Origin Energy
Gas Supply Security Project

MNES Assessment Report

Version	Date	Details	Approved	Document Number
0	11 December 2020	Submitted with Referral	Strategic Approvals	38520142
1	6 January 2021	Submitted with Referral – Minor edits (response to DAWE comments)	Strategic Approvals	38520142

Executive summary

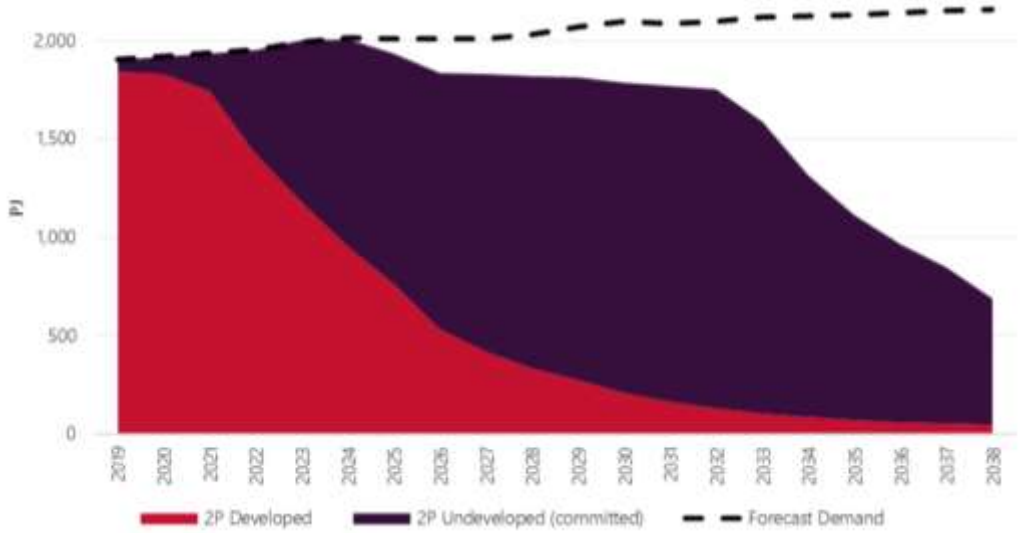
East Coast Gas Market Supply Shortfall

The Australian Energy Market Operator's (AEMO) report Gas Statement of Opportunities (AEMO, 2020) provides the projected supply-demand balance for a 20-year outlook period for the east coast domestic gas market. AEMO identify the following gas supply constraints:

- gas supply shortfall from 2024 onwards unless additional reserves, resources and infrastructure are developed
- potential for increased gas demand and peak-day shortages; while supply from existing and committed natural gas developments is forecast to provide adequate supply to meet gas demands until between 2023 and 2025, weather-driven variances in consumption or electricity market activity could increase gas demand and create potential for peak-day shortages; and
- increased reliance on Queensland supplies to meet gas demand in southern states as natural gas production from Victoria declines between 2021 and 2023.

The AEMO report illustrates the projected shortfall in gas supply from 2024 based on the expected production forecast for existing and committed gas projects, as shown in Figure E- 1.

Figure E- 1 Projected eastern and south-eastern Australian gas production (AEMO, 2020)



The Australian Competition and Consumer Commission (ACCC) Gas inquiry 2017-2025 interim report (ACCC, 2020) reaffirmed this projection by describing two trends (increasing production in Queensland and declining production in the southern states) that are expected to continue in the short to medium term.

Production from developed and undeveloped 2P reserves in Queensland is expected to grow until 2023 and gradually decline thereafter. In contrast, production from developed and undeveloped 2P reserves in the southern states is expected to decline from 2021, falling below southern demand by 2024 (AEMO, 2020). The AEMO report also considers the supply-demand impact from the COVID-19-related restrictions.

The Project

The Gas Supply Security Project (the Project) will supply additional gas to the Australian east coast domestic gas market as well as supplying gas to meet liquified natural gas (LNG) export demand for the Australia Pacific LNG Project. With the advantage of existing capability and capacity of Australia Pacific LNG Project infrastructure and management systems, the Project will provide long-

term gas supply to the east coast domestic market. Based on current appraisal data, production from 2P reserves and 2C resources for the Project is expected to be 453.6 PJ and 591.7 PJ respectively.

The Project, shown on Figure E-2, proposes to continue development and production of existing Australia Pacific LNG acreage. The downstream components of the existing Australian Pacific LNG Project (i.e. the Gladstone gas transmission pipeline and LNG facility) have sufficient capacity to accommodate additional gas generated by the Project.

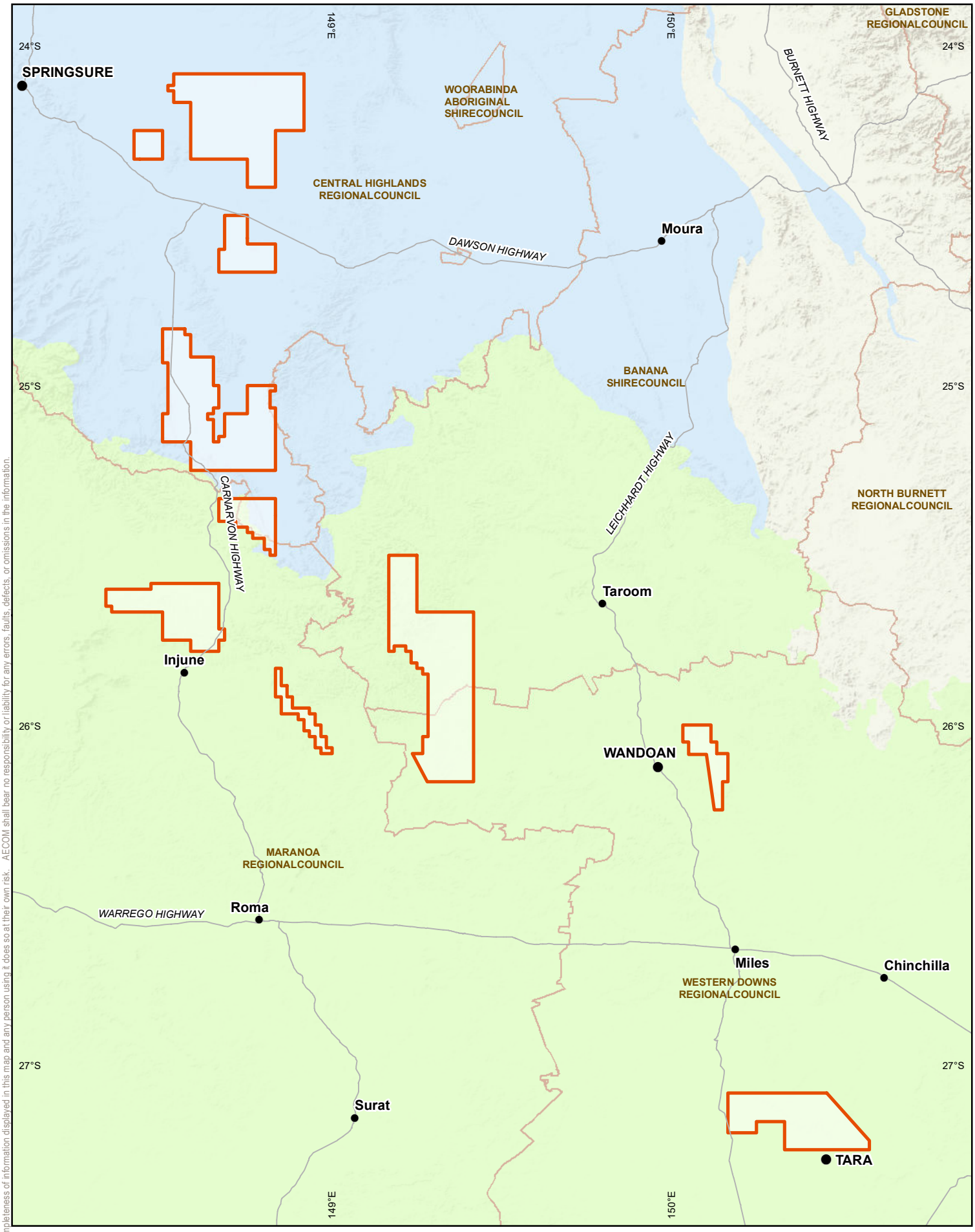
The Project will involve the construction, operation, decommissioning and rehabilitation of gas field infrastructure including wells, gas and water pipelines, gas processing facilities, water management facilities and supporting infrastructure (including accommodation, access tracks, maintenance facilities, laydown areas and utilities). Construction is likely to commence in 2024 and will produce gas over an approximate 50-year period. A 'maximum development scenario' for gas field infrastructure has been used to assess potential impacts to Matters of National Environmental Significance (MNES) associated with the Project. The maximum development scenario is conservative in nature as it assumes:

- there are commercial quantities of recoverable gas over the entire Project Area
- a maximum intensity of gas field infrastructure is constructed
- minimal use of existing gas field infrastructure; and
- minimal avoidance of environmental constraints.

The final size of the Project will be smaller than the maximum development scenario used for this assessment as it will be influenced by:

- the quality of gas resources identified through ongoing exploration and appraisal activities
- the application of constraints planning incorporating environmental, land access, and cultural heritage values; and
- optimising the use of existing infrastructure such as roads, accommodation camps, gas compression and water management facilities.

The Project is located in central and south west Queensland within the Surat and Bowen basins across four regional council areas of the Western Downs, Maranoa, Banana Shire and Central Highlands regional councils. The towns that broadly frame the Project extend from near the town of Blackwater in the north, Wandoan in the east, Tara in the south and Springsure in the west (Figure E-2). The Project is located adjacent to the Australia Pacific LNG Project, as well as other third-party gas projects including the Santos GLNG Project, Queensland Curtis LNG Project, and the Arrow Energy Surat Gas Project (Figure E-3).



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Kilometers

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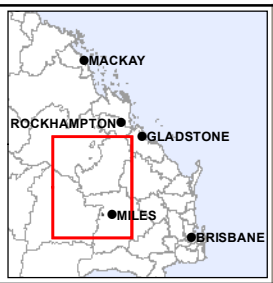
LEGEND

- Towns
- Roads
- Local Government
- Bowen Basin
- Surat Basin
- Project Area



ORIGIN ENERGY PTY LIMITED
GAS SUPPLY SECURITY PROJECT

Project Area

PROJECT ID	60617011
CREATED BY	PK
LAST MODIFIED	stencela: 16/09/2020
VERSION:	1

Figure
E-2

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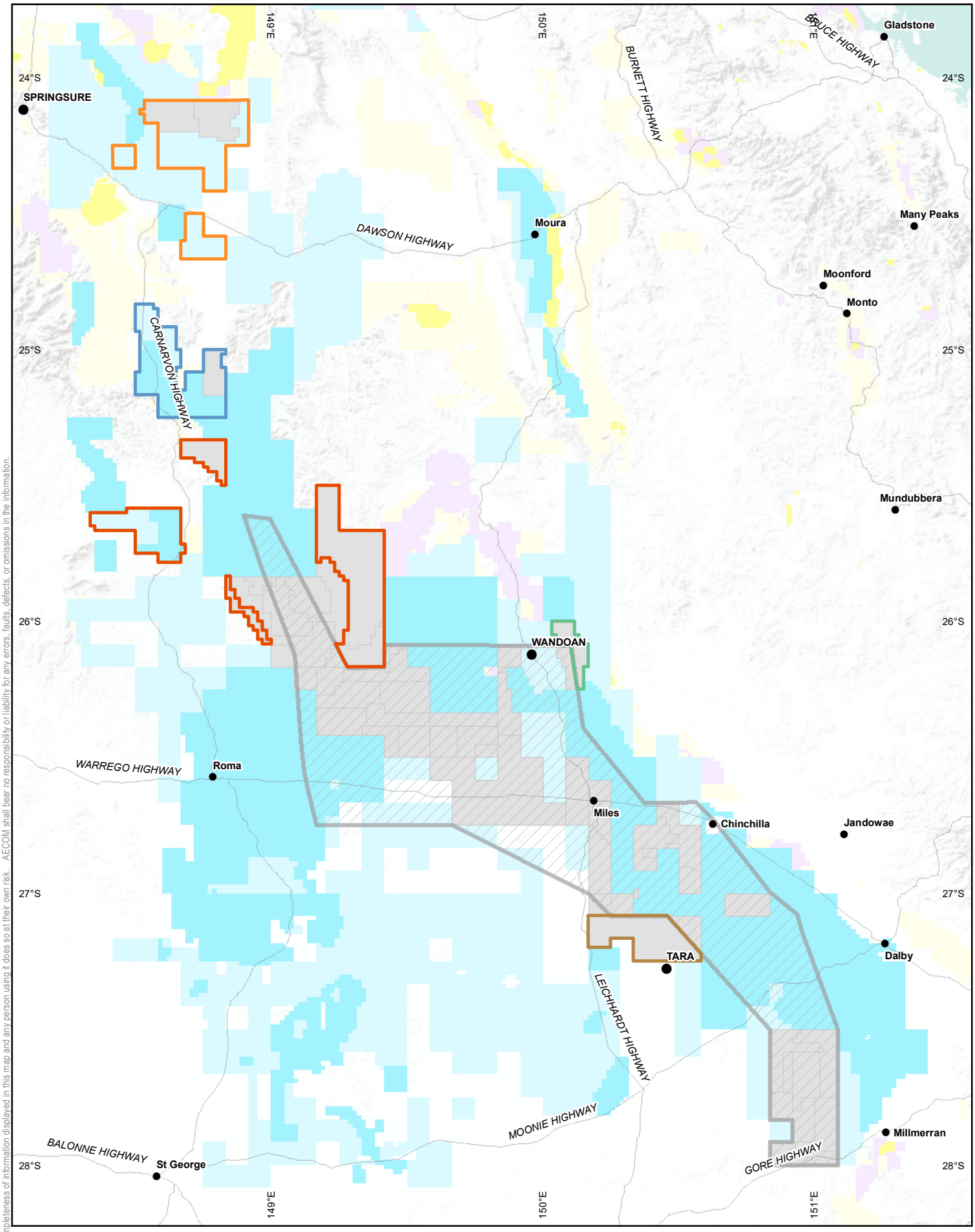

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Kilometers

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LEGEND

- Towns
- Roads
- Australia Pacific LNG approval (EPBC 2009/4974)

Development Areas

- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark

- GRANTED Petroleum Lease (PL)
- GRANTED Authority to Prospect (ATP)
- GRANTED Mining Lease (ML)
- GRANTED Exploration Permit Coal (EPC)
- GRANTED Mineral Development Licence (MDL)

ORIGIN ENERGY PTY LIMITED GAS SUPPLY SECURITY PROJECT

Petroleum Tenures

PROJECT ID	60617011
CREATED BY	PK
LAST MODIFIED	stencela: 18/09/2020
VERSION:	1

Figure

E-3

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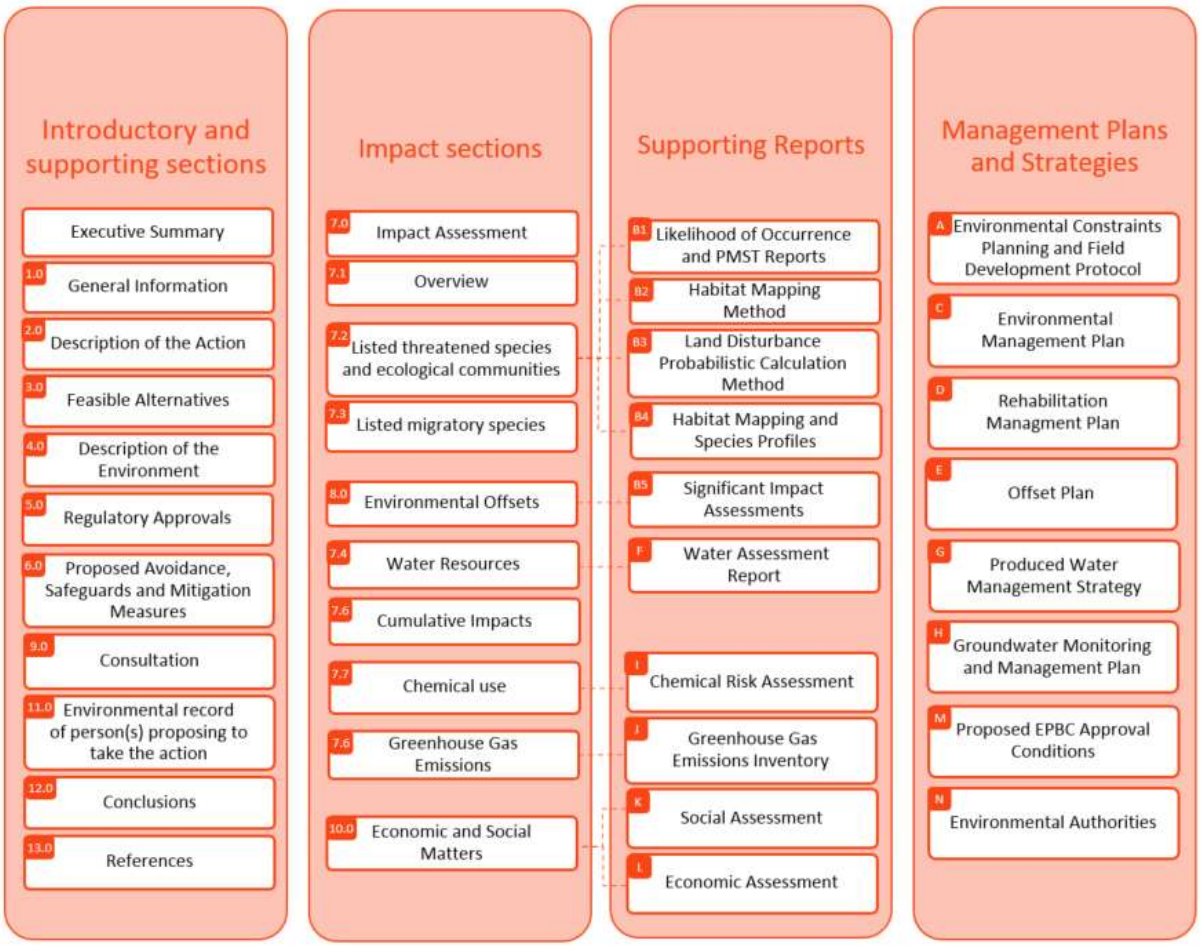
Referral and MNES Assessment Report

This MNES Assessment Report includes a detailed description of the Project, impact assessment, environmental mitigation and management measures and offsets for MNES under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). The MNES Assessment Report contains appendices that include detailed data, analysis and technical assessments and management plans that will be used to avoid, mitigate, manage or offset significant impacts on MNES. Figure E- 4 shows the structure of the MNES Assessment Report and supporting documents.

Figure E- 4 MNES Assessment Report structure and supporting documentation



Existing approvals

Petroleum and gas tenure approvals have been granted over the Project Area, including authorities to prospect (ATPs) for exploration and appraisal activities and petroleum leases (PLs) for development and production activities (Figure E-2) administered under resources legislation, including the *Petroleum Act 1923* (Qld), the *Petroleum and Gas (Production and Safety) Act 2004* (Qld) and the *Mineral and Energy Resources (Common Provisions) Act 2014* (Qld).

The Project also holds Environmental Authorities (EAs) issued under the *Environmental Protection Act 1994* (Qld). These EAs regulate environmental impacts on biodiversity, land, air, surface water, groundwater and wetlands for the Project.

Key regulatory controls

The Project will be undertaken in accordance with the requirements of Commonwealth and Queensland legislation, including:

- *Native Title 1993* (Commonwealth)
- *Water Act 2007* (Commonwealth)
- *Water Act 2000* (Qld)
- *Environmental Offsets Act 2014* (Qld)
- *Nature Conservation Act 1992* (Qld)
- *Aboriginal Cultural Heritage Act 2003* (Qld)
- *Waste Reduction and Recycling Act 2011* (Qld)
- *Regional Planning Interests Act 2014* (Qld).

The Project falls entirely within the Surat Cumulative Management Area (CMA) and will be subject to responsible tenure holder obligations applied through the Underground Water Impact Report (UWIR) under the *Water Act 2000* (Qld) (Water Act). These obligations include implementing 'make good' agreements, undertaking baseline assessments and implementing the water monitoring strategy and spring impact management strategy (OGIA, 2019).

Wells will be designed, constructed, operated, and decommissioned in accordance with all relevant resource legislative requirements and the *Code of Practice for the construction and abandonment of coal seam gas and petroleum wells and associated bores in Queensland* (the Code) (Department of Natural Resources, Mines and Energy, 2019). The Code outlines the mandatory requirements to ensure that all wells and water bores are designed, constructed, maintained and decommissioned to an acceptable standard resulting in long-term well integrity, containment of petroleum and the protection of groundwater resources.

Water extracted from wells (known as produced water) will be transferred to water management infrastructure including structures designed, constructed, and operated in accordance with EA conditions and the Department of Environment and Science's guidelines such as the *Manual for assessing consequence categories and hydraulic performance of structures* (Department of Environment and Science, 2016a) and *Structures which are dams or levees constructed as part of environmentally relevant* (Department of Environment and Science, 2016a).

Management plans and documents

Potential impacts to MNES will be managed through implementation of the following Project-specific management plans, protocols, and assessments:

- Environmental Constraints Planning and Field Development Protocol (Appendix A)
- Environmental Management Plan (Appendix C)
- Rehabilitation Management Plan (Appendix D)
- Offsets Plan (Appendix E)
- Produced Water Management Plan (Appendix G)
- Groundwater Monitoring and Management Plan (Appendix H)
- Chemical Risk Assessment (Appendix I).

Avoidance, safeguards and mitigation measures

The environmental management framework for the Project was developed, refined, and successfully implemented over a period of approximately 10 years of operations for the Australia

Pacific LNG Project. The framework adopts a hierarchy of environmental management practices that will be implemented through planning, development and operation of the Project. This framework has proven to effectively manage potential impacts on MNES from gas field development and complies with regulatory requirements for petroleum projects.

The final number, size and location of infrastructure developed progressively over the life of the Project will be influenced by the location of the gas resources identified through ongoing exploration and appraisal activities and will also account for the constraints associated with environmental, land access and cultural heritage values, as detailed in the Environmental Constraints Planning and Field Development Protocol (the Protocol, Appendix A) for the Project. The Protocol outlines a hierarchy of environmental management practices that will be adopted to minimise potential impacts to MNES through:

- **Avoidance** – avoid disturbance to MNES
- **Minimisation** – minimise disturbance to MNES where disturbance cannot reasonably and practicably be avoided
- **Mitigation** – implement mitigation and management measures to minimise impacts to MNES
- **Rehabilitation** – actively rehabilitate disturbance to MNES in accordance with the Rehabilitation Management Plan and relevant EA conditions
- **Offset** – where required, provide offsets for activities that result in a significant residual impact (SRI) to MNES.

Assessment of impacts to MNES biodiversity values

The Project is located within the Brigalow Belt Bioregion, predominantly in the southern portion with a small section located within the northern portion. Cattle grazing on pastoral leases, extractive industries and scattered urban settlements are consistent with land use across the Brigalow Belt Bioregion with gas fields prevalent throughout the southern portion of the bioregion and coal mining more prevalent in the north. Remnant vegetation is primarily conserved in national parks and other protected areas, the most notable being the Carnarvon Gorge.

To establish the existing environment and MNES biodiversity values within the Project Area, information was compiled from ecology surveys, satellite imagery and measurements, predictive habitat modelling, probabilistic disturbance models and desktop studies. An assessment of MNES biodiversity values relevant to the Project was conducted to identify threatened flora and threatened fauna (threatened species), threatened ecological communities (TECs) and migratory species potentially occurring within the Project Area. A likelihood of occurrence analysis was then conducted to determine those species likely to be present and more detailed assessments were conducted (Appendix B1). This resulted in the following matters being considered likely to occur within the Project Area:

- eight EPBC Act-listed TECs were identified as likely to occur:
  - Brigalow (*Acacia harpophylla* dominant and co-dominant)
  - Coolibah-Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South bioregions
  - Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin
  - Semi-evergreen vine thickets of the Brigalow Belt (north and south) and Nandewar bioregions
  - Community of native species dependent on natural discharge of groundwater from the Great Artesian Basin
  - Weeping Myall Woodlands

  - White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland
  - The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin TEC.
- 44 EPBC Act-listed species were identified as potentially occurring
- 14 EPBC Act-listed migratory species were identified as potentially occurring, however, it is not expected that the Project will result in significant impacts to any EPBC Act-listed migratory species.

Potential impacts to MNES biodiversity values that may occur as a result of the Project include:

- habitat loss from vegetation clearing/removal
- fauna species injury or mortality from project activities
- reduction in soil viability to support plant growth due to soil compaction
- displacement of flora and fauna species by weed and pest species
- reduction in the connectivity of biodiversity corridors
- edge effects to habitat (e.g. weed invasion and reduction of biodiversity)
- habitat fragmentation from vegetation clearing
- barrier effects (e.g. loss of species' migration pathways)
- disturbance to fauna and flora from noise, dust, and light.

Significant residual impacts

Following the application of management and mitigation measures, potential significant residual impacts (SRI) from the Project are only likely as a result of habitat loss from vegetation clearing/removal. SRI criteria have been developed based on an understanding of the circumstances in which vegetation clearing and habitat loss may result in significant impacts to MNES biodiversity values (Appendix B5). The underlying assumption is that threatened species and TECs can tolerate some degree of habitat loss, provided three key parameters are maintained:

- a minimum total extent of habitat
- habitat functionality at a more localised scale; and
- retention of connectivity between habitat areas.

Using the SRI criteria, the maximum development scenario and habitat mapping, the SRI for each threatened species and TEC has been calculated. The result of this analysis is shown in the table E-1. Not all TECs and threatened species potentially occurring within the Project Area will be impacted.

The total project disturbance is based on the maximum development scenario and was devised utilising the results of extensive mathematical modelling of design scenarios (probabilistic modelling method as described in Appendix B3). The maximum disturbance numbers for the Project were then calculated by overlaying the modelling results with the habitat distributions developed for each threatened species and TEC (Appendix B4).

Table E- 1 Summary of Predicted Disturbance and SRI for Maximum Development Scenario

Name	Bioregional extent (ha)	Project Area extent (ha)	Project disturbance % of Bioregion	Project disturbance (ha)	SRI (ha)
THREATENED ECOLOGICAL COMMUNITIES					
Brigalow TEC	576,963	22,868	0.18%	1,065	189
Coolibah TEC	172,854	2,198	0.05%	95	133
Natural grasslands TEC	231,045	2,498	0.05%	110	47
Poplar Box TEC	593,209	22,777	0.19%	1,124	1,016
SEVT TEC	81,498	234	0.02%	13	44
Weeping Myall Woodlands TEC	20,727	928	0.23%	48	10
FLORA					
Austral toadflax	496,144	299	0.00%	11	11
Belson's panic	240,760	3,160	0.10%	238	161
Bluegrass	231,045	2,498	0.05%	111	47
King bluegrass	231,045	2,498	0.05%	111	47
Kogan waxflower	279,543	8,517	0.23%	647	239
Ooline	1,860,157	47,390	0.14%	2,664	920
Shiny-leaved ironbark	477,263	4,790	0.08%	366	200
Tara wattle	135,123	5,940	0.33%	452	170
Aristida annua	231,045	2,498	0.05%	111	47
Marsdenia brevifolia	413,891	7,874	0.08%	317	276
FAUNA					
Australian painted snipe	2,581,000	31,671	0.05%	1,374	0
Brigalow woodland snail	90,458	335	0.03%	29	14
Collared delma	4,335,249	105,692	0.13%	5,633	42
Dulacca woodland snail	63,269	130	0.02%	10	10

Name	Bioregional extent (ha)	Project Area extent (ha)	Project disturbance % of Bioregion	Project disturbance (ha)	SRI (ha)
Dunmall's snake	4,413,095	85,961	0.11%	5,014	69
Fitzroy river turtle	380,786	11,693	0.05%	209	0
Greater glider	6,097,597	87,552	0.08%	4,593	11
Koala	114,381,173	113,742	0.01%	5,870	34
Large-eared pied bat	1,005,441	56,855	0.33%	3,283	10
Ornamental snake	1,097,932	23,101	0.08%	870	10
Painted honeyeater	1,394,953	85,549	0.31%	4,314	61
Red goshawk	8,450,479	114,939	0.07%	6,025	10
South-eastern long-eared bat	6,761,232	120,387	0.09%	6,380	61
Squatter pigeon (southern)	2,214,294	31,623	0.07%	1,540	12
White throated snapping turtle	142,870	4,578	0.00%	0	0
Yakka skink	6,870,107	94,340	0.07%	4,830	3,187

Offsets Plan

Under the EPBC Act Environmental Offsets Policy (Department of Sustainability Environment Water Population and Communities, 2012), offsets are required if an action is going to have an SRI to a protected matter (i.e. only where residual, unavoidable, impacts are considered to be significant). Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment which is impacted, and the intensity, duration, magnitude and geographic extent of the impacts.

Offsets will be provided for all SRI to MNES that result from the Project. An Offsets Bank will be established containing the requisite offset values to acquit offset requirements associated with development. This will be an iterative process as actual impacts occur over the life of the Project.

The areas proposed in the Offsets Bank outlined in the Offsets Plan (Appendix E) includes a range of properties that are known or likely to provide habitat for the threatened species and TECs that are most likely to result in an SRI associated with the initial development activities of the Project. Offset areas will be added to the Offsets Bank, as required, giving priority to areas that provide the best conservation gain, considering the size, location and co-benefit of the offset area. Once SRI is validated and the required offset quantum determined, an acquittal process will be used to 'drawdown' these values from the existing Offsets Bank.

Ongoing management of offset areas will be undertaken to achieve the required conservation gains for each threatened species and TEC. The management measures to be implemented at each area will address both local pressures on the environment and provide specific actions tailored to the threatened species or TEC that are being offset. Each offset area will be managed to maintain their MNES values.

Assessment of impacts to MNES water resources

The Project falls entirely within the Surat CMA and will be subject to responsible tenure holder obligations applied through the Surat CMA UWIR under the Water Act (Qld). As part of the Surat CMA UWIR, a regional groundwater flow model was developed by the Queensland Office of Groundwater Impact Assessment (OGIA) to predict groundwater drawdown from resource tenures. The primary purpose of the model is to predict regional water pressure or water level changes in aquifers within the Surat CMA footprint in response to extraction of water from resource projects. In particular, the OGIA numerical groundwater model is used to assess potential impacts to groundwater bores, EPBC Act-listed springs, and potential groundwater dependent ecosystems (GDEs).

The OGIA simulated groundwater drawdown for the Project using the UWIR model for the Surat CMA. The results of this modelling were used as the basis for a groundwater assessment for the Project to assess potential impacts on water resources.

Through implementation of the following regulatory controls, the Project will have no significant or adverse impacts to water resources including groundwater bores, EPBC Act-listed springs or GDEs:

- Surat CMA UWIR process (OGIA) under the Water Act (Qld)
- Produced water management under the *Environmental Protection Act 1994* (Qld) and *Waste Reduction and Recycling Act 2011* (Qld)
- Chemical storage and handling and stimulation risk assessments under the *Environmental Protection Act 1994* (Qld)
- Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland under the *Petroleum and Gas (Production and Safety) Act 2004* (Qld).

Consistent with Section 75 of the EPBC Act, relevant controlling provisions do not apply to an action if there are no adverse impacts in the absence of beneficial impacts. Offsets are not required as it has been identified that there are no significant or adverse impacts to water resources as a result of the Project. Therefore, a water resource from coal seam gas development and large coal mining development does not qualify as a controlling provision for the action.

Groundwater Bores

Of the approximately 4,850 known groundwater bores located within 50 kms of the Project, 13 bores are predicted to experience drawdown in exceedance of the Water Act (Qld) bore trigger thresholds that were not predicted to exceed the trigger thresholds based on the 2019 Surat CMA UWIR. Only one of these bores is attributed to a sandstone aquifer, all other bores are attributed to the typically non-productive Rewan Formation aquitard or coal measures representing gas formations for the Project.

The Water Act (Qld) requires that a Bore Assessment is conducted for all bores predicted by the UWIR to exceed the Water Act (Qld) bore trigger thresholds. This assessment would determine if the bores would experience potential impaired capacity as a result of groundwater drawdown from the Project. Where the potential for impaired capacity has been demonstrated, bores will be subject to additional 'make good' obligations, including:

- adding a rising main to lower the pump setting in the bore
- increasing the water column above the pump

- improving the pressure at the bore head, including new headworks and piping, if the affected supply is artesian
- changing the pump so that it is better suited to the decreased water level in the bore
- deepening the bore to allow it to access a deeper part of the aquifer
- reconditioning of the water bore to improve its hydraulic efficiency
- drilling a new bore
- providing an alternate water supply
- providing the water bore owner compensation (monetary or otherwise) to offset reduced water supply from the bore.

Given that less than 0.27% of bores in proximity to the project are predicted to exceed the Water Act (Qld) bore trigger thresholds and the implementation of statutory 'make good' obligations, the Project does not have significant impacts to groundwater bores.

EPBC Act-Listed Springs

There are no EPBC Act-listed springs (the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin) that occur within the Project Area. Four EPBC Act-listed springs are located within 50 kms of the Project and are not predicted to experience drawdown in exceedance of the Water Act (Qld) spring trigger threshold under the Project only modelling scenario. The Cockatoo, LuckyLast, and Yebna2 EPBC Act-listed spring complexes are predicted to exceed the 0.2 m Queensland Water Act (Qld) spring trigger threshold under the cumulative modelling scenario; however, the Project's contribution to these exceedances is only 4%, 8%, and 2%, respectively. As documented in the 2019 Surat CMA UWIR, the OGIA has assigned responsible tenure holder obligations to manage potential impacts to these EPBC Act-listed springs.

The Project will not have a significant impact on EPBC Act-listed springs given the relatively small predicted drawdown contribution as a result of the Project and nomination of existing responsible tenure holder obligations for these springs under the Water Act (Qld).

Groundwater Dependent Ecosystems

The OGIA's terrestrial groundwater dependent ecosystem (TGDE) risk assessment has been adopted for the Project and enhanced using TGDE remote sensing data and ecology values applicable to the EPBC Act. In accordance with the OGIA TGDE risk assessment process, predicted long-term drawdown of more than 1 m within Layer 1 of the UWIR model (which contains shallow aquifers including the alluvium, cenozoic sediments, and basalt geology) or aquifer outcrop areas, represent a medium or high risk of significant impacts to potential TGDEs that access groundwater from these units. Using data from the Commonwealth and Queensland governments to identify potential groundwater sources for GDEs and the Independent Expert Scientific Committees (IESC's) process for remote sensing validation of TGDE vegetation, there are no potential TGDEs assessed as at a medium or high risk of significant impacts from groundwater drawdown for the Project.

The IESC Explanatory Note *Assessing groundwater-dependent ecosystems* (IESC, 2019) provides a framework for assessing the suitability of subterranean fauna habitat based on water chemistry and aquifer conditions. Based on this framework and the predicted groundwater level changes, the Project would not have a significant impact on potential subterranean fauna habitat.

Drawdown at potential surface expression GDEs is not predicted to exceed the Water Act (Qld) spring trigger threshold of 0.2 m based on Project-only drawdown predictions. Some non-EPBC Act-listed spring complexes and watercourse springs exceed this trigger threshold based on predicted cumulative drawdown. This includes the 311, SpringRock Creek, Barton, Lonely Eddie, and Wambo spring complexes and 21 watercourse springs. However, given the minor drawdown contribution

from the Project and the assignment of responsible tenure holder obligations in the 2019 Surat CMA UWIR, the Project would not have a significant impact on potential surface expression GDEs.

The Project is considered not to have any significant impacts to water resources as impact significance triggers relevant to water resources listed in Table E-2 will not be exceeded or will be subject to regulatory controls under Queensland law.

Table E- 2 MNES water resource assessment summary

Water Resources	Relevant Impact Significance Drawdown Trigger	Predicted Project Impacts Exceed Trigger?	Key Regulatory Control
Groundwater Bores	Over 5m in a consolidated aquifer Over 2m in an unconsolidated aquifer	Yes	• *Water Act 2000* (Qld) • UWIR including Water Monitoring Strategy (WMS) • *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld) • *Planning Act 2016* (Qld)
EPBC-listed Springs	Over 0.2m	No	• *Water Act 2000* (Qld) • UWIR including Spring Impact Management Strategy (SIMS) • *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld)
Aquatic GDEs	Over 0.2m in outcropping formation	No	• *Water Act 2000* (Qld) • UWIR • *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld)
Terrestrial GDEs	Over 0.2m	No	• *Environmental Protection Act 1994* (Qld) • UWIR • *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld)
Subterranean GDEs	Over 2m for unconfined hydrogeological units	No	• *Environmental Protection Act 1994* (Qld) • *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld)

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Acronyms and abbreviations

Term	Acronym/abbreviations
Atlas of Living Australia	ALA
Australia Pacific LNG Pty Ltd	Australia Pacific LNG
Australian and New Zealand Guidelines for Fresh and Marine Water Quality	ANZECC
Australian Competition and Consumer Commission	ACCC
Australian Energy Market Operator	AEMO
Australian Gas Pipeline Association	AGPA
Australian Height Datum	AHD
Australian Standard	AS
Authority to prospect	ATP
BHP Billiton Mitsubishi Alliance	BMA
Blowout preventers	BOP
Broad vegetation group	BVG
Bureau of Meteorology	BoM
Code of Practice for the construction and abandonment of coal seam gas and petroleum wells and associated bores in Queensland	the Code
Commonwealth	Cwlth
Conduct and compensation agreement	CCA
Cultural Heritage Management Plan	CHMP
Cumulative impact assessment	CIA
Cumulative management area	CMA
Department of Agriculture and Fisheries	DAF
Department of Agriculture, Water and the Environment (previously DOEE or DOTE)	DAWE
Department of Environment and Heritage Protection (now known as DES)	DEHP
Department of Environment and Science (previously DEHP)	DES
Department of Natural Resources and Mines and Energy	DNRME
Department of the Environment (now known as DAWE)	DOTE
Department of the Environment and Energy (now known as DAWE)	DOEE
Design Storage Allowance	DSA
End of waste	EoW
Endangered, Vulnerable, Near Threatened	EVNT

Term	Acronym/abbreviations
Environment Protection and Biodiversity Conservation Act 1999 (Cwlth)	EPBC Act
Environmental authority	EA
Environmental constraints planning and field development protocol	the Protocol
Environmental impact statement	EIS
Environmental management plan	EMP
Environmental Protection Act 1994 (Qld)	EP Act
Environmentally relevant activities	ERA
Environmentally sensitive area	ESA
Exposure point concentrations	EPC
Gas Industry Social and Environmental Research Alliance	GISERA
Gas processing facility	GPF
Gas Supply Security Project	the Project
General ecological significant wetlands	GES wetlands
Greenhouse gases	GHG
Groundwater dependent ecosystem	GDE
Groundwater Dependent Ecosystem Management Plan	GDEMP
Health Safety and Environment	HSE
hectare	ha
High density polyethylene	HDPE
High ecological significance	HES
High ecological value	HEV
Immediately Affected Area	IAA
Independent Expert Scientific Committee	IESC
Indigenous land use agreement	ILUA
kilometre	km
Klohn Berg Crippen	KCB
Liquified natural gas	LNG
Local government area	LGA
Mandatory Reporting Level	MRL
Material safety data sheets	MSDS
Matter of National Environmental Significance	MNES

Term	Acronym/abbreviations
Matters of State Environmental Significance	MSES
Megalitre	ML
Mineral and Energy Resources (Common Provisions) Act 2014 (Qld)	MERCPA
metre	m
metres per second	m/s
millimetre	mm
Million tonnes per annum	Mtpa
National Environment Protection (Site Assessment) Measure	NEPM
National Environment Protection Measure	NEPM
Nature Conservation Act 1992 (Qld)	NC Act
Normalised Difference Vegetation Index	NDVI
Normalised Difference Wetness Index	NDWI
Not applicable	N/A
Office of Groundwater Impact Assessment	OGIA
Offsets Assessment Guide	OAG
Organisation for Economic Co-operation and Development	OECD
Origin Energy Pty Limited	Origin
Petroleum Act 1923 (Qld)	Petroleum Act
Petroleum and Gas (Production and Safety) Act 2004 (Qld)	P&G Act
Petroleum lease	PL
Petroleum lease application	PLA
Polycyclic aromatic hydrocarbons	PAH
Pressure control equipment	PCE
Property Map of Assessable Vegetation	PMAV
Protected Matters Search Tool	PMST
Queensland Environmental Offsets Policy	QEOP
Queensland land use mapping program	QLUMP
Queensland	Qld
Regional ecosystem	RE
Responsible tenure holder	RTH
Reverse Osmosis	RO

Term	Acronym/abbreviations
Right of way	ROW
Central Queensland Statistical Area 4	SA4
Semi-evergreen vine-thicket	SEVT
Significant residual impact	SRI
Soil mapping units	SMU
Species Profile and Threats	SPRAT
Spring Impact Management Strategy	SIMS
Square kilometres	km^2
Square metres	m^2
Stakeholder engagement plan	SEP
Standing water levels	SWL
State Development and Public Works Organisation Act 1971 (Qld)	SDPWO Act
Sum of Proved Reserves and Probable Reserves	2P
terajoule	TJ
Terrestrial groundwater dependent ecosystem	TGDE
Threatened ecological community	TEC
True vertical depth	TVD
Underground water impact report	UWIR
United States Environmental Protection Agency	USEPA
Vegetation Management Act 1999 (Qld)	VM Act
Waste Reduction and Recycling Act 2011 (Qld)	WRR Act
Water Act 2000 (Qld)	Water Act
Water Monitoring Strategy	WMS
Water Resource Plan	WRP

1.0 GENERAL INFORMATION

1.1 Title of the action

Gas Supply Security Project

1.2 Contact details

Table 1: Contact details

Person proposing to take the action	Australia Pacific LNG Pty Limited
Address	GPO Box 148 Brisbane Queensland 4000
Phone number	1800 526 369
Email	envapprovals@originenergy.com.au

1.3 Objective of the action

The Gas Supply Security Project (the Project) proposes to develop Queensland resources to meet gas supply demand of the east coast domestic gas market and liquified natural gas (LNG) export market.

Based on the projected supply-demand balance for east coast domestic gas to 2039, the Australian Energy Market Operator (AEMO) report *Gas Statement of Opportunities* (AEMO, 2020) identifies the following gas supply constraints:

- gas supply shortfall from 2024 onwards unless additional reserves, resources and infrastructure are developed.
- potential for increased gas demand and peak-day shortages; while supply from existing and committed natural gas developments is forecast to provide adequate supply to meet gas demands until between 2023 and 2025, weather-driven variances in consumption or electricity market activity could increase gas demand and create potential for peak-day shortages.
- increased reliance on Queensland supplies to meet gas demand in southern states as natural gas production from Victoria declines between 2021 and 2023.

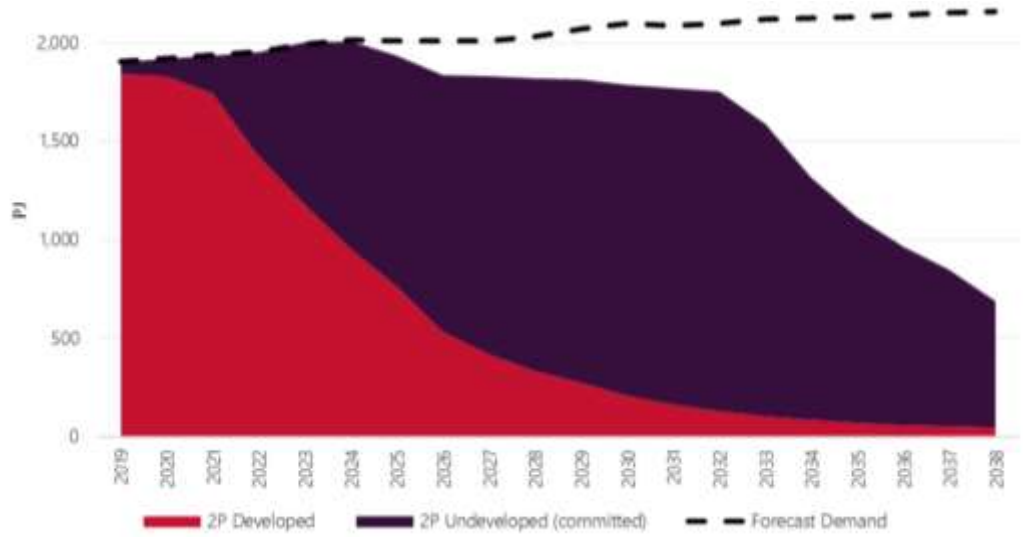
The AEMO report illustrates this projected shortfall in gas supply from 2024 based on the expected production forecast for existing and committed gas projects (Figure 1). The Australian Competition and Consumer Commission (ACCC) Gas inquiry 2017-2025 interim report (July 2020) more recently reaffirmed this projection by describing two trends (increasing production in Queensland and declining production in the southern states) that are expected to continue in the short to medium term (ACCC, 2020).

Production from developed and undeveloped 2P reserves in Queensland is expected to grow until 2023 and gradually decline thereafter. In contrast, production from developed and undeveloped 2P reserves in the southern states is expected to decline from 2021, falling below southern demand by 2024 (AEMO, 2020). The AEMO report considers the supply-demand impact from the COVID-19-related restrictions.

Origin Energy (Origin), is the upstream operator of the Australia Pacific LNG Project, the largest producer of natural gas in eastern Australia with a total domestic contracted supply commitment of more than 30 per cent of total east coast domestic demand for 2020 and 2021 (Australia Pacific LNG, 2019b). With the advantage of existing capability and capacity of Australia Pacific LNG Project infrastructure and management systems, the Project will continue to provide long-term gas supply to the east coast domestic market. Based on current appraisal data, production from 2P reserves

and 2C resources for the Project is expected to be 453.6 PJ and 591.7 PJ respectively. The indicative schedule for commencement of gas supply from the Project coincides with the predicted gas shortfall commencing in approximately 2025.

