Report
S00-ARW-ENV-REP-00087-000

Surat Gas Project (SGP) Stage 1

Offset Strategy

February 2025

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Executive Summary

Purpose

The purpose of this document is to satisfy the Offsets conditions (i.e. Conditions 8A to 8D) of the approval, whereby Arrow is submitting and committing to implement a Stage 1 Offset Strategy for approval by the Minister prior to project commencement. A summary of how Arrow satisfies each condition is found in Table 1.

Background

- On 19 December 2013 Arrow Energy Pty Ltd (Arrow) received approval from the Australian Government to proceed with the Surat Gas Project (SGP) under the Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC 2010/5344).

- The approval included:

  - Maximum disturbance limits to the core habitat of Matters of National Environmental Significance (MNES) for the Whole of Project (in Table 1 of the approval) and Stage 1 activities (in Table 2 of the approval)

  - Minimum Stage 1 offset areas for six listed threatened species and two EPBC Communities. The ratio applied by the Department was for Arrow to offset 2.7 to 4.2 times each hectare of core habitat disturbed. The definition of core habitat included in the approval is, '*means core habitat known and core habitat possible as defined in the rules for habitat mapping for each individual species in the Supplementary Report to the Surat Gas Project EIS (March 2012), Attachment 1 – Matters of National Environmental Significance*.'

  - The requirement to provide a Species Impact Management and Offset Plan (SIMOP) for Stage 1, to be approved by the Minister in writing, prior to the commencement of the action.

- There have been five variations to the original approval (dated 29 March 2017, 29 May 2018, 31 October 2018, 2 July 2019 and 29 March 2022) to:

  - Split the Stage 1 SIMOP into two separate documents: a Species Impact Management Plan (SIMP) and a Stage 1 Offset Strategy.

  - Include the requirement for a more detailed Offset Area Management Plan (OAMP) to be submitted within 12 months of project commencement.

  - Include the requirement to secure and legally register offsets prior to commencing subsequent development Stages.

  - Increase the Stage 1 maximum disturbance to core habitat areas in Table 2 for the two listed threatened species that have very broad core habitat mapping requirements (South-eastern Long-eared Bat and Dunmall's Snake).

- Include a variation to conditions relating to water monitoring and management (not relevant to this Offset Strategy).

- Remove the need to provide details on minimum Stage 1 offset areas from the Stage 1 Offset Strategy because this detail is now to be provided in the OAMP and because the proposed Stage 1 disturbance to core habitat has now been significantly reduced by revising the field development layout to avoid the bulk of the mapped core habitat.

- This document is Revision 10 of the Offset Strategy which supersedes Revision 8 (1 March 2023) and Revision 9 (5 September 2023) and is fully aligned with the variation to the EPBC Approval Conditions dated 29 March 2022. Arrow's comprehensive ecological surveys conducted after the EIS was approved detected the presence of an additional three EPBC Act-listed species in the SGP project area. Residual significant impacts to these species will be assessed as state matters, being impacts to habitat for the Koala (*Phascolarctos cinereus*), Greater Glider (*Petauroides volans*) and Painted Honeyeater (*Grantiella picta*).

Key Elements

- The process and key elements of the Surat Gas Project Stage 1 Offset Strategy field survey methods, habitat mapping for listed threatened species, risk assessment and strategies to identify and secure offsets is entirely consistent with those used for the approved Bowen Gas Project Stage 1 Offset Strategy (approved by, Assistant Secretary Assessments & Post Approvals Branch, 15 October 2018).

- This Stage 1 Offset Strategy has been prepared by suitably qualified ecologists, with evidence of the authors' qualifications and experience provided in Appendix A.

- Arrow has undertaken two years of post-EIS comprehensive seasonal ecological surveys to gain a detailed understanding of EPBC listed threatened species and EPBC communities within the Project development area and have modified our field development layout to avoid and minimise impacts to these national values.

- A Surat Gas Project Species Impact Management Plan (SIMP) that details the measures that Arrow will take to avoid, mitigate and manage impacts to EPBC listed threatened species and their habitat during the construction, operation and decommissioning phases of the action, and how the success of these measures will be monitored, was approved by the Department on 14 December 2018.

- This Stage 1 Offset Strategy describes how Arrow will secure offsets for residual significant impacts to the relevant EPBC listed threatened species and EPBC communities.

- As per Condition 8D, Arrow provides the Department with the commitment that we will implement this Stage 1 Offset Strategy upon approval; and

- In compliance with Condition 10A, Arrow will legally secure all of the Stage 1 offsets prior to the commencement of Stage 2.

Table 1 Cross-reference table for information requirements and Stage 1 Offset Strategy section

Condition Number	Condition requirement	Section of this Offset Strategy	Summary of how the condition has been met
8A	If the approval holder has provided an offset in respect of impacts predicted for a development stage of the project which subsequently are not realised, such parts of the offset in excess of the obligation for that development stage can be applied towards offsets required for the impacts of subsequent development stages.	Section 2	Arrow acknowledges and appreciates the opportunity to 'bank' offsets.
8B	The Offset Strategy may be prepared and submitted to the Minister for approval in stages. Each stage of the Offset Strategy must provide information in respect of the subsequent development stage to commence and all earlier development stages. A development stage must not commence until an Offsets Strategy addressing offset obligations for that development stage has been approved by the Minister.	Section 3	This Offset Strategy has been developed to address the residual significant impacts to MNES predicted for Stage 1 of the SGP. Arrow will submit a revised Offset Strategy for each subsequent development stage to Stage 1.
8C	The Offset Strategy must:		
8C(a)	Include a strategy to secure the offsets proposed for the residual significant impacts to the EPBC listed species and EPBC communities for the subsequent development stage.	Section 4	Offsets will be secured in accordance with the EPBC Act Offsets Policy, whereby a minimum of 90 per cent will be met through direct land-based offsets and the balance (<10 per cent) by other compensatory measures.
8C(b)	Include a map of the location of each EPBC listed threatened species and its habitat or EPBC community in relation to infrastructure for the subsequent development stage.	Section 5	Nine maps have been provided to illustrate the location of each relevant MNES in relation to the proposed State 1 infrastructure.
8C(c)	Describe potential risks to the successful implementation of the Offset Strategy, and a description of the contingency measures that would be implemented to mitigate against these risks.	Section 6	Table 6.1 describes 10 potential risks to the successful implementation of this Stage 1 Offset Strategy and includes a description of the contingency measures that would be implemented to mitigate against these risks

Condition Number	Condition requirement	Section of this Offset Strategy	Summary of how the condition has been met
8C(d)	Detail how the approval holder will address any residual significant impacts to any EPBC listed threatened species and its habitat and/or EPBC communities not identified in Table 1, in accordance with the EPBC Act Offsets Policy.	Section 7	Arrow uses suitably qualified ecologists to undertake pre-clearance surveys for all ground disturbance activities and these surveys will identify any potential impacts to MNES not listed in Table 1 of the approval. Arrow will offset any such residual significant impacts in accordance with the EPBC Act Offsets Policy.
8C(e)	Specify the proposed legal mechanism and timeframe for securing the offset(s).	Section 8	Offsets will be legally secured through the use of a declared area as defined under the *Vegetation Management Act 1999* (VM Act) (Qld). Offset areas will be legally secured prior to commencement of the next project stage.
8D	The approval holder must not commence the action until the Offset Strategy for Stage 1 has been approved by the Minister in writing. The approved Offset Strategy must be implemented by the approval holder.	Section 9	Arrow provides the Department with the commitment that we will not commence the action until the Offset Strategy for Stage 1 has been approved by the Minister in writing and the approved strategy will be implemented.

Acronyms

The following table provides a list of acronyms used throughout this report.

Acronyms

Term	Definition
CSG	Coal Seam Gas
DCCEEW	Department of Climate Change, Energy, the Environment and Water (Australia)
DotEE	Department of the Environment and Energy (Australia) (former)
EA	Environmental Authority
DETSI	Department of Environment, Tourism, Science & Innovation (Queensland)
EIS	Environmental Impact Statement
EPBC Act	*Environment Protection and Biodiversity Conservation Act 1999*
FEED	Front end engineering design
GIS	Geographic Information System
MNES	Matters of National Environmental Significance
MSES	Matters of State Environmental Significance
OAMP	Offset Area Management Plan
RE	Regional Ecosystem
ROW	Right of Way
SREIS	Supplementary Report to the Environmental Impact Statement
SGP	Surat Gas Project
TEC	Threatened Ecological Community

1. Introduction

Arrow Energy is a Queensland based subsidiary of Arrow Energy Holdings Pty Ltd (Arrow), a 50:50 joint venture between Royal Dutch Shell (Shell) and PetroChina Company Ltd (PetroChina). Arrow is currently developing coal seam gas (CSG) resources in Queensland, including resources in the Surat Basin.

The Surat Gas Project (SGP) Environmental Impact Statement (EIS) for up to 6,500 coal seam gas production wells and associated infrastructure was granted approval from the Queensland Government in October 2013 and the Australian Government in December 2013. The Project covers an area of approximately 5,385 km^2, extending from the township of Wandoan in the north towards Millmerran in the south (see Figure 1.1).

The EPBC Act approval for the SGP (EPBC 2010/5344) specifies 'Whole of Project' and 'Stage 1' maximum disturbance limits to core habitat for particular Matters of National Environmental Significance (MNES). Core habitat is defined in the EPBC approval notice as '*means core habitat known and core habitat possible as defined in the rules for habitat mapping for each individual species in the Supplementary Report to the Surat Gas Project EIS (March 2012), Attachment 1 – Matters of National Environmental Significance'.* The approval notice also specifies that a Stage 1 Offset Strategy be submitted for approval of the Minister prior to project commencement and resubmitted for approval prior to the commencement of each subsequent stage. The approval decision defines the stages as:

- Stage 1: means year 1 to 3 (inclusive) of the action, starting at the date of commencement
- Stage 2: means year 4 to 11 (inclusive) of the action
- Stage 3: means year 12 to 20 (inclusive) of the action
- Stage 4: means years 21 to decommissioning (inclusive) of the action.

This Offset Strategy will continue to apply to Stage 1, noting that the activities as described in this Offset Strategy for Stage 1 are not yet complete and will continue after year 3 under this approved Offset Strategy. Stage 2 will not commence before 31 July 2025. All other aspects of the Offset Strategy remain unchanged.

Despite the Stage 1 activities continuing after year 3 of the approved Offset Strategy, Arrow will not exceed the maximum disturbance limits set out in the Offset Strategy. Offsets for Stage 1 will be legally secured before the commencement of Stage 2.

This Stage 1 Offset Strategy addresses each of the information requirements stated in the 'Offsets' section of the approval (i.e. Conditions 8A and 8D). Figure 1.1 shows an indicative location of the Stage 1 activities in relation to the project. The locations shown are subject to change as the project progresses through the detailed design phase and Arrow shareholder and joint venture partner approval processes. For the purpose of this strategy, the Stage 1 activities include the installation of approximately 350 wells and associated gathering lines and access tracks.

The front-end engineering design (FEED) process will provide Arrow with further opportunities to avoid and minimise impacts to MNES through more refined infrastructure location planning.

