	10.14		17.26					
3. Diversity and richness			2.69		13.08		11.63	
4. Threatened species and ecosystems			20.64					
5. Priority species and ecosystems								
6. Special features								
7. Connectivity								
8. Representative-ness			5.01		15.63			

The table below lists and describes the relevant expert panel decisions used to assign conservation significance values to non-riverine wetlands within the AOI.

Table 21: Expert panel decisions for assigning overall levels of non-riverine aquatic conservation significance.

Decision number	Special feature	Catchment	Criteria/Indicator/Measure	Conservation rating (1-4)
(No Records)				

4 is the highest rating/value

Expert panel decision descriptions:

(No Records)

Threatened and Priority Species

Introduction

This chapter contains a list of threatened and priority flora and/or fauna species that have been recorded on, or within 4km of the Assessment Area.

The information presented in this chapter with respect to species presence is derived from compiled databases developed primarily for the purpose of BPAs and ACAs. Data is collated from a number of sources and is updated periodically.

It is important to note that the list of species provided in this report, may differ when compared to other reports generated from other sources such as the State government's WildNet, Herbrecs or the federal government's EPBC database for a number of reasons.

Records for threatened and priority species are filtered and checked based on a number of rules including:

- Taxonomic nomenclature - current scientific names and status,
- Location - cross-check co-ordinates with location description,
- Taxon by location - requires good knowledge of the taxon and history of the record,
- Duplicate records - identify and remove,
- Expert panels - check records and provide new records,
- Flora cultivated records excluded,
- Use precise records less than or equal to 2000m,
- Use recent records greater than or equal to 1975 animals, greater than or equal to 1950 plants.

Threatened Species

Threatened species are those species classified as "Endangered" or "Vulnerable" under the *Environment Protection and Biodiversity Conservation Act 1999* or "Endangered", "Vulnerable" or "Near threatened" under the *Nature Conservation Act 1992*.

The following threatened species have been recorded on, or within approximately 4km of the AOI.

Table 22: Threatened species recorded on, or within 4km of the AOI

Species	Common name	NCA status	EPBC status	Back on Track rank	Migratory species*	Wetland species**	Identified flora/fauna
Acacia spania		NT		Low			FL
Geophaps scripta scripta	squatter pigeon (southern subspecies)	V	V	Medium			FA
Phascolarctos cinereus	koala	V	V	Low			FA
Poephila cincta cincta	black-throated finch (white-rumped subspecies)	E	E	High			FA

NB. Please note that the threatened species listed in this section are based upon the most recently compiled DES internal state-wide threatened species dataset. This dataset may contain additional records that were not originally available for inclusion in the relevant individual BPAs and ACAs.

**JAMBA - Japan-Australia Migratory Bird Agreement; CAMBA - China-Australia Migratory Bird Agreement; ROKAMBA - Republic of Korea-Australia Migratory Bird Agreement; CMS - Convention on the Conservation of Migratory Species*.

***Y - wetland indicator species*.

BPA Priority Species

A list of BPA priority species that have been recorded on, or within approximately 4km of the AOI is contained in the following table.

Table 23: Priority species recorded on, or within 4km of the AOI

Species	Common name	Back on Track rank	Identified flora/fauna
Burhinus grallarius	bush stone-curlew	Low	FA
Chthonicola sagittata	speckled warbler	Low	FA
Climacteris picumnus	brown treecreeper	Low	FA
Gehyra catenata	None	Low	FA
Lagorchestes conspicillatus	spectacled hare-wallaby	Low	FA
Melanodryas cucullata	hooded robin	Low	FA
Petroica goodenovii	red-capped robin	Low	FA
Pseudomys desertor	desert mouse	Low	FA

NB. Please note that the list of priority species is based on those species identified in the BPAs, however records for these species may be more recent than the originals used. furthermore, the BPA priority species databases are updated from time to time. At each update, the taxonomic details for all species are amended as necessary to reflect current taxonomic name and/or status changes.