Figure 1: Projected eastern and south-eastern Australian gas production (AEMO, 2020)



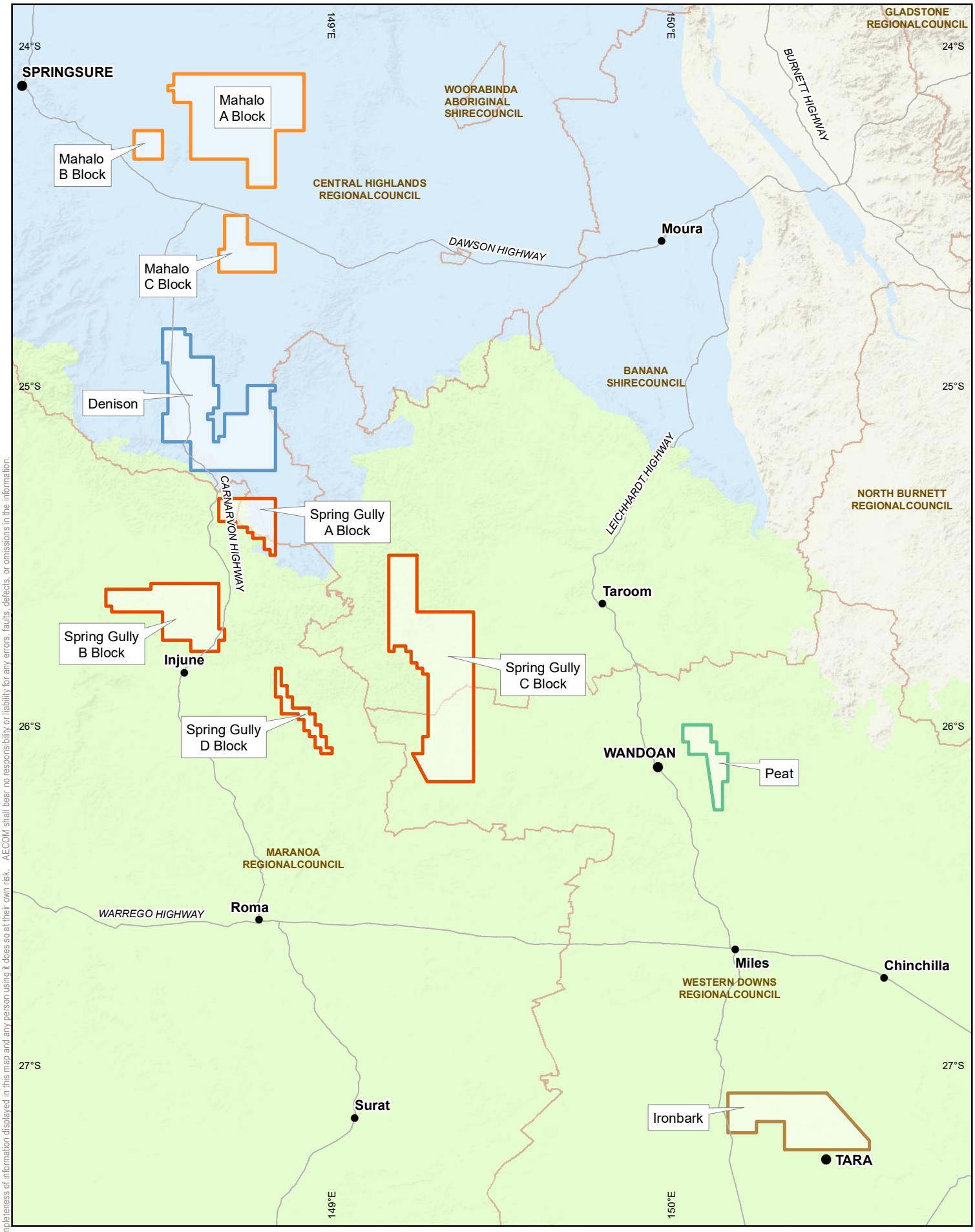
1.4 Location of the action

The Project is located in central and south west Queensland within the Surat and Bowen basins. The towns that broadly frame the Project extend from near the town of Blackwater in the north, Wandoan in the east, Tara in the south and Springsure in the west, and is located across four regional council areas of the Western Downs, Maranoa, Banana Shire and Central Highlands regional councils (Figure 2).

The Project Area is illustrated on Figure 2, and encompasses five development areas, including Mahalo, Denison, Spring Gully, Peat and Ironbark, over an approximate area of 476,492 ha. These development areas are broken into their component parts as outlined in Table 2 and shown in Figure 2.

Table 2: Development areas

Development area	Block
Mahalo	Mahalo Block A
	Mahalo Block B
	Mahalo Block C
Denison	Denison
Spring Gully	Spring Gully Block A
	Spring Gully Block B
	Spring Gully Block C
	Spring Gully Block D
Peat	Peat
Ironbark	Ironbark



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Kilometers

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LEGEND

- Towns
- Roads
- Local Government
- Bowen Basin
- Surat Basin

Development Areas

- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark

ORIGIN ENERGY PTY LIMITED
GAS SUPPLY SECURITY PROJECT

Development Areas

PROJECT ID	60617011
CREATED BY	PK
LAST MODIFIED	stencela: 18/09/2020
VERSION:	1

Figure 2

1.5 Background to developing the action

Following a comprehensive environmental assessment for the Australia Pacific LNG Project, Origin received approval from State and Commonwealth governments in 2010 and 2011, respectively. While the Project was not assessed as part of the Australia Pacific LNG Project authorised by EPBC 2009/4974, the areas were identified as being a source of gas for the Australia Pacific LNG Project in the Environmental Impact Statement (EIS) (APLNG, 2010):

> *It is currently estimated that a maximum of 11.5 million tonnes per annum (Mtpa) will be sourced from these fields with the remaining gas to be sourced from Australia Pacific LNG's existing operational sites, non-operated equity areas and exploration areas. These gas fields may include Spring Gully, Peat, Denison…*

Under the existing authorisations, the Australia Pacific LNG Project has developed productive gas field infrastructure in the Surat and Bowen basins, transmission pipelines and the LNG facility on Curtis Island near Gladstone. The Project extends the commercial production area of existing, previously approved Australia Pacific LNG Project gas fields into adjacent development areas.

Existing Australia Pacific LNG Project and third-party infrastructure components (e.g. gas processing and water management facilities, pipelines, powerlines and roads) may be utilised for the Project, where practicable, to the extent already authorised under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and subject to commercial agreements. Possible related actions are listed in Section 1.6 of this Report.

With existing assets, emerging capacity and infield capability, Origin will develop gas resources for the Project efficiently in a way that balances the needs of landholders, local communities and traditional owners while managing potential environmental impacts.

1.6 How the action relates to any other actions

Existing Australia Pacific LNG EPBC Act authorisations and decisions (illustrated on Figure 3) include:

- EPBC 2009/4977 – Australia Pacific LNG Pty Limited
- EPBC 2009/4976 – Australia Pacific LNG Pty Limited
- EPBC 2009/4974 – Australia Pacific LNG Pty Limited
- EPBC 2016/7720 – Australia Pacific LNG Pty Limited
- EPBC 2017/7902 – Australia Pacific LNG Pty Limited
- EPBC 2017/7881 – Australia Pacific LNG Pty Limited
- EPBC 2016/7805 – Australia Pacific LNG Pty Limited
- EPBC 2019/8534 – Australia Pacific LNG Pty Limited.

Other third-party EPBC Act authorisations within the vicinity of the Project (illustrated on Figure 3) include:

- EPBC 2010/5344 – Arrow Energy Pty Limited
- EPBC 2012/6615 – Santos Limited
- EPBC 2012/6459 – Arrow Energy Pty Limited
- EPBC 2013/7047 – QGC Pty Limited
- EPBC 2015/7463 – QGC Pty Limited
- EPBC 2015/7469 – Senex Energy Limited
- EPBC 2018/8276 – QGC Pty Limited
- EPBC 2018/8223 – Arrow Energy Pty Limited.

1.7 Current status of the action

Petroleum and gas tenure approvals have been granted over the Project Area, including authorities to prospect (ATPs) for exploration and appraisal activities and petroleum leases (PLs) for development and production activities (shown on Figure 4) administered under resources legislation, including the *Petroleum Act 1923* (Petroleum Act) (Qld), the *Petroleum and Gas (Production and Safety) Act 2004* (P&G Act) (Qld) and the *Mineral and Energy Resources (Common Provisions) Act 2014* (MERCPA) (Qld).The Project comprises three ATPs and 11 PLs listed in Table 3.

The Project also holds Environmental Authorities (EAs) issued under the *Environmental Protection Act 1994* (EP Act) (Qld) over all development areas. An EA is required prior to granting of petroleum tenure and provides conditions protecting environmental values including biodiversity, land, air, surface water, groundwater and wetlands. The Project comprises of five EAs listed in Table 3.

The Project falls entirely within the Surat Cumulative Management Area (CMA) and will be subject to responsible tenure holder obligations applied through the Surat CMA Underground Water Impact Report (UWIR) under the *Water Act 2000* (Water Act) (Qld). These obligations include implementing 'make good' agreements, undertaking baseline assessments and implementing the water monitoring strategy (WMS) and spring impact management strategy (SIMS) (OGIA, 2019). Further details of these obligations are prescribed under the *Water Act 2000* are listed in section 6.2 and Table 14. Other State approvals required for the Project are outlined in Section 5.3.

Table 3: Petroleum tenures and EAs

Development area	Authority to prospect (ATP), petroleum lease (PL)	Environmental Authority
Mahalo	ATP 1191 PL 1082 PL 1083	EPPG00872113
Denison	ATP 1191 PL 219 PL 450 PL 451 PL(A) 1062	EPPG00968013 EPPG00872113
Spring Gully	ATP 592 ATP 1191 PL 1012 PL 419 PL 457 PL 220	EPPG00885313 EPPG00968013
Peat	PL 101	EPPG00653413
Ironbark	ATP 788	EPPG00801813

1.8 Consequences of not proceeding with the action

The AEMO report (AEMO, 2020) identifies a projected shortfall in gas supply from 2024 based on the expected production forecast for existing and committed gas projects (refer to Figure 1). Should the Project not proceed, the available gas supply may not be enough to meet gas supply demand of the east coast domestic gas market in the future.

This shortfall may have significant consequences for consumers as a result of peak supply gaps and increased costs across the Australian east coast market. Further cost increases will occur due to commercial production inefficiencies realised as capacity of existing infrastructure (processing

facilities and pipelines) become available and widely distributed across the gas fields. Gas may be less reliable and less affordable, potentially undermining investment in the development of consistent alternative energy supplies and the transition to a low carbon economy.

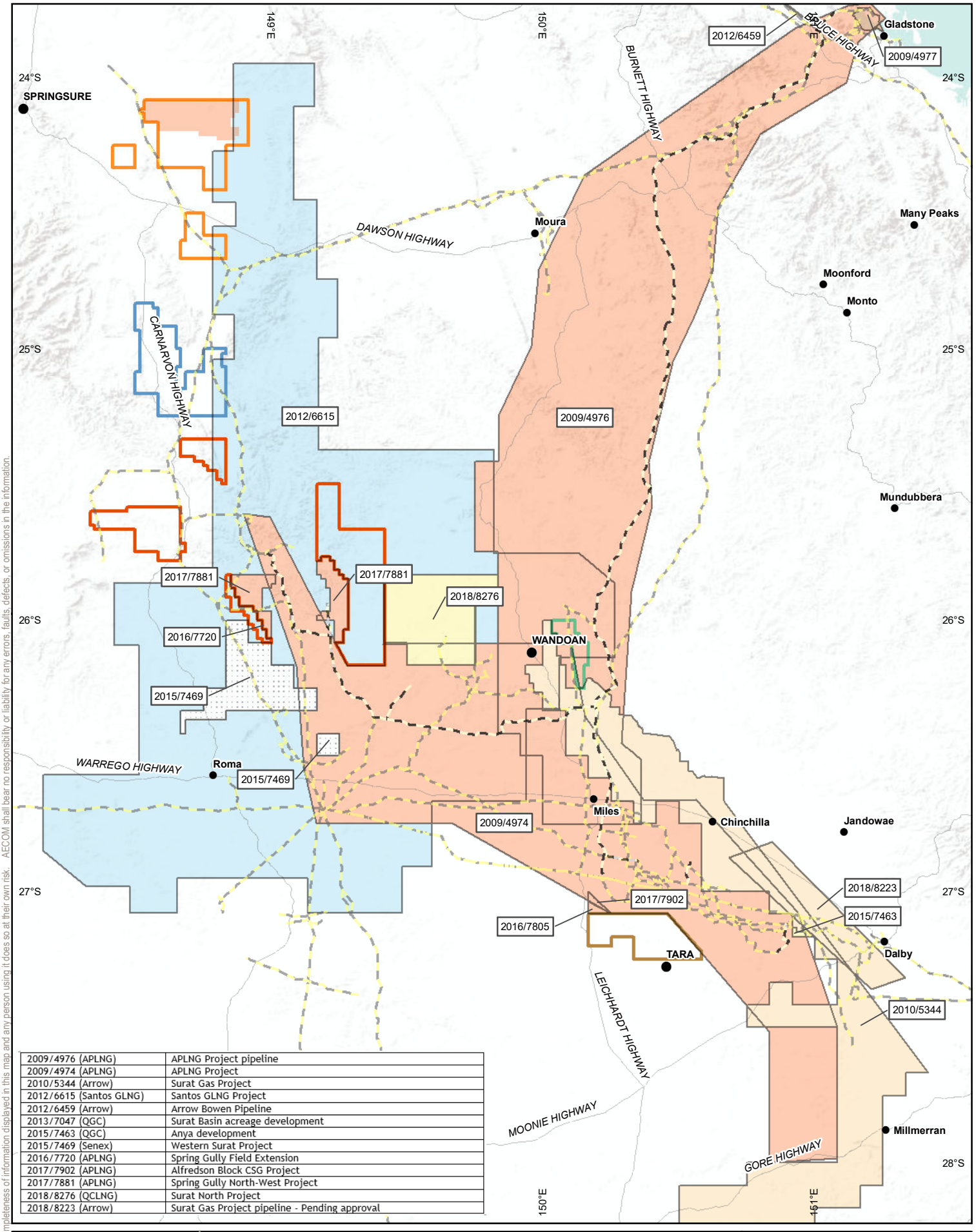
Demand for energy will continue to increase as populations grow and nations seek to improve living standards for their citizens. Not proceeding with the Project will mean that gas supply needed to meet growing demand is not readily available for the east coast domestic gas market and for distribution via the LNG export market. Gas is an abundant, affordable, flexible, easily transportable, low carbon energy source that has a critical role to play in meeting emissions targets both in Australia and globally. When used for electricity generation, gas produces less carbon emissions than coal and is widely acknowledged as an ongoing complementary fuel to support the intermittency of renewable energy sources.

Gas is an essential raw material for manufacturing in Australia with approximately one third of the gas consumed being used by manufacturers (APPEA, 2016). Gas and gas-derived products are used to produce:

- non-ferrous metals (e.g. aluminium, copper, zinc, tin)
- chemicals and polymers (e.g. fertilisers, antifreeze)
- non-metallic mineral products (e.g. glass, ceramics, cement, bricks)
- plastic packaging for foods and beverages.

Gas is also used in food preparation and processing, fermentation and brewing.

If the Project does not proceed, the economic and social benefits over the life of Project will not be realised by traditional owners, landholders, local communities and the State Government (through royalties). Further assessment of the impact of not proceeding with the Project on the social and community values of the region is presented in the Social Assessment (Appendix K) and Economic Assessment (Appendix L).



2009/4976 (APLNG)	APLNG Project pipeline
2009/4974 (APLNG)	APLNG Project
2010/5344 (Arrow)	Surat Gas Project
2012/6615 (Santos GLNG)	Santos GLNG Project
2012/6459 (Arrow)	Arrow Bowen Pipeline
2013/7047 (QGC)	Surat Basin acreage development
2015/7463 (QGC)	Anya development
2015/7469 (Senex)	Western Surat Project
2016/7720 (APLNG)	Spring Gully Field Extension
2017/7902 (APLNG)	Alfredson Block CSG Project
2017/7881 (APLNG)	Spring Gully North-West Project
2018/8276 (QCLNG)	Surat North Project
2018/8223 (Arrow)	Surat Gas Project pipeline - Pending approval

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Kilometers

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LEGEND

- Towns
- Roads

Development Areas
- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark

EIS Referral Boundary
- Santos
- Arrow Energy
- Australia Pacific LNG
- QGC
- Senex Energy Limited

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GAS SUPPLY SECURITY PROJECT

Project and Related EPBC Referral Areas

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Figure 3

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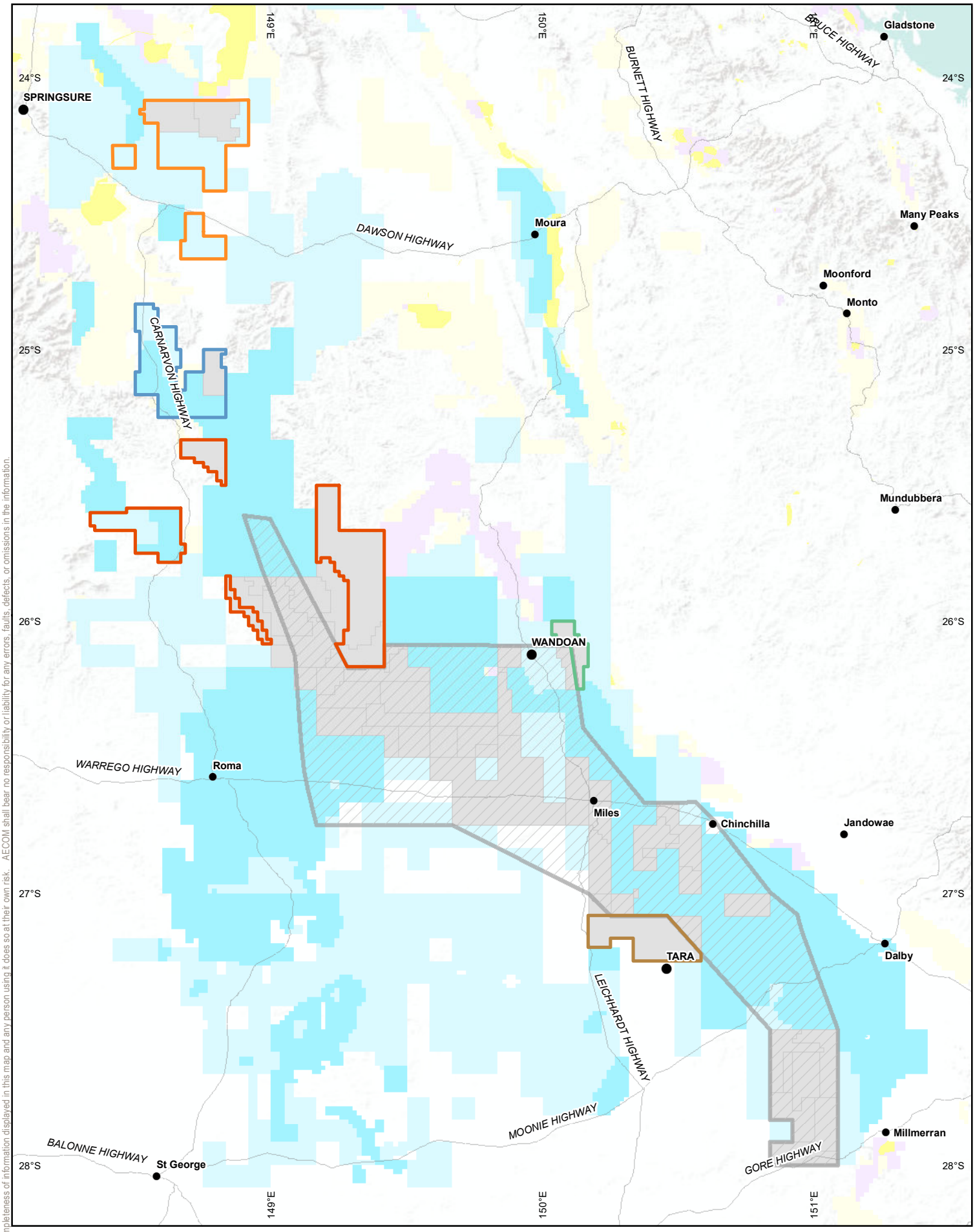

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Kilometers

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LEGEND

- Towns
- Roads
- Australia Pacific LNG approval (EPBC 2009/4974)

Development Areas

- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark

- GRANTED Petroleum Lease (PL)
- GRANTED Authority to Prospect (ATP)
- GRANTED Mining Lease (ML)
- GRANTED Exploration Permit Coal (EPC)
- GRANTED Mineral Development Licence (MDL)

ORIGIN ENERGY PTY LIMITED GAS SUPPLY SECURITY PROJECT

Petroleum Tenures

PROJECT ID	60617011
CREATED BY	PK
LAST MODIFIED	stencela: 18/09/2020
VERSION:	1

Figure 4

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2.0 DESCRIPTION OF THE ACTION

2.1 Project overview

The Project will involve the construction, operation, decommissioning and rehabilitation of gas field infrastructure including the following components (described in detail in Section 2.4):

- wells
- gas and water pipelines
- gas processing facilities (GPFs)
- water management facilities
- supporting infrastructure (including accommodation, access tracks, maintenance facilities, laydown areas and utilities).

The Project will develop Queensland resources to meet gas supply demand of the east coast domestic gas market and LNG export market, and extends the commercial production area of existing, previously approved Australia Pacific LNG Project gas fields into adjacent development areas: Mahalo, Denison, Spring Gully, Peat and Ironbark. Downstream components of the existing Australian Pacific LNG Project (i.e. the Gladstone gas transmission pipeline and LNG facility) have enough approved capacity to accommodate additional gas generated by the Project.

For the purpose of this report, a 'maximum development scenario' for developing gas field infrastructure has been used to assess potential impacts to MNES associated with the Project. The maximum development scenario is conservative in nature as it assumes:

- there are commercial quantities of recoverable gas over the entire Project Area
- a maximum intensity of gas field infrastructure is constructed
- minimal use of existing gas field infrastructure; and
- minimal avoidance of environmental constraints.

Table 4 includes an estimated construction and operational footprint for the Project associated with the maximum development scenario. Rehabilitation will generally commence following construction activities and as operational activities cease.

Table 4: Key project components and the maximum development scenario

Key Project components	Maximum development scenario	Construction footprint (approx.)	Operational footprint (approx.)
Wells	Up to 7,700	Up to 1.5 hectares (ha) per well	0.3 ha per well
Gas and water pipelines	Up to 6,800 kilometres (km)	Up to 25 metres (m) right of way (RoW)	6 m RoW
GPFs	Up to 16 combined facilities	Up to 120 ha per combined facility	100 ha per combined facility
Water management facilities			

The development of the gas fields will occur incrementally over the life of the Project. The final size of the Project will be smaller than the maximum development scenario used for this assessment as it will be influenced by:

- the quality of gas resources identified through ongoing exploration and appraisal activities;

- the application of constraints planning incorporating environmental, land access, and cultural heritage values, as detailed in the Environmental Constraints Planning and Field Development Protocol (the Protocol) (see Section 2.3) for the Project; and
- optimising the use of existing infrastructure such as roads, accommodation camps, gas compression and water management facilities.

Where practicable, the Project will utilise existing or previously approved infrastructure (e.g. accommodation camps, gas processing and water management facilities) from the Australia Pacific LNG Project (EPBC 2009/4974) or other separately approved developments. The Project may also source gas from third-party suppliers, as well as sharing or co-location of gas fields and associated facilities with third parties. To supply gas to market, the Project may be required to make connections via existing third party EPBC Act authorisations (to the extent authorised) or new connections will be developed by third parties, and subject to additional referral, as required.

2.2 Proposed timing

The Project is expected to have a 50-year operational life. For the purposes of this assessment, wells will be developed over a 20-year period and are expected to have an operational life of 30 years. Progressively throughout the Project's operational life, and once the Project has ceased, decommissioning and rehabilitation activities will be completed.

The indicative schedule for the Project's development activities commences in 2024, as detailed in Table 5, with gas supply expected to commence in 2025.

Table 5: Indicative development commencement schedule

Development area	Project year			
	1-5 (2024 - 2028)	6-10 (2029 - 2033)	11-15 (2034 - 2038)	16-20 (2039 - 2043)
Mahalo	♦			
Denison			♦	
Spring Gully	♦			
Peat	♦			
Ironbark	♦			

♦ = Indicative development start date

2.3 Constraints-based planning, siting and field development

The location of wells and infrastructure is primarily influenced by the location of the gas resource, land access, cultural heritage, and environmental constraints within an area. The Protocol (Appendix A) will be implemented to determine infrastructure locations with respect to MNES values.

The Protocol outlines a hierarchy of environmental management practices that will be adopted to minimise potential impacts to MNES through:

- **Avoidance** – avoid disturbance to MNES
- **Minimisation** – minimise disturbance to MNES where disturbance cannot reasonably and practicably be avoided
- **Mitigation** – implement mitigation and management measures to minimise impacts to MNES
- **Rehabilitation** – actively rehabilitate disturbance to MNES in accordance with the Rehabilitation Management Plan and relevant EA conditions

- **Offset** – where required, provide offsets for activities that result in a significant residual impact (SRI) to MNES.

A full list of constraints, constraint categories, permitted activities and mitigation measures are detailed in section 6.3 and Table 16.

2.4 Project components

2.4.1 Wells

Wells will be designed, constructed, operated and decommissioned in accordance with all relevant resource legislative requirements and the *Code of Practice for the construction and abandonment of coal seam gas and petroleum wells and associated bores in Queensland* (the Code) (Department of Natural Resources, Mines and Energy, 2019). The Code outlines the mandatory requirements to ensure that all wells and water bores are designed, constructed, operated and decommissioned to an acceptable standard resulting in long-term well integrity, containment of petroleum and the protection of groundwater resources. A full list of regulatory controls under the Code are listed in Table 14.

Each well pad will utilise a maximum area of up to approximately 1.5 ha during construction. The key equipment and ancillary infrastructure on each well pad, include:

- drill rig and associated equipment (Plate 1)
- generators
- chemical and fuel storage
- drilling fluid storage
- water storage (tank or small dam) for produced water and initial water supply during construction
- fencing and signage where appropriate.

Most of the equipment is typically used on each well pad for less than one week before being relocated to other well sites. A well becomes operational once it is connected to the gas and water gathering pipelines for transfer to the gas processing and water management facilities

Where practicable, Origin will establish well pads with multiple wells (multi-well pad) to maximise gas recovery, reduce the number of well pads required, and reduce the overall Project footprint.

Following construction, the well pad will be partially rehabilitated (progressive rehabilitation) to a minimum area of approximately 0.3 ha, which is required to operate the well and allow for workover rigs to undertake routine maintenance on the well. An example of an Australia Pacific LNG single-well pad during operation, and following progressive rehabilitation, is shown on Plate 2.

Typical well maintenance activities during operation include inspection of wellhead equipment, checks of monitoring equipment, regular inspections and servicing of power generation equipment and inspection of safety devices to ensure system integrity. Occasionally, pumps will be replaced during routine maintenance, called a workover.

Individual wells may be subject to well stimulation techniques (including hydraulic stimulation) to optimise gas supply and extend the operational life of existing wells. The number of wells requiring hydraulic stimulation is determined progressively and is subject to extensive stimulation risk assessment processes in accordance with EA conditions. Where hydraulic stimulation is conducted, it will be undertaken in accordance with the Code (Department of Natural Resources, Mines and Energy, 2019), applicable EA conditions (Appendix N), and as described in the Chemical Risk Assessment (Appendix I).

Information on well production pressures and flow rates are transmitted via a radio telemetry or fibre optic cable to enable production to be controlled from remote sites and regional operation

centres through an integrated control system. Changes to the operation of the wells, such as reducing gas production or shutting down selected wells, can also be managed via telemetry. This control system ensures the safe operation of key facilities associated with the Project.

Plate 1: A typical drill rig

Plate 2: Operational single well

2.4.2 Pipelines

Gathering pipelines are used to transport the gas and/or water from the wells to the GPFs and water management facilities. After processing, larger pipelines are used to transport the gas from the GPFs to the domestic market or the LNG facility, and water from the water management facilities to the storage ponds and end users.

Pipelines will be designed, constructed and operated to comply with EA conditions, resources legislation, *Australian Standards AS2885 – Pipelines Gas and Liquid Petroleum* (AS2885) and the Australian Gas Pipeline Association Ltd (AGPA) *Code of Environmental Practice – Onshore Pipelines Revision 4* (2017). The Code of Practice identifies design, construction and rehabilitation criteria for best practice environmental risk management.

Existing pipelines will be utilised where practicable. Otherwise, new pipelines will be preferentially co-located or constructed adjacent to existing linear infrastructure, access roads and tracks and along known property and fence boundaries, where practicable, to minimise overall disturbance. The route selection for pipeline corridors will be based on the final locations of the wells and facilities, as well as the environmental, landowner and cultural heritage constraints as detailed in the Protocol (Appendix A).

Pipeline construction will be undertaken with a combination of conventional civil plant equipment and specialist pipeline trenching, welding and lifting equipment. A pipeline right of way (RoW) of up to approximately 25 m will be used during construction. Gas and water gathering pipelines are typically made from High Density Polyethylene (HDPE), gas transmission pipelines from steel while water transmission pipelines typically will use either HDPE, glass reinforced epoxy, concrete or steel pipe. Gas gathering pipelines may include water collection at low points in the terrain to capture water condensed within gas pipelines. Water gathering pipelines may include vents at high points in the terrain for the removal of residual gas that might be dissolved in the produced water.

Pipelines will generally operate without the need for major process equipment or ongoing service. The pipeline RoW will be partially rehabilitated (progressive rehabilitation) following construction to a minimum of 6 m easement to allow access to conduct visual inspections, integrity testing and other routine field maintenance activities. In accordance with Australian Standards AS2885, pipeline signage will be installed to identify pipeline locations for both landholders and pipeline maintenance personnel.

2.4.3 Gas processing facilities

GPFs will be installed as required to dehydrate and compress gas to the pressure required for transmission to market. An existing Australia Pacific LNG Project GPF is shown on Plate 3.

The GPFs will typically be constructed using prefabricated modular structures and processing units to minimise onsite construction activities. The GPFs can require up to 120 ha during construction when co-located with water management facilities. Progressive rehabilitation will commence following construction to minimise the disturbance area for operation. Construction activities will typically involve:

- geotechnical and ecological investigations
- clearing vegetation, topsoil removal, and stockpiling for use in future rehabilitation
- grading the area, including placement of gravel subgrade for construction activities
- installing underground utilities and infrastructure, and constructing footings and foundations for buildings and shelters
- constructing buildings and installing modular structure and equipment
- installing piping, electrical equipment, controls, and instrumentation
- rehabilitation of disturbed areas not required for ongoing operation of the GPF.

Buildings at GPFs will include a control room, offices, workshop, storerooms and, in some cases, accommodation. Supporting infrastructure and facilities during construction will typically include:

- construction camps
- laydown yards for the storage of materials and equipment
- concrete batching plants (at remote facilities)
- water supply for construction activities and dust suppression activities
- sanitation facilities at both construction camps and construction sites
- upgrades to existing roads, or the construction of new roads to support the transportation of heavy modular equipment, piping, materials, and workers; and
- temporary power supply.

Commissioning will be undertaken in accordance with industry standards including hydrostatic testing, and performance testing of pumps, compressors, power supply and control systems.

Plate 3: APLNG GPF

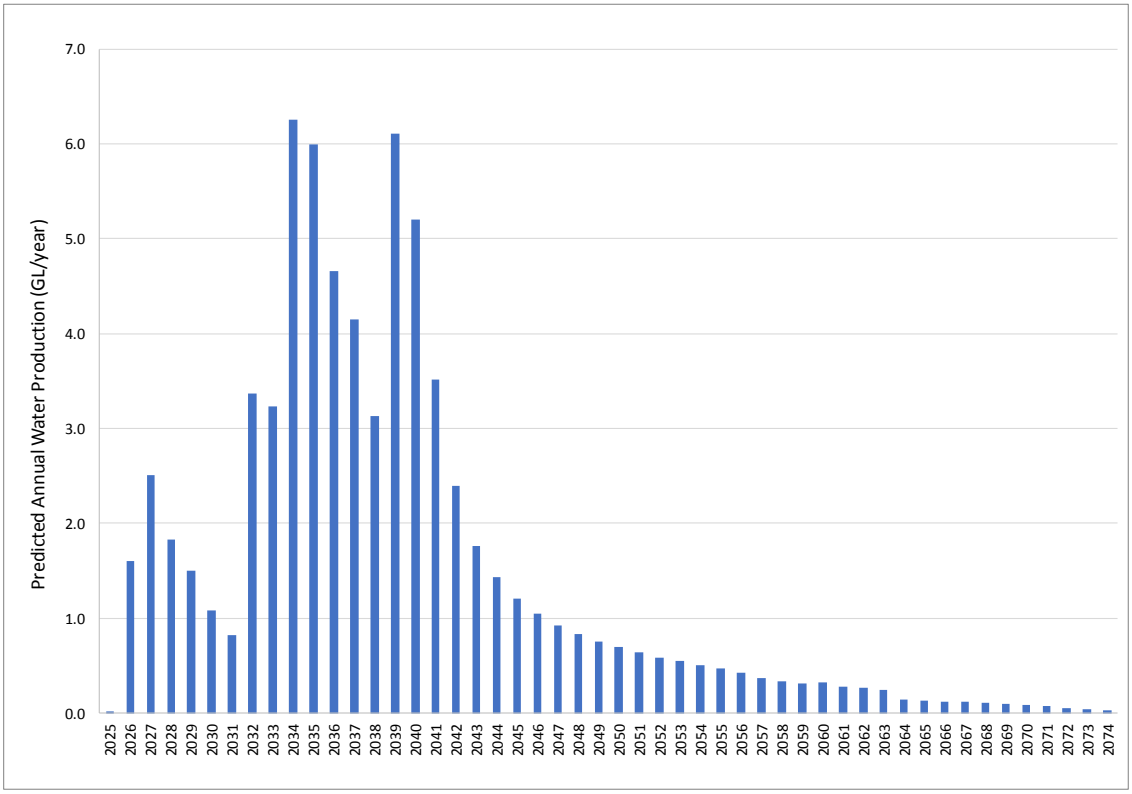
2.4.4 Water management

Water extracted from wells (known as produced water) will be managed in accordance with the Produced Water Management Plan (Appendix G). This Plan describes the applicable Queensland regulatory framework relevant to management of produced water including the EP Act, *Waste Reduction and Recycling Act 2011* (WRR Act) and Water Act (Qld). While the Project will preferentially utilise existing and approved water management infrastructure authorised under the EPBC Act (e.g. EPBC 2009/4974), the Project does not propose any new or additional authorisations for injection and surface water release.

The total volume of produced water forecast over the 50-year operational period for the Project is up to approximately 72.4 GL. This water production forecast overestimates actual water production as it does not account for cumulative dewatering effects from the many gas fields operating adjacent or proximal to the Project.

Figure 5 shows the predicted annual water production for the Project. The peak produced water rate for the Project of approximately 6.1 GL/year represents approximately 10% of the annual amount of groundwater produced by the petroleum industry in the Surat CMA (60 GL/year as calculated by OGIA) and approximately 4% of the annual amount of groundwater produced by non-petroleum groundwater use (largely non stock and domestic uses such as irrigation) in the Surat CMA (164 GL/year as calculated by OGIA).

Figure 5: Predicted Annual Water Production Rate



2.4.4.1 Storage

Produced water and water management by-products will be stored in tanks or dams as required. Where appropriate, Australia Pacific LNG Project water management infrastructure will preferentially be used to the extent of existing authorisations. Water management by-products will be temporarily stored in dams or tanks prior to removal for disposal at a regulated waste facility licenced under the EP Act.

Dams will be designed and constructed in accordance with the requirements of EAs and the Manual for assessing hazard categories and hydraulic performance of structures (Regulated Dam Manual) (Department of Environment and Science, 2016a). Further details of the regulatory controls prescribed by the Regulated Dam Manual are listed in section 6.2 and Table 14.

Tanks will be designed to Australian Standards. Dam design may include the following features:

- placement and testing of clay and/or liner materials to achieve the required hydraulic performance required by the Regulated Dam Manual

- leak detection sumps
- transfer pumps and associated pipework
- emergency spillways
- erosion management topsoil on batters.

An existing example of Australia Pacific LNG Project water management facility and storage dams is illustrated in Plate 4.

Plate 4 Example water management facility and storage dam

2.4.4.2 Treatment

Water management facilities will be designed to provide fit-for-purpose water quality for the intended use. Where practicable, the Project will preferentially utilise existing pipelines, water storage and water management facilities, however, the construction of new water management facilities may be required. Water management facilities will operate up to 24 hours a day and could include the following water treatment capabilities:

- desalination using reverse osmosis (RO) to remove a portion of the total dissolved solids and ions
- amendment using chemical dosing to lower the sodium adsorption ratio and pH/residual alkalinity of the water
- temperature and ionic balance adjustment
- filtration removing suspended solids (lowering turbidity) and nutrients
- sterilisation to remove bacteria
- de-oxygenation
- blending of separate water streams to achieve a target water quality.

The quality of produced water varies significantly and not all produced water requires treatment before use. Potential treatment options for produced water are determined by the water quality requirements for the proposed use of the water e.g. stock watering, construction, irrigation etc.

2.4.4.3 Use

The Queensland *Coal seam gas water management policy 2012* (Department of the Environment and Heritage Protection, 2012) sets out a management hierarchy under the EP Act for prioritising management and use of produced water. Potential options for management of produced water and water management by-products for the Project are listed below in accordance with the Queensland Government's *Coal Seam Gas Water Management Policy 2012* and the *Waste Reduction and Recycling Act 2011*:

- **Priority 1** – Beneficial use of produced water
  - **Make good** – utilising produced water for 'make good' agreements under the Water Act (Qld).
  - **Operational use** – using produced water for operation of the Project including construction, drilling and completions, dust suppression, process water, drinking water, and rehabilitation.
  - **Irrigation** – using produced water to undertake irrigation of crops and pastures.
  - **Water allocation substitution** – providing water to a third-party to reduce their take of water resources.
  - **Injection** – injecting produced water into underground formations including coal seams or aquifers to provide a benefit to water resources.
  - **Surface water release** – releasing produced water to a watercourse to provide a benefit to the environment or downstream users of water.
  - **Landholder activities** – providing produced water to landholders for uses such as stock watering and irrigation.
  - **Regional supply** – providing produced water to a third-party such as irrigators, feed lot operators, heavy industries, council, and construction projects.
- **Priority 2** – Disposal of produced water, after feasible beneficial use options have been considered
  - **Injection** – injecting produced water into underground formations including coal seams or aquifers where it does not mitigate impacts or provide a benefit to water resources.
  - **Surface water release** – release of produced water to surface water where it does not mitigate impacts or provide a benefit to water resources.
  - **Evaporation** – solar evaporation of produced water.

Origin beneficially used 100% of produced water (approximately 17,000 ML) from Australia Pacific LNG Project water management facilities during FY19/20. Beneficial uses include Surat Basin aquifer recharge and irrigation programs including:

- the purpose-built Fairymeadow Road Irrigation Pipeline (FRIP), which started delivering produced water to participating landholders in April 2014
- the Spring Gully irrigation scheme, which was expanded in FY2019 to a larger landholder operated irrigation scheme to further enhance beneficial use for produced water.

The Produced Water Management Plan (Appendix G) describes potential produced water uses for the Project including continued supply to support these existing beneficial uses.

2.4.5 Supporting infrastructure

Supporting infrastructure and services required for development and operation of the Project include:

- accommodation facilities
- sewage treatment facilities
- access roads
- fuel storage, workshops and maintenance areas
- laydown, stockpile and/or storage areas
- borrow pits
- powerlines and communications infrastructure; and
- other ancillary infrastructure.

Most of the supporting infrastructure will be constructed within the Project Area (Figure 2). Where practicable, the Project will utilise existing Australia Pacific LNG Project or third-party infrastructure to the extent authorised under the EPBC Act, or it will develop new infrastructure, subject to additional referrals, as required.

2.5 Decommissioning and rehabilitation

Where an ongoing beneficial use of infrastructure has not been identified, disturbed areas will be rehabilitated to achieve criteria prescribed in EA conditions. These include the following prescribed rehabilitation conditions, which are included in the Rehabilitation Management Plan (Appendix D):

Progressive rehabilitation

Significantly disturbed areas that are no longer required for the on-going petroleum activities, must be rehabilitated within 12 months (unless an exceptional circumstance in the area to be rehabilitated (e.g. a flood event) prevents this timeframe being met) and be maintained to meet the following acceptance criteria:

- contaminated land resulting from petroleum activities is remediated and rehabilitated
- the areas are:
  - non-polluting
  - stable landform
  - re-profiled to contours consistent with the surrounding landform
- surface drainage lines are re-established
- topsoil is reinstated
- either:
  - groundcover, that is not a declared pest species, is growing, or
  - an alternative soil stabilisation methodology that achieves effective stabilisation is implemented and maintained.

Final rehabilitation acceptance criteria

All significantly disturbed areas caused by petroleum activities which are not being or intended to be utilised by the landholder or overlapping tenure holder, must be rehabilitated to meet the following final acceptance criteria measured either against the highest ecological value adjacent land use or the pre-disturbed land use:

- greater than or equal to 70% of native ground cover species richness
- greater than or equal to the total percent of ground cover
- less than or equal to the percent species richness of declared plant pest species
- where the adjacent land use contains, or the pre-clearing land use contained, one or more regional ecosystem(s) (REs), then at least one RE from the same broad vegetation group (BVG), and with the equivalent biodiversity status or a biodiversity status with a higher conservation value as any of the REs in either the adjacent land or pre-disturbed land, must be present.

Final rehabilitation acceptance criteria in environmentally sensitive areas

Where significant disturbance to land has occurred in an environmentally sensitive area, the following final rehabilitation criteria as measured against the pre-disturbance biodiversity values assessment must be met:

- greater than or equal to 70% of native ground cover species richness
- greater than or equal to the total percent ground cover
- less than or equal to the percent species richness of declared plant pest species
- greater than or equal to 50% of organic litter cover
- greater than or equal to 50% of total density of coarse woody material.
- all predominant species in the ecologically dominant layer, that define the pre-disturbance REs are present.

An example of a rehabilitated operational Australia Pacific LNG pipeline corridor is shown on Plate 5.

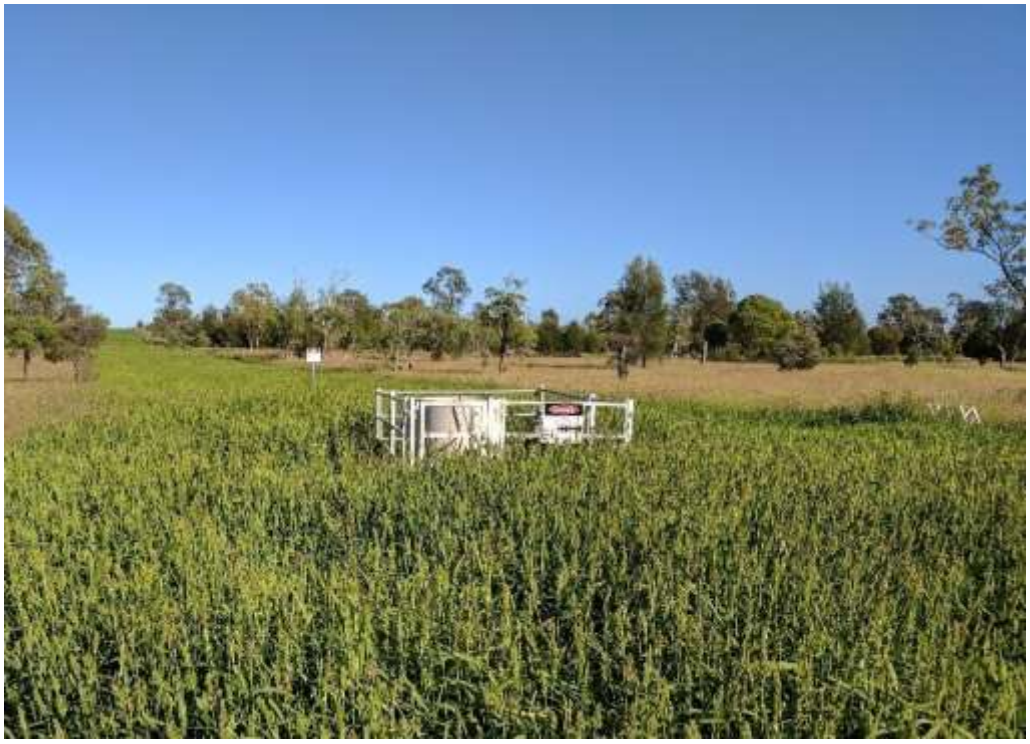


Plate 5 Example of a rehabilitated operational pipeline corridor

3.0 FEASIBLE ALTERNATIVES

As the primary objective of the Project is to help meet gas supply demand of the east coast domestic gas market and LNG export market, the main alternative would be to source gas from a third party (the 'non project' alternative). The considerations and outcomes applicable to the 'non project' alternative as well as to geographical location and timing alternatives are summarised in Table 6.

Table 6: Consideration of feasible alternatives

Alternative	Consideration	Outcome
Alternative gas supply – 'non project'	Supplementary gas could be sourced from third parties only where commercial opportunities become available, and gas meets specifications for treatment and export.	The 'non project' alternative is not viable due to the forecast gas supply shortfall from 2024 onwards as predicted by AEMO (AEMO, 2020). Additional gas reserves, resources and infrastructure are required to provide additional gas supply. A 'non project' alternative would not result in overall reduced environmental impact. The impact would simply occur elsewhere and may in fact be greater than the Project, which will preferentially utilise existing infrastructure to minimise disturbance.
Alternative geographical locations	There are limited alternative Project locations as the Project is restricted to areas overlying viable gas resources within existing petroleum tenures. Project infrastructure will be located following assessment of resource data and environmental constraints during the detailed design and field development stages. Where opportunities exist, existing approved facilities (Australia Pacific LNG or third party) will be used, or infrastructure co-located within existing corridors or footprints to minimise impacts. Flexibility in location decisions can improve gas recovery and reduce potential environmental impacts.	Alternate locations would decrease available gas resources, leading to increased disturbance and less efficient use of existing facilities and infrastructure. Alternative geographic locations are not a viable alternative for the Project.
Alternative timing	The AEMO report identified a gas supply shortfall from 2024 onwards unless additional reserves, resources and infrastructure are developed (AEMO, 2020). The timing of field development and associated activities depends on the progress of approved field development activities and the outcome of ongoing exploration, appraisal and production activities. Flexibility in Project timing can improve planning effectiveness (such as considering the ability to co-locate infrastructure) and allow changes which could reduce environmental impacts or increase gas recovery.	By delaying the project, the additional gas resources will not be developed in time to counter-balance the predicted short-fall. Alternative timing is not a viable alternative for the Project.

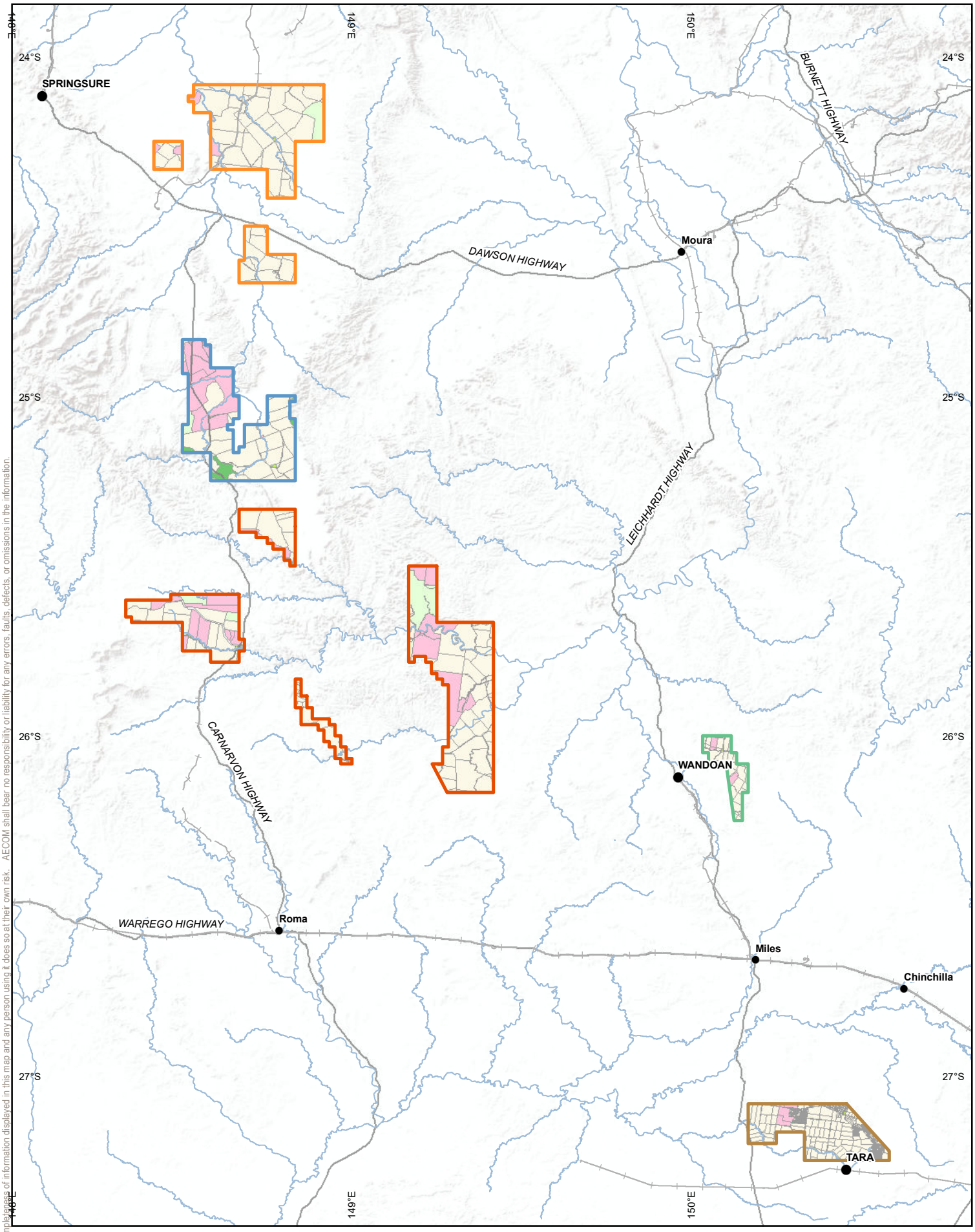
4.0 DESCRIPTION OF THE ENVIRONMENT

4.1 Land tenure and use

The Project Area is mostly privately-owned freehold land (76.4%) associated with larger agricultural properties. The remainder of the land tenure is a combination of lands lease, road reserves, easements and unallocated state land.