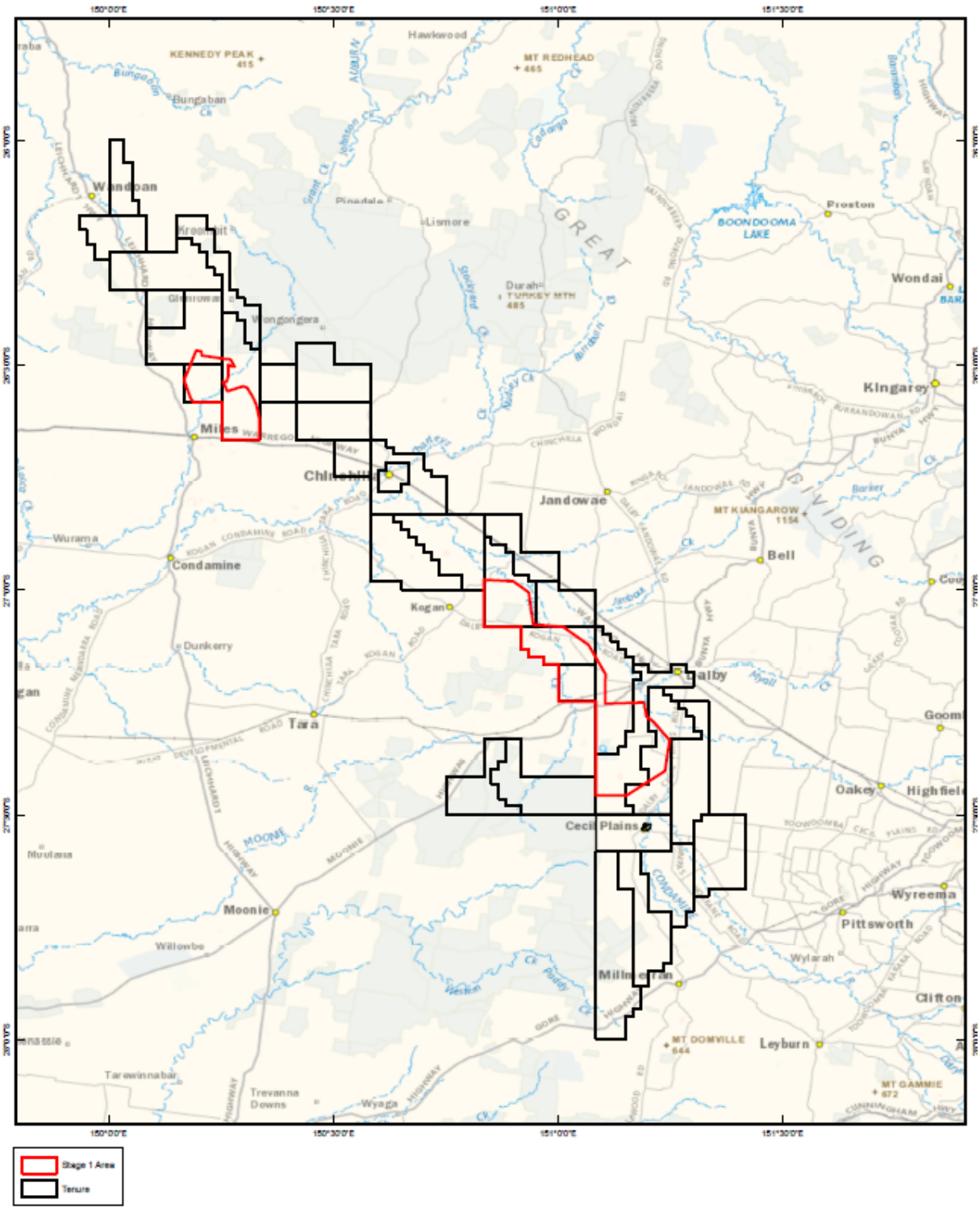

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Figure 1.1
Surat Gas Project
Location in the Regional Context

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2. Banking offsets

Condition 8A: If the approval holder has provided an offset in respect of impacts predicted for a development stage of the project which subsequently are not realised, such parts of the offset in excess of the obligation for that development stage can be applied towards offsets required for the impacts of subsequent development stages.

Arrow acknowledges and appreciates the opportunity to 'bank' offsets. That is, if we have provided an offset in respect of impacts predicted for a development stage that is not realised, we will apply this offset to subsequent development stages.

3. Staged offsets

Condition 8B: The Offset Strategy may be prepared and submitted to the Minister for approval in stages. Each stage of the Offset Strategy must provide information in respect of the subsequent development stage to commence and all earlier development stages. A development stage must not commence until an Offsets Strategy addressing offset obligations for that development stage has been approved by the Minister.

The EPBC Act approval for the SGP (EPBC 2010/5344) specifies 'Whole of Project' and 'Stage 1' maximum disturbance to core habitat limits for specified Matters of National Environmental Significance (MNES). The approval defines the stages as:

- Stage 1: means year 1 to 3 (inclusive) of the action, starting at the date of commencement
- Stage 2: means year 4 to 11 (inclusive) of the action
- Stage 3: means year 12 to 20 (inclusive) of the action
- Stage 4: means years 21 to decommissioning (inclusive) of the action.

This Offset Strategy has been developed to address the residual significant impacts to MNES predicted for Stage 1 of the SGP. The Stage 1 progress has been slower than anticipated. The Stage 1 activities described in this Offset Strategy will continue after year 3. Stage 2 will not commence until 31 July 2025. Arrow will submit a revised Offset Strategy for each subsequent development stage to Stage 1. The benefit of staging the project offsets is the continued focus on reducing the impacts to MNES by means of continuous improvement in the refinement of infrastructure locations (i.e. field development layouts) and increasing knowledge of preferred habitats for MNES gained by ongoing pre-clearance surveys and monitoring of construction activities (e.g. fauna spotter-catcher observations and records of any reptiles removed from the gathering line open trenches).

Arrow will not commence a subsequent development stage until the revised Offset Strategy for that stage has been approved by the Minister or delegate in writing.

4. Strategy to secure offsets

Condition 8C(a): The Offset Strategy must: include a strategy to secure the offsets proposed for the residual significant impacts to the EPBC listed species and EPBC communities for the subsequent development stage.

Arrow plans to secure Stage 1 offsets proposed for the residual significant impacts to the EPBC listed species and EPBC communities through a combination of direct land-based offsets and indirect offsets (i.e. other compensatory measures) in accordance with the EPBC Act Offsets Policy. As per the policy:

- A minimum of 90 per cent of the offset requirements for any given impact will be met through direct offsets
- The balance of the offset requirements (10 per cent or less), will be secured by other compensatory measures that will lead to benefits to the impacted matter.

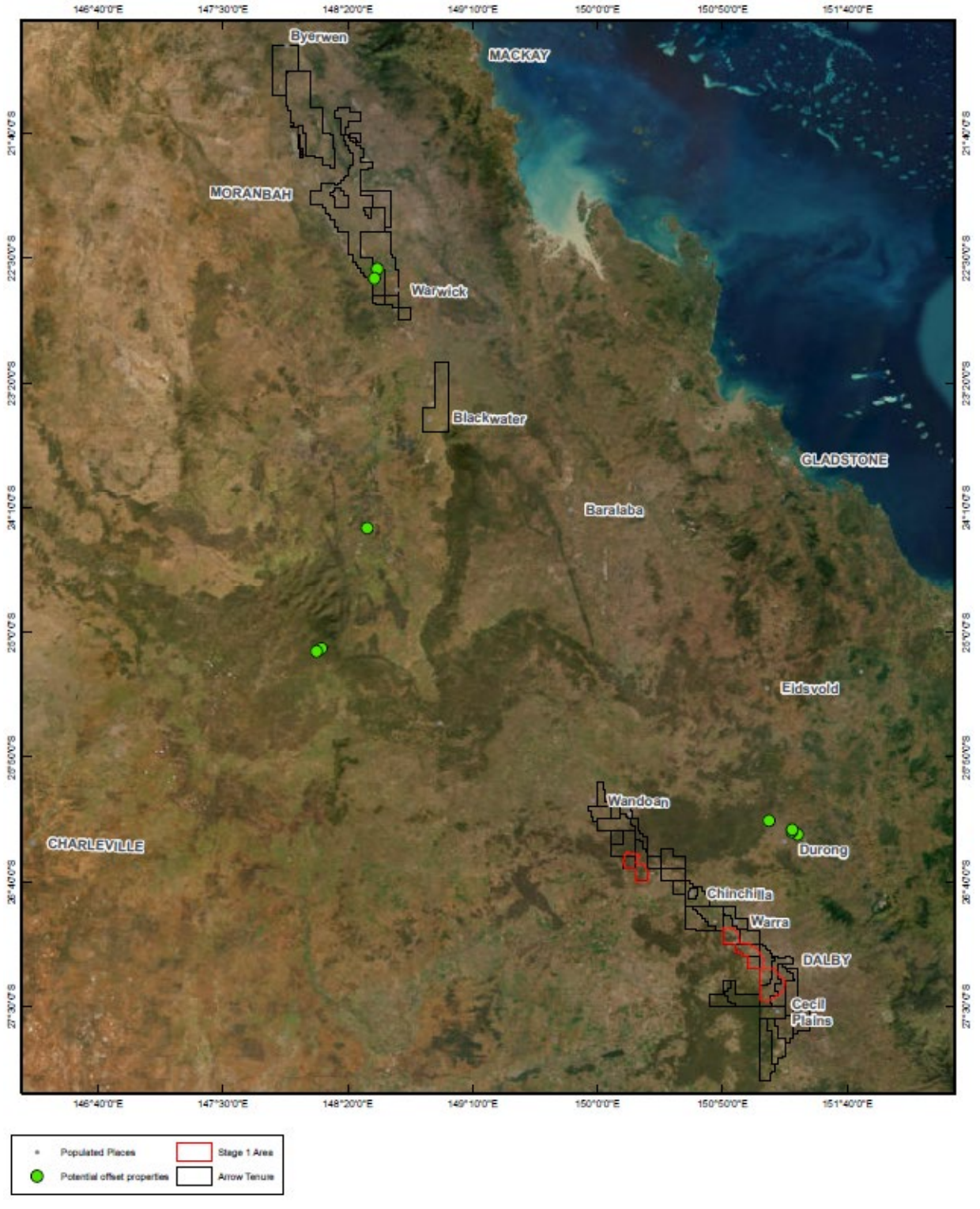
Direct offsets

Arrow's preferred option for direct land-based offsets is to secure as few properties as possible to meet the Stage 1, and ideally subsequent stage, requirements. This provides the advantage of securing a large offset property and thus reducing edge effects and improving the cost efficiency of maintenance activities. It is proposed that the offset areas be legally secured through the use of a declared area as defined under the *Vegetation Management Act 1999* (Queensland) (see Section 8 for details).

Figure 4.1 shows the approximate location of the offset properties that are currently being investigated by Arrow. As commercial discussions/agreements with these landholders are yet to be transacted, the exact property location remains in confidence. These details will be provided within the Offset Area Management Plan (OAMP) required by condition 10B and to be submitted to the Department within 12 months of project commencement.