ACA Priority Species

A list of ACA priority species used in riverine and non-riverine ACAs that have been recorded on, or within approximately 4km of the AOI are contained in the following tables.

Table 24: Priority species recorded on, or within 4 km of the AOI - riverine

(no results)

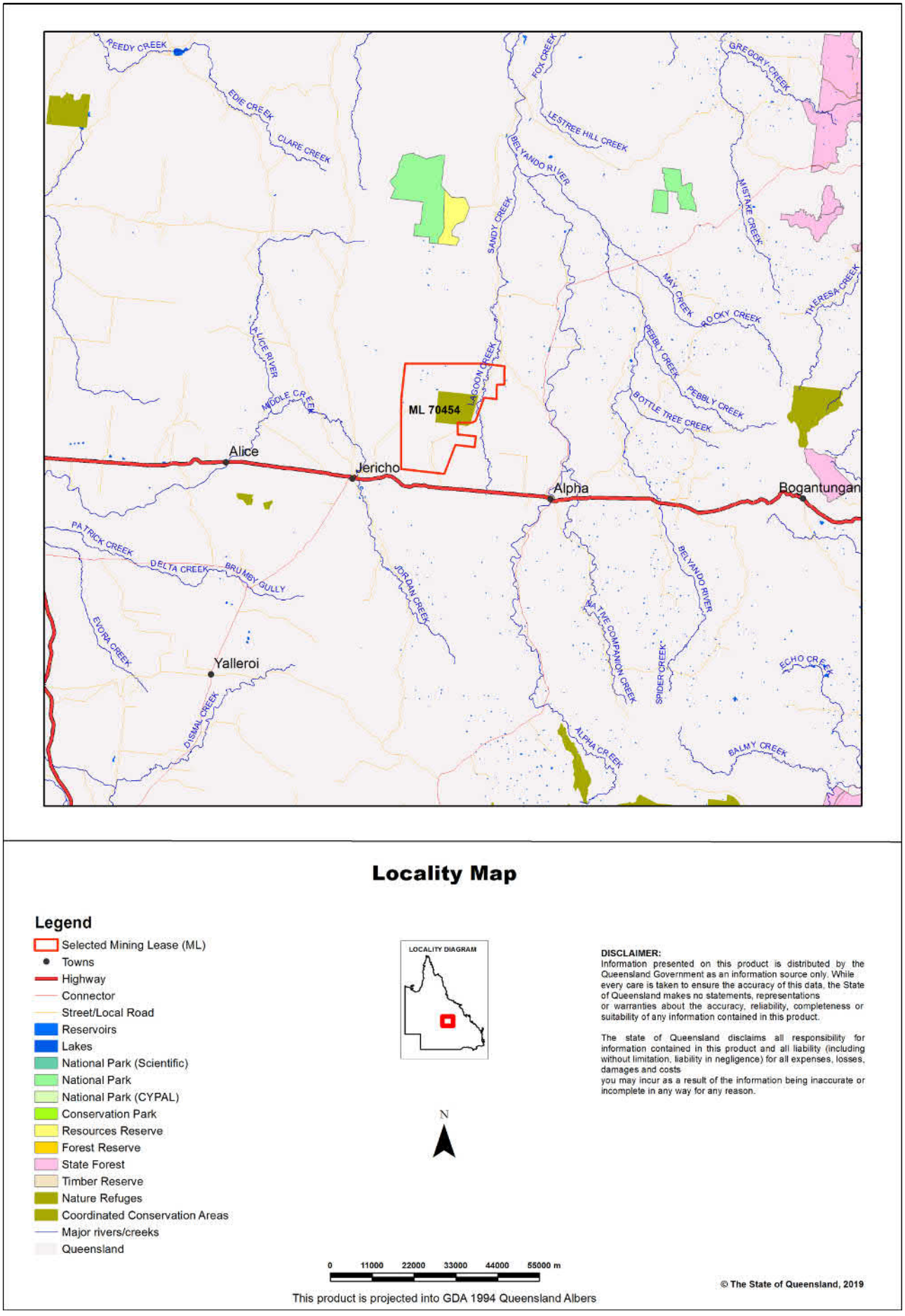
Table 25: Priority species recorded on, or within 4 km of the AOI - non-riverine