The Project Area is subject to land uses, including agricultural production (cropping land and cattle grazing), resource extraction (petroleum activities) and protected areas with conservation and recreation values. Many areas have been subjected to extensive grazing and agricultural related land use activities such as clearing of woody vegetation.

Urban development comprises of regional towns including Injune, Tara, Wandoan and Rolleston and rural residences outside of urban areas. Land tenure is shown on Figure 6.



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DATUM GDA 199

0 12.5 25 50

Kilometers

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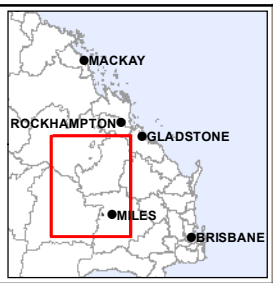
LEGEND

- Towns
- Roads

Development Areas
- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark

Tenure
- Freehold
- Lands Lease
- National Park
- Reserve
- State Forest
- State Land



ORIGIN ENERGY PTY LIMITED
GAS SUPPLY SECURITY PROJECT

Land Tenure

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VERSION:	1

Figure 6

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4.2 Climate

The Project Area is in southern and central Queensland approximately 400 km from the east coast. The regional climate is classified as subtropical with moderately dry winters (between April and September) and dry hot summers (between October and March) (Bureau of Meteorology, 2019). Changes in terrain across the Project Area contribute to some variability in local climate recorded at local stations operated by the Bureau of Meteorology (BOM).

Rainfall is at its highest from late spring through to the end of summer. The wettest month is January, with a median rainfall of 98 millimetres (mm) measured at Taroom Post Office (Station No. 035070). The driest months of the year are April to September. In these months, median rainfall is between 14.2 mm at Rolleston (Station No. 035145) in August and 29.8 mm at Miles Post Office (Station No. 042023) in June.

The mean monthly maximum temperature ranges from 19.3°C in July (Miles Post Office, Station No. 042023) to 34.8°C in January (Rolleston, Station No. 035145). The lowest mean minimum temperatures are experienced in June, July and August. The mean minimum temperature is 3.1°C in July at Injune Post Office (Station No. 043015).

Mean monthly 9:00 am relative humidity varies throughout the year with two peaks occurring in February and June. The highest 9:00 am relative humidity was observed in June for nominated BoM stations. The highest 9:00 am mean monthly relative humidity observation of 77% was made at Surat (Station No. 043035). Mean monthly 3:00 pm relative humidity peaks in February and June. Mean monthly relative humidity ranges from 27% to 49% while at 9:00 am the relative humidity readings range between 66% and 76%.

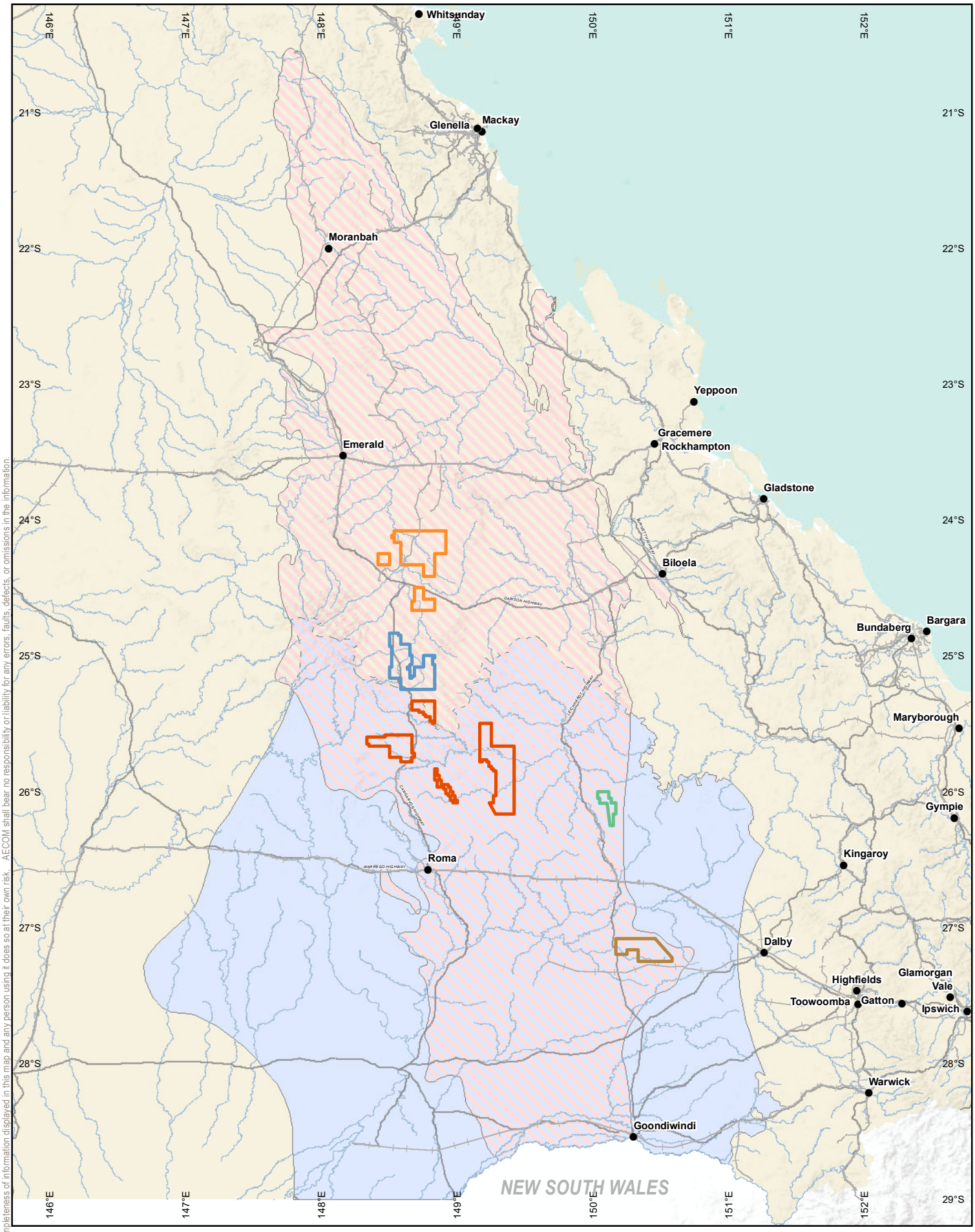
In the north of the Project Area (Rolleston Airport, Station No. 035129), the predominant and strongest winds were out of the south or south-southeast quarter, with the strongest winds yielding velocities of between 5.4 metres per second (m/s) and 7.9 m/s. In the south of the Project Area (Roma Airport, Station No. 043091), winds from the north and northeast quarter dominate, with the strongest winds ranging from 7.9 m/s and 10.7 m/s.

4.3 Geology

The Project is situated within two geological basins (Figure 7), the Permo-Triassic Bowen Basin in the north and the Jurassic-Cretaceous Surat Basin in the south. The Bowen Basin is an elongated north-south trending basin which covers approximately 160,000 square kilometres (km^2) of Queensland and New South Wales. The Surat Basin unconformably overlies the Bowen Basin and extends from north of Taroom, Queensland, to north of Dubbo, New South Wales.

A summary of the stratigraphic units that form the Surat and Bowen Basins are provided on Figure 8. Geologic formations within these basins comprise various layers of sandstone, siltstone and mudstone that were primarily deposited by rivers and lakes, with occasional marine influences. These basins have structurally separate depositional sedimentary centres but are stratigraphically and hydraulically connected (Habermehl, 2002). Overlying these basins are extensive areas of unconsolidated younger alluvial sediments and volcanics that can be deeply weathered and laterised.

The Project is primarily targeting the Walloon Coal Measures of the Surat Basin and the Baralaba Coal Measures / Bandanna Formation and Reids Dome Beds of the Bowen Basin. Further detail with respect to the regional geology is provided in the Water Assessment Report (Appendix F).



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0 30 60 120

Kilometers

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LEGEND

- Towns
- Roads
- Australia Pacific LNG approval (EPBC 2009/4974)
- Supporting Infrastructure Area

Development Areas
- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark

Geological Unit
- Other geolocial unit
- Bowen Basin
- Surat Basin

ORIGIN ENERGY PTY LIMITED
GAS SUPPLY SECURITY PROJECT

Geology

PROJECT ID	60617011
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VERSION:	1

Figure 7

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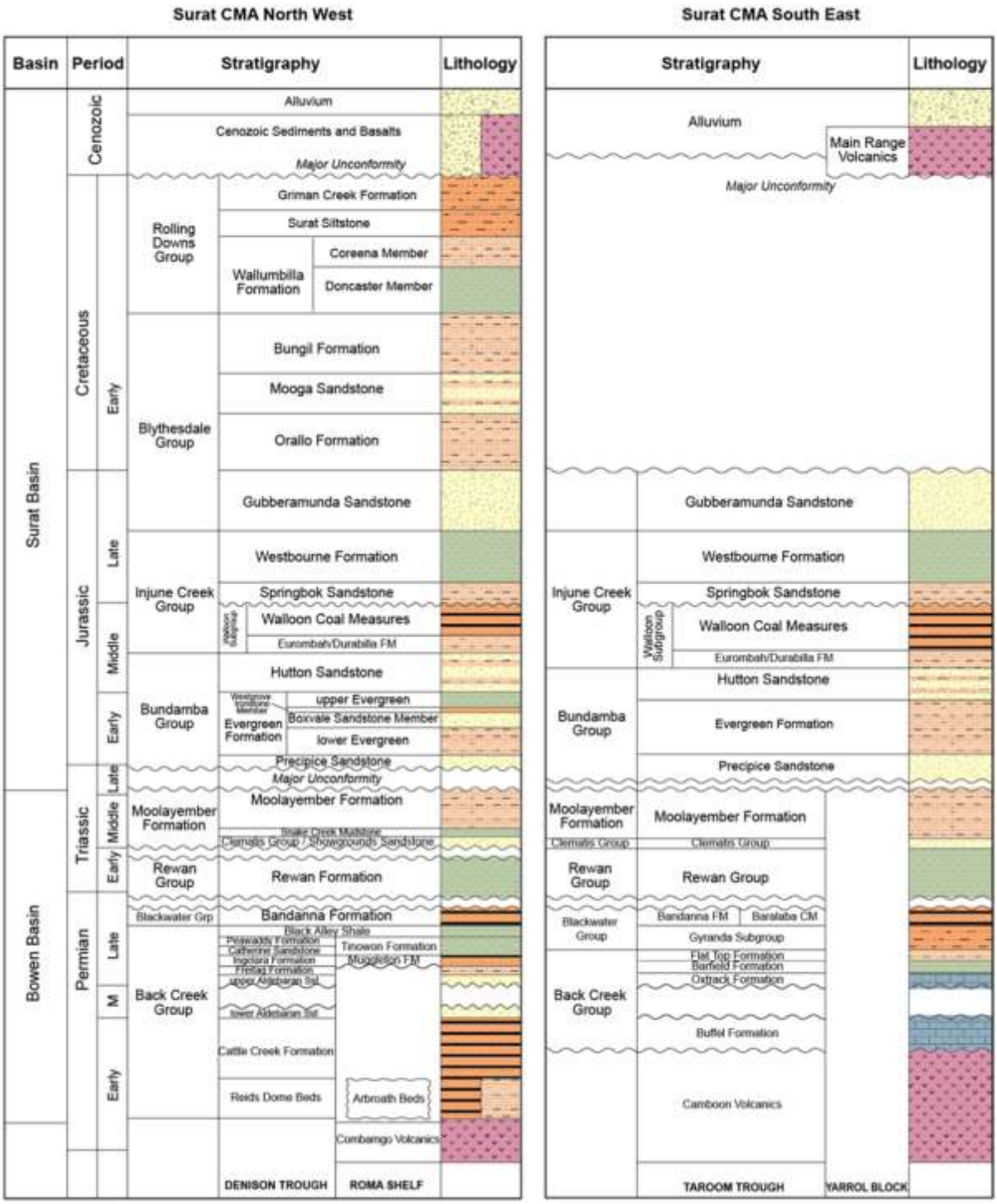
Figure 8: Stratigraphy of the Bowen and Surat Basins (OGIA, 2019b)

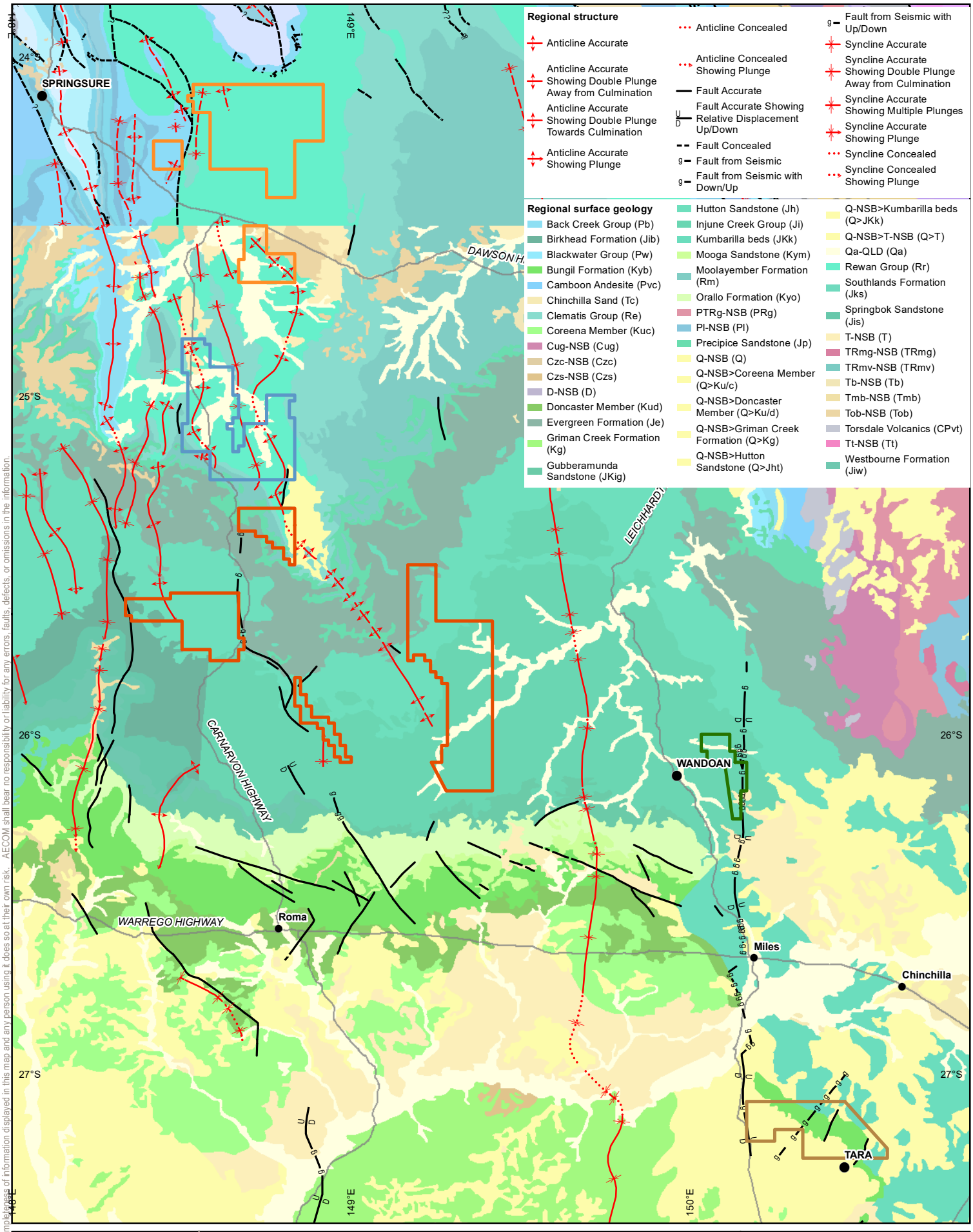


Surface geology and structural features present across the Project Area are shown on Figure 9. The geological setting of each development area is summarised in Table 7.

Table 7: Summary of geological settings

Development area	Alluvium	Outcrop	Subcrop	Major aquatards	Target formation	Target formation occurrence (mbgl)[1]
Mahalo	Quaternary alluvium associated with watercourses	Cenozoic sediments Tertiary basalt	Rewan Group Bandanna Formation	Rewan Group	Bandanna Formation	5 to 640
Denison		Cenozoic sediments Moolayember Formation Clematis Group Rewan Group	Rewan Group	Rewan Group	Bandanna Formation	215 to 865
Spring Gully		Cenozoic sediments Injune Creek Group Bundamba Group Moolayember Formation Rewan Group	-	Rewan Group	Bandanna Formation	170 to 3,355
					Reids Dome Beds	605 to 1,435
Peat		Springbok Sandstone Walloon Coal Measures Eurombah Formation	-	Rewan Group	Bandanna Formation	605 to 1,380
Ironbark		Cenozoic Sediments Bungil Formation	Wallumbilla Formation Bungil Formation Mooga Sandstone	Westbourne Formation Orallo Formation	Walloon Coal Measures	560 to 1,310

[1] Metres below ground level



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Kilometers

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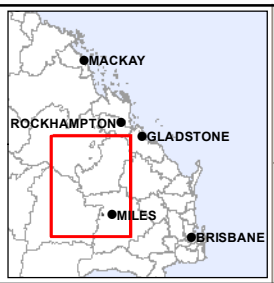
LEGEND

- Towns
- Roads

Development Areas
- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark



ORIGIN ENERGY PTY LIMITED GAS SUPPLY SECURITY PROJECT

Regional Geology

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VERSION:	1

Figure 9

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A4 size

4.4 Landform

The Project Area has north-south topographical highs of the Expedition and Shotover Ranges and an east-west trending topographical high of the Great Dividing Range. Three major river systems are separated by these topographical highs; the Comet River in the north draining to the northwest, the Dawson River in the east draining to the northeast, and the Balonne River in the south draining to the south.

The landscape is largely composed of alluvial plains (flat, near flat and undulating plains associated within valleys along the main rivers and tributary streams), undulating low hills, broad ridges and wide, flat-bottomed valleys and plateau remnants (flat to strongly undulating plateau surface remnants cut by very steep slopes and escarpments). Across the Project area elevations range from less than 200 metres (m) Australian Height Datum (AHD) in the north (Mahalo) to more than 350 m AHD in the south (Ironbark) and east (Peat), with maximum peak of 650 m AHD in Spring Gully. Landform is presented in Figure 10.

4.5 Soils

Eight major soil groups are identified within the Project Area (Stace, 1968), with:

- Mahalo comprising mainly vertosols, sodosols, kandosols and tenosols
- Denison comprising mainly dermosols, sodosols, tenosols and rudosols
- Spring Gully comprising mainly vertosols, rudosols, kandosols, sodosols and chromosols
- Peat comprising mainly vertosols and kandosols
- Ironbark comprising mainly sodosols, kurosols and vertosols.

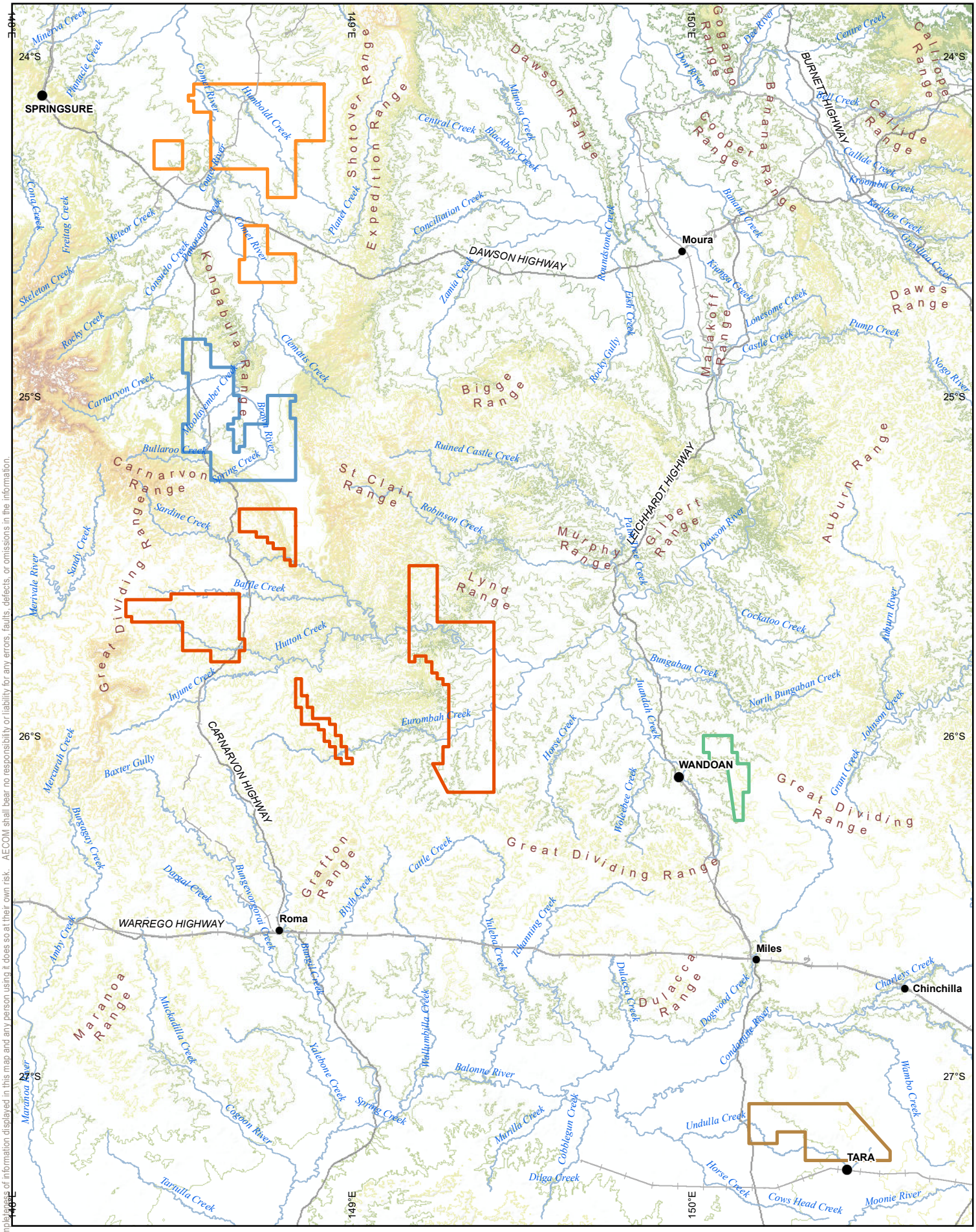
There are no known acid-sulfate soils or acid-bearing rock formations within the Project Area.

Soil types are mapped in Figure 11 (CSIRO, 2019). Typical soil profile characteristics and management practices of each soil type can be described by using soil mapping units (SMUs). Each soil type comprises more than one SMU as outlined in Table 8.

Table 8: Soil types across the Project Area

Soil types	Soil mapping units	
Skeletal and shallow rocky soils (rudosols)	1 Shallow to very shallow (mostly <0.3 m) rocky, stony or gravelly soils (>60% coarse fragments) with a sandy, loamy or clayey soil matrix	
Uniform coarse-textured sandy soils (rudosols)	2 Mostly medium to deep (0.6->1.0 m), some shallow yellow, brown and red sandy soils, some shallow sands and medium to deep thick sandy duplex soils occur locally	
Sandy red and yellow earths and red and yellow massive earths (tenosols and kandosols)	3 Shallow to medium deep (<0.6 m) sandy red-yellow earths-earthy sand soils, shallow gravelly loam soils and gravelly loamy red-yellow earth soils; rock outcrop, broken rock and boulders may occur in parts.	
	4 Medium to deep (0.6->1.0 m) loamy red-yellow earths and lateritic red-yellow earth soils; some occurrences of shallow gravelly red earth soils; minor occurrences of sandy to loamy surface duplex soils, minor deep red sandy soils.	
Texture contrast (duplex) soils (chromosols,	Duplex soils with neutral to moderately acidic, locally	5 Shallow to medium deep (<0.6 m) sandy to loamy surface red, red-brown, brown or dark grey-brown acidic duplex soils; in parts similar but slightly acidic to alkaline duplex soils may also occur; minor deeper duplex soils may also occur locally.

Soil types	Soil mapping units	
kurosols and sodosols)	strongly acidic subsoils	6 Medium to deep (0.6->1.0 m) thick sandy surface duplex soils (Type 5.2) with grey-brown, yellow-brown or red-brown coarsely mottled subsoils; similar but thinner sandy to loamy surface duplex soils also occur; some uniform sandy soils and massive red-yellow earth soils in parts.
	Duplex soils with neutral to moderately alkaline, locally strongly alkaline subsoils	7 Shallow to medium deep (<0.6 m) sandy to loamy surface red, red-brown, brown or dark grey-brown alkaline duplex soils; in parts, similar neutral to slightly acidic duplex soils may also occur together with some deeper duplex soils; some cracking clay soils in lower-lying parts.
		8 Medium to deep (0.6->1.0 m) fine sandy to silt and clay loamy surface duplex soils with dark brown, brown, yellow-brown or red-brown alkaline clay subsoils; may include some occurrences of red and yellow earth soils on rises and dark brown and grey-brown soils and cracking clay soils in lower-lying parts.
Dark brown and grey-brown soils (dermosols)	9 Shallow to medium deep (<0.6 m) mainly uniform fine-textured gravelly clay soils often in association with shallow cracking clay soils; some deeper uniform clays or gradational clay loam over clay soils and cracking clay soils on mid to lower slopes.	
	10 Medium to deep (0.6->1.0 m) mainly uniform clays or gradational clay loam over clay soils; some shallow gravelly uniform or gradational clay soils and shallow cracking clays soils on upper slopes and rises; some deeper dark grey-brown cracking clay soils in lower-lying parts.	
Cracking clay soils (vertosols)	11 Shallow to medium deep (<0.6 m) cracking clay soils (Type 8.1) occurring mainly on crests and upper slopes and underlain by basalt and argillaceous sedimentary rock types, in places with shallow gravelly loams and clay loam soils (Type 4.1) and uniform gravelly clay soils (Type 7.1); some medium to deep cracking clay soils (Type 8.2) may occur on mid to lower slopes.	
	12 Medium to deep (0.6->1.0 m) dark grey-brown, brown or black cracking soils, locally in association with uniform (non-cracking) clay soils (Type 7.3) and some shallow gravelly uniform clay soils on rises; minor shallow to medium deep loamy surface duplex soils may occur locally.	
	13 Medium to deep or very deep (0.6->1.5 m) dark grey-brown or black cracking clay soils with intensive gilgai micro-relief, often in association with silt to clay loamy surface duplex soils on the gilgai mounds; areas of uniform (non-cracking) clay soils are also associated; some loamy red earth soils may occur locally on low rises.	



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Kilometers

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LEGEND

- Towns
- Roads

Development Areas

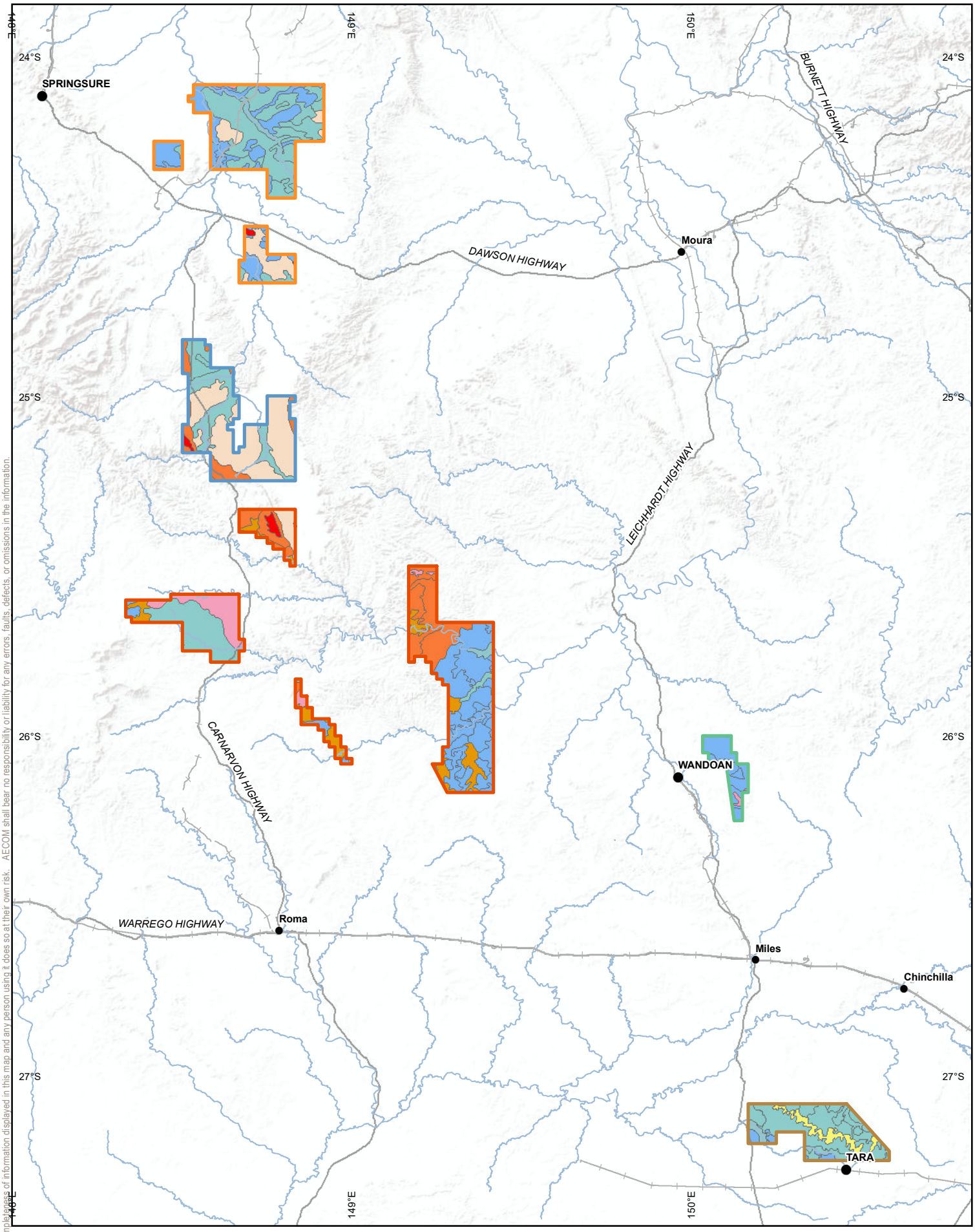
- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark

ORIGIN ENERGY PTY LIMITED
GAS SUPPLY SECURITY PROJECT

Landform

PROJECT ID	60617011
CREATED BY	PK
LAST MODIFIED	stencela: 18/09/2020
VERSION:	1

Figure 10



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Kilometers

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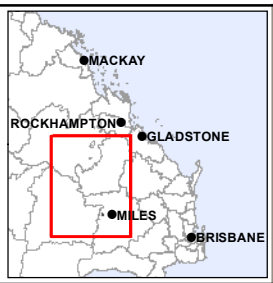
LEGEND

- Towns
- Roads

Development Areas
- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark

Soil Types ASRIS
- Dermosol
- Kurosol
- Kandosol
- Tenosol
- Rudosol
- Chromosol
- Sodosol
- Vertosol



ORIGIN ENERGY PTY LIMITED
GAS SUPPLY SECURITY PROJECT

Soil Types

PROJECT ID	60617011
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VERSION:	1

Figure
11

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4.6 Vegetation

Queensland encompasses a wide variety of landscapes across temperate, wet and dry tropics and semi-arid to arid climatic zones. As of January 2019, 1,424 regional ecosystems (REs) are recognised across Queensland (Neldner, Niehus, *et al.*, 2019).

The Project is located within the Brigalow Belt Bioregion, predominantly in the southern portion with a small section located within the northern portion. Approximately 76% (361,277 ha) of the Project Area has been previously cleared, with only 115,646 ha of remnant vegetation (24%) within the Project Area. The majority of this remnant vegetation is conserved in National Parks and other protected areas, the most notable being Carnarvon Gorge.

The Queensland Herbarium uses Broad Vegetation Groups (BVGs) to amalgamate vegetation communities and REs on a pragmatic basis to form BVGs that communicate higher-level ecological groupings. Floristic, structural, functional, biogeographic and landscape (land zone, landform, and soil type) attributes have all been used in this classification.

At the 1:5 million scale (national), there are 16 defined BVGs (Neldner, Niehus, *et al.*, 2019), 10 of which occur within the Project Area (Table 9).

An overview of vegetation and other key environmental features in the Project Area is provided in Table 10.

Table 9: Overview of vegetation across the Project Area

Total Project Area	Remnant vegetation	Broad Vegetation Groups (Neldner, Niehus, *et al.*, 2019)
476,492 ha	115,646 ha 24%	1. Rainforests and scrubs (0.16%) 3. Eucalypt woodlands to open forests (mainly Eastern) (10.38%) 4. Eucalypt open forests to woodlands on floodplains (1.06%) 5. Eucalypt dry woodlands on inland depositional plains (6.70%) 7. Callitris woodland - open forests (3.16%) 8. Melaleuca open-woodlands on depositional plains (0.013%) 10. Other acacia dominated open forests, woodlands & shrublands (2.19%) 12. Other coastal communities or heaths (0.063%) 13. Tussock grasslands, forblands (0.41%) 15. Wetlands (swamps and lakes) (0.14%)

Table 10: Overview of vegetation and features within each development area

Development area (block)	Area (ha)	Remnant vegetation (ha)	Broad Vegetation Groups	Vegetation features	Other key features
Mahalo (Block A)	98,761	13,440 **13.61%**	1. Rainforests and scrubs 3. Eucalypt woodlands to open forests (mainly Eastern)	The Block is mostly cleared, and the remaining remnant vegetation is largely restricted to Humboldt State Forest in the east or riparian areas along major watercourses and their tributaries. One	Humboldt State Forest Humboldt National Park boarders the

Development area (block)	Area (ha)	Remnant vegetation (ha)	Broad Vegetation Groups	Vegetation features	Other key features
			4. Eucalypt open forests to woodlands on floodplains 5. Eucalypt dry woodlands on inland depositional plains 10. Other acacia dominated open forests, woodlands and shrublands 12. Other coastal communities or heaths	patch of acacia dominated open forests, woodlands and shrublands occurs in the centre. Humboldt State Forest is mostly contained within the Block, with a small area extending south outside of the Block and bordering Humboldt National Park on the eastern boundary. The vegetation within the State Forest is made up of mostly continuous Eucalypt dry woodlands and acacia dominated open forests, woodlands and shrublands; however, there are small patches of non-remnant vegetation throughout. The Forest is also surrounded by vast areas of non-remnant vegetation, excluding Humboldt National Park to the west. Humboldt Creek intersects the Block through the centre from north-west to south-east. Riparian Eucalypt woodlands along this creek are more abundant in the south-east of the Block. Comet River and its tributaries intersect the western border of the Block from north to south. Riparian vegetation along this watercourse is thin and patchy, mostly comprised of Eucalypt or acacia dominated open forests and woodlands on floodplains. Small, restricted patches of rainforest and scrubs occur along Comet River in the north-west of the Block.	eastern boundary Expedition State Forest approx. 14 km east Humboldt Creek Comet River

Development area (block)	Area (ha)	Remnant vegetation (ha)	Broad Vegetation Groups	Vegetation features	Other key features
Mahalo (Block B)	7,807	3,065 **39.25%**	3. Eucalypt woodlands to open forests (mainly Eastern) 4. Eucalypt open forests to woodlands on floodplains 5. Eucalypt dry woodlands on inland depositional plains 8. Melaleuca open-woodlands on depositional plains 10. Other acacia dominated open forests, woodlands and shrublands 13. Tussock grasslands, forblands	Vegetation is predominantly fragmented into patches and strips. The south and south-east section of the Block contains most of the remnant vegetation, including a patch of Tussock grasslands and Eucalypt woodlands to open forests. This patch of vegetation is largely continuous, although it is bordered by large strips of non-remnant vegetation. Aldebaran Creek intersects the southern border of the Block in the south-west. The creek is bordered by riparian vegetation (Eucalypt open forests to woodlands on floodplains) which extends into the south-west corner of the Block. However, this vegetation is not continuous and contains patches of non-remnant vegetation.	Aldebaran Creek Albina National Park approx. 6 km south The far south-east corner of the Block overlays the Protected Plant Trigger.
Mahalo (Block C)	21,500	367 **1.71%**	1. Rainforests and scrubs 3. Eucalypt woodlands to open forests (mainly Eastern) 4. Eucalypt open forests to woodlands on floodplains 5. Eucalypt dry woodlands on inland depositional plains 10. Other acacia dominated open	The Block sits within a large patch of non-remnant vegetation. One small patch of remnant vegetation (approx. 100 ha), consisting mostly of Eucalypt woodlands to open forests, occurs in the north, intersecting the eastern border. The remaining vegetation occurs in small isolated patches, including strips of riparian Eucalypt open forests to woodlands on floodplains which occur along restricted sections of Comet River. This river intersects the Block in the	Comet River

Development area (block)	Area (ha)	Remnant vegetation (ha)	Broad Vegetation Groups	Vegetation features	Other key features
			forests, woodlands and shrublands 13. Tussock grasslands, forblands	south-west and is mostly bordered by non-remnant vegetation.	
Denison	91,882	20,827 **22.67%**	1. Rainforests and scrubs 3. Eucalypt woodlands to open forests (mainly Eastern) 4. Eucalypt open forests to woodlands on floodplains 5. Eucalypt dry woodlands on inland depositional plains 10. Other acacia dominated open forests, woodlands and shrublands 15. Wetlands (swamps and lakes)	Remnant vegetation is largely restricted to State Forests and National Parks, or their borders. Bandana State Forest in the west, and both Carnarvon National Park and Boxvale State Forest in the south-west contain continuous patches of vegetation including Eucalypt and acacia dominated woodlands, open forests and scrubs, and areas of rainforests and scrubs. Only small sections of these State Forests and National Parks intersect the Block, extending into vast areas of remnant vegetation to the west and south-west, outside of the Block. Expedition (Limited Depth) National Park and Nuga National Park also contain larges areas of remnant vegetation to the west and north-west. However, these national parks only intersect the western borders of the Block to a very minimal extent. An area of fragmented vegetation occurs in the northern portion of the Block, where remanent vegetation from the west and east intersect. This vegetation contains non-remnant patches and is fragmented through the	Bandana State Forest Boxvale State Forest Serocold State Forest approx. 4.5 km West Carnarvon National Park Expedition (Limited Depth) National Park Nuga National Park Brown River Arcadia Creek Carnarvon Creek Moolayember Creek Spring Creek

Development area (block)	Area (ha)	Remnant vegetation (ha)	Broad Vegetation Groups	Vegetation features	Other key features
				centre by the Carnarvon Highway. The remainder of the Block is predominantly non-remnant; excluding patches of vegetation within wetlands (swamps and lakes) in the north east, and restricted patches of riparian vegetation (Eucalypt woodland and forest) along sections of the watercourses that intersect the Block.	
Spring Gully (Block A)	18,888	10,620 **56.22%**	3. Eucalypt woodlands to open forests (mainly Eastern) 4. Eucalypt open forests to woodlands on floodplains 5. Eucalypt dry woodlands on inland depositional plains 7. Callitris woodland - open forests 10. Other acacia dominated open forests, woodlands and shrublands	This Block contains large areas of remnant vegetation extending from the north-west to the south-east. However, this vegetation is fragmented and contains large patches of non-remnant vegetation in the centre and to the west. The eastern side of the Block is almost entirely non-remnant, excluding the south-east corner where Expedition (Limited Depth) National Park intersects the Block. Dominant broad vegetation groups throughout include Eucalypt woodlands to open forests (mainly Eastern), and other acacia dominated open forests, woodlands and shrublands.	Expedition (Limited Depth) National Park Boxvale State Forest approx. 4 km west *No major watercourses*
Spring Gully (Block B)	47,570	26,479 **55.66%**	3. Eucalypt woodlands to open forests (mainly Eastern) 5. Eucalypt dry woodlands on inland	Patches of both Callitris woodland to open forests; and eucalypt dry woodlands on inland depositional plains extend across the north and through the centre of the Block to the south. Patches of this vegetation are also	Doonkuna State Forest Forrest State Forest Baffle Creek Hutton Creek

Development area (block)	Area (ha)	Remnant vegetation (ha)	Broad Vegetation Groups	Vegetation features	Other key features
			depositional plains 7. Callitris woodland - open forests 10. Other acacia dominated open forests, woodlands and shrublands	contained within Doonkuna and Forrest State Forests that intersect the Block. The vegetation is patchy and fragmented and is bordered by large areas of non-remnant vegetation in the west, south and south east. Riparian Eucalypt woodlands also occur along Hutton Creek which intersects the south of the Block.	
Spring Gully (Block C)	110,073	29,404 **26.71%**	3. Eucalypt woodlands to open forests (mainly Eastern) 4. Eucalypt open forests to woodlands on floodplains 5. Eucalypt dry woodlands on inland depositional plains 7. Callitris woodland - open forests 10. Other acacia dominated open forests, woodlands and shrublands	The northern section contains a large patch of vegetation mostly comprised of Eucalypt woodlands to open forests. Large portions of this vegetation are contained within Belington Hut State Forest and Stephenton State Forest which intersect the Block in the north and north-west. However, a patch of vegetation also extends further into the Block from the boundaries of these state forests. Riparian vegetation (Eucalypt open forests to woodlands on floodplains) occurs in the north-east along the Dawson River and in the south along Eurombah Creek and its tributaries. The remainder of the Block is mostly comprised of non-remnant vegetation, excluding a long strip of acacia dominated open forests, woodlands and shrublands in the south-east.	Belington Hut State Forest Stephenton State Forest Hallett State Forest approx. 4 km west Expedition (Limited Depth) National Park approx. 4 km west Dawson River and tributaries Eurombah Creek and tributaries

Development area (block)	Area (ha)	Remnant vegetation (ha)	Broad Vegetation Groups	Vegetation features	Other key features
Spring Gully (Block D)	9,862	2,192 **22.23%**	3. Eucalypt woodlands to open forests (mainly Eastern) 5. Eucalypt dry woodlands on inland depositional plains 7. Callitris woodland - open forests 10. Other acacia dominated open forests, woodlands and shrublands	One patch of continuous vegetation intersects the Block in the south. This vegetation is predominantly comprised of Eucalypt woodlands to open forests (mainly Eastern) and is surrounded by vast areas of non-remnant vegetation. Eurombah Creek intersects the Block within this patch of vegetation. The remainder of the Block consist of non-remnant vegetation, excluding small patches of Eucalypt/Callitris woodland to open forests in the northern portion of the Block.	Hallett State Forest approx. 4 km north-east Eurombah Creek
Peat	16,097	713 **4.43%**	3. Eucalypt woodlands to open forests (mainly Eastern) 4. Eucalypt open forests to woodlands on floodplains 10. Other acacia dominated open forests, woodlands and shrublands	Peat sits within an extensive region of predominantly non-remnant vegetation, excluding areas of vegetation within state forests that begin approximately 4 km to the east. Small strips and patches of remnant vegetation occur in the north, comprised of Eucalypt and acacia dominated open forests, woodlands and shrublands on floodplains. Similar vegetation also occurs in the south, including riparian vegetation along a tributary of Downfall Creek.	Barakula State Forest approx. 5 km east Cooaga State Forest approx. 4 km east Quandong State Forest approx. 5 km east Tributary of Downfall Creek
Ironbark	54,482	8,710 **15.98%**	3. Eucalypt woodlands to open forests (mainly Eastern) 4. Eucalypt open forests to	Remnant vegetation has been mostly cleared; however, areas of fragmented remnant vegetation are present in the north to north-east corner and south-east	Condamine State Forest approx. 9 km north Braemar State Forest

Development area (block)	Area (ha)	Remnant vegetation (ha)	Broad Vegetation Groups	Vegetation features	Other key features
			woodlands on floodplains 5. Eucalypt dry woodlands on inland depositional plains 10. Other acacia dominated open forests, woodlands and shrublands	corner. This vegetation is predominantly Eucalypt woodland to open forest. Other small patches and strips of remnant vegetation occur throughout, including areas of riparian vegetation along Undulla Creek in the south.	approx. 15 km east Undulla Creek

4.7 Species and habitats

The Brigalow Belt Bioregion contains a broad range of habitat types that provide suitable values for species including birds, bats, mammals and reptiles. An overview of typical broad habitat types present within the bioregion is provided in Table 11.

Table 11: Broad habitat types

Habitat type	General description and habitat values
Acacia or belah open forest	Generally found on undulating country on fine grained sedimentary rocks and on crests and scarps. *Acacia harpophylla* (brigalow) and *Casuarina cristata* (belah) are generally dominant in tree layer. Acacia forest communities on clay soils provide suitable habitat for threatened flora species including *Solanum dissectum* and *S. johnsonianum*. Remnant patches provide areas of high density of fallen woody debris and dense leaf litter which provide essential microhabitat features for reptiles, including Dunmall's Snake. Moderate to high abundance of fissures and decorticating bark also provide roosting habitat for microbats, including Corben's long-eared bat. Regrowth patches provide lower habitat value due to the lower species diversity and the occurrence of dense clumps of thin brigalow, resulting in a lower mass of fallen woody debris.
Acacia woodland	Woodlands dominant by *Acacia* spp., often found along stock routes / road reserves. *Acacia melvillei* (Yarran) can be present, providing an abundance of mistletoe, which is a microhabitat feature for Painted Honeyeater. Microhabitat features in remnant patches include moderate to high native grass cover, large amounts of woody debris, moderate amounts of leaf litter and a high number of cracks and crevices that provide shelter for ground-dwelling species, including numerous reptile species such as Dunmall's Snake.