Arrow continues to investigate appropriate offset properties, with the property list shown in Figure 4.1 being the result of an identification and assessment exercise undertaken since 2015 that has to date screened over 60 properties.

The offset property list was refined through a ranking process that considered the ability of the property to provide for multiple MNES offset requirements, strong connectivity in the landscape, a combination of remnant and regrowth vegetation, land use and property ownership. Twenty-two (22) of the 60 properties were identified for further investigation and landholder engagement. Over the last few years Arrow has been in commercial in confidence discussions with offset brokers, has narrowed the suitable properties from 22 to eight, and is confident that sufficient property(ies) are available to secure all the required Stage 1 offsets.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Blackwater
GLADSTONE
Baralaba
Eidsvold
Wandoan
Durong
Chinchilla
Warra
DALBY
Cecil Plains
CHARLEVILLE
Populated Places
Stage 1 Area
Potential offset properties
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Figure 4.1 – Approximate location of offset properties being investigated
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In identifying offset properties, Arrow has the following objectives for potentially suitable offsets:

- Property criteria align with EPBC Act Offsets Policy
- On-ground confirmation of offset values for selected option
- Wherever possible, connected in the landscape to adjacent tracts of remnant vegetation and/or riparian corridors
- Contain a number of the required offset values with sufficient area to meet Stage 1 offset requirements and preference to have surplus areas available for future project stages
- Property management aligned with principle of reduction in threats, and an increase in or maintenance of ecological condition.

Responsible parties for the management and monitoring of secured offset properties will be determined and documented in the agreement. A plan/agreement will be prepared confirming the above requirements to which the landholder, Arrow and any required contractors will agree through contractual arrangements.

Arrow will work with the Department during the development of the OAMP to ensure that the proposed offset properties meet the objectives of the EPBC Act Offsets Policy. To facilitate compliance with the EPBC Act Offsets Policy, the offsets delivered will:

- Deliver an overall conservation outcome that improves or maintains the viability of the protected matter
- Be built around direct offsets but may include other compensatory measures. The proportion of direct and compensatory measures will be tailored to each MNES in accordance with the EPBC Act Offsets Policy, and in agreement with DCCEEW, and set out in the OAMP
- Be in proportion to the level of statutory protection that applies to the protected matter
- Be of a size and scale proportionate to the impacts on the protected matter
- Effectively account for and manage the risks of the offset not succeeding
- Be additional to what is already required, determined by law or planning regulations, or agreed to under other schemes or programs
- Be efficient, effective, timely, transparent, scientifically robust and reasonable
- Have transparent governance arrangements including being able to be readily measured, monitored, audited and enforced. Arrow's selection of direct offsets will be aligned with the conservation gain being able to:
    - Improve existing habitat for the protected matter; and/or
    - Create new habitat for the protected matter; and/or
    - Reduce threats to the protected matter; and/or

- Avert the loss of a protected matter and its habitat that is under imminent threat of complete and continuing loss (if the risk of loss is avoided as a result of securing an offset for conservation purposes which will protect the protected matter and its habitat).

5. Maps of species locations and habitats

Condition 8C(b): The Offset Strategy must: include a map of the location of each EPBC listed threatened species and its habitat or EPBC community in relation to infrastructure for the subsequent development stage

There is habitat for three EPBC listed threatened species and one EPBC ecological community within the area of the proposed Stage 1 activities. Figure 1.1 provides a regional context to the location of the proposed Stage 1 activities. It is noted that the specific location of activities may change during the detailed design phase and Arrow shareholder and joint venture partner approval processes. However, the principles and strategies for securing offsets that are presented in this Stage 1 Offset Strategy will be implemented.

This figure shows that the activities are focused in two areas; a northern area that is west, north-west of Dalby, and a southern area that is north of Cecil Plains. Two maps (one for each focus area) have been provided for each of the seven MNES, with each map showing:

- *Overly conservative potential habitat*: which for the purpose of this document is defined as the vegetation types (i.e. Queensland Regional Ecosystems) that correlate with the EPBC Species Profiles and Threats (SPRAT) Database habitat descriptions for each MNES (this area can be considered more broadly as 'potential habitat' and it provides a very conservative appreciation of the maximum extent of habitat that each species may utilise)

- *Core habitat*: which for the purpose of this document is a combination of core habitat known and core habitat possible for each MNES as defined in the rules for habitat mapping for each individual species provided in Appendix B *Surat Gas Project Terrestrial Ecology Report*.

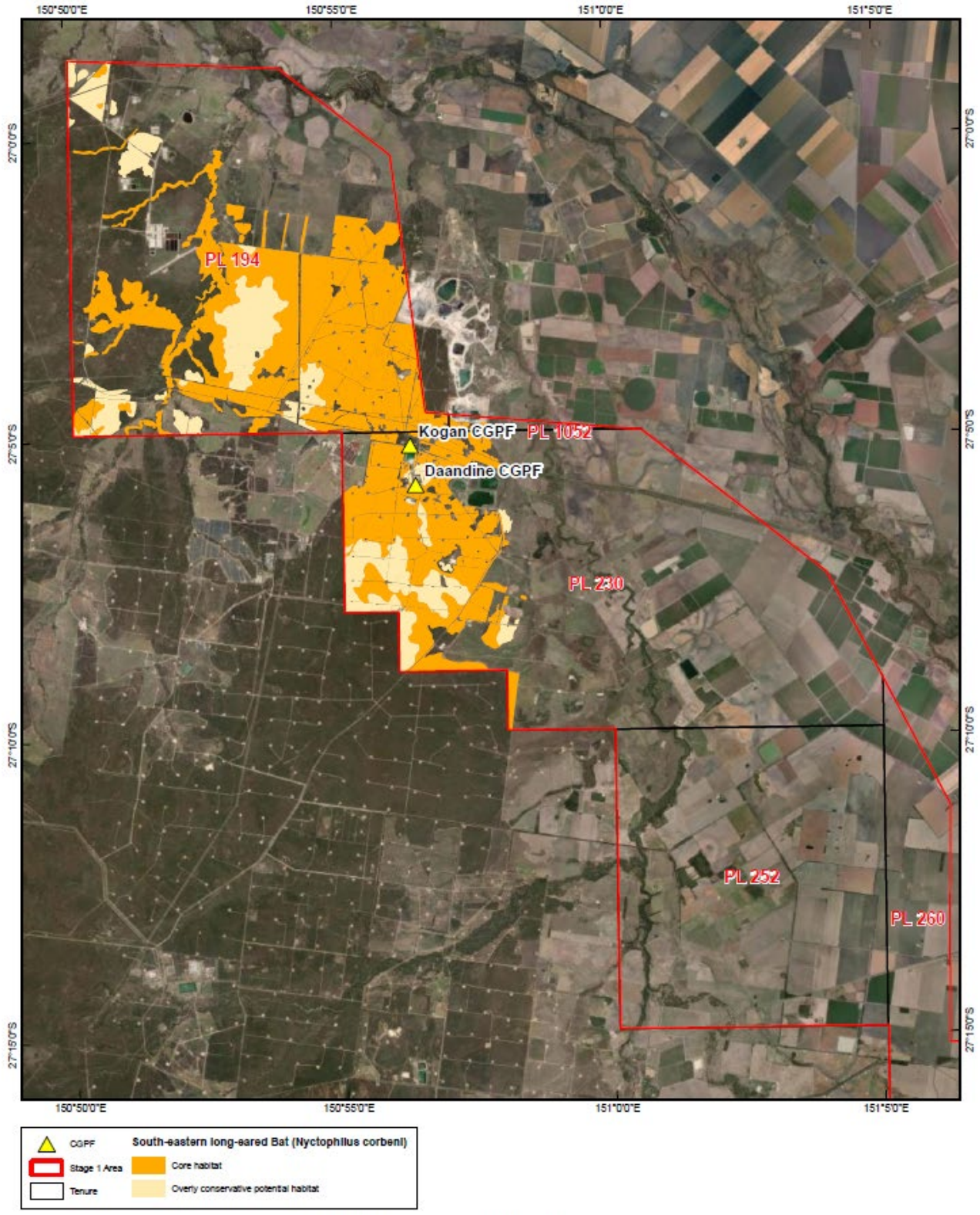
The maps are as follows:

- Figure 5.1(a), Figure 5.1(b) and Figure 5.1(c): South-eastern Long-Eared Bat (Nyctophilus corbeni)

- Figure 5.2(a), Figure 5.2(b) and Figure 5.2(c): Dunmall's Snake (Furina dunmalli)

- Figure 5.3(a), Figure 5.3(b) and Figure 5.3(c): Brigalow (Acacia harpophylla dominant and co- dominant)