(no results)

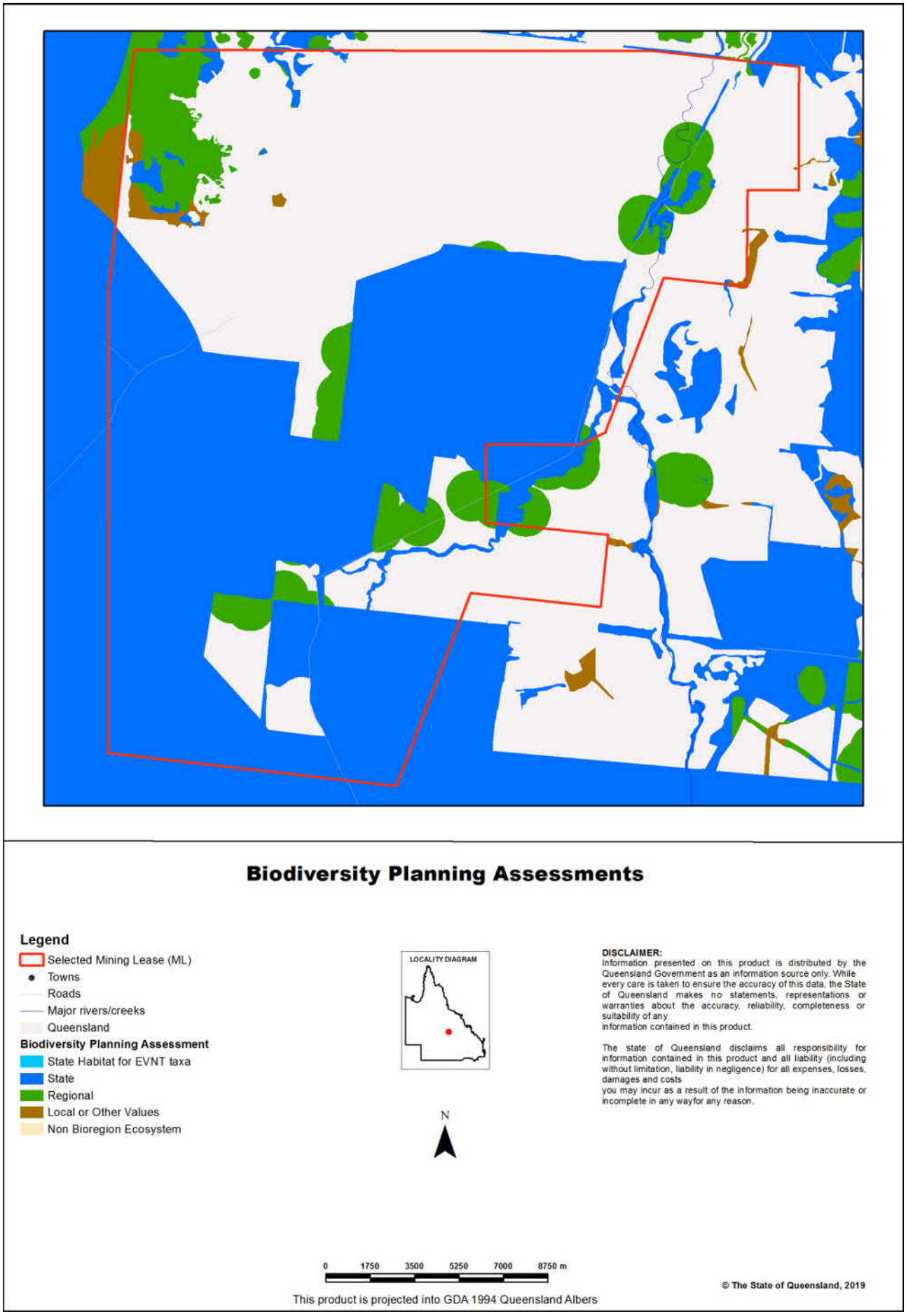
NB. Please note that the priority species records used in the above two tables are comprised of those adopted for the released individual ACAs. The ACA riverine and non-riverine priority species databases are updated from time to time to reflect new release of ACAs. At each update, the taxonomic details for all ACAs records are amended as necessary to reflect current taxonomic name and/or status changes.