Habitat type	General description and habitat values
Cypress pine woodlands	*Callitris glaucophylla* (white cypress pine) woodland found on sandy and deep texture contrast soils. Occasional canopy tree species include *Eucalyptus melanophloia* (silver-leaved ironbark), *E. populnea* (poplar box), *Angophora leiocarpa* (smooth barked apple), *Corymbia clarksoniana* (grey bloodwood) and *C. erythrophloia* (red bloodwood). Microhabitat features include fissures in bark providing habitat for Corben's long-eared bat. Where fall logs on sandy soils are present, this habitat provides potential for Yakka Skink.
Dry eucalypt woodland with shrubby understorey	Found on upper slopes and plateaux with coarse grained sediments and is associated with Cainozoic duricrusts/ironstone jump ups and Quaternary loamy and sandy plains. Habitat is comprised of eucalypt woodland with shrubby understory occurring with a mix of eucalypt species present. Connectivity in the canopy layer and diversity in eucalypt provides foraging opportunities for Koala. Depending on the eucalypt species present, hollow-bearing trees suitable for denning by Greater Glider may be present. A dense, cluttered understorey provides potential foraging habitat for Corben's long-eared bat, with abundance of potential roosting habitat occurring within the extensive stands of vegetation. The ground layer of this habitat type is often moderately complex, with an abundance of fallen woody debris and hollow logs, providing microhabitat resources for Collared Delma and Dunmall's Snake.
Fringing riparian forest	Associated with watercourses throughout the region. Often comprises of remnant riparian vegetation that provides habitat movement corridors and refuge areas during times of drought. These areas provide important habitat for Koala and a reliable water source for Squatter Pigeon. A diversity of eucalypt species is often present, providing primary and secondary food trees for the Koala. Hollow-bearing trees present in this habitat type are generally large and well developed and provide roosting and breeding habitat for hollow dependent arboreal mammals (Greater Glider) and microbats (Corben's long-eared bat). As the habitat type is generally open in structure, microhabitat features such as fallen woody debris and leaf litter are generally low to moderate in abundance, providing little habitat value for reptile species.
Natural Grasslands	This habitat type can occur on both alluvial (associated with land zone 3 and 4) and non-alluvial (associated with land zone 8, 9 and 11) soils. It is characterised by a mid-dense to dense grass layers, comprised predominantly of native species, with sparse shrub coverage and occasionally emergent tree species. A number of grassland bird species utilised the structural complexity of grassland vegetation for foraging and roosting, including Squatter Pigeon. Where present, deep cracks in clay soils are a key microhabitat features for reptiles. Threatened grass species are often found in natural grassland communities, including *Aristida annua*, *Dichanthium queenslandicum* (king blue-grass), *D. setosum* (Bluegrass).

Habitat type	General description and habitat values
Open woodland on sandstone upland / plateaus	Habitat type found on elevated slopes and plateaus in close proximity to sandstone cliff lines throughout the bioregion, providing potential foraging habitat for both northern quoll and Large-eared Pied Bat. Koala food tree species (*Eucalyptus* spp. and *Corymbia* spp.) are often present providing important foraging habitat for the species. The habitat can also contain a high-densities of hollow-bearing trees, providing denning sites for Greater Glider. Microhabitat features include fallen timber, loose surface rocks and varying densities of leaf litter, providing potential habitat for Collared Delma and Dunmall's Snake. Areas of well-draining soils and sparse grass provide potential habitat for Squatter Pigeon.
Sandstone cliff lines, rocky outcrop and escarpment	*Eucalyptus* spp. and *Corymbia* spp. dominate rocky outcrops and sandstone escarpments, providing a food resource for Koala and denning sites for Greater Glider. Exposed sandstone, crevices, rocky overhangs and loose rocks provide shelter for mammals, birds and reptiles. Some areas within the bioregion contain deep, abundant caves, suitable for roosting in by the Large-eared Pied Bat as well as crevices for potential denning by northern quoll. Areas of abundant surface rocks and native grasses provide shelter for Collared Delma.
Semi-evergreen vine-thicket	This habitat type comprises areas of semi-evergreen vine-thicket (SEVT) threatened ecological community (TEC). SEVT consists of a high diversity of plant species and dense foliage, which provides shelter for a range of birds, mammals and reptiles. SEVT provides habitat for a number of threatened flora species, including Ooline (*Cadellia pentastylis*). Areas within the habitat type may also contain rocky gullies, which provide potential northern quoll habitat.
Springs / wetlands / watercourses	Habitat type includes vegetated swamps, lakes, billabongs, depressions on floodplains, creeks and rivers. Permanent watercourses provide habitat for a range of aquatic species including white-throated snapping-turtle. Spring complexes with continuation inundation provide important habitat for spring flora including salt pipewort. Reliable supplies of water also provide an important resource for a range of species, including a water source for Squatter Pigeon and reliable soil moisture for refuge habitat for Koala.
Valleys and plains	A common habitat type throughout the bioregion comprised of woodlands to open woodlands occurring on undulating plains, valleys with sandy soils or flat to undulating wide valley floors on alluvial or colluvial material derived from surrounding dissected sandstone ranges (with duplex soils). *Eucalyptus* spp are generally dominant, however trees often comprise small sized hollows in comparison to habitat occurring on recent Quaternary alluvial systems. A low density of small hollows reduces habitat importance for Greater Glider, but can still provide roosting habitat for microbats. Sparse, grassy woodlands provide suitable habitat for Squatter Pigeon, especially where water resources area present. Fallen woody debris and crevices within this habitat provide potential habitat for Dunmall's Snake and Yakka Skink.

Habitat type	General description and habitat values
Woodlands on coarse-grained sediments	Eucalypt woodlands on coarse-grained sediments, with friable loamy / sandy soils. The dominance of eucalypt species provides primary and secondary food tree species for Koala. Hollow-bearing trees are often present in remnant stands of eucalypt vegetation and provide suitable for denning Greater Glider and roosting Corben's long-eared bat, whilst the predominately native ground-cover provides potential habitat for Collared Delma. Additional microhabitat features include fallen hollow-bearing trees and friable loamy / sandy soils providing suitable potential burrowing habitat for Yakka Skink.
Woodlands on fine-grained sediments	Comprised of eucalypt species occurring on fine-grained sediments, often with a shrubby understorey present. The dominance of eucalypt species provides primary and secondary food tree resources for Koala. The ground cover is often native, with fallen woody debris, providing suitable habitat for Collared Delma. Large hollow-bearing trees are often present with suitable hollows for Greater Glider and microbats. Abundant fallen woody debris provides microhabitat for reptiles and where fallen logs on sandy or loamy surfaces provides habitat for Yakka Skink.
Woodland on floodplains	Predominantly associated with eucalypt species present on floodplains, with common species including *Eucalyptus populnea* (poplar box) and *E. melanophloia*. The alluvial plains and low lying areas with tendencies to hold water provide important habitat features for many bat and bird species. The ephemeral nature of the creeks that inundate these areas are likely to provide resources during the wet season; however, they provide low habitat values for species that require permanent water sources (e.g. breeding habitat for Squatter Pigeon). Remnant areas where older and large eucalypts occur provide important foraging and denning habitat for arboreal species, including Greater Glider. In areas with native grasses and abundance of fallen woody debris may be inhabited by Brigalow belt reptiles.
Non remnant / pastures	Habitat type is comprised of scattered vegetation, pastures and agricultural land, all of which are common within the bioregion. These areas can provide habitat for a range of common bird and reptile species; however, it is of lower value than other habitat types in the bioregion.

4.8 Groundwater

4.8.1 Regional hydrogeology

The Project is located within the Surat CMA established under the Water Act (Qld) to manage potential impacts of cumulative water production from resource projects in the Surat and southern Bowen Basins. A summary of hydrostratigraphic units within the Surat and Bowen Basin relevant to the Surat CMA is shown on Figure 12.

Regionally, groundwater recharge to the Surat and Bowen Basin aquifers occurs via three main processes:

- localised recharge
- preferential pathway flow
- diffuse recharge.

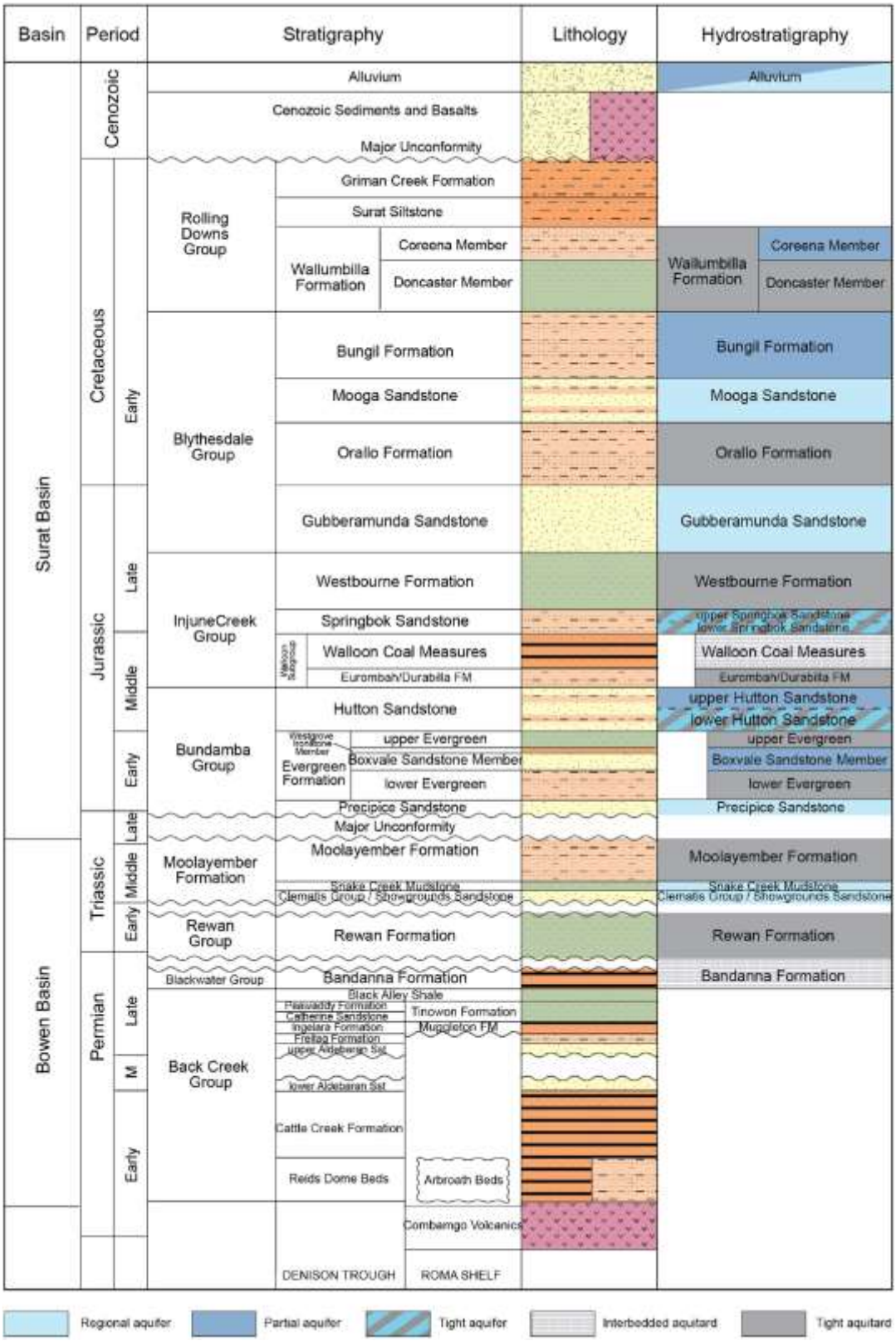
Most recharge occurs along the outcrop areas in the north, northwest, northeast and east along the Great Dividing Range. Within these outcrop areas diffuse aquifer recharge is likely to occur. Diffuse recharge is the process by which rainfall infiltrates directly though outcropping aquifers (Kellett *et al.*, 2003) or indirectly via leakage from streams or overlying aquifers.

Recharge rates for aquifers within the Surat CMA are estimated to range between 1.2 and 26.9 mm per year depending on the hydrostratigraphic unit (OGIA, 2019b). Natural groundwater discharge occurs through vent springs, baseflow to rivers (watercourse springs) and vertical leakage between aquifers.

Recharge water flows primarily along the bedding planes and fractures of aquifers and aquitards from the recharge areas to the south, southwest and west, though there is a minor northward flow component in some aquifers (Hodgkinson *et al.*, 2009) e.g. near Taroom.

Groundwater moves very slowly and flow velocities in the Surat Basin have been estimated to range from 1 to 5 m per year (Habermehl, 2002). Groundwater movement within the Surat Basin is dominated by sub-horizontal flow in the aquifers, with vertical leakage from the aquifers through the low permeability aquitards occurring throughout the basin at a much slower rate.

Figure 12: Generalised hydrostratigraphic classification in the Surat and Bowen Basin



4.8.2 Local hydrogeology

Hydrostratigraphic units within each development area are summarised in Table 12. Around 90% of water bores accessing the Surat Basin within the Surat CMA are for stock and domestic purposes. A summary of groundwater use is summarised in Table 13. Figure 13 shows the location of registered bores within the Surat CMA.

Table 12: Summary of hydrostratigraphic units within each development area

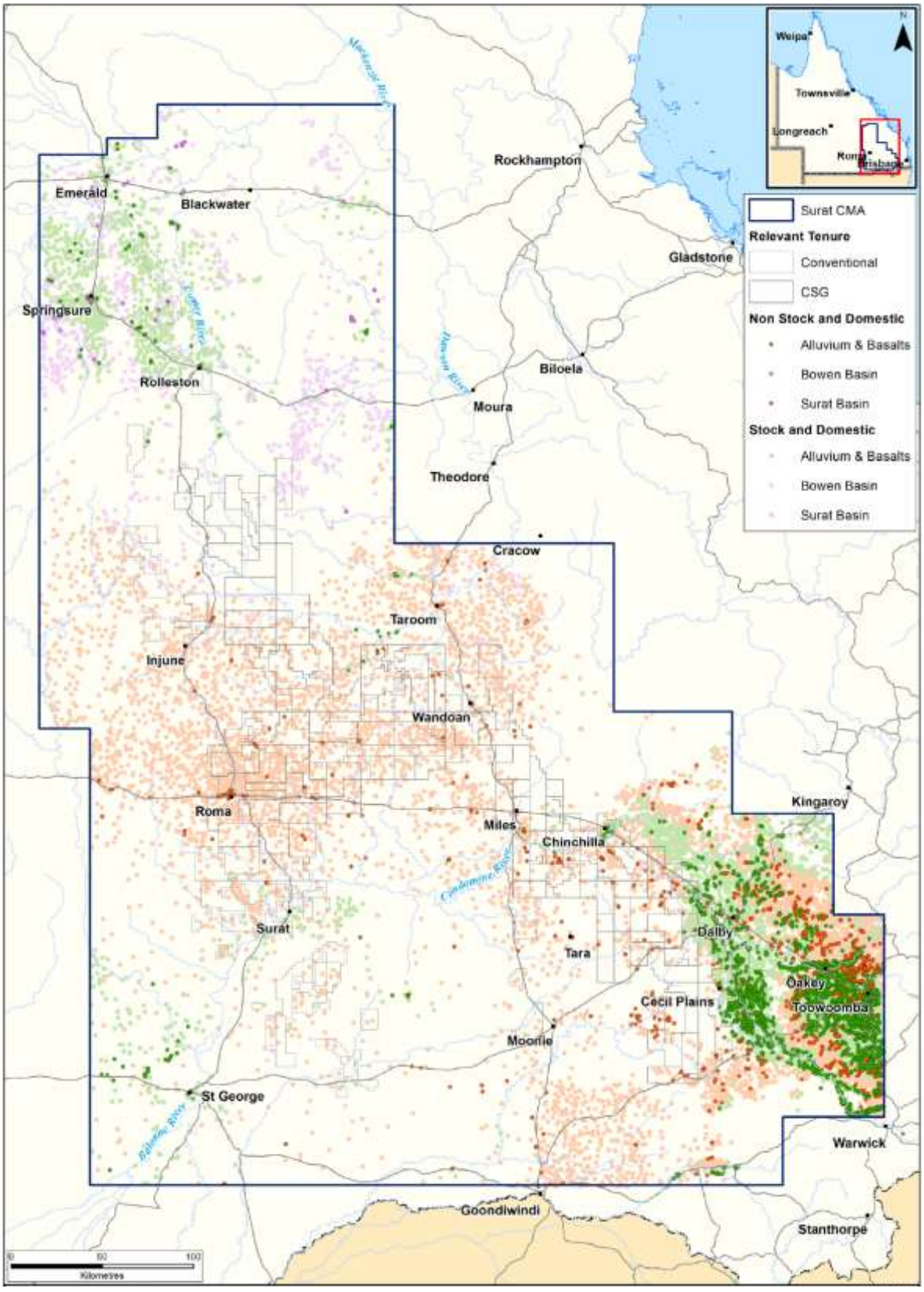
Basin	Stratigraphic unit	Hydrogeological description	Development area
Surat	Alluvium	Unconfined partial aquifer	Mahalo, Denison, Spring Gully, Peat, Ironbark
	Tertiary basalt	Partial aquifer	Mahalo
	Wallumbilla Formation	Aquitard	Ironbark
	Bungil Formation	Partial aquifer	Ironbark
	Mooga Sandstone	Regional aquifer	Ironbark
	Gubberamunda Sandstone	Regional aquifer	Spring Gully
	Westbourne Formation	Aquitard	Spring Gully
	Springbok Sandstone	Tight aquifer	Peat, Spring Gully
	Walloon Coal Measures*	Interbedded aquifer	Ironbark, Peat, Spring Gully
	Eurombah Formation	Aquitard	Peat, Spring Gully
	Hutton Sandstone	Partial aquifer	Spring Gully, Denison
	Evergreen Formation	Aquitard	Spring Gully, Denison
	Boxvale Sandstone	Partial aquifer	Spring Gully
	Precipice Sandstone	Regional aquifer	Spring Gully, Denison
Bowen	Moolayember Formation	Aquitard	Spring Gully, Denison
	Clematis Group	Regional aquifer	Spring Gully, Denison
	Rewan Formation	Aquitard	Spring Gully, Denison, Mahalo
	Bandanna Formation*	Interbedded aquifer	Spring Gully, Denison, Mahalo
	Baralaba Coal Measures*	Interbedded aquifer	Peat

Table 13: Groundwater use within each development area

Development area	Dominant groundwater use	Dominant source aquifer/s	Total water supply bores[2]	Estimated total groundwater extraction (ML/year)
Mahalo	Stock and domestic	Quaternary alluvium Tertiary Basalt	1,606	4,641
Denison	Stock and domestic	Precipice Sandstone Hutton Sandstone Moolayember Formation	645	479
Spring Gully	Stock and domestic	Quaternary alluvium Hutton Sandstone Gubberamunda Sandstone	2,076	4,375
Peat	Stock and domestic	Precipice Sandstone Hutton Sandstone	836	3,332
Ironbark	Stock – intensive	Condamine alluvium Hutton Sandstone Gubberamunda Sandstone	894	7,938

[2] Total supply bores are estimated, groundwater extraction is as per OGIA estimates

Figure 13: Distribution of water bores within the Surat CMA (OGIA, 2019b)



4.9 Surface water

The Project Area is located within the Condamine-Balonne Basin (Ironbark) and Fitzroy Basin (Mahalo, Denison, Spring Gully and Peat). The Condamine-Balonne Basin is predominantly comprised of floodplains, and a complex system of rivers and creeks. The Fitzroy Basin contains several large rivers which discharge into the Coral Sea east of Rockhampton.

The main headwater sub-catchments present within the Project Area are Comet River in the northwest, Upper and Lower Dawson River in the central and northeast, and Upper Balonne tributaries in the south. The location of major drainage basins within the Project Area are shown on Figure 14.

Watercourses in headwater catchments are typically within steep, confined to partially confined valleys that at times become gorges (e.g. Dawson River). These stable, single channels are often highly sinuous, laterally confined and bedrock to coarse bedload dominated. Bedrock controlled discontinuous floodplains become increasingly connected downstream.

Watercourses within the area exhibit a wide range of fluvial geomorphologic characteristics and typically show a moderate to high level of impact from the effects of land clearance for grazing and cropping, stock access and removal of riparian vegetation.

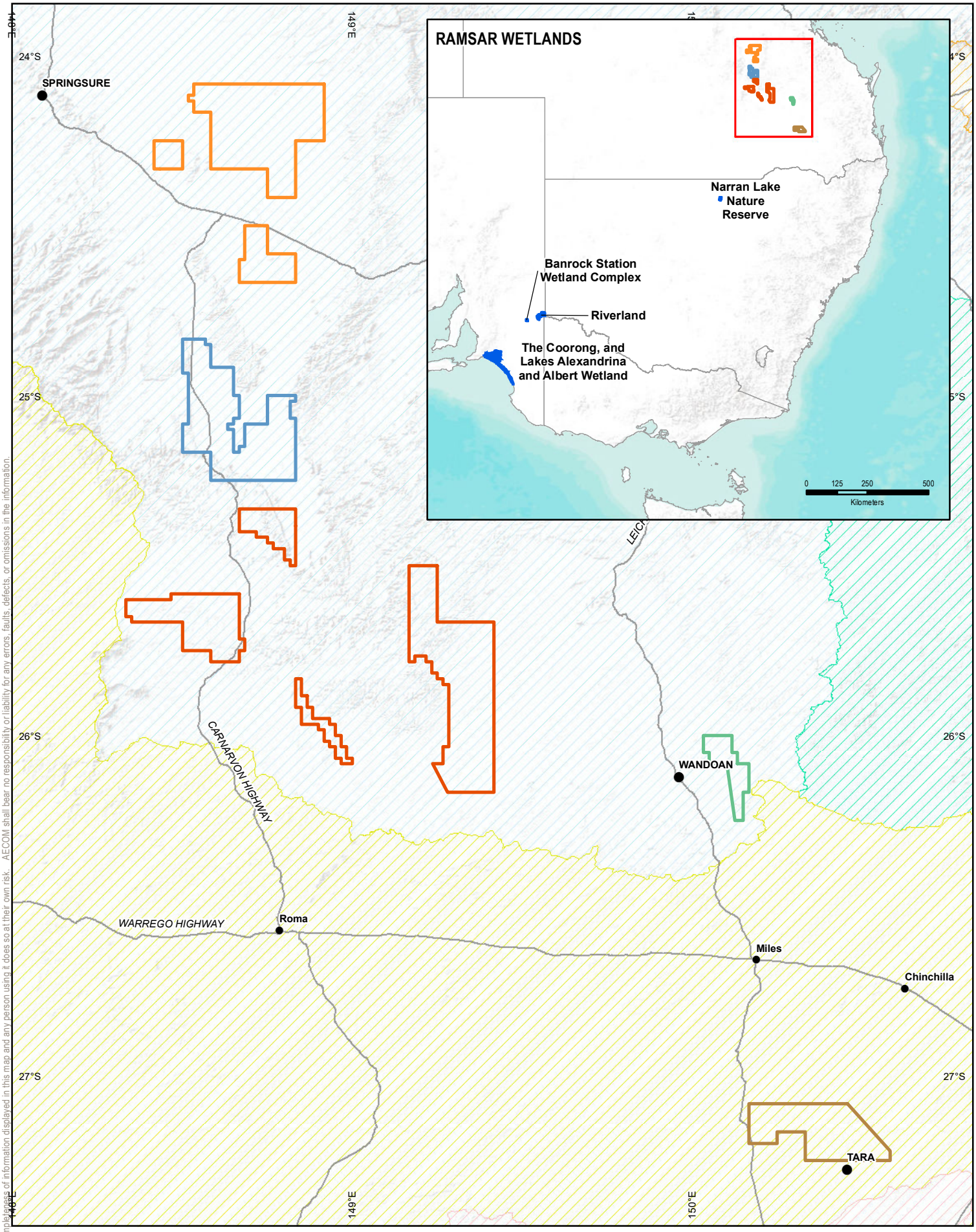
Rainfall and resultant streamflow in the surface water sub-catchments are characterised by a distinct seasonal and highly variable nature. Watercourses within the Project Area are typically ephemeral in nature, only flowing during or immediately after significant rainfall events and subject to relatively rapid flow recessions. Intermittent flows within these waterways support limited watercourse aquatic ecosystems. The waterways instead provide drainage paths and intermittent habitat for aquatic species.

Peak stream discharges usually occur during the wet season months of December to February when rainfall is highest. Dawson River downstream of its confluence with Hutton Creek maintains a relatively consistent baseflow year-round due to inflow from the Dawson River Springs. The high level of variability in both annual and monthly rainfall indicates a high likelihood of both floods and droughts.

The DES waterbody mapping (Department of Environment and Science, 2020b) identifies small lacustrine waterbodies scattered across the landscape. Many of these are associated with farm dams and water storages and are expected to provide refuge and other habitat values to fauna moving through the area. Water bodies are generally shallow, limited in size and impacted by grazing, vegetation clearing and erosion consistent with stream health ratings reported by Telfer (1995).

4.10 Wetlands of international importance

There are no Ramsar wetlands of international importance within the Project area. While the Ironbark development area is located within the upstream catchment of the Narran Lake Nature Reserve as illustrated in Figure 14, the Project is not expected to significantly modify the hydrology of the Ramsar wetland given the significant downstream distance to the Narran Lake Nature Reserve. This Ramsar wetland is comprised of extensive channelised floodplains and floodplain lakes that provides a diverse range of wetland areas. Surface inflows are the dominant source of water for the wetland, with groundwater-surface water interactions believed to be negligible. Butcher *et al.* (2011) report significant flows are generated in the headwaters of the catchment rather than from downstream of the Narran River confluence.



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LEGEND

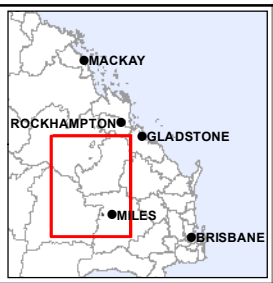
- Towns
- Roads

Development Areas

- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark

Drainage Basin

- Balonne-Condamine
- Burnett
- Calliope
- Fitzroy
- Moonie



ORIGIN ENERGY PTY LIMITED GAS SUPPLY SECURITY PROJECT

Surface Water Drainage and Declared Ramsar Wetlands

PROJECT ID	60617011
CREATED BY	PK
LAST MODIFIED	stencela: 18/09/2020
VERSION:	1

Figure 14

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4.11 EPBC Act-listed springs

There are no EPBC Act-listed springs located within the Project Area. Figure 15 shows the location of four spring complexes located within 50 kms of the Project Area that form part of *the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin*, listed under the EPBC Act, including:

- Cockatoo
- LuckyLast
- Yebna2
- DawsonRiver8.

The groundwater source for the Cockatoo spring complex is the Precipice Sandstone aquifer, though the outcropping formation of this spring complex is the Evergreen Formation aquitard. It is interpreted to be in an area where the confining layer (aquitard) has been thinned by erosion and the underlying artesian aquifer is able to flow to surface. The Scotia gas field (Santos) is located north of the Peat development area, and 19 km southwest of the Cockatoo spring complex.

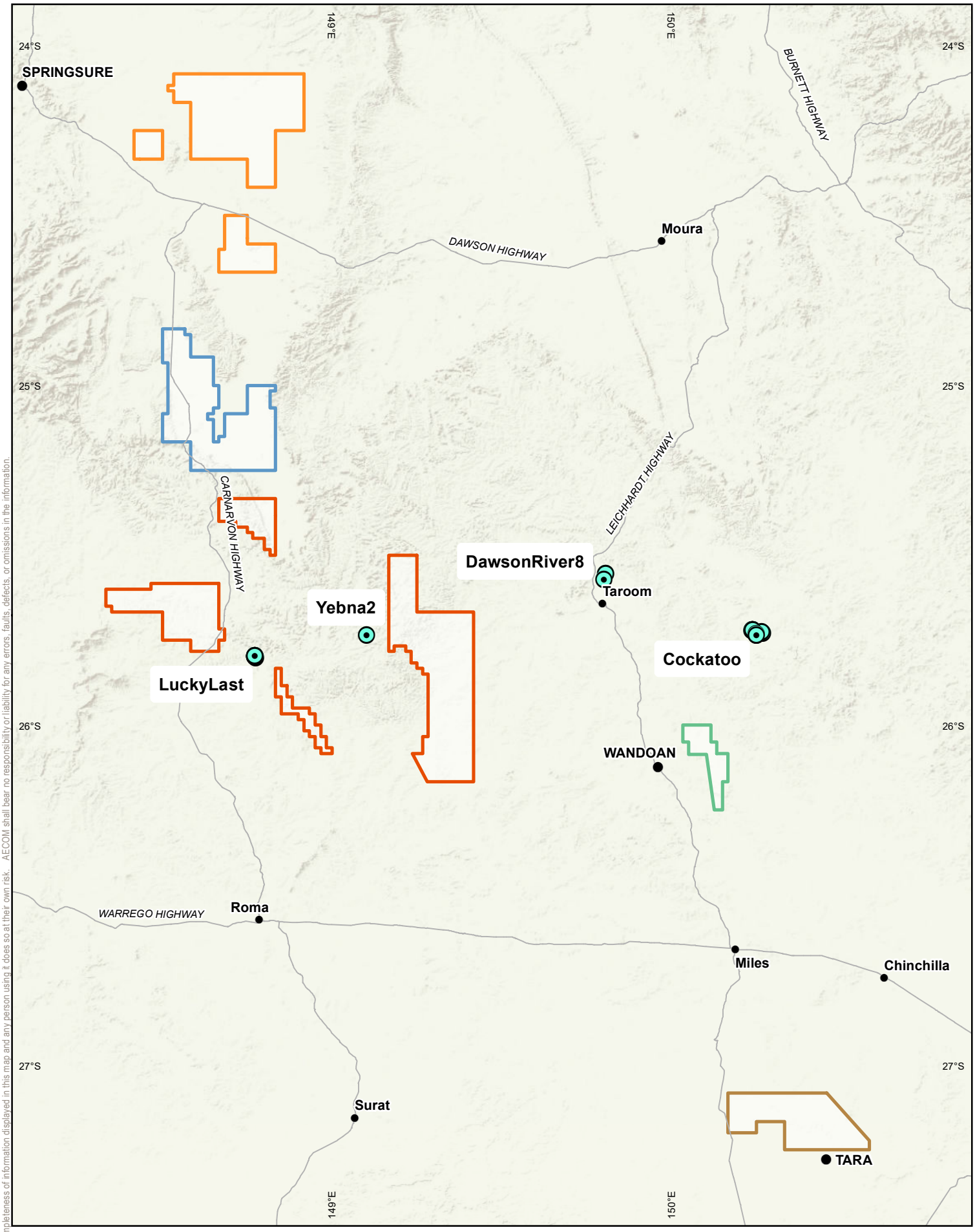
The groundwater source for the LuckyLast spring complex is interpreted to be from the Hutton Sandstone; however, recent investigations have identified that the source aquifer of the LuckyLast spring complex is likely to be the Boxvale Sandstone, emanating through faulting. Outcropping at surface is the basal unit of the Evergreen Formation. The LuckyLast spring complex is located within the Fairview gas field (Santos).

The groundwater source for the Yebna2 spring complex is the Precipice Sandstone; however, surface geology mapping indicates that this complex is situated on outcropping Evergreen Formation. Yebna2 consists of a single vent located within an ephemeral tributary of the Dawson River. The Yebna2 spring complex is located within the Fairview gas field (Santos).

The groundwater source for the DawsonRiver8 spring complex is the Hutton Sandstone and it is situated on alluvium and an outcrop of the Walloon Coal Measures. The complex is likely associated with either a fault or thinning of overlying aquitards which allow the underlying artesian aquifer to flow to surface.

4.12 Heritage places

There are no World Heritage or National Heritage Places within the Project Area, and there are no places listed on the National Heritage List within the Project Area.



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Kilometers

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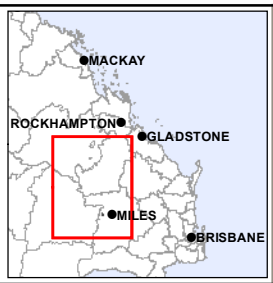
LEGEND

- Towns
- Roads
- EPBC Act listed springs

Development Areas

- Mahalo
- Denison
- Spring Gully
- Peat
- Ironbark



ORIGIN ENERGY PTY LIMITED
GAS SUPPLY SECURITY PROJECT

EPBC Act Listed Springs

PROJECT ID	60617011
CREATED BY	PK
LAST MODIFIED	stencela: 18/09/2020
VERSION:	1

Figure 15

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5.0 REGULATORY APPROVALS

In addition to the EPBC Act, the Project will be developed in accordance with the requirements of the following Commonwealth and State (Qld) legislation.

5.1 Additional Commonwealth approvals

Native Title Act 1993

The purpose of the *Native Title Act 1993* is to provide for the recognition and protection of native title rights for Australia's Indigenous people, as well as providing a legislative approach for dealing with issues concerning native title. Native title agreements are an essential requirement under the *Native Title Act 1993* to enable resource authority holders to carry out activities that impact on native title. They fall into two categories:

- Indigenous Land Use Agreements (ILUAs) negotiated with native title parties and registered with the National Native Title Tribunal
- Agreements under section 31 of the *Native Title Act* 1993 arising out of the Right to Negotiate provisions of the legislation.

Origin have negotiated both ILUAs and section 31 agreements within the Project Area with native title groups, as detailed in section 9.2.3. Origin will seek to negotiate further agreements with relevant native title parties if any higher form of regulatory approvals are required for the Project.

Water Act 2007

The *Water Act 2007* provides the legislative framework for ensuring that the Murray-Darling Basin is managed in the national interest and recognises that Australian states in the Murray-Darling Basin continue to manage Basin water resources within their jurisdictions.

Water Resource Plans (WRPs) are one of the main tools for implementing the Basin Plan 2012 made under the *Water Act 2007*. WRPs are made by 'Basin States' (Queensland, New South Wales, Victoria, South Australia, and the Australian Capital Territory) to specify how water will be shared and managed. To ensure each WRP is consistent with the Basin Plan 2012, the Murray-Darling Basin Authority must assess and recommend to the Minister whether or not a WRP should be accredited in accordance with the *Water Act 2007*. This process ensures that State Water Plans reflect Commonwealth interests in cross jurisdictional water resources.

The Project is partially located within the Condamine-Balonne WRP area located in south-west Queensland in the northern part of the Murray-Darling Basin. The Condamine-Balonne WRP was accredited by the Australian Government on 18 September 2019 as being consistent with the Basin Plan 2012.

The Condamine-Balonne WRP is based on Queensland's water planning framework under the Water Act (Qld) and EP Act (Qld). The key statutory plans under these Acts provide for the sustainable allocation and management and the improvement of Queensland's water resources. Forecast water production for the gas industry are included in setting ongoing sustainable groundwater extraction limits under Queensland's *Water Plan (Condamine and Balonne) 2019*.

5.2 Queensland approvals

Resources legislation: *Petroleum Act 1923*, *Petroleum and Gas (Production and Safety) Act 2004* and *Mineral and Energy Resources (Common Provisions) Act 2014*

Resources legislation regulate activities associated with the exploration, development and production of petroleum and gas resources in Queensland. Approvals administered under these Acts relevant to the Project include ATPs, PLs and pipeline licences. PLs are the petroleum authority required prior to the commercial production of gas. Origin holds the appropriate tenures for the exploration and production of gas across the Project area, these tenures are listed in Table 3.

Resources legislation also prescribe the minimum requirements for the safe undertaking of petroleum activities including minimum design, construction, and operational requirements for wells to ensure long-term well integrity, containment of petroleum and the protection of groundwater resources. Minimum standards are prescribed by the *Code of Practice for the construction and abandonment of petroleum wells and associated bores in Queensland* (Department of Natural Resources, Mines and Energy, 2019). Further details of the regulatory controls prescribed by the Code are listed in section 6.2 and Table 14.The P&G Act identifies underground water rights for petroleum tenures, and states that the holder of a petroleum tenure may take or interfere with underground water in the area of the tenure if the taking or interference happens during the course of, or results from, the carrying out of another authorised activity for the tenure.

Section 36 of the *Mineral and Energy Resources (Common Provisions) Act 2014* (Qld) (MERCPA) provides for the Queensland Land Access Code that facilitates a balance between the interests of the agriculture and resources sectors by establishing processes for good working relationships between landholders and gas companies.

The Project will comply with the Land Access Code established under the MERCPA including:

- guidelines for communication between the holders of resource authorities and owners and occupiers of private land
- mandatory conditions concerning the conduct of authorised resource activities on land, including using the land in a way that minimises disturbance to people, livestock and property
- general principles for negotiations and guidelines for communication.

Further details of the regulatory controls prescribed by the Land Access Code are listed in section 6.2, Table 14.

Environmental Protection Act 1994

The EP Act is the overarching environmental regulatory framework for governing the environmental management of resource activities in Queensland. An EA is required prior to the grant of a tenure and provides conditions protecting environmental values including biodiversity, land, air, surface water, groundwater and wetlands. The EAs applicable to the Project Area are listed in Table 3 and provided in Appendix N.

Environmental Offsets Act 2014

Under the *Environmental Offsets Act 2014* an environmental offset is defined as an activity undertaken to counterbalance an SRI on a prescribed matters of state environmental significance (MSES) including endangered or of concern REs, riparian vegetation, connectivity areas, wetlands and watercourses and wildlife habitat. Origin will be required to secure offsets for SRIs to these prescribed environmental matters associated with the Project. Further details of the regulatory controls prescribed by the *Environmental Offsets Act 2014* are listed in section 6.2,Table 14.

Nature Conservation Act 1992

Permits are required under the *Nature Conservation Act 1992* for interfering with protected animals, listed under the *Nature Conservation (Wildlife Management) Regulation 2006*, and their habitat of a species management plan or other mitigation measures. Additional permits are required for clearing protected plants listed under the *Nature Conservation (Wildlife Management) Regulation 2006* including the approval of an impact management plan for the clearing and offsets for the species if required.

Water Act 2000

Section 370 of the Water Act (Qld) requires that a UWIR is prepared for approval, detailing predicted groundwater drawdown associated with exercising underground water rights, including proposed groundwater extraction for resource activities. Section 376 of the Water Act (Qld) provides the detailed impact assessment requirements for UWIRs, including an assessment of the

likely impacts on potential water resources such as water bores, springs, and groundwater dependent ecosystems (GDEs)).

The Project is located within the Surat CMA and assessed in the UWIR for the Surat CMA (OGIA, 2019b). The monitoring requirements under the Water Act (Qld) include petroleum tenure holders undertaking baseline assessments of private water bores in areas where gas production testing or production has commenced.

OGIA also assign monitoring and mitigation obligations to relevant tenure holders as required to manage potential impacts on springs under the Water Monitoring Strategy (WMS) and Spring Impact Management Strategy (SIMS). Further details of the WMS and SIMS are listed in section 6.2, Table 14.

Water Plan (Great Artesian Basin and Other Regional Aquifers) 2017, Water Plan (Condamine and Balonne) 2019, Water Plan (Fitzroy Basin) 2011.

Water plans authorised under the Water Act (Qld) sustainably manage and allocate water resources in Queensland, balancing the needs of water users (e.g. towns, agriculture, and resource activities) and the environment. The plans determine the volume of water that can be sustainably extracted in the plan area to maintain supply and protect environmental values such as springs, GDEs, and other ecosystems.

Forecast water production for the resource industry, including the Project, are included in setting ongoing sustainable groundwater extraction limits within each plan area. Compliance with these sustainable groundwater extraction limits under the Water Act (Qld) framework manage potential impacts on water resources.

Aboriginal Cultural Heritage Act 2003

The *Aboriginal Cultural Heritage Act 2003* provides recognition, protection and conservation of cultural heritage in Queensland, as well as outlining duty of care obligations. Origin has existing Cultural Heritage Management Plans (CHMPs) with relevant Traditional Owner groups across the Project Area, as detailed in section 9.2.3. Origin will operate within the bounds of the plans developed with each Aboriginal Party under the *Aboriginal Cultural Heritage Act 2003*.

Waste Reduction and Recycling Act 2011

The WRR Act legislates a waste and resource management hierarchy in which waste and resource management options should preferentially be considered. The waste and resource management hierarchy preferences the use of management options for produced water that avoids the generation of waste by-products. Further details of the regulatory controls prescribed by the WRR Act are listed in section 6.2, Table 14.

Regional Planning Interests Act 2014

The *Regional Planning Interests Act 2014* manages the impact of resource activities and other regulated activities on areas of the State that contribute, or are likely to contribute, to Queensland's economic, social and environmental prosperity. Approval under the *Regional Planning Interests Act 2014* is typically required prior to undertaking resource activities in an area of regional interest including priority agricultural areas, priority living areas, strategic cropping areas and strategic environmental areas.

5.3 Other State approvals

The Project may require additional environment and land use related approvals under other Queensland legislation including but not limited to the *Planning Act 2016*, *Biosecurity Act 2014*, Fisheries *Act 1994* and *Forestry Act 1959*. Approvals will be obtained under these Acts as required for the Project.

6.0 PROPOSED AVOIDANCE, SAFEGUARDS AND MITIGATION MEASURES

6.1 Overview

The Project is authorised to conduct petroleum activities within petroleum tenures subject to conditions of those regulatory controls such as conditions of existing EAs. The Project includes implementation of the key regulatory controls required by existing authorisations described in Section 6.2, and the Project-specific controls described in Section 6.3.

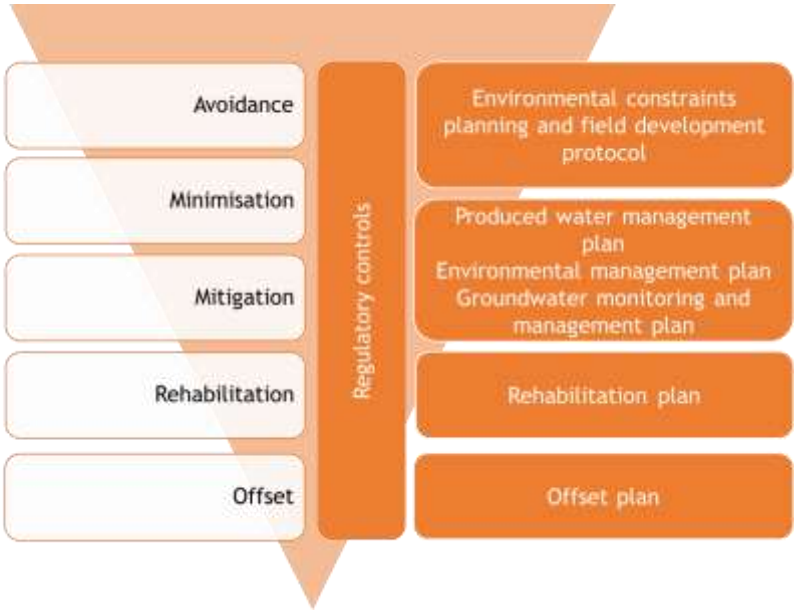
The environmental management framework for the Project was developed, refined, and successfully implemented over a period of approximately 10 years for the Australia Pacific LNG Project. The framework adopts a hierarchy of environmental management practices that will be implemented through planning, development and operation of the Project. This framework has proven to effectively manage potential impacts to MNES from gas field development and operational activities and complies with regulatory requirements for petroleum projects (Section 5.0).

A hierarchy of environmental management practices will be adopted to minimise potential impacts to MNES through:

- **Avoidance** – avoid disturbance to MNES
- **Minimisation** – minimise disturbance to MNES where disturbance cannot reasonably and practicably be avoided
- **Mitigation** – implement mitigation and management measures to minimise impacts to MNES
- **Rehabilitation** – actively rehabilitate disturbance to MNES in accordance with the Rehabilitation Management Plan and relevant EA conditions
- **Offset** – where required, provide offsets for activities that result in an SRI to MNES.

The environmental management hierarchy is presented in Figure 16 with corresponding regulatory and Project-specific controls to management potential impacts to MNES.

Figure 16: Environmental management hierarchy



6.2 Key regulatory controls

Consistent with Section 134(4) of the EPBC Act, in deciding whether to attach a condition to an EPBC Act approval, the Minister must consider any relevant conditions that have been imposed or are likely to be imposed under a law of a State or another law of the Commonwealth.

Key regulatory controls for the Project are prescribed by Queensland legislation as outlined in Table 14. These regulatory controls manage potential impacts to the following MNES:

- listed threatened species and TECs
- listed migratory species
- a water resource, in relation to coal seam gas development and large coal mining development.