The abovementioned maps are provided below.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Stage 1 Area
Tenure
South-eastern long-eared Bat (Nyctophilus corbeni)
Core habitat
Overly conservative potential habitat
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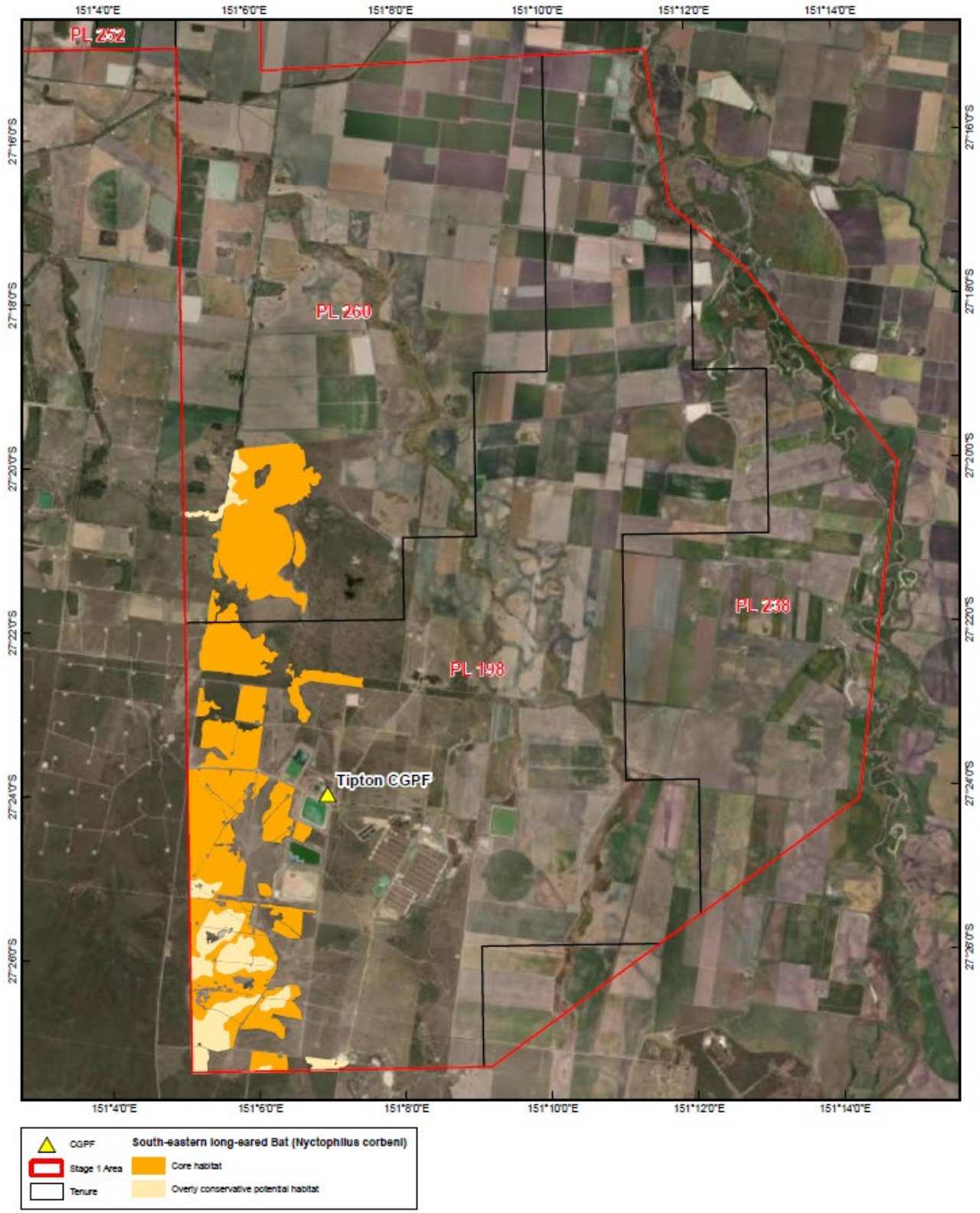
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CGPF
Stage 1 Area
Tenure
South-eastern long-eared Bat (Nyctophilus corbeni)
Core habitat
Overly conservative potential habitat
Based on or contains data provided by the State of Queensland (Department of Environment and Resource Management). In consideration of the State permitting use of this data you acknowledge and agree that the State gives no warranty in relation to the data (including accuracy, reliability, completeness, currency or suitability) and accepts no liability (including without limitation, liability in negligence) for any loss, damage or costs (including consequential damage) relating to any use of the data. Data must not be used for direct marketing or be used in breach of the privacy laws.
© Commonwealth of Australia (Geoscience Australia) year of publication. This material is released under the Creative Commons Attribution 2.5 Australia Licence. http://creativecommons.org/licenses/by/2.5/au/ The dimensions, areas, number of lots, size & location of corridor information are approximate only and may vary.
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Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no warranty is given that the information contained on this map is free from error or omission. Any reliance placed on such information shall be at the sole risk of the user. Please verify the accuracy of all information prior to using it.
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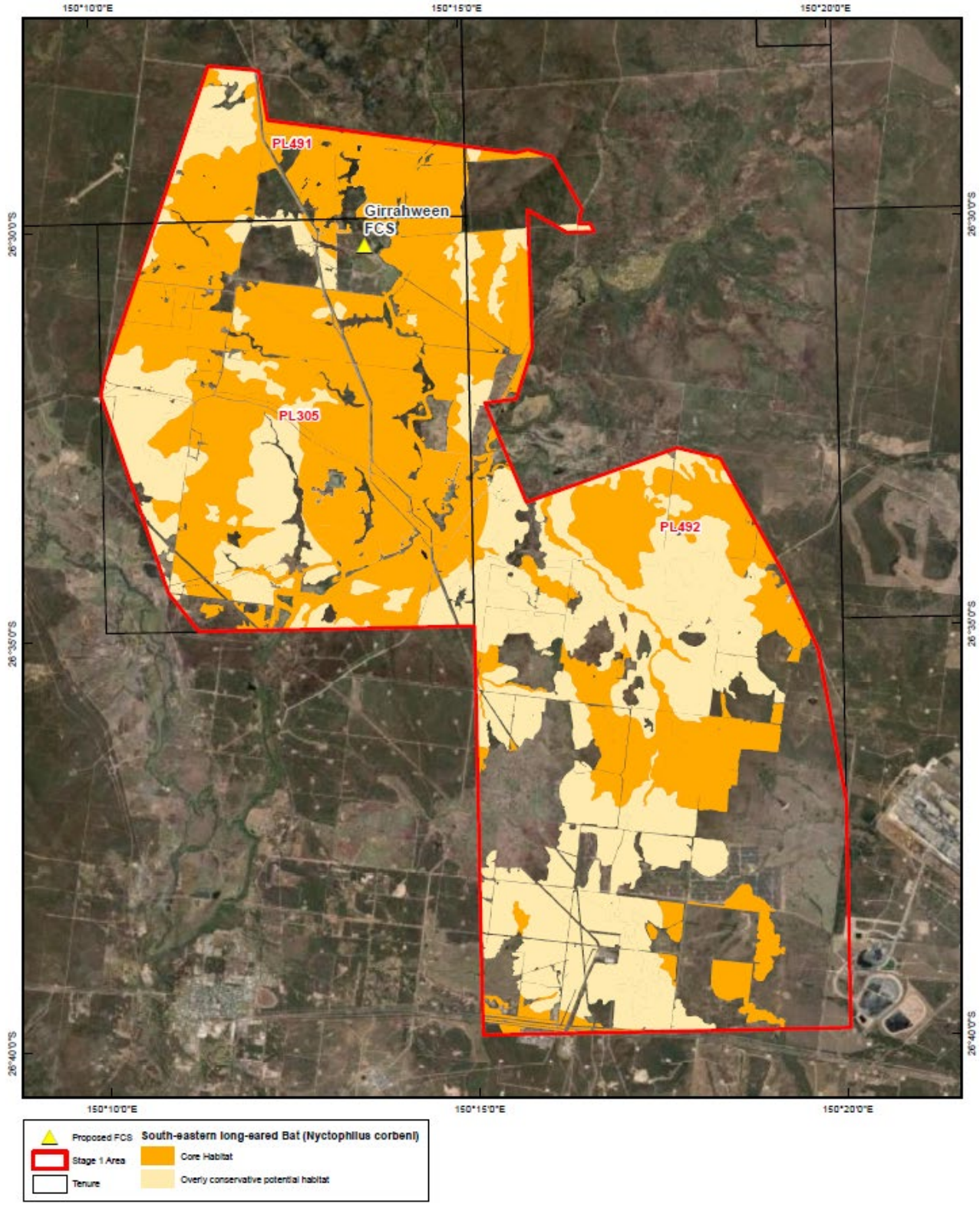

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Author: awolhuter

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Figures 5.1(c):
South-eastern Long-Eared Bat (Nyctophilus corbeni)