Maps

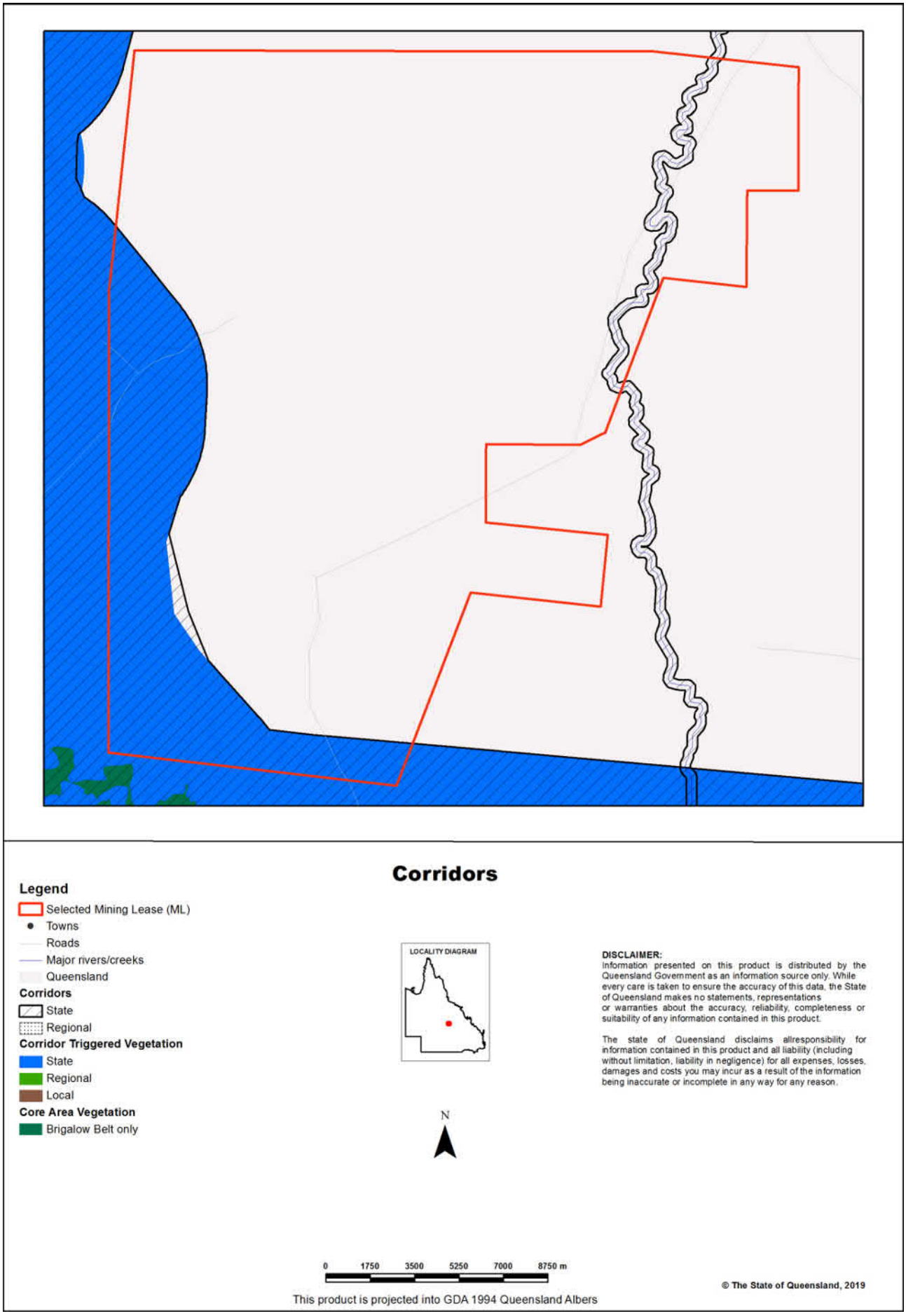
Map 1 - Locality Map