Table 14: Key regulatory controls

Regulatory control	Description
Environmental Protection Act 1994	
Environmental authority conditions - streamlined model conditions (Department of Environment and Science, 2016b) **Relevant MNES** • listed threatened species and TECs • listed migratory species • a water resource, in relation to coal seam gas development and large coal mining development.	The model conditions provide best practice EA conditions for petroleum projects, including the following: • regulating the location of petroleum activities within and proximal to environmentally sensitive areas (ESAs), MSES, wetlands, and watercourses • prohibition of undertaking any petroleum activities within 200 m of a wetland of HES, Great Artesian Basin Spring, or subterranean cave GDEs • undertaking ecological assessments prior to significant disturbance to land to confirm on-the-ground biodiversity values • prohibiting disturbance to watercourses for non-linear infrastructure • providing water quality limits for disturbances to watercourses for construction of linear infrastructure • water quality limits for management of produced water including Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC) Guidelines irrigation limits • seepage monitoring around dams • quality standards for disposal of residual drilling materials • seepage monitoring for produced water storage dams • soil management, and progressive and final rehabilitation requirements for significant disturbance to land • implementing erosion and sediment controls • storage of chemicals and fuels in accordance with Australian Standards • prohibition of oil based or synthetic drilling muds and stimulation fluids containing polycyclic aromatic hydrocarbons (PAH) • water quality baseline and ongoing monitoring of all bores within 2 km of proposed stimulation activities

Regulatory control	Description
	• monitoring to ensure 150% of the volume of stimulation fluids has been extracted from stimulated wells • undertaking a site-specific Stimulation Risk Assessment including the following: – a process description of the stimulation activity to be applied, including equipment and a comparison to best international practice – provide details of where, when and how often stimulation is to be undertaken on the tenures covered by this environmental authority – a geological model of the field to be stimulated including geological names, descriptions and depths of the target gas producing formation(s) – naturally occurring geological faults – seismic history of the region (e.g. earth tremors, earthquakes) – proximity of overlying and underlying aquifers – description of the depths that aquifers with environmental values occur, both above and below the target gas producing formation – identification and proximity of landholder active groundwater bores in the area where stimulation activities are to be carried out – the environmental values of groundwater in the area – an assessment of the appropriate limits of reporting for all water quality indicators relevant to stimulation monitoring in order to accurately assess the risks to environmental values of groundwater – description of overlying and underlying formations in respect to porosity, permeability, hydraulic conductivity, faulting and fracture propensity – consideration of barriers or known direct connections between the target gas producing formation and the overlying and underlying aquifers – a description of the well mechanical integrity testing program – process control and assessment techniques to be applied for determining extent of stimulation activities (e.g. microseismic measurements, modelling, etc) – practices and procedures to ensure that the stimulation activities are designed to be contained within the target gas producing formation – groundwater transmissivity, flow rate, hydraulic conductivity and direction(s) of flow – a description of the chemical compounds used in stimulation activities (including estimated total mass, estimated composition, chemical abstract service numbers and properties), their mixtures and the resultant compounds that are formed after stimulation – a mass balance estimating the concentrations and absolute masses of chemical compounds that will be reacted, returned to the surface or left in the target gas producing formation subsequent to stimulation – an environmental hazard assessment of the chemicals used including their mixtures and the resultant chemicals that are formed after stimulation including Toxicological and ecotoxicological information of chemical compounds used; information on the persistence and bioaccumulation potential of the chemical compounds used; and identification of the chemicals of potential concern in stimulation fluids derived from the risk assessment

Regulatory control	Description
	– an environmental hazard assessment of use, formation of, and detection of polycyclic aromatic hydrocarbons in stimulation activities – identification and an environmental hazard assessment of using radioactive tracer beads in stimulation activities – an environmental hazard assessment of leaving chemical compounds in stimulation fluids in the target gas producing formation for extended periods subsequent to stimulation – human health exposure pathways to operators and the general population – risk characterisation of environmental impacts based on the environmental hazard assessment – potential impacts to landholder bores as a result of stimulation activities – an assessment of cumulative underground impacts, spatially and temporally of the stimulation activities to be carried out on tenures covered by this environmental authority. • potential environmental or health impacts which may result from stimulation activities including, but not limited to, water quality, air quality (including suppression of dust and other airborne contaminants), noise and vibration.
Manual for assessing consequence categories and hydraulic performance of structures (Department of Environment and Science, 2016a) **Relevant MNES** • listed threatened species and TECs • listed migratory species • a water resource, in relation to coal seam gas development and large coal mining development.	This Manual sets out the requirements for consequence category assessment and certification of the design of 'regulated structures', constructed as part of environmentally relevant activities (ERAs) under the EP Act. This Manual imposes design and operational requirements to minimise the potential for seepage and other loss of containment, including: • low permeability materials used in constructing dam walls and floor to avoid seepage • leak detection and / or seepage collection systems • minimum wet season and extreme storm event containment storage up to 1:100 AEP • minimum spillway capacity of up to 1:100,000 AEP.
Guideline: structures which are dams or levees	This guideline provides best practice environmental authority conditions for dams constructed and operated for petroleum projects, including mandatory consequence

Regulatory control	Description
constructed as part of environmentally relevant activities (Department of Environment and Science, 2019c) **Relevant MNES** • listed threatened species and TECs • listed migratory species • a water resource, in relation to coal seam gas development and large coal mining development.	category assessment, design plan and construction certification, mandatory reporting levels, and annual inspections: ***Assessment of consequence category*** • (X 1) The consequence category of any structure must be assessed by a suitably qualified and experienced person in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19335) at the following times: a) prior to the design and construction of the structure, if it is not an existing structure; or b) prior to any change in its purpose or the nature of its stored contents. • (X 2) A consequence assessment report and certification must be prepared for each structure assessed and the report may include a consequence assessment for more than one structure. • (X 3) Certification must be provided by the suitably qualified and experienced person who undertook the assessment, in the form set out in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19335). ***Design and construction of a regulated structure*** • (X 4) Conditions X5 to X9 inclusive do not apply to existing structures. • (X 5) All regulated structures must be designed by, and constructed7 under the supervision of, a suitably qualified and experienced person in accordance with the requirements of the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19338). • (X 6) Construction of a regulated structure is prohibited unless: a) the holder has submitted a consequence category assessment report and certification to the administering authority; and b) certification for the design, design plan and the associated operating procedures has been certified by a suitably qualified and experienced person in compliance with the relevant condition of this authority. • (X 7) Certification must be provided by the suitably qualified and experienced person who oversees the preparation of the design plan in the form set out in the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19338), and must be recorded in the Register of Regulated Structures. • (X 8) Regulated structures must: a) be designed and constructed in compliance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/19338); b) be designed and constructed with due consideration given to ensuring that the design integrity would not be compromised on account of: i) floodwaters from entering the regulated dam from any watercourse or drainage line; and ii) wall failure due to erosion by floodwaters arising from any watercourse or drainage line c) [Insert only in environmental authorities for regulated dams that are dams associated with a failure to contain - seepage] have the floor and sides of the dam designed and constructed to prevent or minimise the passage of the wetting front and any entrained contaminants through either the floor or sides of the dam during the

Regulatory control	Description
	operational life of the dam and for any period of decommissioning and rehabilitation of the dam. • (X 9) Certification by the suitably qualified and experienced person who supervises the construction must be submitted to the administering authority on the completion of construction of the regulated structure, and state that: a) the 'as constructed' drawings and specifications meet the original intent of the design plan for that regulated structure b) construction of the regulated structure is in accordance with the design plan. ***Notification of affected persons*** • (X 10) All affected persons must be provided with a copy of the emergency action plan in place for each regulated structure a) for existing structures that are regulated structures, within 10 business days of this condition taking effect; b) prior to the operation of the new regulated structure; and c) if the emergency action plan is amended, within 5 business days of it being amended. ***Operation of a regulated structure*** • (X 11) Operation of a regulated structure, except for an existing structure, is prohibited unless the holder has submitted to the administering authority in respect of regulated structure, all of the following: a) one paper copy and one electronic copy of the design plan and certification of the 'design plan' in accordance with condition X6; b) a set of 'as constructed' drawings and specifications; c) certification of the 'as constructed drawings and specifications' in accordance with condition X9; d) where the regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, a copy of the certified system design plan; e) the requirements of this authority relating to the construction of the regulated structure have been met; f) the holder has entered the details required under this authority, into a Register of Regulated Structures; and g) there is a current operational plan for the regulated structure. • (X 12) For existing structures that are regulated structures: a) where the existing structure that is a regulated structure is to be managed as part of an integrated containment system for the purpose of sharing the DSA volume across the system, the holder must submit to the administering authority within 12 months of the commencement of this condition a copy of the certified system design plan including that structure; and b) there must be a current operational plan for the existing structures. • (X 13) Each regulated structure must be maintained and operated, for the duration of its operational life until decommissioned and rehabilitated, in compliance with the current operational plan and, if applicable, the current design plan and associated certified 'as constructed' drawings. ***Mandatory reporting level*** • (X 14) Conditions X15 to X18 inclusive only apply to Regulated Structures which have not been certified as low consequence category for 'failure to contain – overtopping'.

Regulatory control	Description
	• (X 15) The Mandatory Reporting Level (the MRL) must be marked on a regulated dam in such a way that during routine inspections of that dam, it is clearly observable. • (X 16) The holder must, as soon as practicable but within forty-eight (48) hours of becoming aware, notify the administering authority when the level of the contents of a regulated dam reaches the MRL. • (X 17) The holder must, immediately on becoming aware that the MRL has been reached, act to prevent the occurrence of any unauthorised discharge from the regulated dam. • (X 18) The holder must record any changes to the MRL in the Register of Regulated Structures. Design storage allowance. • (X 19) The holder must assess the performance of each regulated dam or linked containment system over the preceding November to May period based on actual observations of the available storage in each regulated dam or linked containment system taken prior to 1 July of each year. • (X 20) By 1 November of each year, storage capacity must be available in each regulated dam (or network of linked containment systems with a shared DSA volume), to meet the Design Storage Allowance (DSA) volume for the dam (or network of linked containment systems). • (X 21) The holder must, as soon as practicable but within forty-eight (48) hours of becoming aware that the regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, notify the administering authority. • (X 22) The holder must, immediately on becoming aware that a regulated dam (or network of linked containment systems) will not have the available storage to meet the DSA volume on 1 November of any year, act to prevent the occurrence of any unauthorised discharge from the regulated dam or linked containment systems. ***Annual inspection report*** • (X 23) Each regulated structure must be inspected each calendar year by a suitably qualified and experienced person. • (X 24) At each annual inspection, the condition and adequacy of all components of the regulated structure must be assessed and a suitably qualified and experienced person must prepare an annual inspection report containing details of the assessment and include a recommendations section, with any recommended actions to ensure the integrity of the regulated structure or a positive statement that no recommendations are required. • (X 25) The suitably qualified and experienced person who prepared the annual inspection report must certify the report in accordance with the Manual for assessing consequence categories and hydraulic performance of structures (ESR/2016/193310). • (X 26) The holder must within 20 business days of receipt of the annual inspection report, provide to the administering authority: a) The recommendations section of the annual inspection report; and b) If applicable, any actions being taken in response to those recommendations; and c) If,

Regulatory control	Description
	following receipt of the recommendations and (if applicable) recommended actions, the administering authority requests a copy of the annual inspection report from the holder, provide this to the administering authority within 10 business days11 of receipt of the request. Transfer arrangements – Resource activity only. • (X 27) The holder must provide a copy of any reports, documentation and certifications prepared under this authority, including but not limited to any Register of Regulated Structures, consequence assessment, design plan and other supporting documentation, to a new holder on transfer of this authority. ***Decommissioning and rehabilitation*** • (X 28) Regulated structures must not be abandoned but be either: a) decommissioned and rehabilitated to achieve compliance with condition (X29); or b) be left in-situ for a use by the landholder provided that: i) it no longer contains contaminants that will migrate into the environment; and ii) it contains water of a quality that is demonstrated to be suitable for its intended use(s); and c) the holder of the environmental authority and the landholder agree in writing that the; i) dam will be used by the landholder following the cessation of the environmentally relevant activity(ies); and ii) landholder is responsible for the dam, on and from an agreed date. • (X 29) Before surrendering this environmental authority the site must be rehabilitated to achieve a safe, stable, non-polluting landform. ***Register of Regulated Structures*** • (X 30) A Register of Regulated Structures must be established and maintained by the holder for each regulated structure: • (X 31) The holder must provisionally enter the required information in the Register of Regulated Structures when a design plan for a regulated dam is submitted to the administering authority. • (X 32) The holder must make a final entry of the required information in the Register of Regulated Structures once compliance with condition (X11) and (X12) has been achieved. • (X 33) The holder must ensure that the information contained in the Register of Regulated Structures is current and complete on any given day. • (X 34) All entries in the Register of Regulated Structures must be approved by the chief executive officer for the holder of this authority, or their delegate, as being accurate and correct. • (X 35) The holder must, at the same time as providing the annual return, supply to the administering authority a copy of the records contained in the Register of Regulated Structures, in the electronic format required by the administering authority. ***Transitional arrangements*** • (X 36) All existing structures that have not been assessed in accordance with either the Manual or the former Manual for Assessing Hazard Categories and Hydraulic Performance of Dams must be assessed and certified in accordance

Regulatory control	Description
	with the Manual within 6 months of amendment of the authority adopting this schedule. • (X 37) All existing structures must subsequently comply with the timetable for any further assessments in accordance with the Manual specified in Table 1 (Transitional hydraulic performance requirements for existing structures), depending on the consequence category for each existing structure assessed in the most recent previous certification for that structure. • (X 38) Table 1 ceases to apply for a structure once any of the following events has occurred: a) it has been brought into compliance with the hydraulic performance criteria applicable to the structure under the Manual; or b) it has been decommissioned; or c) it has been certified as no longer being assessed as a regulated structure. • (X 39) Certification of the transitional assessment required by X36 and X37 (as applicable) must be provided to the administering authority within 6 months of amendment of the authority adopting this schedule.
Environmental Offsets Act 2014	
Environmental Offsets Policy Significant Residual Impact Guideline (Qld) (Department of the Environment and Heritage Protection, 2014) **Relevant MNES** • listed threatened species and TECs • listed migratory species • a water resource, in relation to coal seam gas development and large coal mining development.	Environmental offsets are required for the following SRI thresholds for prescribed environmental matters: ***Endangered or of concern RE*** • for clearing for linear infrastructure: – greater than 25 m wide in a grassland (structural category) RE; or – greater than 20 m wide in a sparse (structural category) RE; or – greater than 10 m wide in a dense to mid-dense (structural category) RE. • for clearing other than clearing for linear infrastructure: – area greater than 5 ha where in a grassland (structural category RE; or – area greater than 2 ha where in a sparse (structural category) RE; or – area greater than 0.5 ha where in a dense to mid-dense (structural category) RE. ***REs within mapped wetlands*** • clearing within 50 m of the defining bank. ***REs adjacent to watercourses*** • clearing within 5 m of the defining bank ***Connectivity areas*** • the change in the core remnant ecosystem extent at the local scale (post impact) is greater than a threshold determined by the level of fragmentation at the regional scale; or • any core area that is greater than or equal to 1 ha is lost or reduced to patch fragments (core to non-core). ***Wetlands***

Regulatory control	Description
	• Wetland in a wetland protection area or wetlands of HES as shown on the Map of referrable wetlands under the *Environmental Protection Regulation 2008* • Wetland or watercourse in a high ecological value (HEV) waters as identified under the *Environmental Protection (Water) Policy 2009* • areas of the wetland or watercourse being destroyed or artificially modified; or • a measurable change in water quality of the wetland or watercourse—for example a change in the level of the physical and/or chemical characteristics of the water, including salinity, pollutants, or nutrients in the wetland or watercourse, to a level that exceeds the water quality guidelines for the waters; or • the habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected; or • a substantial and measurable change in the hydrological regime or recharge zones of the wetland, e.g. a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland; or • an invasive species that is harmful to the environmental values of the wetland being established (or an existing invasive species being spread) in the wetland. ***Endangered and vulnerable wildlife habitat (including essential habitat)*** • lead to a long-term decrease in the size of a local population; or • reduce the extent of occurrence of the species; or • fragment an existing population; or • result in genetically distinct populations forming as a result of habitat isolation; or • result in invasive species that are harmful to an endangered or vulnerable species becoming established in the endangered or vulnerable species' habitat; or • introduce disease that may cause the population to decline; or • interfere with the recovery of the species; or • cause disruption to ecologically significant locations (breeding, feeding, nesting, migration or resting sites) of a species. ***Special least concern (non-migratory) animal wildlife habitat*** • a long-term decrease in the size of a local population; or • a reduced extent of occurrence of the species; or • fragmentation of an existing population; or • result in genetically distinct populations forming as a result of habitat isolation; or • disruption to ecologically significant locations (breeding, feeding or nesting sites) of a species. ***Koala habitat in South East Queensland***

Regulatory control	Description
	• remove a non-juvenile koala habitat tree. ***National Parks, Regional Parks, and Nature Refuges*** • the authorised clearing or inundation of all or part of the protected area for the construction of private or publicly owned infrastructure on the area • the exclusion of, or reduction in, the public use or enjoyment of all or part of the protected area • a reduction in the natural or cultural values of all or part of the protected area. ***Fish Habitat Areas and Highly Protected Zones of State Marine Parks*** • works may result in a residual disturbance footprint within the declared fish habitat areas and/or highly protected marine park zone of 40 square metres (m^2) or greater in area. ***Waterway providing for fish passage*** • result in the mortality or injury of fish; or • result in conditions that substantially increase risks to the health, wellbeing and productivity of fish seeking passage such as through the depletion of fish's energy reserves, stranding, increased predation risks, entrapment or confined schooling behaviour in fish; or • reduce the extent, frequency or duration of fish passage previously found at a site; or • substantially modify, destroy or fragment areas of fish habitat (including, but not limited to in-stream vegetation, snags and woody debris, substrate, bank or riffle formations) necessary for the breeding and/or survival of fish; or • result in a substantial and measurable change in the hydrological regime of the waterway, for example, a substantial change to the volume, depth, timing, duration and frequency of flows; or • lead to significant changes in water quality parameters such as temperature, dissolved oxygen, pH and conductivity that provide cues for movement in local fish species. ***Legally secured offset areas*** • a use of the area that is inconsistent with how the environmental offset was or is required to be undertaken to achieve a conservation outcome for the prescribed environmental matter under a delivery or management plan or agreement • an SRI as mentioned elsewhere in the guideline.
Petroleum Act 1923 and ***Petroleum and Gas (Production and Safety) Act 2004***	
Code of Practice for the construction and abandonment of coal seam gas and petroleum wells	The purpose of the Code of Practice is to ensure that all wells and associated bores are designed, constructed, maintained and decommissioned to an acceptable standard resulting in long-term well integrity, containment of petroleum and the protection of groundwater resources. The Code of practice included the following requirements: ***Well Design***

Regulatory control	Description
and associated bores in Queensland Version 2 (Department of Natural Resources, Mines and Energy, 2019) **Relevant MNES** • a water resource, in relation to coal seam gas development and large coal mining development.	• all wells must be designed to ensure the safe and environmentally sound production of gas by preventing any cross-flow contamination between hydrocarbon bearing formations and aquifers, and ensuring that gas is contained within the well and associated pipework and equipment without leakage • consider casing setting depths that take into account aquifer and production zone locations, and the requirements for well control • provide for installation of pressure control equipment (PCE) based on risk assessment, e.g. BOP equipment to API Standard 53 • use appropriate casing weight and grade, and casing running procedures • use appropriate well design and construction materials • use appropriate casing centralisation • use engineered cement slurry and effective cement placement techniques • ensure all fluids produced from the well travel directly from the production zone to the surface without cross contamination. ***Casing*** • Casing, casing connections, wellheads, and valves used in wells must be designed to withstand the loads and pressures that may act on them throughout the entire well life cycle. This includes casing running and cementing, any treatment pressures, production pressures, any potential corrosive conditions, and other factors pertinent to local experience and operational conditions • for wells all surface and production casing in pressure containing applications must meet the relevant requirements of the P&G Regulation, Schedule 1, 'Mandatory and preferred standards for safety requirements' • barriers shall be installed to prevent surface pollutants from entering the well, and prevent wellbore fluids and gas from escaping to the surface environment • when designing casing strings and casing connections for wells, operators must design each well's casing string using appropriate design safety factors. For example, typical design safety factors used in the hydrocarbon industry at large are 1.1 for burst, 1.0 for collapse, 1.3 for static tension and 1.25 for tri-axial analysis. The design safety factors used by a CSG operator need to be appropriate for the anticipated well life, service conditions and local experience • to verify casing integrity during the well construction process, casing must be pressure tested prior to drilling out for the next hole section (in the case of surface or intermediate casing), and prior to completion operations commencing (in the case of production casing). The test pressure must be greater that the anticipated formation pressure possible at the surface, but must not exceed the burst pressure rating of the casing with the design safety factor applied • minimum casing setting depth should be sufficient to meet the isolation requirements of groundwater aquifers and provide an acceptable kick tolerance for the next hole-section to be drilled. The kick tolerance criteria shall be selected by the operator and will be dependent upon knowledge of the local

Regulatory control	Description
	pore pressure and fracture gradient profiles, and of the likely kick conditions in the well: – if it is intended to convert a well to a water supply bore, the surface casing shall not be set shallower than 60 m true vertical depth – when the surface casing is set shallower than 60 m true vertical depth (TVD), the intermediate or production casing must be cemented to surface. • steel casing connections must be made up to ensure an aligned, round, secure, and leak proof joint – only threaded casing connections are permitted in construction of wells. ***Cementing*** • to prevent interconnection between zones of differing pressure and water quality: – all surface casing must be cemented from shoe to surface – for cementing production and intermediate casing, operators must design to ensure cement is either brought to surface or designed to an appropriate safety overlap distance of at least 50 m back inside the previous casing shoe. However, where operators choose not to bring cement to surface, they should consider that after abandonment, two adjacent cement barriers across all aquifers will be required – where cement is not returned to surface, wire-line logging or pressure testing must be performed and recorded, to verify isolation of the casing / casing annulus has occurred, after the cement has reached a compressive strength of 500 psi. at surface conditions – testing pressures shall take into account collapse pressure of the inner casing string and fracture gradient at the outer casing shoe - Production casing cement must be designed so that the base of the cement is no more than 30 m TVD above the prognosed depth of the shallowest production zone. If, once final pressure tests and/or wire-line evaluation are complete, achievement of the cementing objectives cannot be reliably demonstrated then written notification must be sent to The Chief Inspector, Petroleum and Gas. • cement constituents and properties must be suitable for the intended conditions of use and used in compliance with the relevant material safety data sheets (MSDS) requirements • appropriate cement laboratory testing procedures must be carried out in advance of the well being drilled to ensure the resulting slurry meets the requirements of the well design. The testing, as a minimum, must include compressive strength development with time. In the case where a number of similar wells are drilled in an area with constant cement materials and mix water properties, then a representative lab test may suffice • wait on cement setting time – wait on cement time prior to slacking off or removing blowout preventers (BOPs) must be based on the cement achieving a minimum of 100 psi (0.7 MPa) compressive strength at the temperature of any potential flow zone in the annulus just cemented. Alternatively, operators may use a

Regulatory control	Description
	mechanical barrier that is compliant with API 65 – Part 2 and tested to verify a pressure seal prior to removing BOPs – wait on cement time prior to drill out must equate to the laboratory testing time for cement surrounding the casing shoe to have achieved a minimum compressive strength of 500 psi (3.5 MPa). • operators must ensure all zones (both hydrocarbon and groundwater aquifers) are isolated with cement with a minimum ultimate compressive strength of 500 psi (3.5 MPa) • operators must determine and document in their well procedures a minimum required ultimate compressive strength for cement slurries to be used across zones which may be hydraulically fracture stimulated. For example, requirements for ultimate compressive strength of 1400 psi (10 MPa) to 2000 psi (14 MPa) are often used in the hydrocarbon industry for cement across zones requiring fracture stimulation treatment • operators must ensure that the required compressive strength slurry for fracture stimulation also be placed at least 150m above the shallowest target coal to be hydraulically fractured. Refer: API Guidance Document HF-1 • during all cement jobs where the casing to be cemented is installed to the surface, cement returns to surface must be continuously monitored and recorded to confirm the effectiveness of the cement placement. Pressures during the cement job and in particular immediately prior to plug bump must be similarly recorded as a potential indicator of height of cement column and downhole problems • free water content of the cement is specified as less than 2% using the free water test outlined in API RP 10B-2 • casing centralisation simulation must be undertaken for the casing centralisation plan to achieve a minimum of 70% standoff across the total cementing depth – 70% standoff is equal to 23mm for 9-5/8" casing in 12-1/4" hole; 13mm for 7" casing in 8-1/2" hole; 21mm for 5-1/2" casing in 7-7/8" hole. • centralisation calculations for a vertical well must include a deviation of three degrees from vertical at casing depth, unless otherwise proven. Where the actual deviation exceeds three degrees, the actual deviation data must be used. Refer to API 10D-2 • operators must review centraliser selection and application in the API Technical Report 10TR4 Selection of Centralisers for Primary Cementing Operations • it is mandatory that wiper plugs be used for production casing and they are recommended for surface casing to enable plug bump and pressure test of the casing before cement cures. ***Hydraulic Stimulation*** • Hydraulic stimulation is conducted to improve recovery of hydrocarbons. The underlying principles are: – to ensure protection of aquifers is maintained during all operational phases for hydraulic stimulation and flow back

Regulatory control	Description
	– to ensure operations are carried out such that the well operating envelope is not exceeded and well barriers are maintained – to use and source water as per approved regulatory practices – to flow back fluids in such a manner as to ensure all recovered fluids are isolated and do not come into contact with aquifers or pollute soil or soil substrate. • during the well design and planning process, operators must identify any aquifers at risk of being impacted by hydraulic stimulation operations • if any such aquifers have been identified, hydraulic stimulation activities must be designed to not impact these aquifers • hydraulic stimulation fluid additives must be selected and managed to ensure all products used during well procedures are used in accordance with the manufacturer's recommendations and relevant material safety data sheets (MSDS) • the name, type and quantity of each product (including chemical names) used on each well for hydraulic stimulation must be recorded • wells that are to be hydraulically stimulated require evaluation of cement bond quality using appropriate cement evaluation tools. Cement bond log evaluation must continue until repetitive success of slurry design and cement placement, together with adequacy of cement bond for zonal isolation is confirmed (e.g. five wells in each new field or area of different geological conditions). If there is a material change after repetitive success has been shown, such as when a new cementing provider is used, there are issues in the cement job/s or a new design is implemented, then cement bond log evaluation must take place again until repetitive success of slurry design and cement placement • if the annulus between the production casing and the surface/intermediate casing has not been cemented to the surface, the pressure in the annular space must be monitored and controlled while conducting hydraulic fracture stimulation • the pressure relief valves on the pump units must be set so that the pressure exerted on the casing does not exceed the working pressure rating of the casing and wellhead • post hydraulic fracture stimulation, flow-back or produced fluids must be recovered and managed as per approved regulatory practices • stimulation design should take into account location of known faults • operators should consider the risk of casing deformation as part of the well design risk assessment process and they should document any resultant control measures in the operations program(s) • the use of industry recognised software and geo-mechanics data should be used to develop the final stimulation design • the proposed design of the fracture geometry should be included in the stimulation design including (fracturing) target zones, sealing mechanism(s) (both natural geological seals as well as adequate casing and annular cement)

Regulatory control	Description
	and aquifers, so as to minimise possibility of stimulation fluids migrating from the designed fracture zone(s) • water used in hydraulic stimulation operations should be captured and recycled for reuse as reasonably practical • as far as reasonably practicable, fluids with the lowest toxicity should be used in hydraulic stimulation, and the concentrations used should be the minimum required to facilitate effective operations. Chemical suppliers should be required to meet these guidelines • volumes of injected fluid should be accurately monitored. • Operators should refer to API Guidance Document HF1, Hydraulic Fracturing Operations – Well Construction and Integrity Guidelines.
Produced water monitoring and reporting	The volume and quality of produced water is required to be monitored, recorded and reported to the regulator every 6 months.
Waste Reduction and Recycling Act 2011	
End of Waste Code - irrigation of associated water (including coal seam gas water) (Department of Environment and Science, 2019b) End of Waste Code - associated water (including coal seam gas water) (Department of Environment and Science, 2019a) **Relevant MNES** • a water resource, in relation to coal seam gas development and large coal mining development.	The End of Waste Codes establish water quality requirements within the produced water quality and receiving environment monitoring, and reporting and notification requirements for produced water managed under these codes (e.g. for dust suppression and irrigation beneficial uses). Water quality requirements include those limits from the ANZECC Guidelines Volume 1, Chapters 3 and 4, and Volume 3, Chapter 9 and adhering to the Water Quality Management Framework.
Water Act 2000	
'Make good' obligations **Relevant MNES**	Where impacts to a bore occur and make-good obligations apply, a petroleum tenure holder is required to: • undertake a bore assessment

Regulatory control	Description
• a water resource, in relation to coal seam gas development and large coal mining development.	• enter into a make-good agreement with the owner of the bore, including consideration of the following mitigation measures and offsets: – adding a rising main to lower the pump setting in the bore – increasing the water column above the pump – improving the pressure at the bore head, including new headworks and piping, if the affected supply is artesian – changing the pump so that it is better suited to the decreased water level in the bore – deepening the bore to allow it to access a deeper part of the aquifer – reconditioning of the water bore to improve its hydraulic efficiency – drilling a new bore – providing an alternate water supply – providing the water bore owner compensation (monetary or otherwise) to offset reduced water supply from the bore.
UWIR – Water Monitoring Strategy (WMS) **Relevant MNES** • a water resource, in relation to coal seam gas development and large coal mining development.	The WMS includes the following components: • installation, maintenance and collection of data from the groundwater monitoring network including water pressure and water chemistry • monitoring of associated water volumes • a program for baseline assessment • tenure holder reporting of the data and activities relating to the above components. Individual tenure holders are responsible for specific obligations as part of the WMS, which are assigned in accordance with the UWIR. The WMS groundwater pressure network includes 622 pressure monitoring points. The main features of the network are as follows: • of the operational monitoring points, about 13% require repair or replacement • about 47% are within the gas formations • there are 19 new monitoring points (proposed and integrate) in the lower Springbok Sandstone and 23 in the upper Hutton Sandstone. These are key formations for assessing impact propagation from gas production from the Walloon Coal Measures • there are 97 nested monitoring locations. At these locations, monitoring is specified in the gas target formation and in one or more adjacent aquifers at the same location. About 95% of the monitoring points are in formations and locations where groundwater pressure reductions of more than five metres are predicted in the long term. The other 5% are located outside areas of significant impact.
UWIR - Spring Impact Management Strategy (SIMS)	The SIMS is developed for managing impacts on springs and sections of streams that are fed by groundwater within the Surat CMA. The SIMS is specified to achieve the following key outcomes:

Regulatory control	Description
Relevant MNES: • listed threatened species and TECs • a water resource, in relation to coal seam gas development and large coal mining development.	• enhance hydrogeological knowledge about springs, including an assessment of the connectivity to underlying aquifers • improve the prediction and assessment of potential impacts on springs • prescribe actions for the management of predicted impacts where necessary. The SIMS includes the following components: • characterisation of springs and an assessment of connectivity to underlying aquifers: for springs of interest, identification of aquifer(s) that provide flow to the spring • identification of the springs of interest: springs that overlie an aquifer with a predicted impact of more than 0.2 m drawdown at any time • an assessment of risks to springs: the risk of current and planned petroleum and gas development impacting on the source aquifers of the springs of interest • a spring impact mitigation strategy: a strategy for preventing or mitigating impacts on springs where predicted impacts are more than 0.2 m • a spring monitoring program: the program identifies monitoring sites, appropriate techniques and frequency. Individual tenure holders are responsible for specific obligations as part of the SIMS which are assigned by OGIA in accordance with the UWIR.
Planning Act 2016 ***Fisheries Act 1994***	
Accepted development requirements for operational work that is constructing or raising waterway barrier works (Department of Agriculture and Fisheries, 2018) **Relevant MNES:** • listed threatened species and TECs • listed migratory species • a water resource, in relation to coal seam gas development	This document provides design and construction requirements for linear infrastructure such as pipelines and access tracks required to cross watercourses: • pre-work and post-work notification must be given to the Department of Agriculture and Fisheries (DAF) • impacts on water quality are to be minimised by undertaking the works to the standard set out in the current version of the Best Practice Erosion and Sediment Control, published by the International Erosion Control Association, Australasia • provisions are made to minimise the risk of fish kills arising from the works e.g. through entrapment of fish upstream or between works • in the event that fish that have been trapped by the works, fish salvage activities in accordance with the Fisheries Queensland Guidelines for Fish Salvage are implemented immediately • fish kills must be reported to the Department of Environment and Science • for any part of the waterway bed or banks adjacent to the works that has been altered by the waterway barrier works, the site is restored and/or rehabilitated so that as a minimum: – stability and profiles of the bed and banks are re-instated to natural stream profiles and stability within five (5) business days of the completion of the works

Regulatory control	Description
and large coal mining development.	– the waterway bed is retained with natural substrate or reconstructed with substrate comparable to the natural substrate size and consistency – site conditions allow the rapid re-establishment of native vegetation and cover or native species are replanted to re-establish the natural plant community. • maximum instream works durations • watercourse crossing dimension limits • streambed scour protection.
Biosecurity Act 2014	
General biosecurity obligation **Relevant MNES:** • listed threatened species and TECs • listed migratory species • a water resource, in relation to coal seam gas development and large coal mining development.	Under the general biosecurity obligation, individuals and organisations whose activities pose a biosecurity risk must: • take all reasonable and practical steps to prevent or minimise each biosecurity risk • minimise the likelihood of causing a biosecurity event, and limit the consequences if such an event is caused • prevent or minimise the harmful effects a risk could have, and not do anything that might make any harmful effects worse.
Mineral and Energy Resources (Common Provisions) Act 2014	
Land Access Code (Department of Natural Resources and Mines, 2016) **Relevant MNES:** • listed threatened species and TECs • listed migratory species.	Mandatory conditions are imposed in the Land Access Code for conducting authorised resource activities on private land, including the following: ***Access points, roads and tracks*** • a relevant person must, if practicable, use an existing access point, road or track to enter a landholder's land • if it is not practicable to use an existing access point, any new access point, road or track, made by the relevant person, must be located at a place and in a way that minimises the impact of the access point, road or track on the landholder's business or land use activities • a relevant person must, for the period the access point, road or track is used by the person, ensure the access point, road or track is kept in good repair • the relevant person must have regard to the condition of the access point, road or track when the person started using them • a relevant person must operate vehicles on a landholder's land at speeds that

Regulatory control	Description
	– are appropriate for the landholder's land – minimise noise, dust and disturbance to the land. • a relevant person may operate a vehicle in wet conditions on a landholder's land only in a way that minimises damage to access points, roads and tracks on the land • if a relevant person has caused damage to an access point, road or track on a landholder's land, the relevant person must, as soon as practicable – notify the landholder of the damage – repair the damage. ***Livestock and property*** • a relevant person must use a landholder's land in a way that minimises disturbance to people, livestock and property • if, in carrying out authorised activities, a relevant person becomes aware of any potential adverse impact, caused by the activities, on a landholder's livestock or property, the relevant person must immediately notify the landholder of the potential impact • if a relevant person injures or kills a landholder's livestock, the relevant person must immediately notify the landholder of the injury or death of the livestock • if a relevant person damages a landholder's property, the relevant person must – immediately notify the landholder of the damage – repair the damage as soon as practicable. ***Obligations to prevent spread of declared pests*** • a relevant person must take all reasonable steps to ensure that, in carrying out authorised activities, the person does not spread the reproductive material of a declared pest • a relevant person must take all reasonable steps to ensure that, in entering or leaving land in the area of a resource authority, the person does not spread the reproductive material of a declared pest • a holder must ensure each person acting for the holder under a Resource Act washes down vehicles and machinery before entering a landholder's land in the area of the resource authority, if the risk of spreading a declared pest is likely to be reduced by the washing down • the holder must keep a record (the wash-down record) carried out during the period in which the holder is allowed access to the landholder's land • if asked by the landholder, the holder must give a copy of the wash-down record to the landholder. ***Camps*** • if a holder intends to set up a camp on a landholder's land, the holder and the landholder must, before the camp is set up, agree on the location and a plan for managing the camp

Regulatory control	Description
	• however, if the holder and landholder cannot agree on a location and plan for managing the camp, the holder must ensure the location of the camp is in a place that will minimise any impact on the landholder's business or land use activities. ***Items brought onto land*** • a relevant person carrying out authorised activities must collect rubbish or waste produced in carrying out the authorised activities and deposit the rubbish or waste in a suitable local waste facility • a relevant person must not bring firearms, domestic animals or alcohol onto a landholder's land without the landholder's consent. ***Gates, grids and fences*** • a relevant person must, after using a gate, return the gate to its original position unless advised otherwise by the landholder • if a relevant person damages a grid on a landholder's land the person must – immediately notify the landholder of the damage – replace or repair the grid as soon as practicable. • a relevant person must – obtain the landholder's consent before erecting a gate on the landholder's land – ensure any gate erected by the person is stock-proof. • a relevant person must not cut a fence on the landholder's land without the landholder's consent • if the landholder allows a fence to be cut by a relevant person to carry out an authorised activity, the person must, immediately after carrying out the activity – repair the fence; or – erect a stock-proof gate, as required by the landholder, where the fence was cut.

6.3 Project-specific controls

Potential impacts to MNES will be managed through implementation of Project-specific controls presented in the following management documents, with further information provided in Table 15:

- Environmental Constraints Planning and Field Development Protocol (Appendix A)
- Environmental Management Plan (Appendix C)
- Rehabilitation Management Plan (Appendix D)
- Offsets Plan (Appendix E)
- Produced Water Management Plan (Appendix G)
- Groundwater Monitoring and Management Plan (Appendix H)
- Chemical Risk Assessment (Appendix I).

Table 15: Management documents relevant to the Project

Relevant plans	Description
Environmental Constraints Planning and Field Development Protocol (the Protocol) (Appendix A)	• The Protocol provides a framework to guide placement of infrastructure. • The Protocol documents the process for validating MNES and implementing a hierarchy of avoidance, minimising disturbance, and mitigating potential impacts to MNES, while considering landowner, cultural heritage, and engineering / design requirements.
Environmental Management Plan (EMP) (Appendix C)	• The EMP identifies the environmental values potentially affected by the Project and proposes measures to manage the risks of potential adverse impacts to these environmental values. • The EMP has been prepared in accordance with the Department of the Environment's 2014 Environmental Management Plan Guidelines (Department of the Environment, 2014a). • The Plan describes: – specific requirements for compliance with government regulations and environmental approval conditions – communication and documentation of environmental compliance activities for all activities – environmental management measures to be implemented to minimise potential environmental impacts.
Rehabilitation Management Plan (Appendix D)	• The Rehabilitation Management Plan outlines the rehabilitation strategies, criteria, methods and monitoring requirements for the Project. • The plan describes how rehabilitation will be carried out in accordance with the rehabilitation conditions of the EAs. • Overall, the state government specifies rehabilitation goals which require areas disturbed by petroleum and gas activities to be: 1. safe to humans and wildlife 2. non-polluting 3. stable 4. reinstated to pre-disturbed land-use, unless otherwise agreed to by the landholder.
Offsets Plan (Appendix E)	• The Offsets Plan details the process for progressively providing offsets for SRI to MNES in accordance with the EPBC Act Environmental Offsets Policy. • The Offsets Plan establishes an Offset Bank that will be managed to deliver requirements over the life of the Project.
Produced Water Management Plan (Appendix G)	• The Produced Water Management Plan has been prepared to demonstrate how the predicted volume of produced water will be managed over the life of the Project.

Relevant plans	Description
Groundwater Monitoring and Management Plan (Appendix H)	• The Groundwater Monitoring and Management Plan details how potential adverse impacts to MNES water resources will be monitored and managed. • The Plan details commitments under the Water Act (Qld) and UWIR for the Surat CMA, including the Water Monitoring Strategy and Spring Impact Management Strategy.
Chemical Risk Assessment (Appendix I)	• The Chemical Risk Assessment demonstrates that potential risks to MNES from use of chemicals for the Project have been eliminated or reduced as much as is reasonably practicable. • The Chemical Risk Assessment provides activity-specific management measures for the transport, storage, and handling of chemicals.

6.3.1 Avoidance and minimisation

The Protocol (Appendix A) describes how petroleum infrastructure is located and constructed to preferentially avoid, minimise and mitigate significant impacts to MNES. The Protocol documents the process for progressively validating the presence of MNES prior to field development activities. A full list of constraints, constraint categories, permitted activities and mitigation measures are detailed in Table 16. The constraints areas are illustrated on Figure 17.

Table 16: Constraint categories

Constraint category	EPBC Act constraint	Development permitted	Mitigation measure
No-go area	• National Parks • Conservation Parks • Spring vents and/or spring complexes protected under the EPBC Act (i.e. springs where the TEC *the community of native species dependent on natural discharge of groundwater from the Great Artesian Basin* has been identified and/or springs that support other EPBC Act-listed threatened species) • Wetlands of International Importance (Ramsar)	No petroleum activities	Avoidance
High constraint area	• Habitat for a species listed as critically endangered under the EPBC Act at the time of the referral[1]	Low impact petroleum activities[2] Linear infrastructure	Minimisation Mitigation Rehabilitation
Moderate constraint area	• All other MNES constraints under the EPBC Act approval	All petroleum activities[3]	
Low constraint area	• All other environment constraints (non MNES)	All petroleum activities	Rehabilitation

1. *Habitat for species listed as critically endangered under the EPBC Act at the time of referral will be treated as a high constraint area irrespective of the constraint's basis ranking. Infrastructure developments in these areas will be restricted to low impact petroleum activities and linear infrastructure*
2. *Definitions for these activities are defined in the EA*
3. *All petroleum activities will be permitted within the moderate constraint area, however, areas of habitat critical to species' survival will be preferentially avoided over areas with lower MNES values.*

Avoidance

Preliminary infrastructure locations will be relocated or modified to avoid disturbance to MNES where practicable, including the following avoidance measures:

- re-design / relocation of proposed infrastructure
- construction of wells using horizontal drilling technology
- direction drilling of pipelines under TECs, threatened flora, threatened fauna habitat, and migratory fauna habitat
- utilising existing cleared areas and existing infrastructure (e.g. access tracks).

Minimisation

Disturbances to MNES will be minimised where practicable by:

- minimising pipeline right-of-way widths
- minimising disturbance areas required for well pads during construction and operation
- using minimal disturbance well pads and access tracks
- ensuring non-linear infrastructure will be excluded from watercourses
- minimising the direction, intensity and/or extent of impacts, if clearing cannot be avoided.

149°0'0"E
150°0'0"E
24°0'0"S
25°0'0"S
26°0'0"S
27°0'0"S
Rolleston
Biloela
Injune
Taroom
Wandoan
Roma
Yuleba
Miles
Kogan
Source Information:
© Origin/APLNG 2020.
© State of Queensland (Department of Natural Resources, Mines and Energy) 2020.
Service Layer Credits: Sources: Esri, USGS, NOAA

Legend

- Road
- Major Waterway
- Gas Supply Security Project (GSSP)
- APLNG Operated Tenure

EPBC Constraints

- No Go Zone Area
- High Constraint
- Moderate Constraint

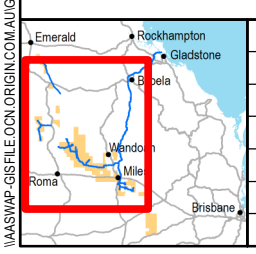
N

Scale 1:1,175,000 (at A3)

0 12.5 25 50

Kilometres

Coordinate System: GCS GDA 1994



Rev	Description	Drawn	Check	QA	Approved	Date
C	Issued For Review	TJB	JS	GNH		02/12/2020
B	Issued For Review	TJB	JS	DJ		08/09/2020
A	Issued For Review	SAW	JS	GNH		02/09/2020

Gas Supply Security Project (GSSP)

EPBC Constraint Categories Overview

Date: 2 December 2020

Map Number	Doc No	Figure
1 of 1	Map ID RITM_144964	17

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6.3.2 Mitigation

The EMP (Appendix C) outlines the environmental management requirements for the Project, which are also summarised in Table 17.

Table 17: Mitigation and management measures

Aspect	Mitigation and management measures
General Fauna Management Measures	• A fauna spotter catcher will be present during the clearing of confirmed MNES fauna habitat. • The length of open pipeline trench will be minimised and progressively backfilled following pipeline construction. • Fauna egress devices (e.g. matting, ladders) will be installed in all excavations left open overnight. • Open excavations and trenches will be inspected daily with relocation of fauna, if present. • Prior to backfilling, excavations or trenches will be inspected for the presence of fauna, and evidence of burrowing fauna or breeding places with relocation of fauna, if present. • The open ends of welded pipeline sections will be plugged at the end of each day using 'night caps' or similar to prevent the ingress of fauna. • Pipeline sections will be laid out with gaps to allow for fauna movement across the pipeline right-of-way.
Dust emissions	• Disturbed land will be minimised and progressively stabilised following construction. • Dust suppression would be undertaken including the watering of disturbed areas as required. • Activities with the potential to generate increased dust (e.g. soil stripping) will be minimised during windy conditions.
Noise emissions	• Noise attenuation devices (e.g. mufflers) will be installed and maintained on all equipment during construction activities to minimise nuisance impacts to breeding or roosting of MNES fauna.
Light emissions	• Directional lighting or shrouding of lights will be used to reduce light spill into adjacent roosting or breeding habitat areas of MNES fauna.
Fire risk	• Fire extinguishers will be present at the location of hot works (e.g. pipeline welding). • Site vehicles will be equipped with fire extinguishers. • Flammable material will not be stockpiled or stored near hot work activities (including vegetation stockpiles). • Smoking areas will be designated with provision for containers for safe disposal of cigarette butts. • Hot works permits will be followed at all times where applicable.

Aspect	Mitigation and management measures
Weeds and pests	• Construction activities will be undertaken in accordance with the Risk Minimisation Requirements of the DAF *Queensland Biosecurity Manual* (Department of Agriculture and Fisheries, 2019). • All vehicles/equipment carrying organic materials must have a valid biosecurity hygiene declaration for that load. • Reinstated areas will be monitored for the presence of weeds.
Chemical and fuel use	• Chemicals and fuel stored, transported and handled on-site will be effectively contained and where relevant, meet the appropriate Australian Standards (e.g. AS 1940:2017 for the storage and handling of flammable and combustible liquids).
Watercourses	• Construction of linear infrastructure (e.g. pipelines and access tracks) requiring a watercourse crossing would be undertaken in accordance with the *Accepted development requirements for operational work that is constructing or raising waterway barrier works* under the *Fisheries Act 1994* and *Planning Act 2016*.
Erosion and Sediment	• Measures will be implemented during construction to minimise the risk of potential sedimentation to sensitive receptors.
Waste management	• All waste will be stored, handled and transported in accordance with the waste and resource management hierarchy, waste and resource management principles prescribed by the *WRR Act*.
Beneficial Use of Produced Water	• Manage produced water to a standard required to facilitate beneficial use of water, including irrigation, construction, and operational uses. Water quality standards are prescribed by EAs for the Project, and/or the *End of Waste Code Irrigation of Associated Water (including coal seam gas water)* and *End of Waste Code Associated Water (including coal seam gas water)* under the WRR Act. • Comply with water quality limits for irrigation in accordance with the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines).
Produced Water Storage	• Produced water and water management by-products will be stored in tanks or dams designed and constructed in accordance with the *Manual for Assessing Consequence Categories and Hydraulic Performance of Structures* (Department of Environment and Science, 2016a) and the Guideline *Structures which are dams or levees constructed as part of environmentally relevant activities* (Department of Environment and Science, 2019c).
Brine Disposal	• Water management by-products will be disposed of at a facility licensed under the EP Act.

Aspect	Mitigation and management measures
Produced Water Reporting	• The volume and quality of produced water will be monitored and reported in accordance with the *Petroleum and Gas (Production and Safety) Act 2004*.

6.3.3 Rehabilitation

All disturbances will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and the relevant EA conditions (Appendix N). The timing and scope of rehabilitation will be dependent on the infrastructure type and operational needs of the Project. Some Project activities such as drilling are temporary in nature, enabling progressive rehabilitation to be undertaken once the disturbance area is no-longer required for construction activities. Other infrastructure and disturbances will remain longer-term with decommissioning and rehabilitation occurring once operation of the infrastructure ceases.

All infrastructure will be decommissioned or removed from site except where it is to remain for a beneficial use with the written agreement of the landholder.

6.3.4 Offset

Following the application of avoidance and mitigation measures where practicable, offsets will be provided to compensate for any SRI to MNES. Section 8.0 and the Offsets Plan (Appendix E) set out the procedures and arrangements for determining SRI and the resultant offset requirements.

6.4 Environmental outcomes

The MNES with the potential to be impacted by the Project include:

- listed threatened species and ecological communities
- listed migratory species
- a water resource, in relation to coal seam gas development and large coal mining development.

Based on the impact assessments provided in Section 7.0, the only MNES that will be significantly impacted by the Project are listed threatened species and ecological communities. No other MNES will be significantly impacted by the Project.

The Project is proposing to achieve a conservation gain by implementing the Offsets Plan (Appendix E) and Rehabilitation Plan (Appendix D). All significant residual impacts to threatened species and ecological communities will be offset by a direct offset, leading to a conservation gain for the species.

The conservation gain will be delivered in a number of ways including via the establishment of an offsets bank, management of offset areas and on ground protection and management, outlined in the Offsets Plan (Appendix E). Within a particular offset area, a conservation gain will be achieved by activities including:

- improving existing habitat for the protected matter
- creating new habitat for the protected matter
- reducing threats to the protected matter
- averting an area of threatened species and/or TEC habitat that is currently under threat.

Ongoing management of offset areas will be undertaken to achieve the desired conservation gains for each threatened species and TEC. The management measures to be implemented at each area will address both local pressures on the environment and provide specific actions tailored to the threatened species and ecological communities that are being offset. Each offset area will be managed to maintain their MNES values.

The proposed EPBC Act approval conditions presented in Appendix M are designed to manage potential significant impacts to these MNES based on the Australia Government's Outcomes-Based Conditions Policy and Outcomes-Based Conditions Guidance. The proposed conditions have also been informed by contemporary conditions for similar EPBC Act approvals.

6.4.1 Adaptive management framework

The Outcomes-Based Conditions Policy and Outcomes-Based Conditions Guidance details the Australian Government's approach to use outcomes-based approval conditions for controlled actions under Section 134 of the EPBC Act. Outcomes-based conditions are tailored to the particular action and define the environmental outcomes that must be achieved for MNES without prescribing how that outcome should be achieved (Department of the Environment, 2016).

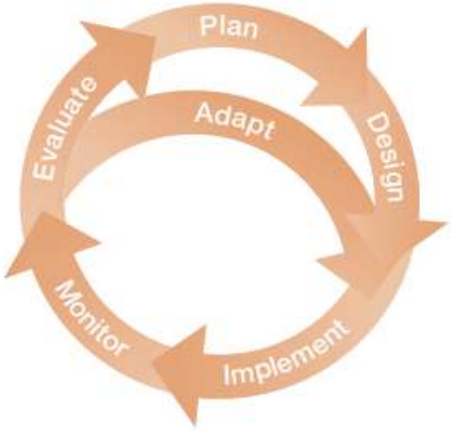
The framework for outcomes-based conditions consists of six key elements:

- outcomes
- milestones
- performance indicators
- monitoring requirements
- adaptive management and continual improvement

- record keeping, publication and reporting.