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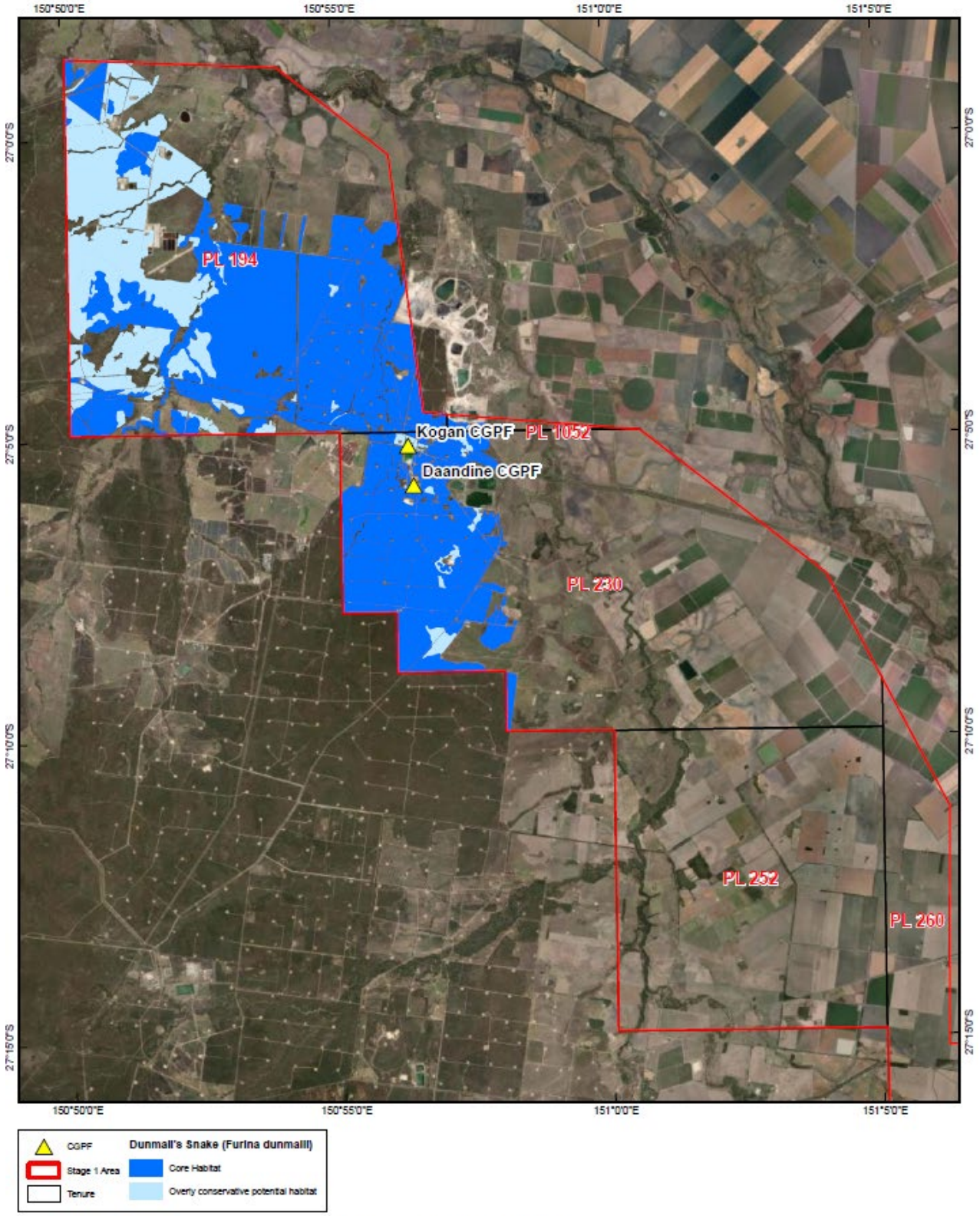
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Daandine CGPF
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CGPF
Stage 1 Area
Tenure
Dunmall's Snake (Furina dunmalli)
Core Habitat
Overly conservative potential habitat
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Figure 5.2(a):
Dunmall's Snake (Furina dunmalli)
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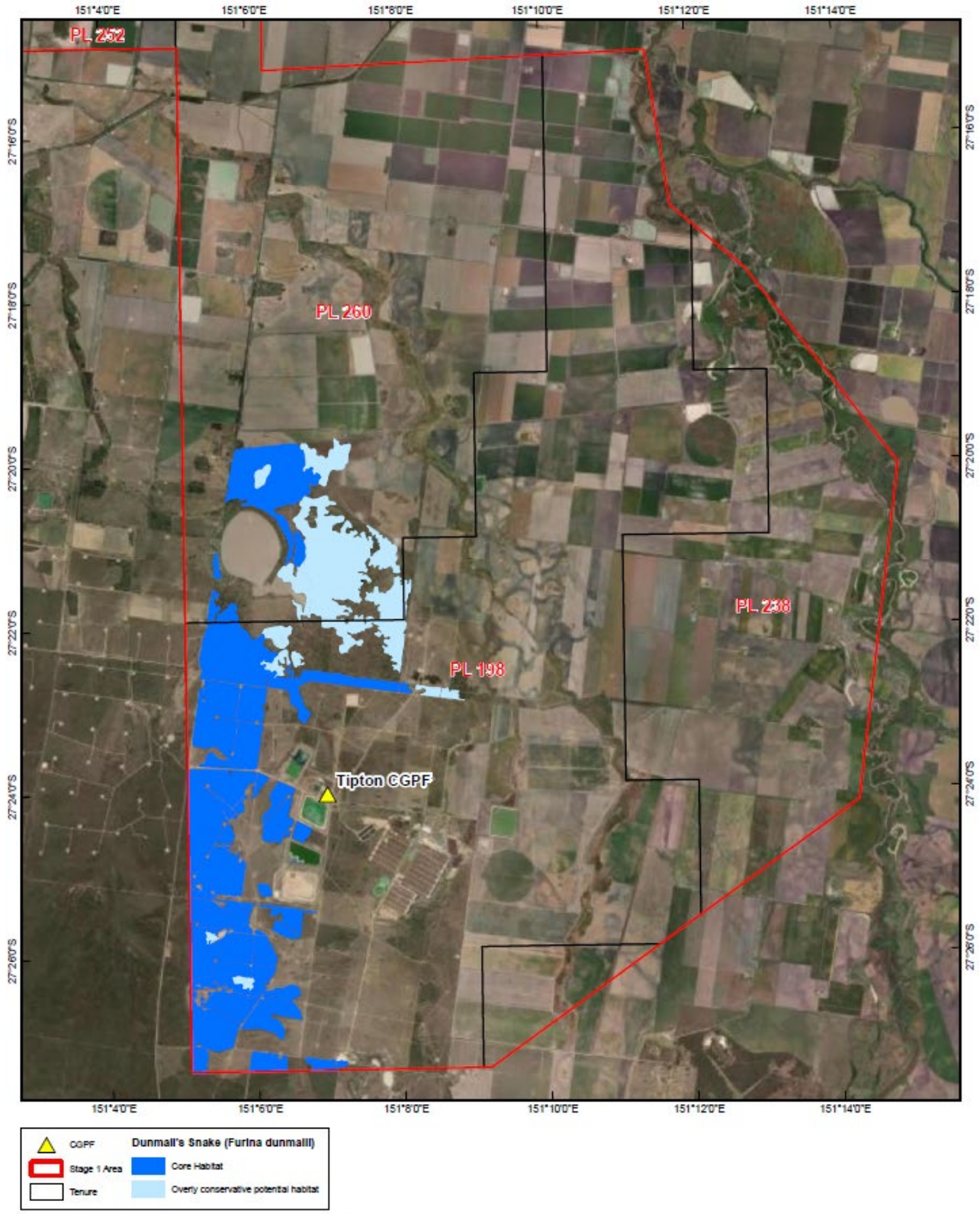
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PL 252
PL 260
PL 238
PL 198
Tipton CGPF
CGPF
Stage 1 Area
Tenure
Dunmall's Snake (Furina dunmalli)
Core Habitat
Overly conservative potential habitat
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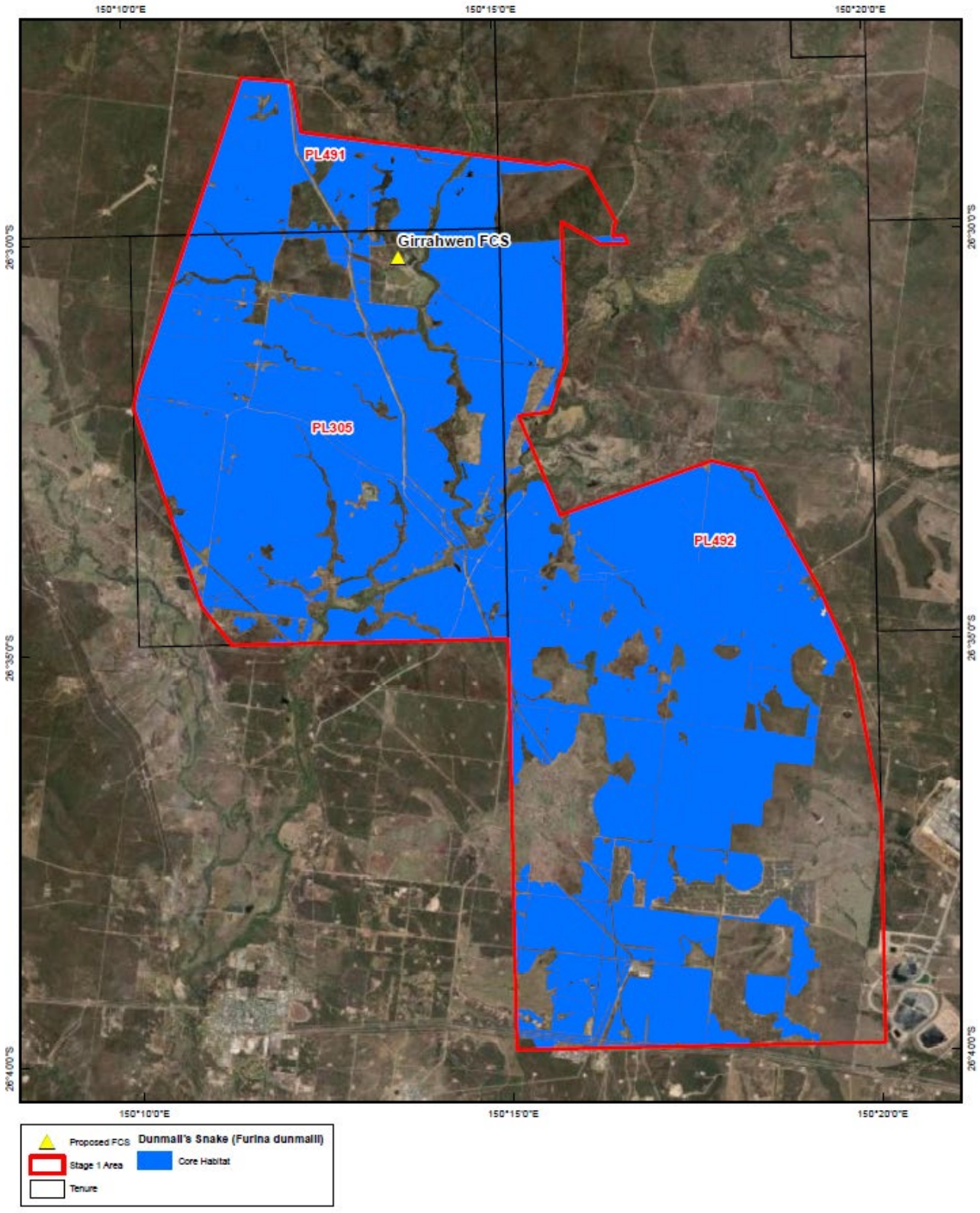

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Author: awolhuter

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Source:
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Dept. Envir. and Resource Mgmt.

N

Coordinate System: GDA2020 MGA Zone 56

0 1 2 4
km

Figure 5.2(c):
Dunmall's Snake (Furina dunmalli)

arrow energy
go further

Date: 12/02/2025

Document: R:\GIS\Geomatics_Team\WORK_REQUESTS\Environment\190521_SGP_Stage1_Offsets_MR\mxd\SREIS_Stage1_MNES_Furina dunmalli_Fig3i2.mxd

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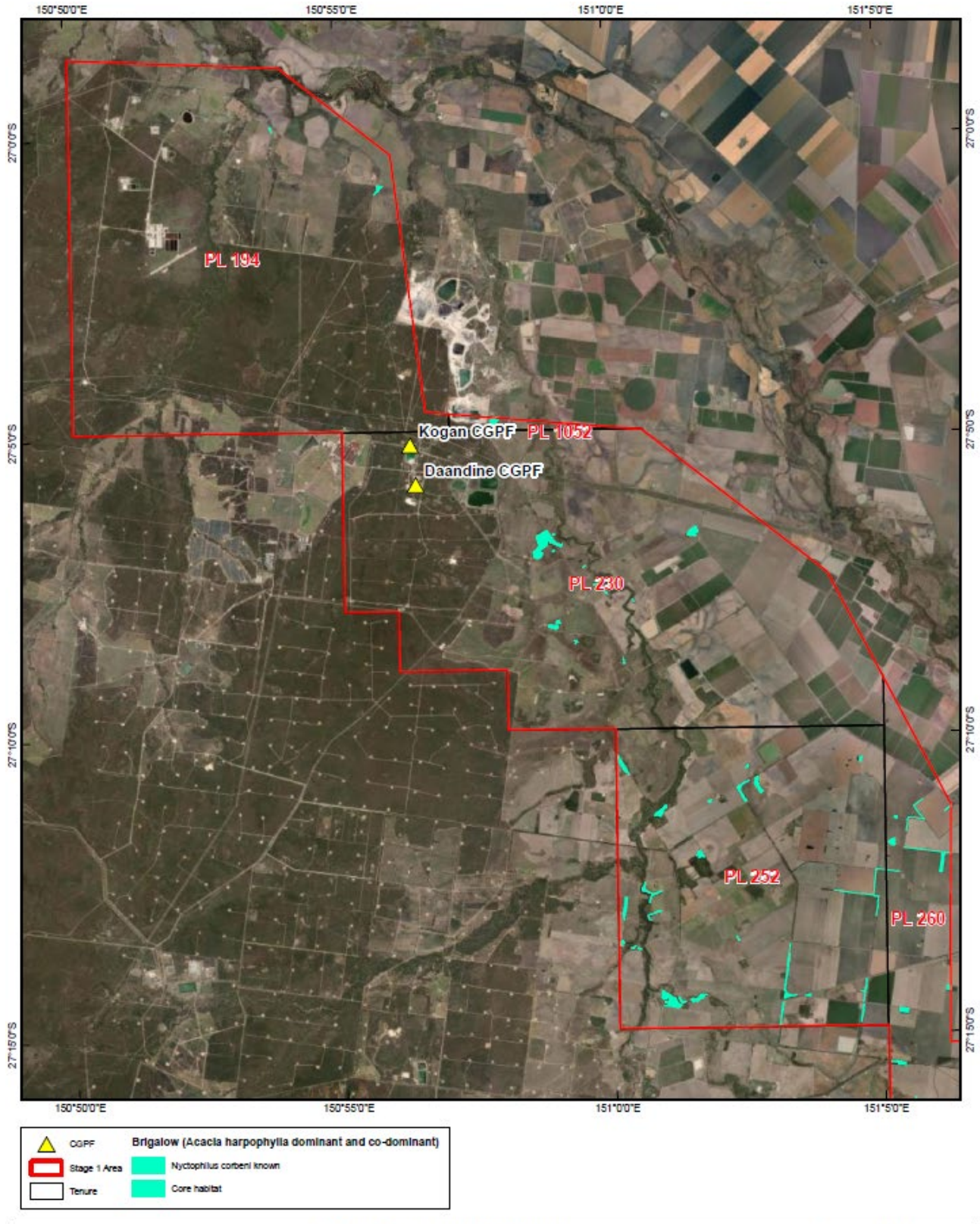