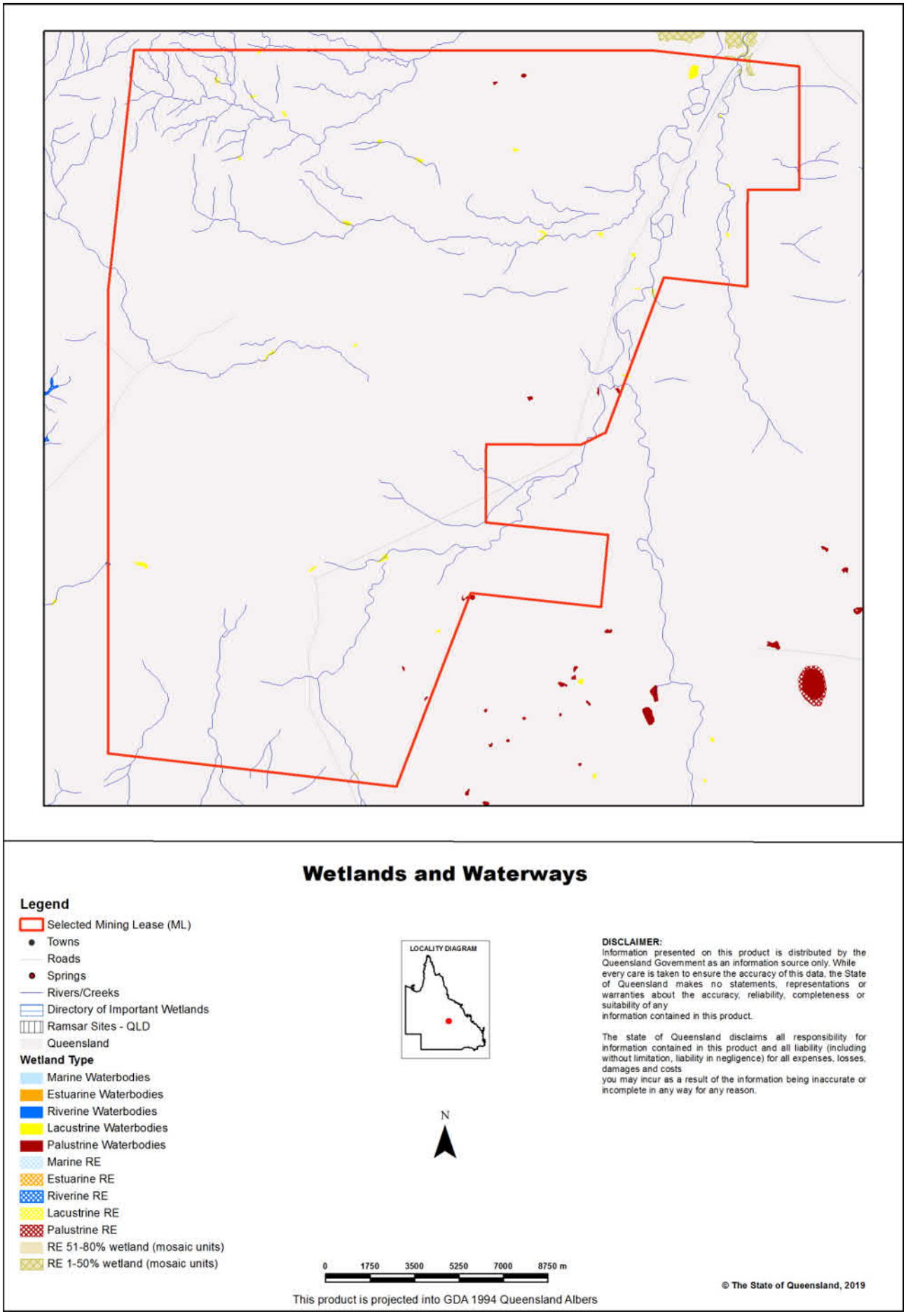
Map 2 - Biodiversity Planning Assessment (BPA)