The Queensland Government also supports an adaptive environmental management system to regulate resource activities (Figure 18). This system allows for best practice environmental management to be implemented as technologies develop over time. In practice, environmental licence conditions issued to operators are regularly updated or amended to take into account new research, monitoring or modelling which identifies potential emerging impacts on the environment.

Figure 18: Adaptive management



6.4.2 Proposed conditions

Consistent with Section 134(4) of the EPBC Act, in deciding whether to attach a condition to an EPBC Act approval, the Minister must consider any relevant conditions that have been imposed or are likely to be imposed under a law of a State or another law of the Commonwealth.

The Project is authorised to conduct petroleum activities within petroleum tenures subject to conditions of regulatory controls such as conditions of existing EAs (Appendix N). The Project includes implementation of the key regulatory controls required by existing authorisations described in Section 6.2, and the Project-specific controls described in Section 6.3.

The proposed EPBC Act approval conditions for the Project include conditions which ensure impacts to MNES are the firstly avoided, then mitigated or managed to an acceptable level. The Project will adopt an adaptive planning and management approach to accommodate changes identified from analyses of data collected over the life of the Project and consider new technologies as these become commercially viable.

The proposed conditions for listed species require Origin to implement a process for progressively determining SRI and to securing offsets in a staged manner as the Project progresses; this process is described in Section 8.0. Reconciliation reports will be submitted to the Department to demonstrate that offset areas any SRI.

For potential impacts to water resources, the Project is located within the Surat CMA, for which the OGIA uses a regional groundwater flow model to conduct a cumulative assessment of water production for the resource industry. The Surat CMA UWIR is revised at least every three years to include updated modelling and research undertaken by OGIA. The proposed conditions require implementation of any responsible tenure holder obligations assigned by OGIA under the Water Act (Qld).

7.0 IMPACT ASSESSMENT

7.1 Overview

The MNES potentially located within the Project Area include:

- listed threatened species and ecological communities (Section 7.2)
- listed migratory species (Section 7.3)
- a water resource, in relation to coal seam gas development and large coal mining development (Section 7.4).

Under the EPBC Act an action requires approval from the Minister if the action has, will have, or is likely to have, a significant impact on a MNES. A 'significant impact' is an impact which is important, notable, or of consequence, having regard to its context or intensity. Whether or not an action is likely to have a significant impact depends upon the sensitivity, value, and quality of the environment impacted, and upon the intensity, duration, magnitude and geographic extent of the impacts. These factors are considered when determining whether an action is likely to have a significant impact on MNES.

This chapter presents the impact assessment and proposed environmental management and mitigation measures for MNES relevant to the Project in accordance with the DAWE guidance:

- MNES Significant impact guidelines 1.1 (Department of the Environment, 2013b).
- Significant impact guidelines 1.3: Coal seam gas and large coal mining developments—impacts on water resources (Department of the Environment, 2013a).

Based on the impact assessments, there is unlikely to be significant impacts to listed migratory species or a water resource. The only MNES that may be significantly impacted by the Project is listed threatened species and ecological communities.

7.2 Listed threatened species and ecological communities

7.2.1 Potential impacts

7.2.1.1 Direct impacts

Vegetation clearing associated with construction activities is the primary impact mechanism for threatened species and ecological communities (TECs). Impacts associated with clearing cannot be fully avoided; however, there are considerable opportunities to minimise the total area of clearing and proportion of clearing within the most important areas (discussed in Section 6.0).

Vegetation clearing will occur in line with the Protocol (refer to Section 6.3), and involves mostly narrow corridors associated with linear infrastructure, or relatively small patches associated with well pads. The Protocol documents the process for validating MNES and implementing a hierarchy of avoidance, minimising disturbance, and mitigating potential impacts to MNES, while considering landowner, cultural heritage, and engineering / design requirements.

A range of habitat types are present within the Project Area (refer to Section 4.7), that are known to be or may potentially be utilised by threatened species and TECs. Clearing may reduce vegetative cover and habitat for fauna dependent on those ecosystems and can reduce the available shelter, nesting, breeding and foraging habitat for threatened fauna species. The Project may result in reductions in the extent of these values and these impacts may be considered a SRI in the context of the EPBC Act (refer to impact assessments for threatened species and TECs in Section 0).

To reduce the likelihood of SRIs to threatened species and TECs, a range of environmental management measures will be implemented in addition to compliance with EA conditions to reduce the total extent of vegetation clearing as far as possible.

Further to the management measures to be implemented at the time of construction, a program of rehabilitation will be implemented post disturbance to re-establish native vegetation and reinstate habitat values over time. Details are provided in the Rehabilitation Management Plan (Appendix D).

7.2.1.2 Indirect impacts

Indirect impacts associated with both the construction and operation of the Project include:

- weed and pest species incursion (plants and animals) via vehicle movements and inappropriate waste storage
- disturbance and displacement of fauna from foraging and roosting habitat as a result of construction noise, vibration and lighting
- degradation of habitats as a result of dust, noise, vibration, light or contaminants released to the receiving environment and changes in water resources
- injury/mortality of fauna during construction and operation as a result of vehicle strike, entrapment or entanglement.

Indirect impacts can be appropriately managed via environmental management measures, with methods and outcomes prescribed in relevant operating conditions (e.g. EAs and other permits and licences) (as outlined in Section 6.0). Consequently, these types of impacts are unlikely to result in significant impacts to MNES and are therefore not considered in the impact assessment. An overview of the types of impacts and how they will be addressed over the life of the Project is provided in Table 18.

Table 18: Indirect impacts and associated management measures

Impact	Management measures	Project phase
Weeds and pests (plants)	Implement a weed, pest, and biosecurity management plan for compliance with obligations under the *Biosecurity Act 2014* (Qld), including weed identification and management Develop and implement clean on entry procedures for vehicles and machinery Where necessary, utilise vehicle wash down facilities to enable inspection and cleaning of vehicles prior to entry	Construction Operation
Feral animals	No domestic animals permitted within the Project Area by personnel employed for the Project	All Project phases
	Implement a weed, pest, and biosecurity management plan for compliance with obligations under the *Biosecurity Act 2014* (Qld), including feral fauna control within the Project Area	Construction Operation
Degradation of habitat	Erosion and sedimentation control measures will be implemented during all construction activities to minimise impacts to sensitive receptors	Construction
	Vehicles access to potentially unstable ground (i.e. slopes, creeks, drainage lines, etc.) shall be restricted	All Project phases
	Vehicles and machinery to remain on approved construction corridors and/or existing tracks to reduce soil compaction	Construction Operation
	Undertake progressive remediation and rehabilitation of areas in accordance with the Rehabilitation Management Plan (Appendix D)	Construction

Impact	Management measures	Project phase
	All hazardous materials will be managed in accordance with standard operating procedures for transport, handling and storage as per the requirements of AS-1940 Hazardous materials are to be provided and stored in sealed, labelled containers, without leaks All vehicles and equipment to be cleaned in designated wash bays fitted with suitable pollution control equipment	Construction Operation
Noise and vibration	Correctly functioning noise attenuation devices (e.g. mufflers) must be installed and maintained on all construction equipment adjacent to important habitat (e.g. roosting and breeding habitat) Ensure all vehicles and machinery are serviced and maintained to minimise machinery noise and vibration	Construction Operation
Dust emissions	Appropriate dust controls (including but not limited to dust suppression, application of non-toxic soil binders, or vehicle covers) to be implemented throughout construction as required to prevent and minimise dust emissions Enforcing vehicle speed limits Regular cleaning of vehicles	Construction Operation
Bushfire	All relevant construction and operation personnel to undertake training in fire prevention and management Smoking only permitted in designated smoking areas	All Project phases
	All site vehicles to be supplied with appropriate fire control equipment, which will be regularly replenished and maintained No burning of cleared vegetation Hot works permits will be followed at all times	Construction
Entrapment/ entanglement	Minimise length of open trench and backfilling undertaken progressively Excavations backfilled immediately following completion of construction activities Fauna egress (e.g. ramp, matting, ladder) will be installed in all excavations left open overnight Prior to backfilling, the excavation or trench must be inspected for presence of fauna and evidence of burrowing fauna or breeding places. If fauna present, a fauna spotter catcher must relocate the animal The use of “night caps” will be implemented over ends of welded pipe to prevent the ingress of wildlife Pipes will be initially placed with gaps to allow for fauna movement across the line of the pipe Minimise the use of barbwire when erecting fencing, where possible When using barbwire, the top strand will be high tensile steel (non-barbwire) to avoid fauna getting caught and tangled in the barbs Install reflectors on fencing to deter fauna interaction	Construction

Impact	Management measures	Project phase
Changes in water quality or resources	Construct watercourse crossings in accordance with the accepted development requirements for operational work that is constructing or raising waterway barrier works (Department of Agriculture and Fisheries, 2018). Further details of waterway barrier works requirements are listed in section 6.2, Table 14. Erosion and sedimentation control measures will be implemented during all construction activities to ensure that sensitive receptors are not adversely impacted Implement dust control measures as required	Construction Operation
	Produced water will be managed in accordance with the Produced Water Management Plan (Appendix G) Impacts will be detected via Groundwater Monitoring and Management Plan (Appendix H)	Construction Operation
Vehicle strike	All construction and operation personnel to undergo induction training on the fauna values of the Project Area and vehicle speed limits Implement speed limits within the Project Area A speed limit of 60km/h shall apply on private access tracks adjacent to koala habitat	Construction Operation

7.2.2 Assessment methods

The Brigalow Belt bioregion is known as a biodiverse region with over 600 terrestrial vertebrate taxa recorded. Endemism is low in the Brigalow Belt, although the percentage of species listed as threatened is high compared to other bioregions (Department of Environment and Science, 2018). There are a range of threatened species that occur in low numbers across the region and those frequently encountered in the Project Area and surrounding region include:

- threatened flora ranging from trees (Ooline) and shrubs to grasses (king blue-grass)
- mammals e.g. Koala, Greater Glider, threatened microbats
- Brigalow belt reptiles e.g. Ornamental Snake, Yakka Skink, threatened freshwater turtles
- Brigalow belt snails; and
- birds e.g. woodland and wetland species and birds of prey.

Threatened species are commonly associated with areas of remnant vegetation, although regrowth and cleared areas may support local populations particularly where the regrowth is connected or adjacent to viable remnant patches.

Most assessments for large developments focus their analysis on impact on the total area of vegetation clearing/habitat loss for relevant values. This is an appropriate methodology, given the configuration of impacts is generally spatially concentrated in one area and will remove entire habitat patches, thereby having the potential to result in significant impacts to species' populations at a local scale. However, the spatial configuration of gas field development in the landscape across the Project Area is very different. Individual well pads and flow lines require only small areas of clearing and there are opportunities for local scale impact avoidance (Section 6.3).

The impacts from Project activities are dispersed across the Project Area. Larger components of infrastructure such as GPFs can be sited to avoid major impacts. Therefore, a more considered

approach to impacts analysis is required to inform whether residual impacts should be considered significant at both a local and regional scale.

The processes that was undertaken to assess potential impacts on threatened species and TECs as a result of the maximum disturbance development scenario is shown visually in Figure 19. The assessment incorporates analysis of data from a range of sources and utilises field data, species and vegetation records, published data and recognised modelling techniques (Section 7.2.2.1).

The assessment of MNES biodiversity values relevant to the Project identifies threatened flora, threatened fauna, TECs and migratory species likely to occur within the Project Area (Section 7.2.3.1), and then quantifies the potential impacts (Section 7.2.3.3).

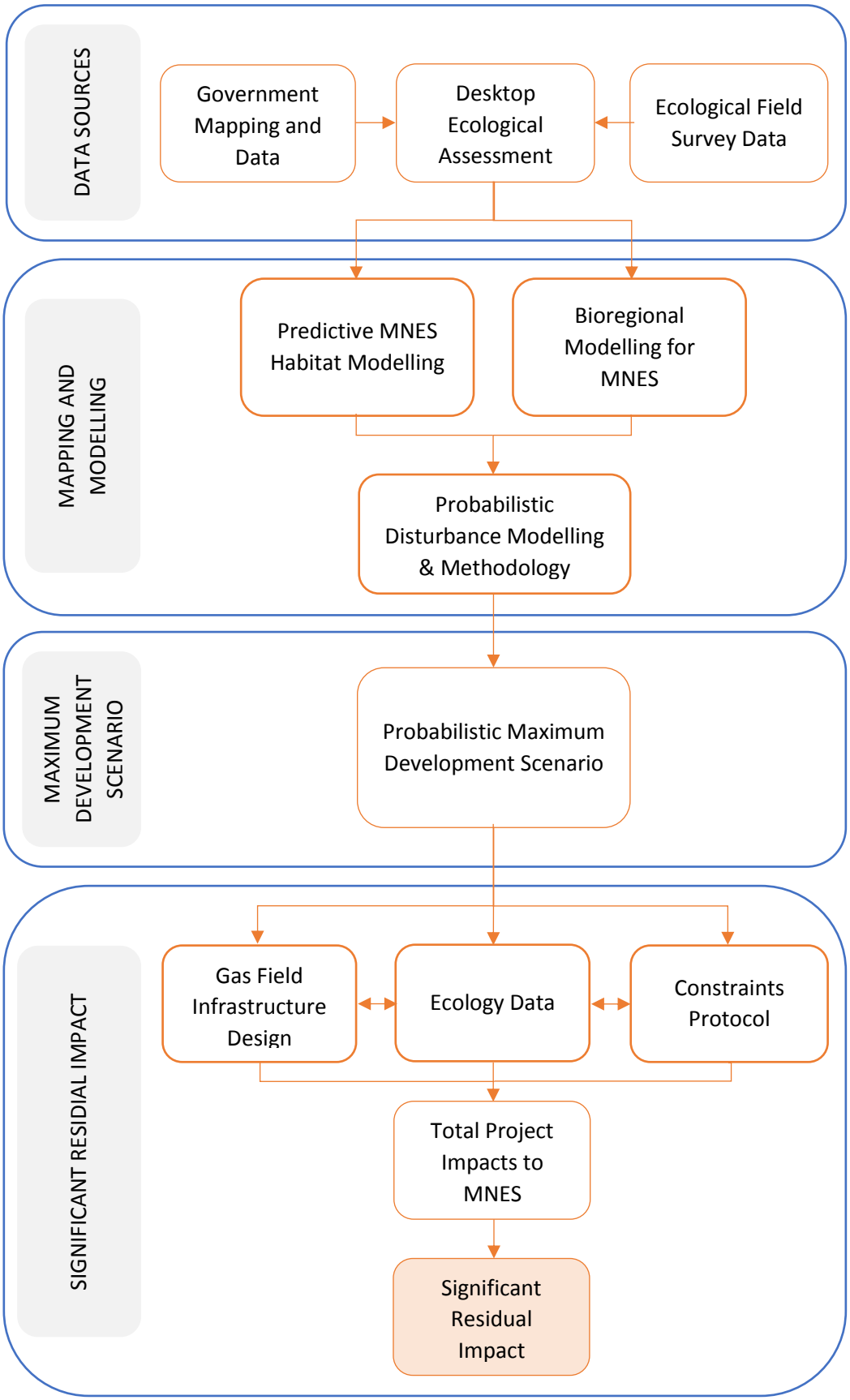
Predictive habitat modelling was used to provide greater certainty in predicting the likelihood of threatened species or TEC habitat occurring and being impacted by the Project.

Impacts from the Project have been quantified in full as 'projected maximum disturbance' (the maximum development scenario) for each threatened species and TEC. However, this should not be taken as the full measure of impact. Instead, a suite of additional analysis has been developed to further understand how impacts are likely to affect threatened species and TECs when they are considered in the dispersed fashion in which they will manifest in the environment. The additional analysis has been termed quantification of SRI and is based on a number of criteria, which are detailed in the sections below.

This methodology for assessment is considered appropriate and consistent with the EPBC Act Survey Guidelines (Eyre, 2018)'How to use these guidelines' that note:

> *"… Alternatives to a dedicated survey may also be appropriate. For example, a desktop analysis of historic data may indicate that a significant impact is not likely. Similarly, a regional habitat analysis may be used to determine the importance of a site to the listed birds. Proponents should also consider the proposals impact in the context of the species' national, regional, district and site importance to establish the most effective survey technique(s)…"*

Figure 19: Impact assessment process (threatened species and ecological communities)



7.2.2.1 Data sources

Publicly available information sources were reviewed to determine the confirmed and potential presence of environmental values within the Project Area and surrounding bioregion, with a focus on MNES values. These data sources include previous published environmental studies, databases and mapping. The most relevant data sources are summarised in Table 19.

Table 19: Desktop data sources for ecological assessment

Source	Description
ENVIRONMENTAL STUDIES	
Field derived datasets related to species occurrence, vegetation community mapping, habitat suitability and the presence of micro-habitat features	Previous studies undertaken for the Project Area have utilised published material, databases and field assessments and have provided a range of outputs including impact assessments and environmental constraints mapping (refer below).
MAPPING	
DNRME Remnant and pre-clearing RE mapping	Provides mapping of remnant vegetation communities and their conservation status (endangered, of concern or least concern).
DNRME Regulated vegetation management	Provides mapping of regulated vegetation within Queensland, including Essential Habitat.
DNRM Watercourse identification	Provides mapping of watercourses within Queensland, including drainage features, lakes, swamps, lagoons, creeks and springs.
DES Referable wetlands and wetland associated RE layers	Provides mapping of wetland protected areas and wetland values within Queensland.
DAF Waterway barrier classification mapping	Provides mapping of waterways defined under the Fisheries Act to help identify potential barriers to fish movement due to proposed actions
High resolution aerial photography	Aerial photography of the site, combined with site derived datasets.
Government derived cadastral datasets	Provides mapping of cadastre within Queensland.
Topographic and geological information	Mapping of topography and geology within Queensland.
DATABASES	
Atlas of Living Australia (ALA)	Online database of flora and fauna records across Australia. Sources of this data include research organisations, government, museums and citizen science.
Protected Matters Search Tool (PMST)	Provided by DAWE. This online tool identifies any MNES that are likely to occur within a defined area. This information is based on map layers of MNES such as species distributions (not known records). The results of PMST searches conducted for each development area is provided in Appendix B1.

Source	Description
WildNet	A Queensland Government database that provides a range of information regarding flora and fauna within Queensland. Sources of this data include government, research organisations, natural research managers and citizen science.
Queensland springs database	Provides information on springs within Queensland which have a fixed location.
DAWE Species Profile and Threats (SPRAT) database, conservation listing advices and recovery plan documentation	Provides a range of information on threatened species and TECs listed under the EPBC Act.

The assessment also included data collected during ecological field surveys and targeted threatened species surveys undertaken within and surrounding the Project Area. A summary of relevant field surveys is provided in Table 20 and the spatial coverage displayed on Figure 20.

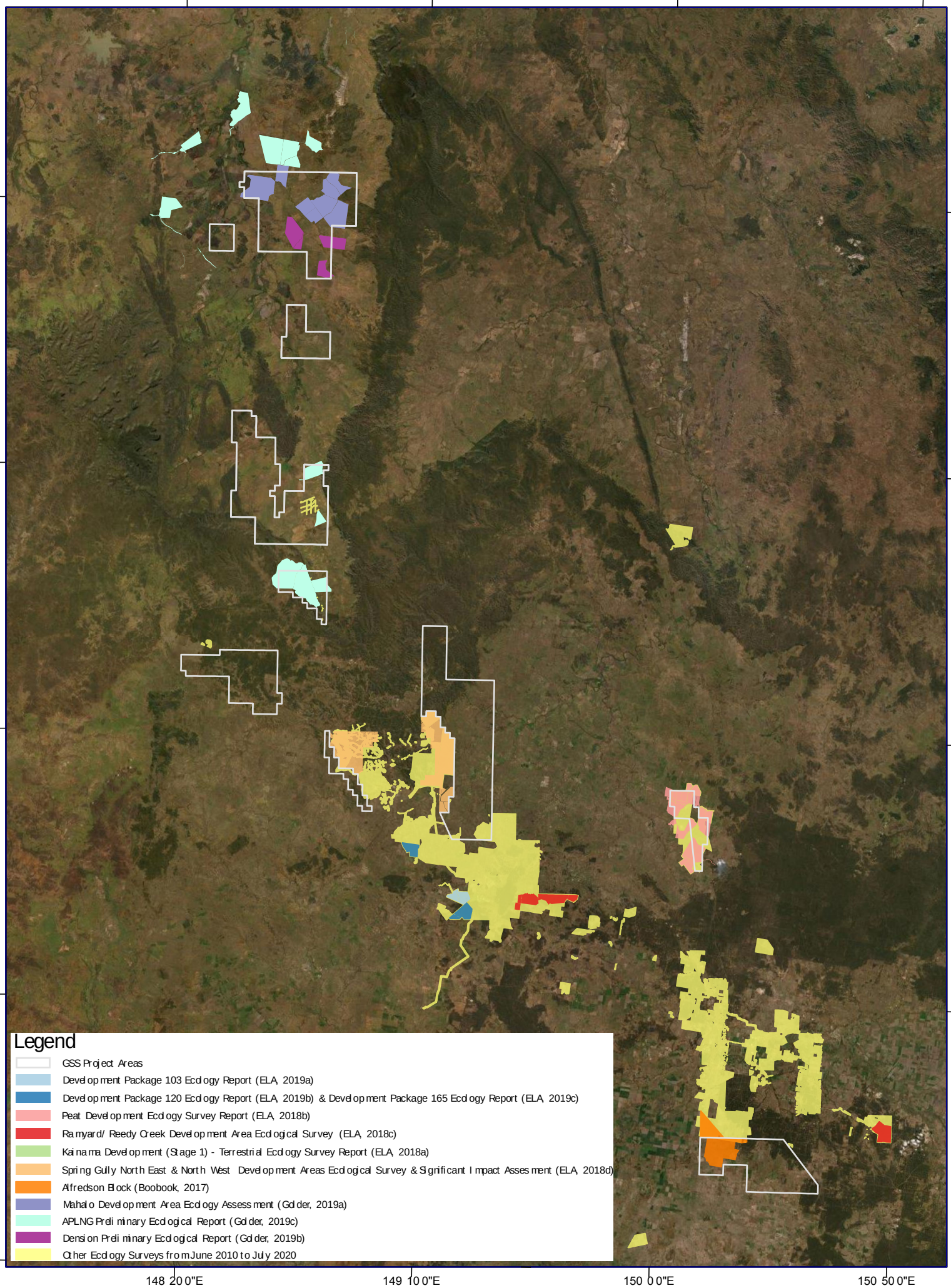
Field data related to species occurrence, vegetation community mapping, habitat suitability and the presence of micro-habitat features were used to inform and refine development of the predictive habitat models (described in Section 7.2.2.2).

Survey techniques were informed by relevant guidelines for surveys of EPBC Act-listed threatened species and TECs, which includes the application of methods consistent with the methodology described by the Queensland Herbarium for the survey of REs and vegetation communities (Neldner, Thompson, *et al.*, 2019) and the standard methodologies for the systematic survey of terrestrial fauna in eastern Australia (Eyre *et al.*, 2018).

Table 20: Summary of relevant field surveys

Survey	Description	Location
Development Package (DP) 103 Ecology Report (ELA, 2019a)	Threatened flora and fauna surveys Vegetation assessments TEC assessments Habitat assessments Weed and pest species assessment Wetlands, watercourses and drainage features assessments	Spring Gully South/Ramyard West (DP 103)
Denison Preliminary Ecological Report (Golder, 2019c)	Habitat assessment Vegetation assessments TEC assessments	Denison and Spring Gully (Block B)
Development Package 120 Ecology Report (ELA, 2019b) & Development Package 165 Ecology Report (ELA, 2019c)	Threatened flora and fauna surveys Vegetation assessments TEC assessments Habitat assessments Weed and pest species assessment Wetlands, watercourses and drainage features assessments	Spring Gully South/Ramyard West (DP 120 & 165)

Survey	Description	Location
Ironbark Project Baseline Ecology Report (Golder, 2019a)	Vegetation assessments Habitat assessments Flora and fauna surveys Weed and pest species assessment	Ironbark
Peat Development Ecology Survey Report (ELA, 2018b)	Targeted habitat assessments for listed threatened fauna Targeted threatened fauna surveys Vegetation assessments TEC assessments	Peat
Ramyard / Reedy Creek Ecology Survey (ELA, 2018c)	Threatened flora and fauna surveys Vegetation assessments TEC assessments Weed and pest species assessment Wetlands, watercourses and drainage features assessments	Ramyard (Reedy Creek)
Kainama Development (Stage 1) – Terrestrial Ecology Survey Report (ELA, 2018a)	Threatened flora and fauna surveys Vegetation assessments Weed and pest species assessment Wetlands, watercourses and drainage features assessments	Kainama
Mahalo Development Area Ecology Assessment (Golder, 2019b)	Threatened flora and fauna surveys Targeted surveys for Ornamental Snake Vegetation assessments TEC assessments Aquatic flora surveys (species and abundance) Habitat assessment (including aquatic habitat) Physico-chemical water quality testing	Mahalo (Block A, B and C)
Spring Gully North-east and North-west Ecological Survey and Significant Impact Assessment (ELA, 2018d)	Targeted habitat assessments for listed threatened flora and fauna Targeted threatened flora and fauna surveys Vegetation assessments TEC assessments	Spring Gully (Block C and D)
Alfredson Block (Boobook, 2017)	Targeted survey for Dulacca Woodland Snail *Adclarkia dulacca* and Brigalow Woodland Snail *Adclarkia cameroni*. Habitat assessments Vegetation assessments	Adjacent to Ironbark on PL1011



Spatial co erage o ield sur ey across t e Project area Lot on Plan

Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

0 12 5 25 50
Kilometers
Datum Pro ection
GD 1994 MG one 55

Figure 20

Prepared by SP

Date 21 10 2020

7.2.2.2 Predictive habitat modelling

The predictive habitat model for each threatened species and TEC identified in the likelihood of occurrence assessment (Section 7.2.3.1) was designed to provide a dynamic, robust and predictive spatial mapping layer (GIS). The layer incorporates data from scientific literature, verified government datasets, DAWE guidelines, Species Profiles and Threats (SPRAT) database, specimen backed datasets (i.e. data derived from a known/confirmed location of an observed specimen or TEC) and field identified records into a single GIS data set that could be used to identify areas that are known, or considered to have the potential to support specific threatened species and TECs.

The models were developed using a base layer methodology that has previously been accepted in similar EPBC Act assessments. The base layer model used an expert-driven approach to model the distribution of threatened species and TECs via ESRI ArcGIS, in which RE mapping was the main driver of habitat delineation for each threatened species and TEC. The model used a range of available data including publicly available spatial datasets and field verified data.

For this assessment, further refinements were undertaken to improve the accuracy and robustness of the modelling outputs. These improvements included the following:

- incorporating additional insights into species habitat preferences, in particular using spatial drivers of distribution that are additional to RE mapping
- identifying ecologically robust habitat categories that better represent preferred and suitable habitat for each species
- applying modelling methods and remote sensed data to improve scientific rigour and/or logic of approach.

The opportunities for improvement were built into the species profiles and mapping rules. Appendix B2 contains a report on the methods used to develop the habitat maps.

Species-specific rules

A species-specific ruleset for each threatened species and TEC was used to refine spatial distribution into:

- preferred habitat critical for reproduction and persistence of local populations
- suitable habitat generally providing
  - additional foraging and dispersal habitat (fauna); or
  - desirable substrate (flora).

The habitat maps for each threatened species and TECs is provided in Appendix B4 along with the species profiles that includes the species-specific ruleset used to inform the predictive habitat models.

7.2.2.3 Bioregional analysis

A bioregional analysis was undertaken using a consistent predictive modelling approach to quantify the extent of threatened species and TEC habitats across the Brigalow Belt Bioregion and analyse potential impacts of the Project proportionally.

The MNES significant impact guideline (Department of the Environment, 2013b) defines a ‘significant impact’ as an impact which is important, notable, or of consequence, having regard to its context or intensity. For critically endangered and endangered species, significant impact criteria define a population of a species’ as a population, or collection of local populations, that occurs within a particular bioregion (Department of the Environment, 2013b).

7.2.2.4 Probabilistic disturbance calculations

To estimate the potential impacts to MNES threatened species habitat and/or TECs associated with the Project activities, a probabilistic method of calculating the maximum development scenario for the Project has been adopted, referred to as the 'Probabilistic Disturbance Methodology and Model' (outlined in Appendix B3).

The Probabilistic Disturbance Methodology and Model was chosen to estimate the maximum development scenario for the Project because it is a transparent and repeatable process that can be used to model various development scenarios for a defined project Area. This methodology takes into consideration the process of gas field development and the way in which activities, such as well pads and linear infrastructure, are designed within a development area. This information is then combined with validated spatial data for ecological values such as threatened species habitat and TECs across the Project Area.

The Probabilistic Disturbance Methodology and Model involves several iterations of Monte-Carlo Simulations which simulate potential development scenarios with various infrastructure density footprints (1, 2 or 3 wells per km^2 or a combination) and distribution of different vegetation/habitat coverage. Consistent with standard statistical methods, probabilistic ranges of disturbance were calculated and select probabilities (50^{th} and 75^{th} percentiles of a normally distributed population) applied to field data to estimate a 'predicted' maximum disturbance with and without avoidance.

The Probabilistic Land Disturbance Methodology and Model used a GIS database and applied 1 km^2 grid cells across the Project Area. Within each grid cell, spatial data was used to determine the following:

- area in each cell available for development
- area in each cell where there are threatened species and TECs, and
- total coverage of all MNES values combined in the cell.

The modelled dataset provides the distribution and densities of the threatened species and TECs which the probabilistic disturbance criteria can then be applied to.

The estimated disturbance associated with the Project in each 1 km^2 cell for various intensities of development (1, 2 or 3 wells per km^2 or a combination) were considered. Estimates of total (combined) values and individual threatened species and TECs in each cell were aggregated into a total disturbance figure for each threatened species and TEC by Project tenement. To estimate the maximum development scenario for the Project, ten development scenarios were modelled to account for differences that could occur in resource availability and constraints that could be present. These scenarios formed the basis of determining how decisions around areas of avoidance and focused development would affect the estimate of maximum disturbance. The ten scenarios modelled are listed in Table 21.

Table 21: Probabilistic model scenarios

Scenario	Model Parameters
Scenario 1	One well per 1 km^2 cell with no avoidance
Scenario 2	well per 1 km^2 cell with avoidance
Scenario 3	Two wells per 1 km^2 cell with no avoidance
Scenario 4	Two wells per 1 km^2 cell with avoidance
Scenario 5	Three wells per 1 km^2 cell with no avoidance

Scenario	Model Parameters
Scenario 6	Three wells per 1 km^2 cell with avoidance
Scenario 7	Intensified development no avoidance – two wells per 1km^2 cell in various locations within a defined boundary and one well per cell in locations outside this boundary.
Scenario 8	Intensified development in the south - two wells in each per 1km^2 cell in southern Project Area tenements and no wells in the other Project Area tenements.
Scenario 9	Intensified development in the centre - two wells per 1km^2 cell within the central Project area tenements and the remainder of the wells distributed across the other tenements.
Scenario 10	Intensified development in the northern - two wells per 1km^2 cell within the northern Project Area tenements and the remainder of the wells distributed across the other tenements.

The scenario selected as the maximum development scenario for the Project was 'scenario 7' which is highlighted grey in Table 21 . This scenario provides an indicative and conservative upper limit of the impacts to threatened species and TECs that could occur as a result of the Project activities. Table 29 in section 7.2.2.6 lists the maximum disturbance associated with the Project as a result of probabilistic modelling carried out for scenario 7 for each threatened species and TEC. The Probabilistic Land Disturbance Methodology Report is attached as Appendix B3.

7.2.2.4.1 Validating the probabilistic model

As described above, the Probabilistic Disturbance Methodology and Model has been used to predict the maximum amount of disturbance that could occur to MNES threatened species habitat and/or TECs as a result of Project activities based on an indicative gas field development scenario. Due to the progressive nature of gas field development this method of predicting disturbance was considered a reliable method to adopt for estimating the Project's maximum disturbance and has been accepted for previous EPBC Act assessments.

As highlighted in Table 21, the probabilistic model scenario 7 was selected for the assessment as it was considered the most likely scenario to represent the intensity of development that would occur across the Project Area. It is important to note that the probabilistic modelling for scenario 7 is conservative in nature due to the following assumptions:

1. The target gas resource was available consistently across the entire Project Area.
2. The density of well development in each 1km^2 grid cell across most of the Project Areas was 1 well (and associated linear infrastructure) per cell. The density of wells increased to 2 wells (and associated linear infrastructure) per 1km^2 grid cell in a defined boundary to take into consideration access and utilisation of existing infrastructure.
3. MNES threatened species / TEC's were not avoided for the modelling scenario as the constraints planning and field development protocol was not applied to the probabilistic modelling. The predicted impacts to MNES are therefore greater than what will actually occur during field development after the constraints planning and field development protocol has been applied.

To validate the probabilistic modelling, a comparison between the 'actual' planned disturbance that could occur to the MNES threatened species and TECs within the initial development areas (first 5-10 years of the Project) and the 'probabilistic' modelled disturbance that could occur to MNES threatened species and TECs within the same initial development areas was completed. Due

to the size of the initial development areas the most suitable development scenario to use was 1 well (and associated linear infrastructure) per 1km^2 grid cell across the area with no resource information and no avoidance to MNES.

Initial gas field development layouts have been prepared to enable indicative impacts to MNES threatened species and TECs to be calculated for initial development area activities. The initial design has been developed to align with the quality and quantity of the target resource and to apply avoidance and minimisation measures in line with the Protocol. It is anticipated that further refinement of the design and reduction of impacts is expected as infrastructure designs are finalised.

Table 22 below gives a comparison of the impacts to MNES based on the 'actual' planned disturbance and the 'probabilistic' modelled disturbance for the initial development areas. The results indicate that the 'probabilistic' modelled disturbance within the initial development areas is based on development of 508 wells, which is 44% more wells than the 'actual' planned disturbance of 283 wells within the initial development areas. This highlights the conservative nature of the probabilistic modelling development scenario utilised for this assessment and the impact that resource quality and quantity and constraints planning avoidance and minimisation measures has on the number of wells, linear infrastructure and associated disturbance and impacts to MNES within the Project Area.

Table 22: Comparison of impacts for initial development areas

MNES	Impacts (ha) ('Actual' planned disturbance)[1]	Impacts (ha) ('Probabilistic' modelled disturbance)[2]
THREATENED ECOLOGICAL COMMUNITIES		
Brigalow TEC	18	105
Coolibah TEC	0	0
Natural grasslands TEC	1	2
Poplar Box TEC	1	29
SEVT TEC	3	2
Weeping Myall Woodlands TEC	1	0
FLORA		
Austral toadflax	0	0
Belson's panic	0	25
Bluegrass	0	1
King bluegrass	0	1
Kogan waxflower	0	93
Ooline	15	23
Shiny-leaved ironbark	0	41
Tara wattle	0	80
Aristida annua	0	1
Marsdenia brevifolia	0	7

MNES	Impacts (ha) ('Actual' planned disturbance)[1]	Impacts (ha) ('Probabilistic' modelled disturbance)[2]
FAUNA		
Australian painted snipe	7	88
Brigalow woodland snail	1	16
Collared Delma	22	147
Dulacca woodland snail	0	6
Dunmall's snake	26	206
Greater glider	4	91
Koala	14	202
Large-eared Pied Bat	0	0
Ornamental snake	0	55
Painted Honeyeater	29	222
Red Goshawk	2	177
South-eastern Long-eared Bat	31	262
Squatter Pigeon	4	21
Yakka Skink	23	243

[1] Impacts associated with the actual development scenario within the initial development area includes 283 wells and associated linear infrastructure.

[2] Impacts associated with the probabilistic model (based on a uniform development of 1 well per 1km^2 grid cell and associated linear infrastructure) within the initial development area includes 508 wells and associated linear infrastructure.

7.2.2.5 Land disturbance

For purpose of assessment in accordance with a conservative approach, an indicative disturbance footprint was prepared to correspond with the maximum development scenario.

A probabilistic disturbance model (outlined above) was developed to determine the potential extent of disturbance for the Project. The extent of this disturbance was intersected with the extent of modelled habitat providing an estimated upper limit of direct disturbance to threatened species and TEC habitat. This data was then used to inform SRI assessments for each threatened species and TEC.

The disturbance footprint extent is considered a conservative estimate, using the likely extent maximum development scenario of direct disturbance, and a conservative estimate of habitat distribution. In practice the Protocol (Origin, 2020a) includes detailed guidance as to how land disturbance will be firstly avoided, then minimised and mitigated, and quantified during Project development (Appendix A). Accordingly, the disturbance values presented are indicative only and will be refined during development of the Project.

7.2.2.6 Significant impact assessment

The significant impact assessments for threatened species and TECs with potential to be impacted by the Project consider the extent of the disturbance and circumstances (the SRI criteria) in which vegetation clearing and habitat loss may result in significant impacts to MNES. The SRI criteria

assume that threatened species and TECs can tolerate some degree of habitat loss, provided three key parameters are maintained:

- a minimum total extent of habitat
- habitat functionality at a more localised scale
- retention of connectivity between habitat areas (outlined further below).

These concepts have been reflected in the SRI criteria, with thresholds applied based on published scientific guidance. Descriptions of the three key parameters for SRI assessment are presented in Table 23. Corresponding thresholds for each threatened species and TEC is provided in Table 24.

Table 23: SRI parameters

SRI parameter	Description
1. Minimum total extent of habitat criterion (clearing rule)	It is logical that threatened species and TECs require a minimum extent of habitat in order to persist in a region. In line with both Queensland and Commonwealth government bioregional classifications and conservation planning initiatives, the SRI analysis has adopted the Brigalow Belt Bioregion (Queensland extent only) as an appropriate regional scale. The percent thresholds used to determine the effects of clearing have been derived from the literature, which generally demonstrate that there is a 10 to 30% threshold of habitat loss within a landscape below which species will be lost from the ecosystem (Andren 1994; McIntyre et al. 2000; Radford et al. 2005 – as quoted in Eyre *et al.* (2015)). This approach has provided the following SRI rule regarding total extent of habitat: • impacts will be considered SRI, if the total extent of clearing from the Project is greater than the following thresholds: – 0% of critically endangered species'/TECs available habitat within the Brigalow Belt Bioregion – 10% of endangered species'/TECs available habitat within the Brigalow Belt Bioregion – 30% of vulnerable species'/TECs available habitat within the Brigalow Belt Bioregion.
2. Habitat function criterion (functionality rule)	Irrespective of its total extent in a region, available habitat must still retain its ecological function at a local scale in order to support populations of threatened species. For TECs, this concept is recognised very explicitly via listing criteria, where for most TECs, a patch of vegetation is not recognised as being the TEC unless it is of a minimum size. This concept of functionality has been reflected in the SRI analysis and minimum patch sizes have been adopted in the development of criteria. For most threatened species, a minimum patch size of 5 ha has been adopted. This is based on the Queensland Government *Guide to Determining Terrestrial Habitat Quality* (Department of Environment and Science, 2020a) that nominates patches <5 ha in size as having a zero site context score i.e. they are considered non-viable for species. Smaller patch size thresholds have been set for some threatened reptile species, based on guidance in the *Draft Referral guidelines for the nationally listed Brigalow Belt reptiles* (Department of Sustainability Environment Water Population and Communities, 2011). These thresholds are: • 2 ha for Collared Delma (*Delma torquate*) and Ornamental Snake (*Denisonia maculata*) • 4 ha for Dunmall's Snake (*Furina dunmalli*). For TECs, the adopted patch size threshold is that provided in the TEC's approved conservation advice or listing advice. This is a logical application, as

SRI parameter	Description
	once patches fall below the nominated size, they are no longer considered the TEC and the TECs' status will have been lost. Thresholds are: • 0.5 ha for Brigalow and Weeping Myall TECs • 5 ha for all other TECs. Importantly, the habitat functionality rule considers the whole patch, not just the portion which is predicted to be directly impacted. That is, where impacts result in a patch being fragmented into a number of resulting smaller patches, SRI includes both the direct clearing and the extent of the resulting patch(es) that fall below the functionality threshold. Where resulting patches remain above threshold (i.e. are still considered functional) no SRI is accumulated. In this way and for some values, SRI may be larger than the total direct impact, as the SRI will include both the direct impact and the loss of functionality to patches which will be retained in the landscape, but at a size that is not considered to have viable ecological function.
3. Habitat connectivity criterion (connectivity rule)	For mobile species, loss of functionality as described above, may be mitigated if local connectivity between patches is retained. That is, a network of individual patches that fall below the 5 ha threshold may still provide viable habitat for mobile species, provided these patches are in close proximity to each other. Therefore, for mobile species (e.g. arboreal mammals, birds, bats) a habitat connectivity criterion has also been applied. Under this rule, habitat function is only considered lost as per the functionality rule (above) if the smaller patches created via fragmentation of larger patches during clearing are both below the size threshold and separated by 26 m or greater. The distance of 26 m was considered an appropriate distance for a range of species including Koala (as per McAlpine *et al.* (2007) and Greater Glider (Threatened Species Scientific Committee, 2016b)) and is likely to be conservative for other species such as threatened birds and bats. For non-mobile species, a distance of 0 m or greater was applied to the analysis.

Table 24: SRI threshold for threatened species and TECs

Threatened species and TECs	EPBC Act Listing status*	Total extent (bioregional clearing threshold)	Functionality (min patch size)	Connectivity (min patch separation distance)
White-throated Snapping Turtle	CE	0%	5 ha	26 m
Weeping Myall TEC and Brigalow TEC	E	10%	0.5 ha	0 m
Brigalow Woodland Snail, Dulacca Woodland Snail, King Blue-grass, Salt Pipewort, *Solanum dissectum*, *Solanum johnsonianum*, Coolibah TEC, Natural Grasslands TEC, Poplar Box TEC, SEVT TEC	E	10%	5 ha	0 m
Australasian Bittern, Black-throated Finch, Australian Painted Snipe	E	10%	5 ha	26 m
Collared Delma	V	30%	2 ha	0 m
Ornamental Snake	V	30%	2 ha	0 m
Dunmall's Snake	V	30%	4 h	0 m

Threatened species and TECs	EPBC Act Listing status*	Total extent (bioregional clearing threshold)	Functionality (min patch size)	Connectivity (min patch separation distance)
Yakka Skink, Curly-bark Wattle, Tara Wattle, *Aristida annua*, *Bertya opponens*, Ooline, *Calytrix gurulmundensis*, *Daviesia discolour*, Bluegrass, Shiny-leaved Ironbark, Belson's Panic, *Marsdenia brevifolia*, Kogan Waxflower, Austral Toadflax	V	30%	5 ha	0 m
Large-eared Pied Bat, Red Goshawk, Squatter Pigeon (southern), Painted Honeyeater, South-eastern Long-eared Bat, Greater Glider, Koala, Grey-headed Flying-fox, Fitzroy River Turtle	V	30%	5 ha	26 m

* EPBC Act listing status: CE = Critically Endangered, E = Endangered, V = Vulnerable

7.2.3 Results

7.2.3.1 Likelihood of occurrence

The PMST and field surveys identified a range of biodiversity values that may occur in the Project Area. These are summarised in Table 25.

Table 25: MNES (biodiversity) overview

MNES (biodiversity values)	PMST results (Project Area)	Potential impacts assessed
Listed TECs	8 TECs	TECs that may occur within the Project Area are assessed in Section 7.2.3.3.1
Listed Threatened Species	44 threatened species	Threatened flora and threatened fauna that may occur within the Project Area are assessed in Section 7.2.3.3.2 and Section 7.2.3.3.3 respectively
Listed Migratory Species	14 migratory species	Refer to Section 7.3

A likelihood of occurrence assessment was undertaken to identify threatened species and TECs that may occur within the Project Area using databases (primarily the PMST and ALA), existing information from desktop assessments and field surveys (Section 7.2.2.1). The results were then analysed to determine which threatened species and TECs require detailed assessment.

The results of the likelihood of occurrence assessment identified eight TECs, 13 threatened flora species and 19 threatened fauna species as 'potentially' occurring within the Project Area (Table 26). The completed likelihood of occurrence assessments are provided in Appendix B1.

Table 26: Threatened species and TECs with the potential to occur within the Project Area

Name		EPBC Act listing status*
THREATENED ECOLOGICAL COMMUNITIES		
Brigalow (*Acacia harpophylla* dominant and co- dominant)		E
Coolibah - Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South bioregions		E
Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin		E
Poplar Box Grassy Woodland on Alluvial Plains		E
Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar bioregions		E
Weeping Myall Woodlands		E
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland		CE
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin TEC		E
FLORA		
Scientific name	**Common name**	
Acacia curranii	Curly-bark Wattle	V
Acacia lauta	Tara Wattle	V
Aristida annua		V
Bertya opponens		V
Cadellia pentastylis	Ooline	V
Dichanthium queenslandicum	King Blue-grass	E
Dichanthium setosum	Bluegrass	V
Eriocaulon carsonii	Salt Pipewort	E
Eucalyptus virens	Shiny-leaved Ironbark	V
Homopholis belsonii	Belson's Panic	V
Marsdenia brevifolia		V
Philotheca sporadica	Kogan Waxflower	V
Thesium australe	Austral Toadflax	V
FAUNA		
Scientific name	**Common name**	
Adclarkia cameroni	Brigalow Woodland Snail	E
Adclarkia dulacca	Dulacca Woodland Snail	E
Chalinolobus dwyeri	Large-eared Pied Bat	V
Delma torquata	Collared Delma	V

Name		EPBC Act listing status*
Denisonia maculata	Ornamental Snake	V
Egernia rugosa	Yakka Skink	V
Elseya albagula	White-throated Snapping Turtle	CE
Erythrotriorchis radiatus	Red Goshawk	V
Falco hypoleucos	Grey Falcon	V
Furina dunmalli	Dunmall's Snake	V
Geophaps scripta	Squatter Pigeon (southern)	V
Grantiella picta	Painted Honeyeater	V
Nyctophilus corbeni	South-eastern Long-eared Bat	V
Petauroides volans	Greater Glider	V
Phascolarctos cinereus	Koala	V
Poephila cincta	Black-throated Finch	E
Pteropus poliocephalus	Grey-headed Flying-fox	V
Rheodytes leukops	Fitzroy River Turtle	V
Rostratula australis	Australian Painted Snipe	E

* EPBC Act listing status: CE = Critically Endangered, E = Endangered, V = Vulnerable

The likelihood of occurrence assessment identified six threatened flora species and six threatened fauna species as 'unlikely' to occur within the Project Area, either due to lack of suitable habitat or no records within and surrounding the Project Area. These threatened species are described and assessed in Table 27 and were not considered further.