Figure 5.3(a):
Brigalow (Acacia harpophylla dominant and co-dominant)

Document: R:\GIS\Geomatics_Team\WORK_REQUESTS\Environment\250211_RITM0838048_SGPOffsetStrategy_JBrOffsetStrategyMaps.aprx

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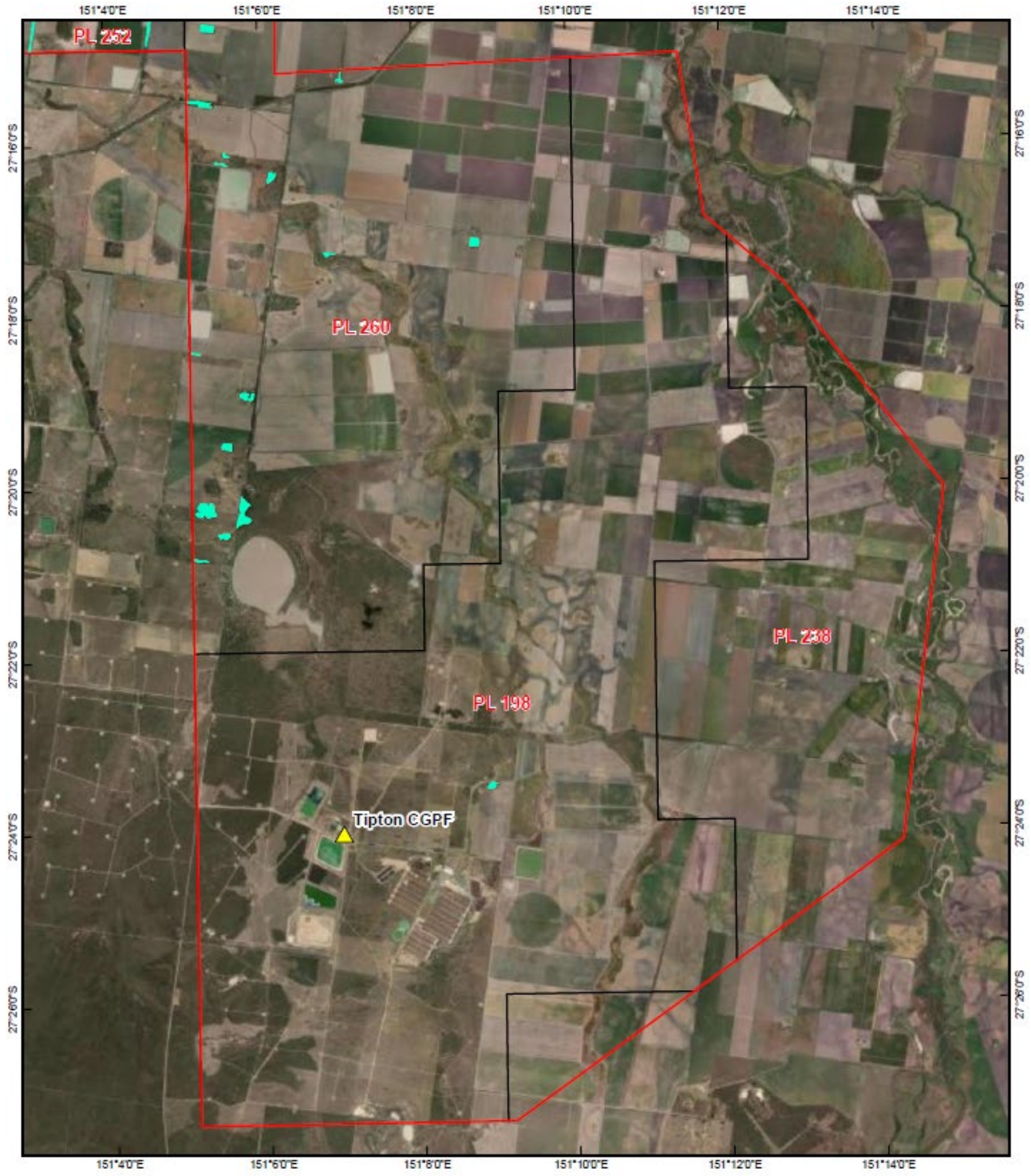

CGPF
Stage 1 Area
Tenure
Brigalow (Acacia harpophylla dominant and co-dominant)
Nyctophilus corbeni known
Core habitat

Disclaimer: While all reasonable care has been taken to ensure the information contained on this map is up to date and accurate, no warranty is given that the information contained on this map is free from error or omission. Any reliance placed on such information shall be at the sole risk of the user. Please verify the accuracy of all information prior to using it.

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Source:
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N

Coordinate System: GDA2020 MGA Zone 56
0 1 2 4
km

Figures 5.3(b): Brigalow (Acacia harpophylla dominant and co-dominant)

arrow energy go further

Date: 12/02/2025

Issued To:) Burckhardt
Author: awolhuter

Document: R:\GIS\Geomatics_Team\WORK_REQUESTS\Environment\250211_RITM0638048_SGPOffsetStrategy_JBKOffsetStrategyMaps.aprx

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Source: Arrow Energy Limited, Geoscience Australia Dept. Envir. and Resource Mgmt.

Coordinate System: GDA2020 MGA Zone 56

0 1 2 4 km

Issued To: J Buckhardt
Author: awolhuter

Document: R:\GIS\Geomatics_Team\WORK_REQUESTS\Environment\190521_SGP_Stage1_Offsets_MR\mxd\SREIS_Stage1_MNES_Brigalow_Fig3i2.mxd

Figures 5.3(c): Brigalow (Acacia harpophylla dominant and co-dominant)

arrow energy go further

Date: 12/02/2025

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6. Risks to successful implementation of this Strategy

Condition 8C(c): The Offset Strategy must: describe potential risks to the successful implementation of the Offset Strategy, and a description of the contingency measures that would be implemented to mitigate against these risks.

There are ten potential risks to the successful implementation of this Stage 1 Offset Strategy. The risks, existing controls, risk rating, trigger that will be monitored and contingency measures that would be implemented if the trigger was realised are described in Table 6.1.

Table 6.1 Risks to the successful implementation of this Stage 1 EPBC Offset Strategy

Risk description	Existing controls	Risk Rating	Trigger that will be monitored	Contingency measure
Arrow does not implement the Offset Strategy	• Section 9 of this Strategy provides Arrow's commitment to implementing the SGP Stage 1 Offset Strategy.	Low	Annual report, including accurate records substantiating impacts to MNES and demonstrating compliance with this Strategy, will be made available on Arrow's website within 3 months of every 12-month anniversary of project commencement.	Arrow will notify the DCCEEW of the non- compliance and either rectify within 3 months or seek an alternative arrangement with DCCEEW.
Insufficient resources are assigned to implementing the Strategy	• Arrow is committed to implementing our Health Safety and Environment Policy, which specifically states, 'Arrow will fully support the implementation of this Policy by providing sufficient resources, systems and training to effectively manage HSE risks.' • Arrow has a dedicated Environment Team that is sufficiently resourced to implement this Strategy.	Low	Compliant Annual report as per above.	Assign sufficient resources to implement this Strategy and deliver a compliant Annual report or rectify as per above.
The Offset Area Management Plan (OAMP) is not submitted within 12 months of project commencement	• The Environment Team has already commissioned offset specialists and an offset broker to assist in the search for suitable offset properties. These consultants are also experienced in preparing, and having OAMPs approved by DCCEEW. • Arrow is well underway with the search for proposed offset property(ies) and will commence preparation of the OAMP before the actual commencement of the SGP.	Low	In-principle, agreement on the quantification of offsets (i.e. inputs to the offset calculator) will be reached with DCCEEW within 7 months of project commencement.	Meet with DCCEEW within 3 and 6 months of project commencement to discuss the quantification of offsets and provide the Draft OAMP for Stage 1 within 9 months of project commencement.

Risk description	Existing controls	Risk Rating	Trigger that will be monitored	Contingency measure
Arrow is unable to legally secure the required offset property(ies)	• As noted above, Arrow is well advanced in the search for suitable offset properties. An offset area has been identified and an offset agreement has been presented to the landholder in executable form. Upon execution of the agreement Arrow will commence the process of legally securing the offset via the declared area process.	Low	The request for a declared area will be submitted to the Queensland Government within sufficient time to legally secure the offset area before the start of Stage 2.	If the request for a declared area is not submitted 4 months before the start of Stage 2 Arrow will pursue other options (e.g. purchase the required offset property(ies).

Risk description	Existing controls	Risk Rating	Trigger that will be monitored	Contingency measure
Impacting MNES areas greater than the approved limits because of a relocation of SGP infrastructure	• The current field development layout has avoided and minimised impacts to MNES in consideration of other competing constraints • It is possible however that infrastructure will be relocated as part of the detailed engineering design process and Arrow shareholder and joint venture partner approval processes.	Mediu m	Any clearing of MNES core habitat outside of the approved limits.	Actual and proposed clearing areas will be tracked for each ground disturbance activity as described in Section 7 of this Strategy. DCCEEW will be notified of any clearing of core habitat outside of the approved limits within 10 business days and offsets will be provided for all impacts on MNES.
Failure to accurately track impacts to Stage 1 MNES	• The coordinates and total area of cleared MNES habitats and communities will be recorded by GPS in the field and tracked quarterly against approved Stage 1 maximum core habitat disturbance limits • The quarterly tracking of impacts to MNES core habitat will be provided in the annual compliance reporting to DCCEEW and the Environment Team will audit the reported clearing areas against the predicted clearing areas annually.	Low	Post-clearing GPS records of impacts to MNES core habitat are greater than predicted impacts.	DCCEEW will be notified of any clearing outside of the approved limits within 10 business days, offsets will be provided for impacts on MNES and Arrow will engage a third-party audit of predicted / actual clearing.
Failure to detect impacts to other MNES not addressed in this Strategy	• Arrow has completed seasonal field surveys across the SGP to identify all MNES that may potentially occur. • This information has been included on our GIS mapping layers that are interrogated when assessing the implications of any new disturbance • Pre-clearance surveys are conducted by suitably qualified ecologists prior to any new disturbance in vegetated areas and bio-condition assessments will be undertaken in areas requiring clearing of MNES habitat.	Low	Post-clearing GPS records of impacts to MNES will be reviewed to detect any clearing of MNES not addressed in this Strategy.	The process and measures described in Section 7 will be implemented.

Risk description	Existing controls	Risk Rating	Trigger that will be monitored	Contingency measure
Arrow shortlists offset properties that do not meet the offset requirements	• Arrow will use the EPBC Offsets Assessment Guide, using conservative assumptions, to identify suitable offset properties. • Arrow will submit the draft OAMP to DCCEEW within 9 months of project commencement.	Low	DCCEEW assessment of the OAMP (including the offset calculators).	Arrow will aim to secure offsets beyond those required for Stage 1 and will be in a position to secure additional offset properties/areas to meet agreed offset requirements.
The offsets do not address the principles of the EPBC Offset Policy	• Arrow has engaged external parties experienced in delivering EPBC offsets to the satisfaction of DCCEEW. • Arrow will continue to seek DCCEEW advice on compliance with the principles of the EPBC Act Offsets Policy.	Low	An approved OAMP and compliant Annual report.	Meet with DCCEEW within 3 and 6 months of project commencement to discuss the quantification of offsets and provide the Draft OAMP for Stage 1 within 9 months of project commencement. Arrow will notify DCCEEW of the non-compliance and either rectify within 3 months or seek an alternative arrangement with DCCEEW.