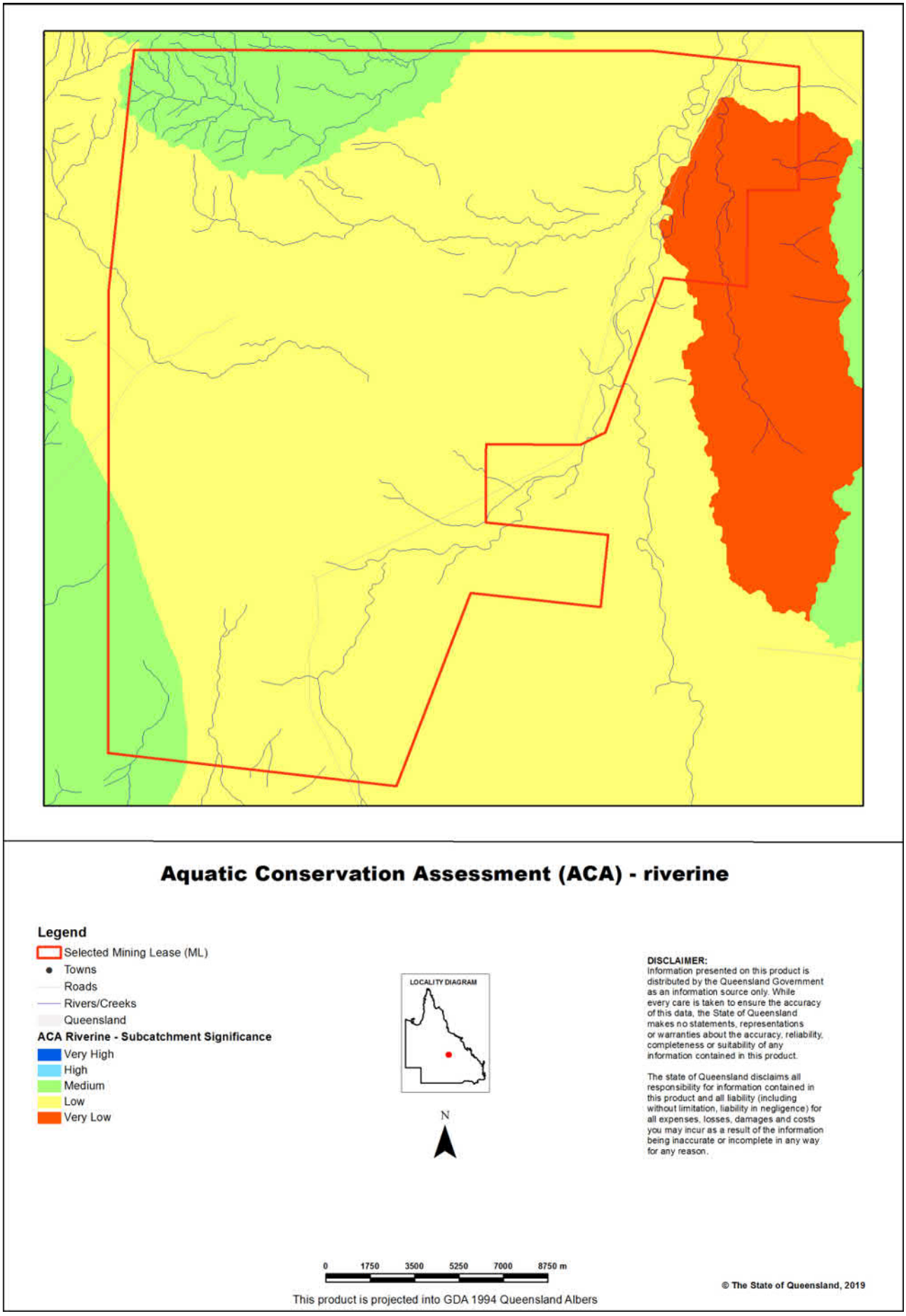
Map 3 - Corridors



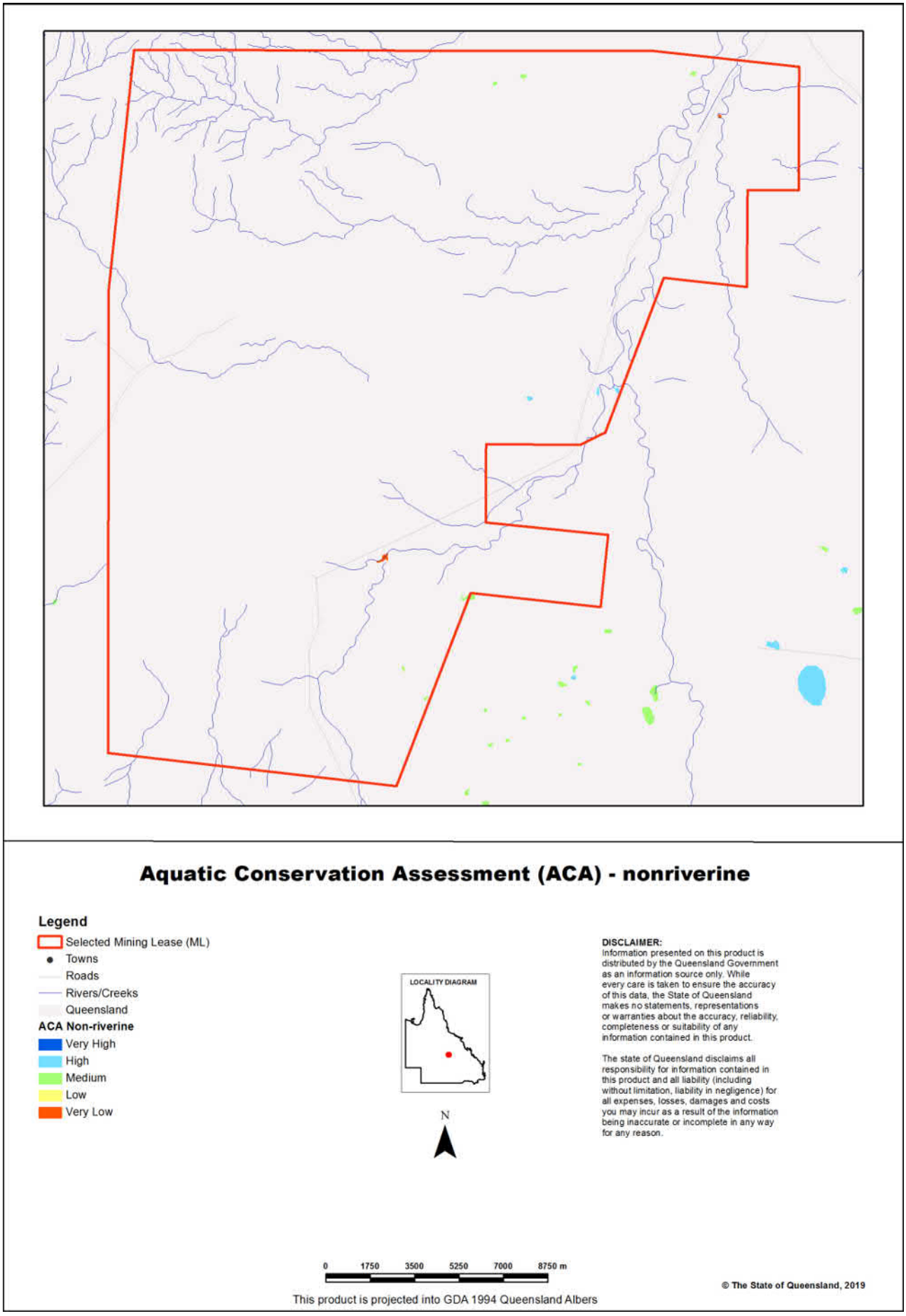
Map 4 - Wetlands and waterways



Map 5 - Aquatic Conservation Assessment (ACA) - riverine



Map 6 - Aquatic Conservation Assessment (ACA) - non-riverine



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Appendices

Appendix 1 - Source Data

Theme	Datasets
Aquatic Conservation Assessments Non-riverine*	Combination of the following datasets: Cape York Peninsula Non-riverine v1.1 Eastern Gulf of Carpentaria v1.1 Great Barrier Reef Catchment Non-riverine v1.3 Lake Eyre and Bulloo Basins v1.1 QMDB Non-riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Non-riverine ACA v1.1
Aquatic Conservation Assessments Riverine*	Combination of the following datasets: Cape York Peninsula Riverine v1.1 Eastern Gulf of Carpentaria v1.1 Great