Table 27: Threatened species considered unlikely to occur within the Project Area

Scientific name	Common name	Listing status*	Justification for exclusion
FLORA			
Acacia grandifolia	-	V	*Acacia grandifolia* is endemic to south-east Queensland, where it is restricted to a small area around Gayndah, Mundubbera, Coulston Lakes and Proston in the Burnett District. The species grows in hilly terrain on hillslopes of varying aspects and slope, and also occurs on hillcrests, gullies and plains. *Acacia grandifolia* appears to flourish in disturbed ground and grows well on roadsides. This species is not known from the Project Area.
Arthraxon hispidus	Hairy-joint grass	V	Hairy-joint Grass occurs in New South Wales and Queensland with most occurrences from Noosa southwards. There are disjunct occurrences around mound springs in Carnarvon National Park. In New South Wales and Queensland, Hairy-joint Grass is found in or on the edges of rainforest and in wet

Scientific name	Common name	Listing status*	Justification for exclusion
			eucalypt forest, often near creeks or swamps as well as woodland. In south-east Queensland, Hairy-joint Grass has also been recorded growing around freshwater springs on coastal foreshore dunes, in shaded small gullies, on creek banks, and on sandy alluvium in creek beds in open forests and also with bog mosses in mound springs. Suitable habitat for this species does not exist in the Project Area.
Eucalyptus beaniana	Bean's Ironbark	V	*Eucalyptus beaniana* is known only from two locations at Isla Gorge and north-east of Baroondah station, Queensland. The total number of plants is unknown. The species grows in woodland with numerous other eucalypt species, on quartzose sandstone ridges. This species is not known from the Project Area.
Macrozamia platyrhachis	A cycad	E	*Macrozamia platyrhachis* is restricted to the Blackdown Tableland / Planet Downs area of the Dawson Range in central Queensland. This species is not known from the Project Area.
Tylophora linearis	-	E	There are known populations of this species in Myall Park, near Glenmorgan, Queensland. It grows in dry scrub, open forest and woodlands. This species is not known from the Project Area.
Xerothamnella herbacea	-	E	*Xerothamnella herbacea* is known from two sites north east of Chinchilla, a single record from near Theodore and a record near Yelarbon east of Goondiwindi, Queensland. This species is not known from the Project Area.
FAUNA			
Calidris ferruginea	Curlew Sandpiper	CE, migratory	In Queensland, scattered records of the Curlew Sandpiper occur in the Gulf of Carpentaria, with widespread records along the coast south of Cairns. There are sparsely scattered records inland. This species usually forages and roosts in intertidal mudflats in sheltered coastal areas, such as estuaries, bays, inlets and lagoons and around non-tidal swamps, lakes and lagoons near the coast, and ponds in saltworks and sewage farms. The occurrence of this species within the Project Area is highly unlikely.
Dasyurus hallucatus	Northern Quoll	E	In Queensland, the Northern Quoll is known to occur as far south as Gracemere and Mt Morgan, south of Rockhampton, as far north as Weipa, and as far west as Carnarvon Range National Park. Previous field surveys conducted within the Project Area have not

Scientific name	Common name	Listing status*	Justification for exclusion
			identified any evidence of the Northern Quoll or suitable habitat such as rocky denning areas. There are also no confirmed nearby records for the species. The occurrence of this species within the Project Area is highly unlikely.
Hirundapus caudacutus	White-throated Needletail	V, migratory	The White-throated Needletail has been recorded in all coastal regions of Queensland. In Australia, it is almost exclusively aerial (1-1000 m above ground). The species occurs over a variety of habitats, with a preference for wooded areas. The occurrence of an important population within the Project Area is highly unlikely.
Maccullochella peelii	Murray Cod	V	The Murray Cod occurs within major rivers and streams in the northern, central and southern parts of the Murray Darling Basin. It is frequently found in the main channels of rivers and larger tributaries, inhabiting a diverse range of river habitats, from clear rocky streams to slow-flowing, turbid lowland rivers and billabongs. The occurrence of an important population within the Project Area is highly unlikely.
Macroderma gigas	Ghost Bat	V	The Queensland subpopulations of the Ghost Bat are located in four to five highly disjunct localities (migration is uncommon) which are distributed across coastal and near-coastal eastern Queensland, from Cape York to near Rockhampton, and in western Queensland. The species occupies habitats ranging from the arid Pilbara to tropical savanna woodlands and rainforests. During the day, roosting sites include caves, rock crevices and disused mine entrances. The occurrence of an important population within the Project Area is highly unlikely.
Neochmia ruficauda	Star Finch (eastern), Star Finch (southern)	E	Recent records of the Star Finch have been obtained only from scattered sites in central Queensland (between 21°S and 25°S, and 141°E and 150°E); the species now appears to be extinct in both south-eastern Queensland and northern New South Wales. The Star Finch occurs mainly in grasslands and grassy woodlands that are located close to bodies of fresh water. The occurrence of this species within the Project Area is highly unlikely.

* EPBC Act listing status: CE = Critically Endangered, E = Endangered, V = Vulnerable

7.2.3.2 Refinement of threatened species and TECs to be assessed

Further refinement was undertaken on some potentially occurring threatened species and TECs (identified in Table 28) in the context of the Project. The rationale applied was that some values, while identified as potentially present, can be avoided such that impacts do not warrant detailed consideration. This approach was applied where habitat modelling predicts development will occur away from areas of suitable habitat or only very small areas of habitat occur within the area. Conservative application of the following criteria determined the species to be subject to further detailed assessment:

- known/ modelled distribution of the species or TEC
- known records from previous surveys within or in the vicinity of the Project Area
- additional records from desktop resources; and
- ability to avoid impacts.

The results of this analysis demonstrate there are eight values that had habitat modelling and initial impact analysis undertaken, that are not likely to be impacted by the Project. Habitat modelling rules and outputs are presented in Appendix B4. Detailed analysis of SRIs for these values have not been undertaken, for reasons presented in Table 28.

Table 28: Values which do not require detailed impact analysis

Threatened species / TEC name	Brief summary of species presence and predicted habitat modelling results	Detailed analysis of impacts
The community of native species dependent on natural discharge of groundwater from the Great Artesian Basin TEC	This TEC has been ground-truthed within the Project Area (Spring Gully (Block C and D)) It has been recognised as an area of very high ecological significance and designated a no-go zone (Origin, 2020b) Disturbance to this TEC protected under the EPBC Act will be avoided as detailed in the Protocol	Not required – full avoidance
White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland TEC	Vegetation that comprises the TEC is not present within the Project Area	Not required – mapping indicates value not present
Black-throated Finch *Poephila cincta*	Predicted habitat modelling indicates no habitat for this species is located in the Project Area	Not required – mapping indicates value not present
Grey Falcon *Falco hypoleucos*	No breeding habitat in the Project Area. Project Area limited to general foraging habitat which could be used at any time for opportunistic hunting	Not required, mapping indicates impacts negligible (foraging habitat only)
Bertya opponens	Predicted habitat modelling indicates no habitat for this species is located in the Project Area	Not required – mapping indicates value not present
Curly-bark wattle *(Acacia curranii)*	Predicted habitat modelling indicates no habitat for this species is located in the Project Area	Not required – mapping indicates value not present

Threatened species / TEC name	Brief summary of species presence and predicted habitat modelling results	Detailed analysis of impacts
Salt pipewort (*Eriocaulon carsonii*)	Project Area extent - 3 ha Projected maximum disturbance - 0 ha	Not required - no impacts predicted
Grey-headed flying-fox *(Pteropus poliocephalus)*	Predicted habitat modelling indicates no habitat for this species is located in the Project Area	Not required - mapping indicates value not present

7.2.3.3 Significant residual impact assessments

Significant residual impact assessments for identified threatened species and TECs are detailed in Appendix B5.

It is important to note that the development scenarios, disturbance numbers and SRI analyses are indicative and upper limits. They are included to provide a quantum of possible impacts and, most importantly, to demonstrate that the subsequent ecological assessment that will follow gas field infrastructure design will provide accurate and detailed results.

Both the habitat and the probabilistic modelling methods have resulted in a conservative (over) estimate of maximum disturbance associated with the Project activities. In reality it is expected that these numbers will reduce, particularly as the mapped extent of habitat is often overestimated due to the GIS modelling methods being unable to distinguish micro habitat features (e.g. fallen timber that may be an essential habitat requirement for many species such as the Yakka skink and Dunmall's snake). As a result, the assessment has taken a conservative approach and all potential areas of habitat are included in the species map to minimise scientific uncertainty.

In addition, once an ecological assessment is undertaken during design and execution further reductions in habitat disturbance is likely through the implementation of the Constraints Protocol which includes detailed guidance as to how land disturbance to MNES will be firstly avoided where possible, and then minimised or mitigated (Appendix A).

As a result, the proposed maximum disturbance numbers are an upper limit derived from a conservative pre-mitigation scenario based on the maximum development scenario.

The SRI calculations for each threatened species and TEC are also indicative only as they will also be revised following application of the Protocol and further ecological assessment. The SRI numbers presented in this report have been derived using a possible indicative development scenario.

Determination of actual SRI will occur after detailed planning of gas field design is undertaken and the Protocol has been implemented to minimise residual impacts on MNES. Section 3.2.3 in Appendix E - Offsets Plan provides an example of how actual SRI will be determined.

Table 29 provides an overview of the outcomes of the detailed impact analysis for all threatened species and TECs addressed in the sections below.

Table 29: Summary of predicted disturbance and SRI for maximum development scenario

Name	Bioregional extent (ha)	Project Area extent (ha)	Project disturbance % of Bioregion	Project disturbance (ha)	SRI (ha)
THREATENED ECOLOGICAL COMMUNITIES					
Brigalow TEC	576,963	22,868	0.18%	1,065	189
Coolibah TEC	172,854	2,198	0.05%	95	133

Name	Bioregional extent (ha)	Project Area extent (ha)	Project disturbance % of Bioregion	Project disturbance (ha)	SRI (ha)
Natural grasslands TEC	231,045	2,498	0.05%	110	47
Poplar Box TEC	593,209	22,777	0.19%	1,124	1,016
SEVT TEC	81,498	234	0.02%	13	44
Weeping Myall Woodlands TEC	20,727	928	0.23%	48	10
FLORA					
Austral toadflax	496,144	299	0.00%	11	11
Belson's panic	240,760	3,160	0.10%	238	161
Bluegrass	231,045	2,498	0.05%	111	47
King bluegrass	231,045	2,498	0.05%	111	47
Kogan waxflower	279,543	8,517	0.23%	647	239
Ooline	1,860,157	47,390	0.14%	2,664	920
Shiny-leaved ironbark	477,263	4,790	0.08%	366	200
Tara wattle	135,123	5,940	0.33%	452	170
Aristida annua	231,045	2,498	0.05%	111	47
Marsdenia brevifolia	413,891	7,874	0.08%	317	276
FAUNA					
Australian painted snipe	2,581,000	31,671	0.05%	1,374	0
Brigalow woodland snail	90,458	335	0.03%	29	14
Collared delma	4,335,249	105,692	0.13%	5,633	42
Dulacca woodland snail	63,269	130	0.02%	10	10
Dunmall's snake	4,413,095	85,961	0.11%	5,014	69
Fitzroy river turtle	380,786	11,693	0.05%	209	0
Greater glider	6,097,597	87,552	0.08%	4,593	11
Koala	114,381,173	113,742	0.01%	5,870	34
Large-eared pied bat	1,005,441	56,855	0.33%	3,283	10
Ornamental snake	1,097,932	23,101	0.08%	870	10

Name	Bioregional extent (ha)	Project Area extent (ha)	Project disturbance % of Bioregion	Project disturbance (ha)	SRI (ha)
Painted honeyeater	1,394,953	85,549	0.31%	4,314	61
Red goshawk	8,450,479	114,939	0.07%	6,025	10
South-eastern long-eared bat	6,761,232	120,387	0.09%	6,380	61
Squatter pigeon (southern)	2,214,294	31,623	0.07%	1,540	12
White throated snapping turtle	142,870	4,578	0.00%	0	0
Yakka skink	6,870,107	94,340	0.07%	4,830	3,187

7.2.3.3.1 *Threatened ecological communities*

Detailed analysis of impacts has been undertaken for the following TECs:

- Brigalow (*Acacia harpophylla* dominant and co-dominant)
- Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt South bioregions
- Natural Grasslands of the Queensland Central Highlands and northern Fitzroy Basin
- Poplar Box Grassy Woodland on Alluvial Plains
- Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar bioregions) (SEVT)
- Weeping Myall Woodlands.

Each TEC has been described in terms of the following:

- listing status
- description
- community in the bioregion
- community in the Project Area
- potential impacts
- direct disturbance calculations
- SRI calculations
- offset provisions.

Predicted impacts for each TEC have been assessed consistent with the Significant Impact Guidelines (Department of the Environment, 2013b).

7.2.3.3.1.1 Brigalow TEC

The Brigalow TEC has been field-verified within the Mahalo (Block A, B and C), Spring Gully (Block B, C and D), Denison and Ironbark development areas of the Project. An overview of the TEC within the bioregion and the Project Area is provided in Table 30. A detailed profile and mapping for Brigalow TEC (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the potential impact to Brigalow TEC against the Significant Impact Guidelines (Department of the Environment, 2013b).

Table 30: Overview of Brigalow TEC

Attribute	Description
TEC listing status	Endangered
TEC description	• The TEC is characterised by the tree species *Acacia harpophylla* (Brigalow) as either dominant or co-dominant with *Casuarina cristata* (Belah) or other *Acacia* and *Eucalyptus* species (Department of Agriculture Water and the Environment, 2020). • To be considered a TEC, vegetation patches must also have <50% exotic perennial cover and be >0.5 ha in size.
TEC in the bioregion	• Approximately 576,963 ha of Brigalow TEC exists in the bioregion (refer Appendix B4). • 85% of the TEC occurs on flat to gently undulating Cainozoic clay plains. • 10% of the TEC is associated with river and creek flats. • 5% of the TEC is associated with old loamy and sandy plains, basalt plains and hills, or hills and lowlands on metamorphic or granitic rocks (Threatened Species Scientific Committee and Department of the Environment, 2013).
TEC in the Project Area	• Approximately 22,868 ha of potential Brigalow TEC has been mapped in the Project Area and comprises patches greater than 0.5 ha of component REs (see Appendix B4). • Most mapped TEC patches are 5-20 ha in size and are located within a highly fragmented landscape.
Potential impacts to the TEC	• The approved conservation advice for Brigalow TEC (Threatened Species Scientific Committee and Department of the Environment, 2013) highlights the following key threats: clearing; fire; weeds and pests; inappropriate grazing regimes; and climate change. • Clearing may result in an SRI to Brigalow TEC. • Residual impacts will be mitigated through offsets and rehabilitation measures. • Other threats can be appropriately managed.

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.18% of the TEC present in the bioregion. • This equates to approximately 1,065 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 189 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 189 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through a combination of rehabilitation and offsets the long-term outcomes should result in a net increase in TEC extent.

7.2.3.3.1.2 Coolibah - Black Box TEC

The Coolibah – Black Box TEC has been field-verified within the Spring Gully (Block C and D) development area. An overview of the TEC within the bioregion and the Project Area is provided in Table 31. A detailed profile and mapping for Coolibah – Black Box TEC (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Coolibah - Black Box TEC against the Significant Impact Guidelines criteria.

Table 31: Overview of Coolibah - Black Box TEC

Attribute	Description
TEC listing status	Endangered
TEC description	• The TEC is characterised by woodlands with dominant tree species *Eucalyptus coolabah subsp. coolabah* and/or *Eucalyptus largiflorens* (Threatened Species Scientific Committee, 2011). • To be considered the TEC, vegetation patches must present: a crown cover of >8%, <50% exotic perennial cover and be >5 ha in size.
TEC in the bioregion	• The Coolibah – Black Box TEC is found on grey, self-mulching clays of floodplains (periodically waterlogged), swamp margins, ephemeral wetlands, and stream levees. • This TEC is associated with drainage depressions and floodplains (Threatened Species Scientific Committee, 2011). • Approximately 172,854 ha of Coolibah – Black Box TEC exists in the bioregion (refer to Appendix B4).
TEC in the Project Area	• Approximately 2,198 ha of potential Coolibah - Black Box TEC has been mapped in the Project Area and comprises patches greater than 5 ha of component REs (see Appendix B4). • The TEC is only located in three development areas (Mahalo (Block C), Denison and Spring Gully (Block C)) and occurs in fragmented patches along or close to riparian zones. • Some patches form part of larger, continuous patches outside of the Project Area, or connect multiple patches.
Potential impacts to the TEC	• The approved conservation advice for Coolibah – Black Box TEC highlights the following key threats: clearing and fragmentation; changes to hydrology; weeds; inappropriate grazing regimes; and climate change. • The Project may result in an SRI to Coolibah – Black Box TEC from clearing and fragmentation. • Residual impacts will be mitigated through offsets and rehabilitation measures. • Other threats can be appropriately managed or are not likely to result in residual significant impacts.

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.05% of the TEC present in the bioregion. • This equates to approximately 95 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 133 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 133 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through a combination of rehabilitation and offsets the long-term outcomes should result in a net increase in TEC extent.

7.2.3.3.1.3 Natural Grasslands TEC

The Natural Grasslands TEC has been field-verified within the Mahalo (Block A, B and C), Spring Gully (Block B) and Denison development areas. An overview of the TEC within the bioregion and the Project Area is provided in Table 32. A detailed profile and mapping for Natural Grasslands TEC (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Natural Grasslands TEC against the Significant Impact Guidelines criteria.

Table 32: Overview of Natural Grasslands TEC

Attribute	Description
TEC listing status	Endangered
TEC description	• The TEC is characterised by native tussock grasslands, typically composed of native perennial grass species (Threatened Species Scientific Committee, 2009a). • To be considered a TEC, vegetation patches must have: ≥3 native perennial grasses, ≥200 native grass tussocks, <50% canopy cover, <30% exotic perennial cover and be >5 ha in size.
TEC in the bioregion	• The Natural Grasslands TEC typically occurs on flat ground or gently undulating rises. • This TEC is found on soils that are fine textured (often cracking clays) derived from either basalt or fine-grained sedimentary rocks (Threatened Species Scientific Committee, 2009a). • Approximately 231,045 ha of Natural Grasslands TEC exists in the bioregion (refer to Appendix B4).
TEC in the Project Area	• Approximately 2,498 ha of potential Natural Grasslands TEC has been mapped in the Project Area and comprises patches greater than 5 ha of component REs (see Appendix B4).
Potential impacts to the TEC	• The approved conservation advice for Natural Grasslands TEC highlights the following key threats: grazing; cropping/pasture improvement; mining; weeds and pests; and infrastructure construction including roads. • The Project may result in an SRI to Natural Grasslands TEC from clearing due to the construction of infrastructure. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.05% of the TEC present in the bioregion. • This equates to approximately 110 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule.

Attribute	Description
	• 47 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 47 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through a combination of rehabilitation and offsets the long-term outcomes should result in a net increase in TEC extent.

7.2.3.3.1.4 Poplar Box TEC

The Poplar Box TEC has been field-verified within the Mahalo (Block A, B and C), Spring Gully (Block B) and Denison development areas. An overview of the TEC within the bioregion and the Project Area is provided in Table 33. A detailed profile and mapping for Poplar Box TEC (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the potential impact to Poplar Box TEC against the Significant Impact Guidelines criteria.

Table 33: Overview of Poplar Box TEC

Attribute	Description
TEC listing status	Endangered
TEC description	• The TEC is characterised by a grassy woodland with a canopy dominated by *Eucalyptus populnea* and an understorey mostly consisting of grasses and other herbs (Department of the Environment and Energy, 2019). • To be considered a TEC, vegetation patches must have: ≥10% canopy cover, >50% native perennial cover and be >5 ha in size.
TEC in the bioregion	• Poplar Box TEC typically occurs on gently undulating to flat landscape sand occasionally on gentle slopes and occurs on a wide range of soil types of alluvial and depositional origin (Department of the Environment and Energy, 2019). • Approximately 593,209 ha of Poplar Box TEC exists in the bioregion (refer to Appendix B4).
TEC in the Project Area	• Approximately 22,777 ha of potential Poplar Box TEC has been mapped in the Project Area and is comprised of patches greater than 5 ha of component REs (see Appendix B4). • The TEC occurs in all development areas except Mahalo (Block B), including in large continuous patches.
Potential impacts to the TEC	• The approved conservation advice for Poplar Box TEC highlights the following key threats: clearing and fragmentation; inappropriate fire and grazing regimes; weeds; changes to hydrology; salinization; dieback; chemical spray; increased nutrients; invasive fauna; and climate change. • The Project may result an SRI to Poplar Box TEC from clearing and fragmentation. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed, or are not applicable, in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.19% of the TEC present in the bioregion. • This equates to approximately 1,124 ha

Attribute	Description
SRI calculations	• 0 ha will be impacted via the SRI clearing SRI rule. • 1,016 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 1,016 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through a combination of rehabilitation and offsets the long-term outcomes should result in a net increase in TEC extent.

7.2.3.3.1.5 Semi-evergreen Vine Thickets TEC

The SEVT TEC has been field-verified within the Mahalo (Block A, B and C), Spring Gully (Block B, C and D), and Denison development areas. An overview of the TEC within the bioregion and the Project Area is provided in Table 34. A detailed profile and mapping for SEVT TEC (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the potential impact to SEVT TEC against the Significant Impact Guidelines criteria.

Table 34: Overview of SEVT TEC

Attribute	Description
TEC listing status	Endangered
TEC description	• The TEC is characterised by the prominence of trees with microphyll sized leaves (2.5–7.5 cm long) and the common presence of swollen-stemmed 'bottle trees' (*Brachychiton australis, B. rupestris*) emerging from the vegetation (McDonald, 2010). • To be considered a TEC, vegetation patches must consist of component REs (see Appendix B4). • There is no minimum patch size threshold for the TEC as per the listing advice. • A minimum patch size of 5 ha has been adopted for SEVT TEC. [3]
TEC in the bioregion	• SEVT TEC typically occurs on undulating plains on fine-grained sedimentary rocks (often shale) and on basalt hills and plains. • The TEC is associated with elevated, freely drained sites (McDonald, 2010). • Approximately 81,498 ha of SEVT TEC exists in the bioregion (refer to Appendix B4).
TEC in the Project Area	• Approximately 234 ha of potential SEVT TEC has been mapped in the Project Area and is comprised of patches greater than 5 ha of component REs (see Appendix B4). • The SEVT TEC primarily occurs within Mahalo (Block A and C), often within riparian zones.
Potential impacts to the TEC	• The approved recovery plan for the SEVT TEC highlights the following key threats: clearing; fire; weeds; grazing; exotic fauna; and coastal development. • The Project may result in an SRI to SEVT TEC from clearing. • Residual impacts will be mitigated through offsets and rehabilitation measures.

[3] Patches <5 ha have been determined to lose TEC functionality (Department of Environment and Heritage Protection, 2017). This is consistent with the minimum patch size for other listed TECs.

Attribute	Description
	• All other threats can be appropriately managed, or are not applicable, in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.02% of the TEC present in the bioregion. • This equates to approximately 13 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 44 ha will be impacted via the SRI habitat function and connectivity rules. • A residual significant impact of 44 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through a combination of rehabilitation and offsets the long-term outcomes should result in a net increase in TEC extent.

7.2.3.3.1.6 *Weeping Myall Woodlands TEC*

The Weeping Myall Woodlands TEC has been field-verified within the Mahalo (Block A, B and C), Spring Gully (Block B) and Denison development areas. An overview of the TEC within the bioregion and the Project Area is provided in Table 35. A detailed profile and mapping for Weeping Myall Woodlands TEC (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the potential impact to Weeping Myall Woodlands TEC against the Significant Impact Guidelines criteria.

Table 35: Overview of Weeping Myall Woodlands TEC

Attribute	Description
TEC listing status	Endangered
TEC description	• The TEC is characterised by woodlands in which Weeping Myall (Acacia pendula) trees are the sole or dominant overstorey species. • To be considered a TEC, vegetation patches must have: ≥50% Weeping Myall canopy composition (living or dead), >5% canopy cover and be >0.5 ha in size. • In Queensland, the TEC occurs within two REs (11.3.2 & 11.3.28) and is estimated to comprise no more than 5% of these REs (Threatened Species Scientific Committee, 2009b). [4]
TEC in the bioregion	• The Weeping Myall Woodlands TEC typically occurs on flat areas, shallow depressions or gilgais on raised (relict) alluvial plains. • This TEC occurs on black, brown, red-brown or grey clay or clay loam soils (Threatened Species Scientific Committee, 2009b). • Approximately 20,727 ha of Weeping Myall Woodlands TEC exist in the bioregion (refer to Appendix B4).
TEC in the Project Area	• Approximately 928 ha of potential Weeping Myall Woodlands TEC has been mapped in the Project Area and is comprised of patches greater than 0.5 ha of component REs (see Appendix B4).
Potential impacts to the TEC	• The approved Listing Advice for Weeping Myall Woodlands TEC highlights the following key threats: clearing and fragmentation; overgrazing; weeds; and herbivory by caterpillars of the Bag-shelter Moth (*Ochrogaster lunifer*). • The Project may result in an SRI to Weeping Myall Woodlands TEC from clearing and fragmentation. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.

[4] Area extent values for Weeping Myall Woodlands have used 5% of the mapped extent as per the approved Listing Advice (Threatened Species Scientific Committee, 2009b)

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.23% of the TEC present in the bioregion. • This equates to approximately 48 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 10 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 10 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through a combination of rehabilitation and offsets the long-term outcomes should result in a net increase in TEC extent.

7.2.3.3.2 Threatened flora and habitats

Detailed analysis of impacts has been undertaken for the following threatened flora species:

- Austral Toadflax
- Belson's Panic
- Bluegrass
- King Bluegrass
- Kogan Waxflower
- Ooline
- Shiny-leaved Ironbark
- Tara Wattle
- Aristida annua
- Marsdenia brevifolia.

Each species has been described in terms of the following:

- listing status
- description
- species in the bioregion
- species in the Project Area
- potential impacts
- direct disturbance calculations
- SRI calculations
- offset provisions.

Predicted impacts for each flora species have been assessed consistent with the Significant Impact Guidelines (Department of the Environment, 2013b).

7.2.3.3.2.1 *Austral Toadflax (Thesium australe)*

Austral Toadflax is known to occur within the Project Area. An overview of Austral Toadflax within the bioregion and the Project Area is provided in Table 36. A detailed profile and mapping for Austral Toadflax (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Austral Toadflax against the Significant Impact Guidelines criteria.

Table 36: Overview of Austral Toadflax

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• The species occurs sporadically between the Bunya Mountains in southeast Queensland down to northeast Victoria. • In Queensland, local populations have been recorded in Kumbia, Glen Rock Regional Park, Carnarvon National Park, Crow's Nest, Clifton, Warwick, Greenmount, Cambooya, Dalby, the Bunya Mountains, Blackbutt and Imbil. • Found across a range of altitudes in shrubland, grassland or woodland in subtropical, temperate and subalpine climates on black clay loam to peaty loam soils.
Population and habitat in the bioregion	• Species distribution overlaps with the Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy Basin and the White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland TECs (Department of Agriculture Water and the Environment, 2020). • Approximately 496,144 ha of potential Austral Toadflax habitat is mapped in the bioregion.
Population and habitat in the Project Area	• Approximately 299 ha of Austral Toadflax habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4. • Habitat primarily occurs as continuous patches of riparian vegetation.
Potential impacts to the species	• The approved conservation advice for Austral Toadflax highlights key threats of lack of fire and/or disturbance, existing and intensified grazing by livestock and herbivores, weed invasion and infrastructure and agriculture development. • Lack of disturbance can cause lower, mid and upper stratum canopy thickening which reduces species diversity. • The Project may result in an SRI to Austral Toadflax by infrastructure development and fragmentation. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.002% of the potential habitat present in the bioregion. • This equates to approximately 11 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 11 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 11 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.2.2 *Belson's Panic (Homopholis belsonii)*

Belson's Panic is known to occur within the Project Area. An overview of Belson's Panic within the bioregion and the Project Area is provided in Table 37. A detailed profile and mapping for Belson's Panic (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Belson's Panic against the Significant Impact Guidelines criteria.

Table 37: Overview of Belson's Panic

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• In Queensland, the species occurs within the southern Brigalow belt- extending from Darling Downs west of Toowoomba further west to between Miles and Roma. • Found in dry woodland habitats on poor soils (e.g. basalt derived).
Population and habitat in the bioregion	• Species distribution overlaps with the Brigalow TEC (Department of Agriculture Water and the Environment, 2020). • Approximately 240,761 ha of potential Belson's Panic habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 3,160 ha of Belson's Panic habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4. • Habitat primarily occurs in Ironbark; however small scattered patches are also located in Peat. • Large contiguous patches occur in the Ironbark development area.
Potential impacts to the species	• The approved conservation advice for Belson's Panic highlights key threats including habitat clearing for agriculture, development or pasture improvement, overgrazing by domestic stock, invasion of habitat by introduced weeds and clearing for mining. • The Project may result in an SRI to Belson's Panic by habitat clearing. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.10% of the potential habitat present in the bioregion. • This equates to approximately 238 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule.

Attribute	Description
	• 161 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 161 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.2.3 *Bluegrass (Dichanthium setosum)*

Bluegrass is known to occur within the Project Area. An overview of Bluegrass within the bioregion and the Project Area is provided in Table 38. A detailed profile and mapping for Bluegrass (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Bluegrass against the Significant Impact Guidelines criteria.

Table 38: Overview of Bluegrass

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• In Queensland, the species occurs in the Leichhardt, Morton, North Kennedy and Port Curtis regions, including its presence within the Main Range National Park and the adjacent Glen Rock Regional Park. • Found in moderately disturbed settings of cleared woodland, grassy roadside remnants, grazed land and pasture on basaltic black soils and stony red-brown lard setting loam with clay subsoil.
Population and habitat in the bioregion	• Species distribution overlaps with the SEVT, Brigalow and White Box-Yellow Box-Blakelys Red Gum Grassy Woodland and Derived Natural Grassland TECs (Department of Agriculture Water and the Environment, 2020). • Approximately 231,045 ha of potential Bluegrass habitat in the bioregion[5].
Population and habitat in the Project Area	• Approximately 2,498 ha of Bluegrass habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for Bluegrass highlights key threats being heavy grazing by domestic stock, of loss of habitat due to clearing for agriculture, frequent fires, invasion by introduced grasses and road widening. • The Project may result in an SRI to Bluegrass by habitat clearing. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.

[5] As the species area of occupancy is patchy and there is minimal survey data for the species, it has been assessed using the Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy basin TEC modelling data. This is an appropriate substitute as the species distribution is known to overlap with this TEC (Department of Agriculture Water and the Environment, 2020). As the species is restricted and not commonly observed, the TEC modelling data is considered to provide an overestimation of the actual species distribution throughout the Project Area. This approach therefore provides a conservative assessment for Bluegrass.

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.05% of potential habitat present in the bioregion. • This equates to approximately 111 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 47 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 47 ha SRI may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.2.4 *King Bluegrass (Dichanthium queenslandicum)*

King Bluegrass is known to occur within the Project Area. An overview of King Bluegrass within the bioregion and the Project Area is provided in Table 39. A detailed profile and mapping for King Bluegrass (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to King Bluegrass against the Significant Impact Guidelines criteria.

Table 39: Overview of King Bluegrass

Attribute	Description
Listing status	Endangered
Ecology and distribution	• Occurs in central Queensland and restricted to the Emerald and Springsure districts of the Bowen Basin, but populations most concentrated in the Emerald region. • Occurs on heavy black clay soils of undulating plains, in tussock grasslands, often in association with other species of blue grass (Threatened Species Scientific Committee, 2013). • Has also been recorded in communities with a range of other grasses, as well as *Acacia* grasslands and *Eucalyptus* woodlands.
Population and habitat in the bioregion	• Species distribution is associated with the Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy basin TEC (Threatened Species Scientific Committee, 2013). • The main habitat for the species is the Bluegrass grassland of central Queensland, of which an estimated 70% has been cleared or replaced. • Species population size and area of occupancy is poorly understood due to minimal survey data. • Approximately 231,045 ha of potential King Bluegrass habitat in the bioregion[6].
Population and habitat in the Project Area	• Approximately 2,498 ha of King Bluegrass habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• Conservation advice for King Bluegrass highlights key threats include loss of habitat through agriculture and mining; road construction; unsustainable grazing regimes; and weed invasion (Threatened Species Scientific Committee, 2013).

[6] As the species area of occupancy is unknown and there is minimal survey data for the species, it has been assessed using the Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy basin TEC modelling data. This is an appropriate substitute as the species distribution is known to overlap with this TEC (Threatened Species Scientific Committee, 2013). As the species is restricted and not commonly observed, the TEC modelling data is considered to provide an overestimation of the actual species distribution throughout the Project Area. This approach therefore provides a conservative assessment for King bluegrass.

Attribute	Description
	• As specified in the approved conservation advice, the species surrounding environment, especially in the case of small and scattered populations, is threatened by impacts coincident with the development and operation of mines and associated infrastructure in the Bowen Basin. • The Project may result in an SRI to King Bluegrass from loss of habitat. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.05% of potential habitat present in the bioregion. • This equates to approximately 111 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 47 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 47 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.2.5 *Kogan Waxflower (Philotheca sporadica)*

Kogan Waxflower is known to occur within the Project Area. An overview of Kogan Waxflower within the bioregion and the Project Area is provided in Table 40. A detailed profile and mapping for Kogan Waxflower (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Kogan Waxflower against the Significant Impact Guidelines criteria.

Table 40: Overview of Kogan Waxflower

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• In Queensland, the species is known to occur from north of Tara to 12km east of Kogan. • Found in low open forest on shallow, uniform sandy loam to clay-loam soils on residual hills, remnants of laterised Cretaceous sandstones.
Population and habitat in the bioregion	• Species distribution overlaps with the Brigalow and White Box-Yellow Box-Blakelys Red Gum Grassy Woodland TECs (Department of Agriculture Water and the Environment, 2020). • Approximately 279,543 ha of potential Kogan Waxflower habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 8,517 ha of Kogan Waxflower habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4. • Habitat primarily occurs in Ironbark as predominately large contiguous patches; however small scattered patches are also mapped.
Potential impacts to the species	• The approved conservation advice for Kogan Waxflower highlights key threats of habitat loss due to grazing invasive weeds and inappropriate fire regime. • The Project may result in an SRI to Kogan Waxflower by habitat clearing and fragmentation. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.23% of the potential habitat present in the bioregion. • This equates to approximately 647 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule.

Attribute	Description
	• 239 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 239 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.2.6 *Ooline (Cadellia pentastylis)*

Ooline is known to occur within the Project Area. An overview of Ooline within the bioregion and the Project Area is provided in Table 41. A detailed profile and mapping for Ooline (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Ooline against the Significant Impact Guidelines criteria.

Table 41: Overview of Ooline

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• In Queensland, the species occurs from Balcomba (west of Rockhampton) south to the New South Wales border and west to the vicinity of Blackall. • It is found in semi-evergreen vine thickets and sclerophyll vegetation on undulating terrain of various geology. • The species forms a closed or open canopy, as a dominant or commonly with White Box (Eucalyptus albens) and White Cypress Pine (Callitris glaucophylla) (Department of Agriculture Water and the Environment, 2020).
Population and habitat in the bioregion	• The species is found within both Brigalow and SEVT TECs (Department of Agriculture Water and the Environment, 2020). • Approximately 1,860,157 ha of potential Ooline habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 47,390 ha of Ooline habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4. • Large continuous areas of suitable habitat occur in Denison and Spring Gully (Block A and B). • Patches of preferred habitat are scattered across the Project Area and are predominantly small.
Potential impacts to the species	• The approved conservation advice for Ooline highlights the following key threats: fragmentation and vegetation clearing; localised extinction (small and scattered populations); inbreeding; low seed viability, clearing for agriculture; grazing and soil compaction; feral animals, weeds, fire, erosion; and insect attack. • The Project may result in an SRI to Ooline from fragmentation and vegetation clearing. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.14% of potential habitat present in the bioregion. • This equates to approximately 2,664 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 920 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 920 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.2.7 *Shiny-leaved Ironbark (Eucalyptus virens)*

Shiny-leaved Ironbark is known to occur within the Project Area. An overview of Shiny-leaved Ironbark within the bioregion and the Project Area is provided in Table 42. A detailed profile and mapping for Shiny-leaved Ironbark (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Shiny-leaved Ironbark against the Significant Impact Guidelines criteria.

Table 42: Overview of Shiny-leaved Ironbark

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• The species is endemic to south-east Queensland. • Species has been recorded at five sites as far south as Inglewood and west as Mt Moffatt. • Found in areas of remnant vegetation on plateaus, sandstone escarpments or sandy soils on low rises (Department of Agriculture Water and the Environment, 2020).
Population and habitat in the bioregion	• Species is found within the Brigalow, Bluegrass, SEVT, White-box Yellow-box and the community of native species dependant on the natural discharge of the Great Artesian Basin TECs (Department of Agriculture Water and the Environment, 2020). • Approximately 477,263 ha of potential Shiny-leaved Ironbark habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 4,790 ha of Shiny-leaved Ironbark habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for Shiny-leaved Ironbark highlights key threats of timber harvesting of the species itself, disturbance of habitat during timber harvesting operations and loss of habitat due to vegetation clearing. • The Project may result in an SRI to Shiny-leaved Ironbark from species and habitat clearing. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.08% of the potential habitat present in the bioregion. • This equates to approximately 366 ha

Attribute	Description
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 200 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 200 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.2.8 *Tara Wattle (Acacia lauta)*

Tara Wattle is known to occur within the Project Area. An overview of Tara Wattle within the bioregion and the Project Area is provided in Table 43. A detailed profile and mapping for Tara Wattle (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Tara Wattle against the Significant Impact Guidelines criteria.

Table 43: Overview of Tara Wattle

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• The species occurs in a small region of the Darling Downs in southeast Queensland between Inglewood and Tara. • Distribution restricted to a small number of sites on freehold land and roadsides. • Found in open woodland on sandy soils. • Known from south-east Queensland in a small region of the Darling Downs between Inglewood and Tara.
Population and habitat in the bioregion	• Species is found within the Brigalow and White Box-Yellow Box-Blakely's Red Gum Grassy Woodland and Derived Native Grassland TECs. • Approximately 135,123 ha of potential Tara Wattle habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 5,940 ha of Tara Wattle habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• Key threats to Tara Wattle require further research, the approved conservation advice identifies potential threats, including restricted distribution of the species; locations are areas which makes the species susceptible to disturbance; and too frequent fire may deplete the soil seed bank. • The Project may result in an SRI to Tara Wattle from fragmentation and habitat clearing. • Residual impacts will be mitigated through offsets and rehabilitation measures. • Any threats to the species identified as part of this Project will be appropriately managed in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.33% of the potential habitat present in the bioregion. • This equates to approximately 452 ha

Attribute	Description
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 170 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 170 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.2.9 *Aristida annua*

Aristida annua is known to occur within the Project Area. An overview of *Aristida annua* within the bioregion and the Project Area is provided in Table 44. A detailed profile and mapping for *Aristida annua* (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to *Aristida annua* against the Significant Impact Guidelines criteria

Table 44: Overview of *Aristida annua*

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• Occurs in central Queensland, restricted to the Emerald and Springsure districts of the Bowen Basin. • Found in eucalypt woodlands on black clay and basalt soils and potentially on disturbed sites.
Population and habitat in the bioregion	• Species distribution is associated with the Natural Grasslands of the Queensland Central Highlands and the northern Fitzroy basin TEC within the Project Area (Department of Agriculture Water and the Environment, 2020). • Species population size is poorly understood due to minimal survey data. • Approximately 231,045 ha of potential *Aristida annua* habitat in the bioregion[7].
Population and habitat in the Project Area	• Approximately 2,498 ha of *Aristida annua* habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for *Aristida annua* highlights the following key threats: loss of habitat due to clearing for agriculture and persistent overgrazing; and mining operations and associated infrastructure in the Bowen Basin causing detrimental damage to the species surrounding environment (habitat). • The Project may result in an SRI to *Aristida annua* from habitat clearing and impact to surrounding environment. • Residual impacts will be mitigated through offsets and rehabilitation measures.

[7] As the species area of occupancy is patchy and there is minimal survey data for the species, it has been assessed using the Natural Grasslands of the Queensland Central Highlands and the Northern Fitzroy basin TEC modelling data. This is an appropriate substitute as the species distribution is known to overlap with this TEC (Department of Agriculture Water and the Environment, 2020). As the species is restricted and not commonly observed, the TEC modelling data is considered to provide an overestimation of the actual species distribution throughout the Project Area. This approach therefore provides a conservative assessment for *Aristida annua*.

Attribute	Description
	• All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.05% of the potential habitat present in the bioregion. • This equates to approximately 111 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 47 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 47 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.2.10 *Marsdenia brevifolia*

Marsdenia brevifolia is known to occur within the Project Area. An overview of *Marsdenia brevifolia* within the bioregion and the Project Area is provided in Table 45. A detailed profile and mapping for *Marsdenia brevifolia* (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to *Marsdenia brevifolia* against the Significant Impact Guidelines criteria.

Table 45: Overview of *Marsdenia brevifolia*

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• The species occurs in north and central Queensland, near known localities of Townsville, Springsure and Rockhampton. • Found within eucalypt woodland or open forest, on serpentine derived, granite derived or acid agglomerate soils.
Population and habitat in the bioregion	• Species distribution overlaps with the SEVT and Brigalow TECs. • Approximately 413,891 ha of potential *Marsdenia brevifolia* habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 7,874 ha of *Marsdenia brevifolia* habitat has been mapped in the Project Area. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for *Marsdenia brevifolia* highlights key threats of grazing, land clearing, mining and too frequent burning. • The Project may result in an SRI to *Marsdenia brevifolia* by infrastructure development and fragmentation. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.08% of the potential habitat present in the bioregion. • This equates to approximately 316 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 276 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 276 ha may result from the Project.

Attribute	Description
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this TEC will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3 Threatened fauna and habitats

Detailed analysis of impacts has been undertaken for the following threatened fauna species:

- Australian Painted Snipe
- Brigalow Woodland Snail
- Collared Delma
- Dulacca Woodland Snail
- Dunmall's Snake
- Fitzroy River Turtle
- Greater Glider
- Koala
- Large-eared Pied Bat
- Ornamental Snake
- Painted Honeyeater
- Red Goshawk
- South-eastern Long-eared Bat
- Squatter Pigeon
- White throated Snapping Turtle
- Yakka Skink.

Each species has been described in terms of the following:

- listing status
- description
- species in the bioregion
- species in the Project Area
- potential impacts
- direct disturbance calculations
- SRI calculations

- offset provisions.

Predicted impacts for each fauna species have been assessed consistent with the Significant Impact Guidelines (Department of the Environment, 2013b).

7.2.3.3.3.1 *Australian Painted Snipe (Rostratula australis)*

Australian Painted Snipe is known to occur within the Project Area. An overview of Australian Painted Snipe within the bioregion and the Project Area is provided in Table 46. A detailed profile and mapping for Australian Painted Snipe (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Australian Painted Snipe against the Significant Impact Guidelines criteria.

Table 46: Overview of Australian Painted Snipe

Attribute	Description
Listing status	Endangered
Ecology and distribution	• Found within all states and territories, however, most common within the eastern states. • East to central dispersal movement, following favourable conditions. • Preferred habitat includes shallow freshwater wetland (permanent and ephemeral) habitats. • Generally, habitat will have dense grasses, rushes and reeds, low scrub, *Muehlenbeckia* spp., open timber or samphire (Department of Sustainability, Environment, Water, 2013).
Population and habitat in the bioregion	• Approximately 2,581,000 ha of potential Australian Painted Snipe habitat is present in the bioregion.
Population and habitat in the Project Area	• Approximately 31,671 ha of Australian Painted Snipe habitat has been mapped in the Project Area. This mapping is considered a substantial overestimate due to the modelling data being unable to distinguish important micro habitat features such as dense grasses, rushes and reeds. Further ecological assessment of habitat will be required. • The habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The EPBC Act Referral Guidelines for the Australian Painted Snipe highlight the following key threats: loss and degradation of habitat; and predation from introduced predators. • The conservation advice further identifies the following threats: grazing and the associated trampling of wetland vegetation/nests, nutrient enrichment and disturbance to substrate by livestock; and reduced rainfall and runoff in the Murray Darling Basin. • Forecast impacts to the species' habitat is limited and is not expected to result in an SRI. Potential impacts will be mitigated through avoidance measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.05% of the potential habitat present in the bioregion. • This equates to approximately 1,374 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 0 ha is predicted to be impacted via the SRI habitat function and connectivity rules. • Loss of habitat will be mitigated through good practice environmental management and rehabilitation measures; therefore, it is anticipated that the actual SRI will be 0 ha.
Offset provision	• No SRI, therefore, no offset required. • Disturbance of this habitat is limited under the Protocol. • Loss of habitat will be mitigated through good practice environmental management and rehabilitation measures.

7.2.3.3.3.2 *Brigalow Woodland Snail (Adclarkia cameronii)*

Brigalow Woodland Snail is known to occur within the Project Area. An overview of Brigalow Woodland Snail within the bioregion and the Project Area is provided in Table 47. A detailed profile and mapping for Brigalow Woodland Snail (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Brigalow Woodland Snail against the Significant Impact Guidelines criteria.

Table 47: Overview of Brigalow Woodland Snail

Attribute	Description
Listing status	Endangered
Ecology and distribution	• Endemic to south-east Queensland where it occurs in a small number of remnant and scattered *Acacia harpophylla* (Brigalow) and eucalypt woodland patches on the Condamine River floodplain, especially in the area around Dalby and Chinchilla. • Found in vegetation of alluvial black soils. • The narrow Condamine River riparian corridor is an important refuge for the species. • Severely fragmented distribution. • Known to occur under logs and leaf litter, and areas of relatively high canopy density and relatively high moisture (Threatened Species Scientific Committee, 2016c).
Population and habitat in the bioregion	• Occurs within the Brigalow and Coolibah TECs (Threatened Species Scientific Committee, 2016c). • Approximately 90,458 ha of potential Brigalow Woodland Snail habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 335 ha of Brigalow Woodland Snail habitat has been mapped in the Project Area. This mapping is considered an overestimate due to the modelling data being unable to distinguish important micro habitat features such as leaf litter and moisture levels. Further ecological assessment of species presence will be required. • Habitat consists of preferred and suitable habitat types as defined in Appendix B4. • The suitable and preferred habitat is all largely fragmented and only covers a small area.
Potential impacts to the species	• The approved conservation advice for Brigalow Woodland Snail highlights the following key threats: habitat loss and fragmentation; invasive species (predation by rats, mice and feral pigs and invasion of buffel grass); impacts of domestic species; and fire. • The Project may result in an SRI to Brigalow Woodland Snail from habitat loss and fragmentation.

Attribute	Description
	• Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.03% of the potential habitat present in the bioregion. • This equates to approximately 29 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 14 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 14 ha may result from the Project
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.3 *Collared Delma (Delma torquatus)*

Collared Delma is known to occur within the Project Area. An overview of Collared Delma within the bioregion and the Project Area is provided in Table 48. A detailed profile and mapping for Collared Delma (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Collared Delma against the Significant Impact Guidelines criteria.

Table 48: Overview of Collared Delma

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• Found within south-east Queensland. • Preferred habitat includes eucalypt dominated woodland and open forest with suitable micro-habitats (exposed rocky outcrops). • Groundcover predominantly will consist of native grasses, such as Kangaroo Grass, Barbed-wire Grass, Wire Grass and Lomandra. • Highly fragmented distribution (Department of the Environment Water Heritage and the Arts, 2008).
Population and habitat in the bioregion	• Approximately 4,335,249 ha of potential Collared Delma habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 105,692 ha of Collared Delma habitat has been mapped in the Project Area. This mapping is considered a substantial overestimate due to the modelling data being unable to distinguish important micro habitat features such as native grasses and rocky outcrops. Further ecological assessment of habitat will be required. • Mapped habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for Collared Delma highlights the following key threats: loss and modification of habitat (from urban and agricultural development); disturbance; fire regime changes; and invasive weeds (particularly Dwarf Lantana). • The Project may result in an SRI to Collared Delma from habitat loss. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.13% of the potential habitat present in the bioregion. • This equates to approximately 5,633 ha

Attribute	Description
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 42 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 42 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.4 *Dulacca Woodland Snail (Adclarkia dulacca)*

Dulacca Woodland Snail is known to occur within the Project Area. An overview of Dulacca Woodland Snail within the bioregion and the Project Area is provided in Table 49. A detailed profile and mapping for Dulacca Woodland Snail (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Dulacca Woodland Snail against the Significant Impact Guidelines criteria.