7. Residual Significant Impacts to other MNES

Condition 8C(d): The Offset Strategy must: detail how the approval holder will address any residual significant impacts to any EPBC listed threatened species and its habitat and/or EPBC communities not identified in Table 1, in accordance with the EPBC Act Offsets Policy.

Prior to describing the process that Arrow will follow in the event of causing any residual significant impact to a MNES not included in Table 1 of the SGP EPBC approval, Section 7.1 describes the process that will be followed prior to and during activities within all areas proposed for ground disturbance.

7.1 Process followed for disturbance activities

The following process will be implemented by Arrow in all areas proposed for ground disturbance activities:

- Pre-clearance surveys will be undertaken by suitably qualified ecologist and will include:
  - field inspection of the proposed disturbance footprint identified during detailed design will be undertaken by a suitably qualified ecologist (typically two to six months prior to planned disturbance activities) and the presence, absence and extent of MNES values will be verified and mapped in the field via GIS
  - where MNES (or State) values are confirmed, a 'framing trade-offs' session will be held with the project engineers, planners and ecologist to determine if the location of the activities can be changed to avoid and/or reduce the impact to the identified values
  - for any habitat areas of MNES required to be impacted, Arrow will complete a Habitat Quality Assessment in accordance with the DCCEEW Offsets Assessment Guide (How to Use the Offsets Assessment Guide) and the Queensland Government Department of Environment and Heritage Protection's *Guide to determining terrestrial habitat quality – A toolkit for assessing land based offsets under the Queensland Environmental Offsets Policy* (2017), or any subsequent versions. This assessment will lead to a determination as to whether an MNES not listed in Table 1 is to be impacted and a habitat quality score out of 10 for the impacted habitat based on the following indicators (as per the EPBC Offset Assessment Guide):
    - site condition: a general condition assessment of vegetation compared to a benchmark
    - site context: an analysis of the site in relation to the surrounding environment
    - species stocking rate: an analysis of the usage and/or density of a

species at a particular site.

- A fauna spotter-catcher(s) will be present during clearing. The spotter-catcher will be a suitably qualified ecologist as per the definition provided in EPBC 2010/5344 (i.e. means a person who has professional qualifications, training, skills or experience relevant to the nominated subject matter and can give authoritative assessment, advice and analysis to performance relative to the subject matter using relevant protocols, standards, methods and literature)

- The coordinates and total area of cleared MNES habitats and communities will be recorded and tracked monthly against approved Stage 1 maximum core habitat disturbance limits and used for annual compliance reporting. Offsets will be provided for all MNES in accordance with the approved OAMP.

7.2 Process followed to address residual significant impacts to MNES listed under the EPBC Act at the time of the approval (December 2013) but not listed in Table 1 of the approval

If the abovementioned pre-clearance survey, framing trade-offs session and habitat quality assessment identifies the potential for a residual significant impact to a threatened species or EPBC community that was listed under the EPBC Act at the time of the approval but not listed in Table 1 of the EPBC approval, the following process will be implemented:

- Information on the survey and habitat quality assessment will be collated and notification provided to DCCEEW (and Queensland Department of Environment, Tourism, Science & Innovation (DETSI)) within 10 business days of determining the location and extent of a residual significant impact to an MNES that was listed under the EPBC Act at the time of the approval but not included in Table 1.

- Approval for additional residual significant impacts to any threatened species or community that was listed under the EPBC Act at the time of the approval but not listed in Table 1 will be sought from DCCEEW within 20 business days of identifying the need.

- Any residual significant impacts to threatened species or EPBC community that was listed under the EPBC Act at the time of the approval but not identified in Table 1 of the SGP approval will be offset in accordance with the EPBC Act Environmental Offsets Policy.

- In the unlikely event that clearing of an MNES habitat that was listed under the EPBC Act at the time of the approval but not listed in Table 1 occurs prior to Arrow seeking approval, Arrow will notify the Department of the non-compliance as soon as practical and within no later than 10 business days of becoming aware of the non- compliance.

- Should this occur, the following will be implemented:

  - Cease clearing works in the immediate area to protect the identified species/community

  - Tag/barricade the identified species/community in an appropriate manner to ensure protection

- Record species/community GPS coordinates so that it may be incorporated into the site environmental map as a ‘no-go zone’ area until all necessary approvals have been obtained

- Record all relevant information for inclusion in the incident reporting and annual compliance report.

8. Securing offsets

Condition 8C(e): The Offset Strategy must: specify the proposed legal mechanism and timeline for securing the offset(s).

Legal mechanism

Offsets will be legally secured in accordance with Queensland legislation. It is proposed that the offset areas be legally secured through the use of a declared area as defined under the *Vegetation Management Act 1999* (VM Act) (Qld). The declared area process provides a simplified and streamlined procedure for landholders seeking to voluntarily protect native vegetation on their land. The declared area provides a permanent, binding mechanism linked to the property title, with direct reference to the approved offset plan that includes information on the area protected as the offset and requirements that must be met. There is also potential to build on the declared area by declaring the offset area as a nature refuge under the *Nature Conservation Act 1992* (NC Act) (Qld). This may be done at a later date in consultation with the landholder and DETSI.

There are other State approved options for legally binding mechanisms which can be considered once the final offset property is identified and if the landholder is not accepting of a declared area (the experience of our offset broker suggests that a declared area is preferred by landholders).

Timeline for securing offsets

Offset areas will be legally secured prior to commencement of the next project stage. Arrow commits to the following timelines relevant to securing offsets:

- Within 20 business days after the commencement of the action Arrow will advise the Department in writing of the actual date of commencement
- Arrow will continue its discussions with the landholders of the offset properties and undertake habitat quality assessments of the suitable properties following the commencement of the project
- Arrow will meet with DCCEEW within 3 and 6 months of project commencement to discuss the quantification of Stage 1 offsets
- The Stage 1 Offset Area Management Plan (OAMP) will be submitted to the Department within 12 months (anticipated to be within 9 months) of project commencement (as per EPBC SGP Condition 10B). The OAMP will include the details of the offset package including, for direct offsets, each of the nine requirements specified in condition 10B
- The request for a declared area will be submitted to the Queensland Government at least 6 months before the start of Stage 2
- Arrow will legally secure the Stage 1 offsets prior to the commencement of Stage 2.

Arrow commits to the additional timelines relevant to this Stage 1 Offset Strategy:

- Annual and cumulative impacts to MNES for the SGP will be tracked against approved core habitat disturbance limits (whole project and each stage) and reported annually

- Within three months of every 12-month anniversary of the commencement of the action, and for the life of the approval, Arrow will publish the annual report on our website. Furthermore, Arrow will provide the Department, at the same time as the compliance report, documentary evidence providing proof of the date of publication and non-compliance with any of the conditions of the approval

- At least 3 months prior to the commencement of Stage 2, Arrow will submit for approval of the Minister a revised version of the EPBC Offset Strategy for Stage 2

- Arrow will notify the Department of potential non-compliance with any condition of approval as soon as practical and within no later than 10 business days of becoming aware of the potential non-compliance.

9. Arrow Commitment

Condition 8D: The approval holder must not commence the action until the Offset Strategy for Stage 1 has been approved by the Minister in writing. The approved Offset Strategy must be implemented by the approval holder.

Arrow acknowledges this condition and provides the Department with the commitment that we will not commence the action until the Offset Strategy for Stage 1 has been approved by the Minister in writing.

Arrow also provides the commitment that the approved Offset Strategy will be implemented.

10. References

Arrow Energy (2012). Surat Gas Project Environmental Impact Statement.

Arrow Energy (2013). Supplementary Report to the Surat Gas Project Environmental Impact Statement.

APPENDIX A

Curriculum vitae of the suitably qualified ecologists that prepared the Stage 1 Offset Strategy

Summary

Name	Qualifications	Years of Experience	Experience
Dr Michael Ryan (Author)	B. App. Sc; PhD (Ecology)	28	• 80 EIAs • 30 EPBC Referrals • 23 years of fauna field surveys
Dr Paul Finn (Technical Review)	B. Sc (Hons); PhD (Ecology)	20	• Detailed fauna and flora surveys • Targeted threatened species surveys and management plans • Migratory shorebird specialist
David Stanton (Flora surveys lead)	B. Sc (Hons)	24	• Professional and academic award winner • Extensive flora experience
Mark Sanders (Fauna surveys lead)	B. Sc (Hons)	20	• One of Australia's most respected fauna ecologists
Peter Hall (Future pre-clearance surveys)	B.Sc	20	• Flora surveys • Ecosystem assessment and validation • Habitat assessments • Land zone and soil classification

Dr Michael Ryan

Approvals Manager - Arrow Energy

Expertise

- Management of complex multi-disciplinary projects
- Advising and leading teams to deliver environmental impact and risk assessments
- Environmental legislation and approval processes

Summary

Dr Ryan is an experienced manager / director, having supervised and authored more than 80 environmental impact and risk assessments for development projects. Michael has an excellent working knowledge of Commonwealth and Queensland environmental approvals legislation for development projects (both primary and secondary approvals). For the last three years Michael has been the Approvals Manager for Arrow Energy and guest lecturer to post-graduate students at Bond University in Environmental Impact Assessment.

Michael sought and attained the collaboration of the Australian Government, the Queensland Government and the Western Australian Government in delivering joint half day pre-conference workshops on 'How to prepare a good EIS'. He is passionate about sharing knowledge and published the *Essentials Package for Successful Environmental Consulting*, a practical guidebook to assist practitioners on how to manage Environmental Impact Assessments, influence decision-makers and deliver agreed environmental outcomes.

He has excellent communication skills, both written and verbal, and has used these skills in negotiations and conflict resolution across all levels of government and non-government organizations.

Michael was selected by BHP Billiton to manage and author the Environmental Impact Statement (EIS) for the multi-billion dollar Olympic Dam mining and processing plant expansion in South Australia. He was also the Director and principal author for BHP Billiton's proposed Yeelirrie uranium mine in Western Australia. Michael was appointed as the Lead Environmental Consultant for Xstrata Copper (now Glencore) for the proposed Mount Isa Mines Open Pit Project in Queensland and the Tampakan Off Lease Linear Infrastructure Project in the Philippines.

Michael is innovative in his application of management standards to help organizations maximise socio-economic benefits, minimise impacts; comply with applicable laws and regulations; and develop frameworks for continual improvement via succinct guidelines, standards, management plans and monitoring programs.

Michael has extensive experience with the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* having been an invited speaker on the EPBC Act for the Queensland Environmental Law Association, Environmental Protection Agency and the Queensland Resources Council. In October 2009, Michael was an invited speaker on achieving the balance between environmental legislation and company leadership at the China Mining 2010 Conference in Tianjin, China.