Barrier Reef Catchment Riverine v1.1 Lake Eyre and Bulloo Basins v1.1 QMDB Riverine ACA v1.4 Southeast Queensland ACA v1.1 WBB Riverine ACA v1.1
Biodiversity Planning Assessments*	Combination of the following datasets: Brigalow Belt BPA v2.1 Cape York Peninsula BPA v1.1 Central Queensland Coast BPA v1.3 Channel Country BPA v1.1 Desert Uplands BPA v1.3 Einasleigh Uplands BPA v1.1 Gulf Plains BPA v1.1 Mitchell Grass Downs BPA v1.1 Mulga Lands BPA v1.4 New England Tableland v2.3 Southeast Queensland v4.1
Statewide BPA Corridors*	Statewide corridors v1.4
Threatened Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
BPA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.
ACA Priority Species	An internal DES database compiled from Wildnet, Herbrecs, Corveg, the QLD Museum, as well as other incidental sources.

***These datasets are available at:**

http://dds.information.qld.gov.au/DDS

Appendix 2 - Acronyms and Abbreviations

AOI	- Area of Interest
ACA	- Aquatic Conservation Assessment
AQUABAMM	- Aquatic Biodiversity Assessment and Mapping Methodology
BAMM	- Biodiversity Assessment and Mapping Methodology
BoT	- Back on Track
BPA	- Biodiversity Planning Assessment
CAMBA	- China-Australia Migratory Bird Agreement
DES	- Department of Environment and Science
EPBC	- *Environment Protection and Biodiversity Conservation Act 1999*
EVNT	- Endangered, Vulnerable, Near Threatened
GDA94	- Geocentric Datum of Australia 1994
GIS	- Geographic Information System
JAMBA	- Japan-Australia Migratory Bird Agreement
NCA	- *Nature Conservation Act 1992*
RE	- Regional Ecosystem
REDD	- Regional Ecosystem Description Database
ROKAMBA	- Republic of Korea-Australia Migratory Bird Agreement