Table 49: Overview of Dulacca Woodland Snail

Attribute	Description
Listing status	Endangered
Ecology and distribution	• Endemic to south-east Queensland in small number of isolated and fragmented populations between Miles and Dulacca. • Inhabits a variety of habitats including vine thicket and Brigalow woodland patches on rocky outcrops, ironbark species with Lancewood on ridges, and Gum-topped Box woodland (preferred). • Occurs in Brigalow regrowth and cleared paddocks if logs, woody debris or other suitable microhabitat provides suitable habitat. • Severely fragmented distribution. • Known to occur under rocks and timber, and areas of relatively high canopy density and relatively high moisture. • Limited mobility but able to move between suitable areas of microhabitat (Threatened Species Scientific Committee, 2016a).
Population and habitat in the bioregion	• May occur within the Brigalow; Coolibah – Black Box Woodlands of the Darling Riverine Plains and the Brigalow Belt Bioregions; and Semi-evergreen vine thickets of the Brigalow Belt (North and South) and Nandewar bioregions TECs (Threatened Species Scientific Committee, 2016a). • Approximately 63,269 ha of potential Dulacca Woodland Snail habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 130 ha of Dulacca Woodland Snail habitat has been mapped in the Project Area. This mapping is considered a substantial overestimate due to the modelling data being unable to distinguish important micro habitat features such as leaf litter and moisture levels. Further ecological assessment of species presence will be required. • Mapped habitat consists of preferred and suitable habitat types as defined in Appendix B4. • The suitable and preferred habitat is all largely fragmented and only covers a small area.
Potential impacts to the species	• The approved conservation advice for Dulacca Woodland Snail highlights the following key threats: habitat loss and fragmentation;

Attribute	Description
	invasive species (predation by rats, mice and feral pigs and invasion of buffel grass); impacts of domestic species; and fire. • The Project may result in an SRI to Dulacca Woodland Snail from habitat loss and fragmentation. • Residual impacts will be mitigated through rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.02% of the potential habitat present in the bioregion. • This equates to approximately 10 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 10 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 10 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.5 *Dunmall's Snake (Furina dunmalli)*

Dunmall's Snake is known to occur within the Project Area. An overview of Dunmall's Snake within the bioregion and the Project Area is provided in Table 50. A detailed profile and mapping for Dunmall's Snake (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Dunmall's Snake against the Significant Impact Guidelines criteria.

Table 50: Overview of Dunmall's Snake

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• Distribution occurs in the Brigalow Belt region of interior southeast Queensland. • The species is secretive or very rare with limited records. • Found in open forests and woodlands dominated by Brigalow on black alluvial cracking clay and clay loam soils. • Thought to require microhabitat features for shelter including fallen timber and, ground litter and cracks in alluvial clay soils (Department of Agriculture Water and the Environment, 2020).
Population and habitat in the bioregion	• Species distribution is associated with Brigalow TEC (Department of Agriculture Water and the Environment, 2020). • Approximately 4,413,095 ha of potential Dunmall's Snake habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 85,961 ha of Dunmall's Snake habitat has been mapped in the Project Area. This mapping is considered a substantial overestimate due to the modelling data being unable to distinguish important micro habitat features such as fallen timber and cracks in alluvial clay soils. Further ecological assessment of species presence will be required. • Mapped habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for Dunmall's Snake highlights the following key threats: ongoing land clearing and habitat modification, overgrazing of stops, modification of habitat for grazing or agriculture, crop grazing or urban development, predation by feral animals and potentially drainage of swamps. • The Project may result in an SRI to Dunmall's Snake from habitat clearing. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.11% of the potential habitat present in the bioregion. • This equates to approximately 5,014 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 69 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 69 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.6 *Fitzroy River Turtle (Rheodytes leukops)*

Fitzroy River Turtle is known to occur within the Project Area. An overview of Fitzroy River Turtle within the bioregion and the Project Area is provided in Table 51. A detailed profile and mapping for Fitzroy River Turtle (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Fitzroy River Turtle against the Significant Impact Guidelines criteria.

Table 51: Overview of Fitzroy River Turtle

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• Only found in the Fitzroy River and its tributaries. • Found in flowing rivers with large deep pools with rocky, gravelly or sandy substrates, connected by shallow riffles. • Prefers habitat with high water clarity and is often associated with Ribbonweed (*Vallisneria sp.*) beds (Department of Agriculture Water and the Environment, 2020).
Population and habitat in the bioregion	• Often associated with logs in deeper water, and may sit on the downstream side or under rocks in fast flowing riffles occur, or microhabitat where colonies are likely to be found (Department of Agriculture Water and the Environment, 2020). • Approximately 380,786 ha of potential Fitzroy River Turtle habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 11,693 ha of Fitzroy River Turtle habitat has been mapped in the Project Area. This mapping is considered a substantial overestimate due to the modelling data being unable to distinguish important micro habitat features such as deep pools with rocky, gravelly or sandy substrates. Further ecological assessment of species presence will be required. • Mapped habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for Fitzroy River Turtle highlights the following key threats: egg predation by feral and native animals; habitat loss and disturbance from agriculture, mining, and damming; and injury/mortality from boat strike (fishing and recreation). • Residual impacts will be mitigated through avoidance and rehabilitation measures. • Large areas of mapped habitat overlap with White-throated Snapping Turtle (Section 7.2.3.3.3.15); disturbance of this habitat will be limited under the Protocol. • All other threats can be appropriately managed or are not applicable in the context of the Project.

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.05% of the potential habitat present in the bioregion. • This equates to approximately 209 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 0 ha is predicted to be impacted via the SRI habitat function and connectivity rules. • Loss of habitat will be mitigated through good practice environmental management and rehabilitation measures; therefore, it is anticipated that the actual SRI will be 0 ha.
Offset provision	• No SRI, therefore, no offset required. • Disturbance of this habitat is limited under the Protocol. • Loss of habitat will be mitigated through good practice environmental management and rehabilitation measures.

7.2.3.3.3.7 *Greater Glider (Petauroides volans)*

Greater Glider is known to occur within the Project Area. An overview of the Greater Glider present within the bioregion and the Project Area is provided in Table 52. A detailed profile and mapping for Greater Glider (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Greater Glider against the Significant Impact Guidelines criteria.

Table 52: Overview of Greater Glider

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• Occurs within eucalypt forests and woodlands in eastern Australia, from Victoria to Queensland. • Key habitat requirements include the present of medium to large tree hollows (for denning) and large, well connected patches of habitat (Threatened Species Scientific Committee, 2016b).
Population and habitat in the bioregion	• Approximately 6,097,597 ha of potential Greater Glider habitat is present in the bioregion.
Population and habitat in the Project Area	• Approximately 87,522 ha of Greater Glider habitat has been mapped in the Project Area. This mapping is considered an overestimate due to the modelling data being unable to distinguish important micro habitat features such as tree hollows. Further ecological assessment of species presence will be required. • The habitat consists of preferred and suitable habitat types as defined in Appendix B4. • The preferred habitat is associated with riparian areas and large patches of well-connected habitat.
Potential impacts to the species	• The approved conservation advice for the Greater Glider highlights the following key threats: habitat loss, including dispersal habitat; intense or frequent fires; timber production; climate change; entanglement in barbed-wire fencing; hyper-predation by owls; competition from sulphur crested cockatoos; and *Phytophthora* root fungus. • Residual impacts will be mitigated through appropriate management and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.08% of the potential habitat present in the bioregion. • This equates to approximately 4,593 ha

Attribute	Description
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 11 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 11 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.8 *Koala (Phascolarctos cinereus)*

Koala is known to occur within the Project Area. An overview of Koala within the bioregion and the Project Area is provided in Table 53: Overview of Koala. A detailed profile and mapping for Koala (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Koala against the Significant Impact Guidelines criteria.

Table 53: Overview of Koala

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• The Queensland Koala distribution extends across several bioregions (Einasleigh Uplands, Wet Tropics, Desert Uplands, Central Mackay Coast, Mitchell Grass Downs, Mulga Lands, Brigalow Belt, South Eastern Queensland and Channel Country). • The species distribution encompasses a great diversity of habitats with the greatest concentration located in southeast Queensland. • In inland regions, the species is most commonly found in woodlands and forests (where Koala food trees have reliable access to soil moisture) (Department of the Environment, 2014b).
Population and habitat in the bioregion	• The species is also known to have a low stocking density in inland environments (Department of the Environment, 2014b). • Approximately 114,381,173 ha of potential Koala habitat exists in the bioregion.
Population and habitat in the Project Area	• Approximately 113,742 ha of Koala habitat has been mapped in the Project Area. • The Koala habitat consists of preferred and suitable habitat types as defined in Appendix B4. • Habitat is present in all development areas, with preferred habitat associated with riparian areas. • Across the Project Area, the Koala assessment tool indicates habitat quality is 7/10[8]. This will be further considered and confirmed at a more appropriate scale during detailed planning and implementation.
Potential impacts to the species	• The EPBC Act Referral Guidelines for Koala highlight the following key threats: loss, fragmentation and degradation of habitat, including dispersal habitat; predicted increase in the frequency and severity of droughts, periods of extremely high temperatures and increased frequency of fire; lack of access to refuges from climatic extremes; and mortality due to vehicle strikes and dog attack.

[8] Koala occurrence – 2; vegetation composition – 2; habitat connectivity – 1; key existing threats – 1; recovery value – 1; TOTAL – 7/10

Attribute	Description
	• The Project may result in an SRI to Koala from loss and fragmentation of habitat. • Residual impacts will be mitigated through offsets and rehabilitation measures. • All other threats can be appropriately managed, or are not applicable, in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.01% of the potential habitat present in the bioregion. • This equates to approximately 5,870 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 34 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 34 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.9 *Large-eared Pied Bat (Chalinolobus dwyeri)*

Large-eared Pied Bat is known to occur within the Project Area. An overview of Large-eared Pied Bat within the bioregion and the Project Area is provided in Table 54. A detailed profile and mapping for Large-eared Pied Bat (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Large-eared Pied Bat against the Significant Impact Guidelines criteria.

Table 54: Overview of Large-eared Pied Bat

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• Found within eastern New South Wales and south-eastern Queensland. • Within Queensland, found north of Rockhampton south to the New South Wales border, and inland to sandstone escarpments in the Carnarvon and Expedition Ranges and Blackdown Tablelands. • Requires a combination of sandstone cliff/ escarpment to provide roosting habitat. Almost all records are within several kilometres of cliff-lines or rocky terrain. • Found roosting within caves, overhangs, abandoned mine tunnels and disused fairy martin nests. • Preferred roosting habitat is sandstone cliff-lines with a north-westerly to south-westerly aspect, where it roosts in small caves and fissures. • Maternity roosts are very specific, requiring arch caves with dome roofs. • Available roosts are not evenly distributed across the species range. • Preferred foraging habitat is on fertile foot-slopes and valley floors, within 2-2.5 km of preferred roosting habitat. Foraging appears to be concentrated particularly along ecotones between moist and dry vegetation types and abrupt edges between woodland and pasture (Threatened Species Scientific Committee, 2010).
Population and habitat in the bioregion	• Approximately 1,005,441 ha of potential greater Large-eared Pied Bat habitat is present in the bioregion.
Population and habitat in the Project Area	• Approximately 56,855 ha of Large-eared Pied Bat habitat has been mapped in the Project Area. • The habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The major threatening processes for the Large-eared Pied Bat have not been clearly established, however the approved conservation advice for the Large-eared Pied Bat highlights the following potential threats: destruction of/and interference with maternity and other roosts; mining of roosts; mine induced subsidence of cliff lines;

Attribute	Description
	disturbance from human recreational activities; habitat disturbance by other animals, including livestock and feral animals; predation by introduced predators; vegetation clearance in the proximity of roosts; fire in the proximity of roosts; and loss of genetic diversity. • Residual impacts will be mitigated through appropriate management and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.33% of the potential habitat present in the bioregion. • This equates to approximately 3,283 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 10 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 10 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.10 *Ornamental Snake (Denisonia maculata)*

Ornamental Snake is known to occur within the Project Area. An overview of Ornamental Snake within the bioregion and the Project Area is provided in Table 55. A detailed profile and mapping for Ornamental Snake (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Ornamental Snake against the Significant Impact Guidelines criteria.

Table 55: Overview of Ornamental Snake

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• The species distribution is restricted to the drainage system of the Fitzroy and Dawson Rivers in Queensland (Brigalow Belt North and parts of Brigalow Belt South). • The species is found on floodplains, undulating clay pans and along the margins of swamps, lakes and watercourses (and adjoining areas of elevated ground). • It prefers woodlands and open forests associated with moist areas, particularly gilgai (melon-hole) mounds and depressions. • The species requires microhabitat features for shelter including logs, coarse woody debris and ground litter (Threatened Species Scientific Committee, 2014).
Population and habitat in the bioregion	• The species is associated with Brigalow TEC and also occurs within Coolibah and Poplar Box dominated vegetation. • Its known important habitat includes all gilgai depressions and mounds within its distribution (Threatened Species Scientific Committee, 2014). • Approximately 1,097,932 ha of potential Ornamental Snake habitat occurs within the bioregion.
Population and habitat in the Project Area	• A total of 23,101 ha of Ornamental Snake habitat has been mapped in the Project Area. • The habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for Ornamental Snake highlights the following key threats: habitat clearing, fragmentation and degradation; trampling of wetland habitat by stock; and ingestion of cane toads (*Rhinella marina*). • The Project may result in an SRI to Ornamental Snake from habitat clearing and fragmentation. • Residual impacts will be mitigated through rehabilitation measures. • All other threats can be appropriately managed, or are not applicable, in the context of the Project.

Attribute	Description
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.08% of the potential habitat present in the bioregion. • This equates to approximately 870 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 10 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 10 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.11 *Painted Honeyeater (Grantiella picta)*

Painted Honeyeater is known to occur within the Project Area. An overview of Painted Honeyeater within the bioregion and the Project Area is provided in Table 56. A detailed profile and mapping for Painted Honeyeater (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Painted Honeyeater against the Significant Impact Guidelines criteria.

Table 56: Overview of Painted Honeyeater

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• Sparsely distributed from south-eastern Australia to north-western Queensland and eastern Northern Territory. • Mostly found on inland slopes of the Great Dividing Range up to Roma, Queensland. • Highly dispersive, moving across landscapes in seasonal north-south migrations to follow the mistletoe fruiting pattern. • Inhabits mistletoes in eucalypt forests and woodlands, acacia-dominated woodlands, as well as paperbarks, casuarinas and cypress pine. • Preference for forests and woodlands that contain a high number of mature trees.
Population and habitat in the bioregion	• Approximately 1,394,953 ha of potential Painted Honeyeater habitat is present in the bioregion.
Population and habitat in the Project Area	• Approximately 85,549 ha of Painted Honeyeater habitat has been mapped in the Project Area. • The habitat consists of preferred and suitable habitat types as defined in Appendix B4. • Large patches of continuous habitat is present, often along riparian zones.
Potential impacts to the species	• The approved conservation advice for the Painted Honeyeater highlights the following current, key threats: habitat loss (breeding and non-breeding); habitat degradation due to livestock, macropod and rabbit grazing; competition with aggressive noisy miner birds; predation by invasive species, deliberate destruction of mistletoe in production forests; exacerbation of tree declines through pasture improvement activities; collision with road vehicles; and nest predation by over-abundant pied currawongs, pied and grey butcherbirds, and crows and ravens. • The Project may result in an SRI to Painted Honeyeater from habitat loss.

Attribute	Description
	• Residual impacts will be mitigated through appropriate management and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.31% of the potential habitat present in the bioregion. • This equates to approximately 4,314 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 61 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 61 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.12 *Red Goshawk (Erythrotriorchis radiatus)*

Red Goshawk is known to occur within the Project Area. An overview of Red Goshawk within the bioregion and the Project Area is provided in Table 57. A detailed profile and mapping for Red Goshawk (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Red Goshawk against the Significant Impact Guidelines criteria.

Table 57: Overview of Red Goshawk

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• Thinly dispersed throughout tropical and sub-tropical forests and woodlands of northern Australia, from the Kimberley in Western Australia to north-east New South Wales. • Nest trees are large (frequently the tallest and largest in the stand, almost always >20 m height), invariably within 1 km of and often immediately adjacent to permanent water, and usually within biologically rich forest or woodland that supports an abundance of medium-sized birds which the Red Goshawk feeds upon. • Prefers forests of intermediate density or ecotones between habitats of different densities to support fast attack and manoeuvring but also cover for ambushing. • Avoids very dense forests and very open habitats.
Population and habitat in the bioregion	• Has an estimated home range of about 200 km^2, known to disperse into central Australia but unlikely to breed there. • Approximately 8,450,479 ha of potential Red Goshawk habitat is present in the bioregion.
Population and habitat in the Project Area	• Approximately 114,939 ha of Red Goshawk habitat has been mapped in the Project Area. • The habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for the Red Goshawk highlights the following current, key threats: vegetation clearance causing habitat fragmentation and degradation, forestry operations, altered fire frequencies, and decline of prey species. • The Project may result in an SRI to Red Goshawk from habitat loss and fragmentation. • Residual impacts will be mitigated through appropriate management and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of

Attribute	Description
	approximately 0.07% of the potential habitat present in the bioregion. • This equates to approximately 6,025 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 10 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 10 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.13 South-eastern Long-eared Bat (Nyctophilus corbeni)

South-eastern Long-eared Bat (or Corben's long-eared bat) is known to occur within the Project Area. An overview of South-eastern Long-eared Bat within the bioregion and the Project Area is provided in Table 58. A detailed profile and mapping for South-eastern Long-eared Bat (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to South-eastern Long-eared Bat against the Significant Impact Guidelines criteria.

Table 58: Overview of South-eastern Long eared Bat

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• Inhabits forests and woodlands from southern central Queensland to eastern South Australia. • Occurs within a wide range of inland woodland vegetation types including box/ironbark/cypress pine woodlands, Buloke woodlands, Brigalow woodlands, Belah woodlands, Smooth-barked Apple woodlands, Black Box woodlands, River Red Gum forests and various types of tree mallee. • Distinctly more common in box/ ironbark/cypress-pine vegetation that occurs in the north-south belt along the western slopes and plains of New South Wales and southern Queensland. • More abundant in more extensive stands of vegetation compared to smaller woodland patches. • Found to be more abundant in habitats with distinct tree canopy and a dense understorey. • Roosts mainly within dead trees or dead branches of living trees, and under loos bark. Most roosting sites are used for a single day but within 4 km radius (Threatened Species Scientific Committee, 2015).
Population and habitat in the bioregion	• Associated with the Brigalow TEC (Threatened Species Scientific Committee, 2015). • Approximately 6,761,232 ha of potential South-eastern Long-eared Bat habitat is present in the bioregion.
Population and habitat in the Project Area	• Approximately 120,387 ha of South-eastern Long-eared Bat habitat has been mapped in the Project Area. • The habitat consists of preferred and suitable habitat types as defined in Appendix B4. • Preferred habitat is often associated with riparian areas and large patches of well-connected habitat.
Potential impacts to the species	• The approved conservation advice for the South-eastern Long-eared Bat highlights the following key threats: habitat loss (particularly in New South Wales and Queensland) and habitat fragmentation. • Due to the lack of knowledge not all threats are known or understood. The conservation advice highlights the following as

Attribute	Description
	potential threats: habitat degradation associated with altered fire regimes, timber extraction, mining and other factors; habitat fragmentation; reduction in hollow availability; exposure to agrichemicals; grazing; and predation by feral animals. • The Project may result in an SRI to South-eastern Long-eared Bat from habitat loss and fragmentation. • Residual impacts will be mitigated through appropriate management and rehabilitation measures. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.09% of the potential habitat present in the bioregion. • This equates to approximately 6,380 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 61 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 61 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.14 *Squatter Pigeon (Geophaps scripta scripta)*

Squatter Pigeon (southern subspecies) is known to occur within the Project Area. An overview of Squatter Pigeon within the bioregion and the Project Area is provided in Table 59. A detailed profile and mapping for Squatter Pigeon (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Squatter Pigeon against the Significant Impact Guidelines criteria.

Table 59: Overview of Squatter Pigeon

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• The Squatter Pigeon distribution extends south from the southern region of Cape York Peninsula to the Border Rivers region of northern New South Wales, and from the east coast to Hughenden, Longreach and Charleville, Queensland. • The species distribution is contacting northward from southern Queensland. • This species is typically found in pen-forests to sparse, open-woodlands and scrub on well-draining, gravelly, sandy or loamy soils that are close (<3 km) to a permanent water source (rivers, creeks and waterholes). • The Squatter Pigeon prefer the grassy understorey of open eucalypt woodland and, to a lesser extent, savannas. • This species occurs in remnant, regrowth and modified vegetation communities (Department of Agriculture Water and the Environment, 2020).
Population and habitat in the bioregion	• Populations within the region are considered to be relatively small, isolated and sparsely distributed due to significant fragmentation. • Populations in the Carnarvon Ranges in Central Queensland (the Project Area) are considered to be important sub-populations of the subspecies (Squatter Pigeon Workshop, 2011). • Approximately 2,214,294 ha of potential Squatter Pigeon habitat is present in the bioregion.
Population and habitat in the Project Area	• Approximately 31,623 ha of Squatter Pigeon habitat has been mapped in the Project Area. • The habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for the Squatter Pigeon highlights the following current, key threats: vegetation clearance and fragmentation; overgrazing by livestock and rabbits (*Oryctolagus cuniculus*); weed incursion such as Buffel Grass (*Cenchrus ciliaris*); inappropriate fire regimes; predation by invasive species; and trampling of nests by livestock.

Attribute	Description
	• The Project may result in an SRI to Squatter Pigeon from vegetation clearance and fragmentation. • Residual impacts will be mitigated through the appropriate management and rehabilitation measures. • All other threats can be appropriately managed, or are not applicable, in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.07% of the potential habitat present in the bioregion. • This equates to approximately 1,540 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • 12 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 12 ha may result from the Project.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.2.3.3.3.15 *White-throated Snapping Turtle (Elseya albagula)*

The White-throated Snapping Turtle is known to occur within the Project Area. An overview of White-throated Snapping Turtle within the bioregion and the Project Area is provided in Table 60. A detailed profile and mapping for White-throated Snapping Turtle (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to White-throated Snapping Turtle against the Significant Impact Guidelines criteria.

Table 60: Overview of White-throated Snapping Turtle

Attribute	Description
Listing status	Critically Endangered
Ecology and distribution	• Only found in south-east Queensland in the Fitzroy, Mary and Burnett Rivers, as well as associated drainages within the south-east. • Habitat preference for areas with clear, flowing, well-oxygenated water and areas with suitable shelter and refuges, such as fallen tree. • Also recorded in areas with little or no flow of water, but only in low numbers. • Microhabitat preferences for the species include sections of streams characterised by steep undercut banks, rocky or sand-gravel substrates, submerged boulders and/ or log jams that are used for shelter. • The White-throated Snapping Turtle generally breeds during Autumn and Winter and build nests by digging into the slopes of riverbanks (Department of the Environment and Energy, 2017b).
Population and habitat in the bioregion	• Habitat deemed critical to the survival of the species is riverine systems with permanent water within the species' distribution and any known or new nesting sites. • Total area of occupancy across the species range (restricted within the three river systems) is estimated to be <50,000 ha (Department of the Environment and Energy, 2017b). • Approximately 142,870 ha of potential White-throated Snapping Turtle habitat in the bioregion.
Population and habitat in the Project Area	• Approximately 4,578 ha of White-throated Snapping Turtle habitat has been mapped in the Project Area and is restricted to waterways. This mapping is considered a substantial overestimate due to the modelling data being unable to distinguish important micro habitat features such as deep pools with rocky, gravelly or sandy substrates. Further ecological assessment of species presence will be required. • The habitat consists of preferred and suitable habitat types as defined in Appendix B4. • Habitat is restricted to waterways and wetlands.

Attribute	Description
Potential impacts to the species	• The approved conservation advice for the White-throated Snapping Turtle highlights the following key threats: egg predation by feral and native animals; trampling of nests by cattle; habitat fragmentation via construction of dams and weirs; loss of riparian vegetation; and water allocation activities. • Residual impacts will be mitigated through avoidance and rehabilitation measures. • Disturbance of this habitat will be limited under the Protocol. • All other threats can be appropriately managed or are not applicable in the context of the Project. • All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Due to the critically endangered status of the White-throated Snapping Turtle being a high constraint as per the Protocol (Appendix A), the predictive disturbance modelling avoided impacts to White-throated Snapping Turtle habitat. • It is therefore highly unlikely the Project will have direct disturbance to White-throated Snapping Turtle habitat.
SRI calculations	• It is anticipated that the SRI will be 0 ha.
Offset provision	• No SRI, therefore, no offset required. • Loss of habitat will be mitigated through good practice environmental management and rehabilitation measures.

7.2.3.3.3.16 *Yakka Skink (Egernia rugosa)*

Yakka Skink is known to occur within the Project Area. An overview of Yakka Skink within the bioregion and the Project Area is provided in Table 61. A detailed profile and mapping for Yakka Skink (Project Area and bioregion) is provided in Appendix B4, and Appendix B5 assesses the Project's impact to Yakka Skink against the Significant Impact Guidelines criteria.

Table 61: Overview of Yakka Skink

Attribute	Description
Listing status	Vulnerable
Ecology and distribution	• The species is distributed from the coast to the hinterland of sub-humid to semi-arid eastern Queensland including portions of the Brigalow Belt (North and South). • It is found in open dry sclerophyll forest, woodland and scrub on various soil types, excluding highly rocky habitats. • The species require microhabitat features including cavities under and between partly buried rocks, logs or tree stumps, root cavities and abandoned animal burrows (Threatened Species Scientific Committee, 2008).
Population and habitat in the bioregion	• Distribution is highly fragmented due to clearing. • Core habitat includes the Brigalow Belt South bioregion. • Species is found within Brigalow TEC. • Known important habitat includes any suitable habitat where colonies are known to occur, or microhabitat where colonies are likely to be found (Threatened Species Scientific Committee, 2008). • Approximately 6,870,107 ha of potential Yakka Skink habitat is recorded within the bioregion.
Population and habitat in the Project Area	• Approximately 94,340 ha of Yakka Skink habitat has been mapped in the Project Area. This mapping is considered a substantial overestimate due to the modelling data being unable to distinguish important micro habitat features such as buried rocks, logs or tree stumps. Further ecological assessment of species presence will be required. • Its habitat consists of preferred and suitable habitat types as defined in Appendix B4.
Potential impacts to the species	• The approved conservation advice for Yakka Skink highlights the following key threats: habitat clearing and degradation; inappropriate roadside management; removal of microhabitat features; ripping of rabbit warrens; and predation by feral animals. • The Project may result in an SRI to Yakka Skink from habitat clearing. • Residual impacts will be mitigated through offsets and rehabilitation measures.

Attribute	Description
	• All other threats can be appropriately managed or are not applicable in the context of the Project.
Direct disturbance calculations	• Based on the maximum development scenario and predictive habitat modelling, the Project may result in the disturbance of approximately 0.07% of the potential habitat present in the bioregion. • This equates to approximately 4,830 ha
SRI calculations	• 0 ha will be impacted via the SRI clearing rule. • A total of 3,187 ha will be impacted via the SRI habitat function and connectivity rules. • A significant residual impact of 3,187 ha has been estimated from the modelling, the actual extent of impact is expected to be substantially lower.
Offset and rehabilitation provisions	An offset commensurate with the actual SRI will be provided in line with the EPBC Act offsets policy and Offsets Plan (Appendix E). Disturbances to this species will be rehabilitated in accordance with the Rehabilitation Management Plan (Appendix D) and EA conditions.
Long-term outcomes	Impacts to this matter are expected to occur for the life of the Project, however, through rehabilitation the long-term outcomes should result in no net loss in habitat extent.

7.3 Listed migratory species

Migratory species also have the potential to occur in the Project Area. Migratory species were not subject to detailed assessment as all species are either common throughout their range and/or opportunistic visitors to wetland environments. As wetland environments will be avoided during detailed design, impacts have been considered based on the likelihood of population level effects.

As outlined in the EPBC Act Significant Impact Guidelines 1.1 (Department of the Environment, 2013b), an action is likely to have a significant impact on a migratory species if there is a real chance or possibility that it will seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population. Equally, an action is likely to have a significant impact on a migratory species if it modified, destroys or isolates an area of important habitat or introduces an invasive species into an area of important habitat.

In general terms, an area of 'important habitat' for a migratory species is:

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

Important habitat is defined more specifically for migratory shorebirds as outlined in *EPBC Act Policy Statement 3.21* (Department of the Environment and Energy, 2017c). According to this approach, wetland habitat should be considered internationally important if it regularly supports:

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

Nationally important habitat for migratory shorebirds can be defined using a similar approach to these international criteria i.e. if it regularly supports:

- 0.1% of the flyway population of a single species of migratory shorebird or
- 2,000 migratory shorebirds or
- 15 migratory shorebird species.

Important habitat for Latham's snipe is described as areas that have previously been identified as internationally important for the species, or areas that support at least 18 individuals of the species.

An 'ecologically significant proportion' of the population varies with the species; guidance for a species relevant to this assessment is provided in three documents:

- Draft referral guideline for 14 birds listed as migratory species under the EPBC Act (Department of the Environment, 2015)
- EPBC Act Policy Statement 3.21 - Industry guidelines for avoiding, assessing and mitigating impacts on EPBC Act-listed migratory shorebird species (Department of the Environment and Energy, 2017c)
- Revision of the East Asian-Australasian Flyway Population Estimates for 37 listed Migratory Shorebird Species (Hansen *et al.*, 2016).

The above listed documents also provide threshold beyond which impacts to migratory species may be considered significant. These are reproduced for the species relevant to this assessment in Table 62.

Table 62: Significant impact thresholds for migratory species

Species	Area thresholds (ha unless otherwise stated)		Thresholds (no. of individuals)	
	1%	0.1%	1%	0.1%
Migratory shorebirds				
Common Greenshank	*	*	1100	110
Common Sandpiper	*	*	1900	190
Curlew Sandpiper	*	*	900	90
Latham's Snipe	*	*	300	30
Pectoral Sandpiper	*	*	12,200	1220
Sharp-tailed Sandpiper	*	*	850	85
Migratory birds – other than shorebirds				
Fork-tailed Swift	*	*	1,000	100
Oriental Cuckoo	250,000	25,000	10,000	1,000
Osprey	840 km coastline	84 km coastline	240	24
Rufous Fantail	7,500	750	3,400	344
Satin Flycatcher	4,400	440	1,700	170
White-throated Needletail	*	*	Not provided	100
Yellow Wagtail	*	*	10,000	1,000

* No threshold area provided in policy guidance.

Habitat in central Queensland in general, and within the Project Area more specifically, is unlikely to be considered important habitat for migratory species. Important habitat for migratory shorebirds is primarily located in coastal areas, where large flocks of birds aggregate for over-winter foraging. There have been a number of field assessments that provide insights into how these birds are using the landscape within the Project Area (refer Section 7.2.2.1 for a list of studies). These studies collectively show that habitat within the Project Area may be used by migratory species, with the presence, abundance and activity of the species dependant on the habitat type and its location in the landscape. However, there is no evidence to suggest habitats throughout the Project Area provide habitat that is of critical importance to the species at particular life-cycle stages. The Brigalow Belt Bioregion is not at the limit of migratory species range for the species relevant to this assessment and any area where these species may be declining are not known.

Studies within the Project Area also do not provide evidence that ecologically significant proportions of migratory bird species are present within the Project Area. As highlighted above, ecological significant thresholds are at a minimum in the 10's of birds and up to thousands of birds for some species. Given the nature of impacts from the Project, which are both linear and widespread across the Project Area, it is considered extremely unlikely that aggregations of these population sizes would occur.

Accordingly, it is not expected that significant impacts to migratory species will result from the Project.

7.4 Water resources

7.4.1 Potential impacts

7.4.1.1 Groundwater

As part of developing gas resources, groundwater within coal seams is depressurised to allow the release of gas resulting in water being produced at the surface. This water production is authorised under the P&G Act and subject to environmental assessments under the Water Act (Qld) and EP Act (Section 5.2).

Potential impacts to MNES from water production may include:

- decline in groundwater level at water bores reducing water availability
- reduction in groundwater pressure resulting in reduced groundwater discharge at spring complexes
- reduction in groundwater pressure resulting in reduction of baseflow to watercourses.

These potential impacts, where water resources exist within the vicinity of the Project, are assessed against the Water Act (Qld) trigger thresholds to determine the significance of potential impacts including to MNES values as detailed in Section 7.4.2.2.

Compliance with regulatory requirements and implementing standard industry controls avoids other potential pathways for groundwater impacts that could occur, including:

- Well construction creating a connection between hydrostratigraphic units potentially altering groundwater flow and quality
- Drilling fluids and chemicals used during well construction potentially altering local groundwater quality
- Produced water storage facilities potentially altering local shallow groundwater levels and quality through seepage or unplanned releases
- Fuel spills or improper storage of chemicals potentially altering local shallow groundwater quality
- Beneficial use activities such as irrigation and stock watering potentially altering local shallow groundwater levels and quality.

While the Project will utilise existing and approved water management infrastructure authorised under the EPBC Act (e.g. EPBC 2009/4974), the Project does not propose any new or additional authorisations for discharge to groundwater systems.

7.4.1.2 Surface water

The Project will utilise existing and approved water management infrastructure authorised under the EPBC Act (e.g. EPBC 2009/4974) and does not propose any new or additional authorisations for discharge to, or abstraction from, surface water systems. Accordingly, no significant direct impacts to surface water resources are predicted from the Project.

Compliance with regulatory requirements and implementing standard industry controls avoids other potential pathways for surface water impacts that could occur, including:

- Construction activities causing transport of sediment to watercourses, potentially resulting in the localised changes to surface water quality
- Water storage facilities potentially alter surface water quality from unplanned releases
- Fuel spills or improper storage of chemicals potentially altering local surface water quality

- Beneficial use activities such as irrigation and stock watering potentially altering local surface water quality.

7.4.2 Assessment methods

7.4.2.1 Data sources

A buffer of 50 km was applied to the Project Area to identify water resources relevant to the Project. Publicly available data and reports utilised for the water resources assessment are listed in Table 63. Detailed information regarding the assessment methodology and data sources is provided in the Water Assessment Report (Appendix F).

Table 63: Data sources for water resources assessment

Item	Data source	Applicability
Climate	Bureau of Meteorology (BOM)	Daily rainfall excess/deficit trends were plotted against long-term averages to inform seasonal trends and correlate rainfall events to aquifer recharge response.
Land use	Queensland Land Use Mapping Program (QLUMP)	Land use was classified into one of six primary classes that are then divided into 32 land use classes and subclasses.
Environmental values	Draft Environmental Values and Water Quality Objectives: Queensland Murray-Darling Basin	Environmental values identified for relevant surface water and groundwater resources.
	Dawson River Sub-basin Environmental Values and Water Quality Objectives	
	Comet River Sub-basin Environmental Values and Water Quality Objectives	
Watercourses	Hydrologic flow type (Kennard *et al.*, 2010)	Hydrologic flow types: permanent (or perennial), semi-permanent or ephemeral.
	Ordered Drainage 100K (Department of Natural Resources Mines and Energy, 2020)	Stream order assigned based on the Strahler Method.
	Water Monitoring Information Portal (State of Queensland, 2018)	Surface water flow and water quality records.
Wetlands	Aquatic Ecosystems Task Group	Identification of types of wetland: lacustrine, palustrine and riverine.
	Directory of Important Wetlands	Identification of nationally important wetlands.
	MSES wetlands under the *Environmental Protection (Water and Wetland Biodiversity) Policy, 2019* (Qld)	Identification of HES wetlands and declared HEV wetlands.
Springs	EPBC Act	Identification of EPBC Act-listed springs.

Item	Data source	Applicability
Flood regime	Queensland Floodplain Overlay	Identification of areas that may experience inundation from flood events of varying scales.
Water quality (surface and groundwater)	OGIA	Classification of water types based on the relative concentration of major ions. Used to characterise water source and mixing over time.
Groundwater		Classification of hydrostratigraphic units into one of the following categories: regional aquifer, partial aquifer, tight aquifer interbedded aquifer or tight aquitard.
		Characterisation of recharge processes into one of the following categories: localised, preferential pathway or diffuse.
		Groundwater model geometry.
		2019 UWIR for the Surat CMA.
		Groundwater modelling report of the Surat CMA.
Geology	Origin	Seismic sections.
	OGIA	Updated geology and geological model for the Surat CMA.
GDEs	Queensland Department of Science, Information Technology and Innovation Groundwater Dependent Ecosystem Mapping and Queensland Spring Database	Identification of surface and expression and terrestrial GDEs.
Third party groundwater use	Queensland Groundwater Database	Determine the number, type and use of registered private and government water supply and monitoring bores in proximity to the Project Area; this data has been used to assess stratigraphy and standing water levels (SWLs).
	Origin	Baseline bore assessments.
	OGIA – Aquifer attribution	Used to assess groundwater use from different aquifers within and proximal to the Project Area for input into the groundwater flow model.

7.4.2.2 Assessment Methodology

The OGIA have developed a regional groundwater flow model as part of the Surat CMA UWIR. First published in 2012, the UWIR assesses the cumulative groundwater level drawdown impacts of resource tenure holders exercising their underground water rights. The primary purpose of the Surat CMA UWIR numerical groundwater model (the UWIR model) is to predict regional water pressure or water level changes in aquifers within the Surat CMA in response to water production from resource projects. In particular, the UWIR model is used to assess potential impacts to landholder groundwater bores and springs relative to the Water Act (Qld) trigger thresholds and assess potential impacts to other environmental values including GDEs (outlined below).

The OGIA published the most recent Surat CMA Groundwater Modelling Report on the UWIR model in October 2019 (OGIA, 2019a), which details the modelling methodology, specification, parameterisation, calibration and set-up for predictive runs. The UWIR model has been used to simulate water production for the Project using the MODFLOW-USG 'drain' boundary condition. As a result, the model may overestimate water production for the Project, providing a conservative assessment of potential groundwater drawdown.

The OGIA simulated groundwater drawdown both for the standalone Project (Project only modelling) and for drawdown inclusive of all operating and proposed gas and coal projects in the Surat CMA (cumulative modelling). These scenarios were simulated by the OGIA using the numerical groundwater model for the Surat CMA. A summary of the impact assessment for the Project only modelling results is provided below, and a summary of the cumulative modelling results is provided in Section 7.5.2.

The modelling outputs from the 2019 UWIR model were provided by the OGIA to inform this assessment in accordance with information provided in the Independent Expert Scientific Committee (IESC) factsheet – environmental assessment (IESC, 2019). The information provided as part of the assessment of groundwater resources also considered the information requirements of the IESC, including remote sensing validation of potential terrestrial GDEs in accordance with the IESC Explanatory Note *Assessing groundwater-dependent ecosystems* (IESC, 2019).

Relevant Water Act (Qld) trigger thresholds were used to assess the significance of potential impacts to groundwater resources including:

- **Bore trigger threshold** - representing the maximum allowable groundwater level decline in a groundwater bore, due to a resource tenure holders' activities, prior to triggering an investigation into the water level decline:
  - for a consolidated aquifer: 5 m
  - for an unconsolidated aquifer: 2 m.
- **Spring trigger threshold** - representing the maximum allowable decline in the water level of an aquifer in connection with a spring, at the spring location, prior to triggering an investigation into the water level decline:
  - for springs: 0.2 m.

The OGIA's terrestrial GDE risk assessment, as presented in the 2019 Surat UWIR, was used to determine potential risk to terrestrial GDEs with predicted drawdown less than 1 m representing a low risk of impact.

The significance of potential impacts to surface water resources was assessed using the significant impact criteria listed in the *Significant impact guidelines 1.3: Coal seam gas and large coal mining developments - impacts on water resources* (DoE, 2013b).

7.4.3 Results

The Project is considered not to have any significant impacts to water resources as impact significance triggers relevant to water resources listed in Table 64will not be exceeded or will be subject to regulatory controls under Queensland law.

Table 64: MNES water resource assessment summary

Water Resources	Relevant Impact Significance Drawdown Trigger	Predicted Project Impacts Exceed Trigger?	Key Regulatory Control
Groundwater Bores	Over 5m in a consolidated aquifer	Yes	• *Water Act 2000* (Qld) • UWIR including Water Monitoring Strategy (WMS)

Water Resources	Relevant Impact Significance Drawdown Trigger	Predicted Project Impacts Exceed Trigger?	Key Regulatory Control
	Over 2m in an unconsolidated aquifer		• *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld) • *Planning Act 2016* (Qld)
EPBC-listed Springs	Over 0.2m	No	• *Water Act 2000* (Qld) • UWIR including Spring Impact Management Strategy (SIMS) • *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld)
Aquatic GDEs	Over 0.2m in outcropping formation	No	• *Water Act 2000* (Qld) • UWIR • *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld)
Terrestrial GDEs	Over 0.2m	No	• *Environmental Protection Act 1994* (Qld) • UWIR • *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld)
Subterranean GDEs	Over 2m for unconfined hydrogeological units	No	• *Environmental Protection Act 1994* (Qld) • *Petroleum Act 1923* and the *Petroleum and Gas (Production and Safety) Act 2004* (Qld)

7.4.3.1 Groundwater bores

Based on the Project only modelling results, a summary of the groundwater bores predicted to experience drawdown greater that the Water Act (Qld) bore trigger thresholds within 50 km of the Project are shown on Figure 21 to Figure 25. Of the approximately 4,850 known groundwater bores located within 50 kms of the Project, 13 bores are predicted to experience drawdown greater than the Water Act (Qld) bore trigger thresholds of 2 m for an unconsolidated aquifer and 5 m for a consolidated aquifer (listed in Table 65). Cumulative impacts are to groundwater bores are assessed in Section 7.5.2.

As shown in Table 65, one of these bores is attributed to a sandstone aquifer, all other bores are attributed to the typically non-productive Rewan Formation aquitard or coal measures representing gas formations for the Project. Several of the identified supply bores are reported to be screened across multiple hydrostratigraphic units. Where this occurs, the bore's source aquifer is attributed to the screened interval nearest the target formation, providing a conservative assessment of potential impacts.

Table 65: Maximum predicted groundwater bore trigger threshold exceedances

UWIR model layer no.	Stratigraphic unit	No. of bores	No. of bores predicted to exceed trigger
1	All Alluvium and Basalt	1,247	-
2	Upper Cretaceous / Cenozoic Sediments	1	-
3	Wallumbilla Formation	10	-
4	Bungil Formation	63	-
5	Mooga Sandstone	231	-
6	Orallo Formation	305	-
7	Gubberamunda Sandstone	374	-
8	Westbourne Formation	61	-
9	Lower Springbok Sandstone	67	-
10	Upper Springbok Sandstone	39	1
11	Walloon Coal Measures (non-productive zone)	5	-
12	Upper Walloon Coal Measures	68	1
13	Middle 1 Walloon Coal Measures	109	-
14	Middle 2 Walloon Coal Measures	60	1
15	Middle 3 Walloon Coal Measures	60	-
16	Lower Walloon Coal Measures	42	1
17	Eurombah Formation	47	-
18	Upper Hutton Sandstone	527	-
19	Lower Hutton Sandstone	262	-
20	Upper Evergreen Formation	88	-
21	Boxvale Sandstone	3	-
22	Lower Evergreen Formation	164	-
23	Precipice Sandstone	161	-
24	Moolayember Formation	81	-
25	Clematis Group	135	-
26	Rewan Group	80	2
27	Bandanna Formation (non-productive zone)	0	-
28	Upper Bandanna Formation	34	-
29	Lower Bandanna Formation	68	5
30	Lower Bowen 1	94	-
31	Cattle Creek Formation (non-productive zone)	0	-

UWIR model layer no.	Stratigraphic unit	No. of bores	No. of bores predicted to exceed trigger
32	Upper Cattle Creek Formation	3	-
33	Lower Cattle Creek Formation	0	-
34	Lower Bowen 2	61	-

Figure 21 - Predicted Groundwater Bore Trigger Threshold Exceedances: Mahalo

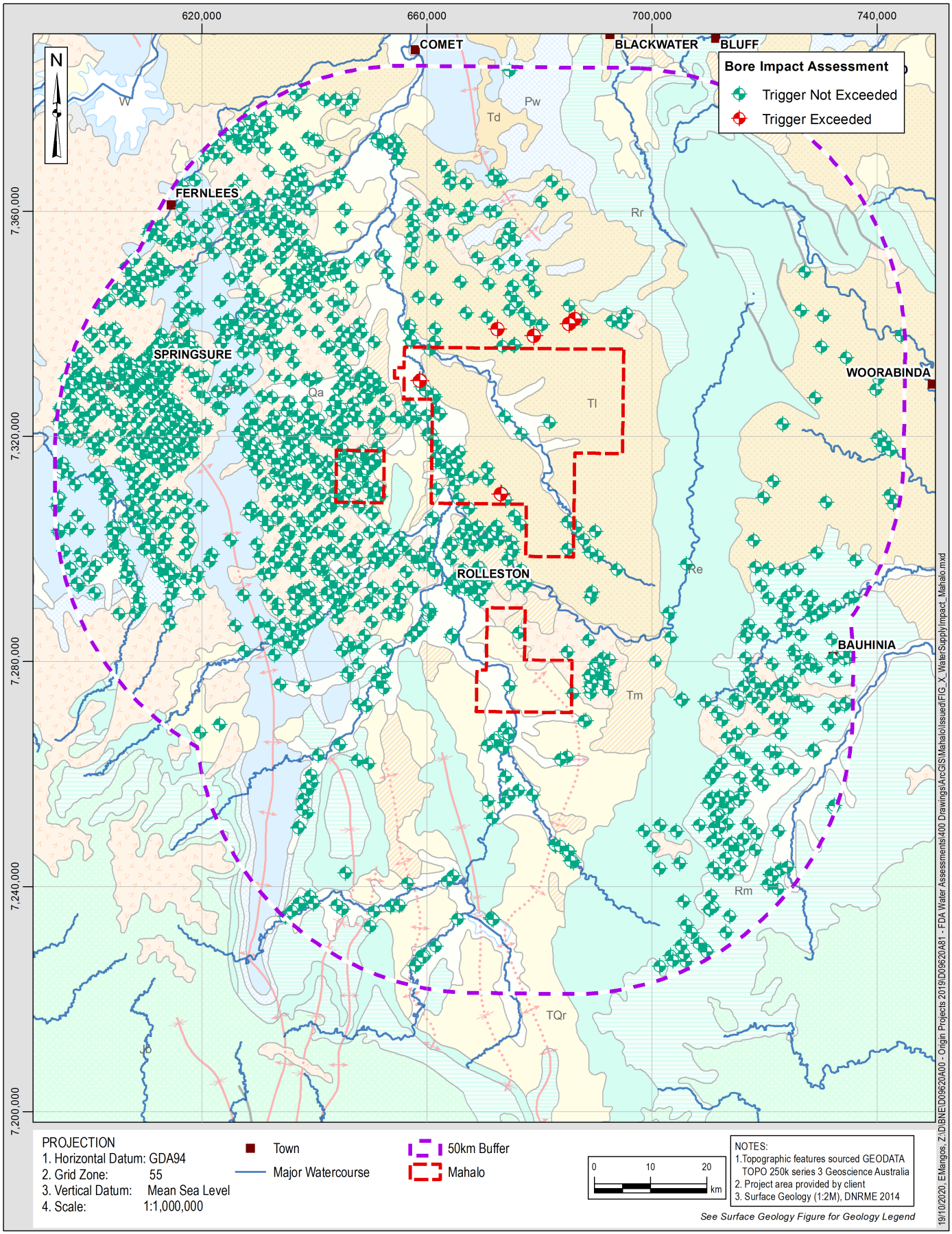


Figure 22 - Predicted Groundwater Bore Trigger Threshold Exceedances: Denison