Qualifications

Bachelor of Applied Science, Queensland University of Technology, 1989
Doctor of Philosophy, Ecology, University of Queensland, 1996

Projects as Gamut Consulting

Olympic Dam Expansion Investigation Phase Study Reports

Year: 2013 - 2014

Location: Semi-arid central South Australia (Roxby Downs)

Client: BHP Billiton

Main project features: BHP Billiton is re-investigating the mining and processing options for the previously approved expansion project.

Position held: Lead Environmental Consultant

Activities performed: Michael is assisting the BHP Billiton Environment Group with their Investigation Phase Study by developing the following:

- a Legal and Regulatory Approvals Register
- initial HSEC risk assessments and a Risk Register
- to document the likely process, scope and requirements of a future whole-of-project Environmental and Social Impact Assessment (ESIA)
- a global benchmarking study report on heap leach facilities
- a strategy for the timing, purpose and key messages for engagement with the Australian and South Australian governments in relation to five different water supply options.

Olympic Dam Mine Expansion Environmental and Social Impact Assessment

Year: 2004 - 2011

Location: Semi-arid central South Australia (Roxby Downs)

Client: BHP Billiton

Main project features: Major expansion of an existing mine to increase production from 200,000 tonnes/annum (tpa) copper cathodes to 350,000 tpa copper cathodes, 1.6 Mtpa copper concentrate, 1M ounces of silver, 270,000 ounces of gold and 17,000 tpa of uranium oxide. Also included 72 Mtpa of ore processing; 280 mega litre (ML)/day coastal desalination plant; 320 km water supply pipeline; 50 ML groundwater wellfield; 270 km electrical transmission line; 400 km gas pipeline; on-site 550 MW gas power station; 105 km rail line; airport, 90,000 t copper concentrate handling and ship loading facility; rail/road intermodal freight terminal; 10,000 person camp and 6,000 person expansion to existing township.

Position held: Manager and Author

Activities performed: I was a hands on manager of a core team of 20 people to deliver all environmental, social and cultural heritage assessments; developed the scope of works for 17 work packages; managed and understood technical inputs from more than 300 specialists from 75 different environmental and engineering companies; conducted stakeholder engagement and consultation; and authored the EIS and Supplementary EIS.

Projects as Gamut Consulting

Tampakan Copper-Gold Mine Development – Off-Lease Infrastructure Environmental and Social Impact Assessment (ESIA)

Year: 2011 - 2014

Location: Southern Island of Mindanao, the Philippines

Client: Xstrata Copper (now Glencore Xstrata)

Main project features: 105 km copper-gold concentrate pipeline; 100 km electrical transmission line; copper-gold concentrate filtration plant.

Position held: Manager and Author

Activities performed: Manager for all environmental, social and cultural heritage disciplines and author of the Supplementary Report to address the International Finance Corporation (IFC) requirements and Equator Principles for an international ESIA.

415 MW Coal-fired Power Station and Copper Concentrate Loading Port Facility ESIA

Year: 2012 - 2013

Location: Southern Island of Mindanao, the Philippines

Client: Sagittarius Mines Inc. (SMI)

Main project features: 415 MW power station; coal unloading and copper concentrate loading port facilities.

Position held: Peer Reviewer and Advisor on Commercial Risk

Activities performed: Peer reviewer for an ESIA developed by in-country consultants to ensure it is developed in accordance with IFC requirements / Equator Principles; provision of advice regarding additional third party studies required to reduce commercial risk (and the subsequent scoping and management of air quality modelling, noise modelling and thermal plume modelling technical specialist studies). This project entailed liaison with SMI senior management regarding the outcomes of the commercial risk assessment to ensure SMI met their international and corporate responsibilities.

Mount Isa Open Pit Project (MIOP) Pre-Feasibility Study Environmental Studies

Year: 2011 - 2013

Location: Mount Isa, Queensland

Client: Xstrata Copper (now Glencore Xstrata)

Main project features: Major expansion of existing underground and small open pits into a single large open pit, expansion of copper, lead and zinc processing facilities and port facilities.

Position held: Lead Consultant, Manager, Peer Reviewer and Author

Activities performed: Authored the Pre-Feasibility Study environmental technical reports for the Project Description, Stakeholder Engagement Strategy, Surface Water, Closure and Environmental Design Criteria. Managed and peer reviewed technical reports from Amec (Ecology and Cultural Heritage), Klohn Crippen Berger (Groundwater and Geochemistry), SLR (Noise), PAEHolmes (Air Quality) and Arup (Traffic).

Projects as Gamut Consulting

Yeelirrie Uranium Mine Environmental Review and Management Plan (ERMP)

Year: 2010 - 2011

Location: Perth, Western Australia

Client: BHP Billiton

***Main project features*:** New greenfield uranium mine and associated infrastructure.

Position held: Lead Consultant, Project Director, Peer Reviewer and Author

Activities performed: Lead consultant to manage URS and SKM to a successful delivery of the ERMP for the proposed uranium mine in Western Australia. For this project, Michael was appointed the ERMP Project Director and Principal Author. In this role I reviewed all environmental, social and heritage technical reports and draft ERMP chapters and provided a technical review for the ERMP as Principal Author.

Essentials Package for Successful Environmental Consultants

Year: 2013

Location: Brisbane, Australia

Client: None – published to enhance general capacity building and skills

Main project features: Published practical guide to better influence key decisions and environmental outcomes for mining developments.

Positions held: Author / Publisher

Activities performed: I authored this publication to teach environmental practitioners and clients how to more efficiently manage an impact and risk assessment and put themselves and the mining company environmental representatives in a position to influence key decisions that promote better environmental outcomes. The book outlines the key steps in delivering an environmental and social assessment and includes clear guidance on how to appropriately apply the two separate, but integrated, approaches to impact and risk assessments. The publication provides many of the management tools that I developed over the last 20 years to deliver projects on time and on budget.

Olympic Dam Closure Plan – Risk Assessment

Year: 2013

Location: Adelaide, South Australia

Client: BHP Billiton

Main project features: BHP Billiton reviews its Olympic Dam copper, gold, silver and uranium mine closure plan annually. For the current review, BHP Billiton has been requested by the South Australian Government to include a detailed environmental risk assessment for closure.

Positions held: Author/facilitator for the closure plan risk assessment

Activities performed: I have developed and authored the risk assessment component of the annual update to the Olympic Dam Closure Plan. This required liaison with numerous technical specialists from varying mining disciplines to identify and assess risk events/situations for the decommissioning and closure phase. Detailed tables where prepared for each risk event, identifying the source, pathway, receptor, initial risk rating, control / contingency measures and residual risk rating. Proposed closure outcomes, closure criteria and monitoring requirements where then identified for each risk event with a high or moderate residual risk rating.

Projects as Gamut Consulting

Gladstone Steel Making Facility EIS

Year: 2012 - 2013

Location: Gladstone, Queensland

Client: Boulder Steel (CQG Consulting)

Main project features: 5 Mtpa integrated steel plant, 17 km private haul road, rail loop and import/export port facilities.

Positions held: Advice and chapter author

Activities performed: Gamut was commissioned by CQG Consulting on behalf of Boulder Steel to assist in the timely delivery of this EIS. We authored the executive summary, hazard and risk assessment, nature conservation, traffic impact assessment, environmental management framework and cumulative effects chapters and provided peer review on all other EIS chapters and technical appendices.

Projects prior to forming Gamut Consulting

Gateway Motorway EIS Project

Michael was appointed as the environmental advisor to the Queensland Government (Main Roads) to assist in the determination of the preferred Federal and State legislative process under which to develop an EIS for the $1.6 billion Gateway Motorway Upgrade Project. Michael also developed the Initial Advice Statement to accompany the request for State Significant Project status and developed the Draft Terms of Reference for the EIS. Michael was also commissioned to undertake the technical review for the EIS and provide advice regarding the direction and compliance of the EIS as per Commonwealth and State legislation.

Enertrade North Queensland Gas Pipeline EIS Project

This was an EIS for a 400 km gas pipeline. This project was a controlled action under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* and a Project of State Significance under the Queensland Department of State Development's *State Development and Public Works Organisation Act 1971*. Michael completed the development of targeted ecological documents and presentations for the then Commonwealth Department of Environment and Heritage and the Queensland Environmental Protection Agency in relation to endangered ecological communities, threatened species and migratory species. Michael also successfully negotiated environmental approvals and compliance for the project.

Tamil Nadu Road Sector Project, India

Michael was the author of the physical (Climate, Geology and Soils, Land Use) and biological (fauna, flora, water quality, air quality, noise, heritage) environmental components of the Feasibility Study and Sectoral Environmental Assessment reports assessing the potential impacts associated with upgrading 3,328 km of roads in south-eastern India. Michael also authored the project's Environmental Management Plan. All deliverables were written under the guidelines of, and gained the approval of, the World Bank.

Reef Cove Resort, False Cape

Michael was the Manager of the environmental assessments for this major coastal development in Cairns. The site is adjacent to the Great Barrier Reef World Heritage Area, Fish Habitat Reserve and the ecologically significant Trinity Inlet. The project was deemed a controlled action under the EPBC Act and Michael negotiated the environmental approvals for the project under both Commonwealth and State legislation.

Projects prior to forming Gamut Consulting

Port of Brisbane Motorway - Environmental Review

Michael completed a review of all the environmental documentation compiled for the Port of Brisbane Motorway, undertaking a gap analysis with regards to recently introduced and amended environmental legislation, and providing reports to promote environmental compliance of this major road infrastructure project. Environmental approvals were gained for this project in a timely manner and as such avoided potential construction delays.

Cerito Road Review of Environmental Factors (REF) and EMP

Michael was the Manager and completed the legislative review and fauna assessment for the new 22 km road link between the Mt Coolon - Collinsville Road and the Glenden – Newlands Road. This project included the assessment of all environmental aspects and provided mitigation measures to minimise impacts on Commonwealth endangered ecological communities and State listed threatened species.

Brisbane City Council Ecological Corridors Project

Michael was appointed as an ecological specialist to assist Brisbane City Council and Chenoweth & Associates to identify appropriate civil structures to maintain fauna movement along corridors throughout Brisbane City. A detailed case study was also completed for fauna movement across the Logan Motorway for safe passage between the Greenbank Military Training Area and Karawatha Forest.

Federal Government Legislative Reviews

Michael was commissioned to negotiate the implications of the Federal Government's environmental protection legislation on behalf of the Queensland Department of Main Roads. Following presentations to the Main Roads Senior Management Group, he was commissioned to review all projects being constructed on state-controlled roads for the period 2000 - 2002 and in the Brisbane Metropolitan District from 2000 - 2005. This was more than 160 projects, resulting in presentations to DEWHA (then DEH) regarding referrals for 80 projects.

WMC Fertilizers Ltd

Michael completed the ecological assessment for the High Analysis Fertilizer Plant at Phosphate Hill, north-west Queensland. This assessment included comprehensive field surveys of fauna and flora to determine potential impacts on ecosystems and to provide appropriate mitigation strategies to ameliorate identified impacts.

Rockhampton Airport EIS and EMP

Michael was the Manager and author of the EIS for a proposed runway extension to the Rockhampton Airport. The risk of bird strikes was the key issue to be resolved for this project, given the surrounding environs being dominated by wetlands.

Rationalisation of Council and State Government Vegetation Mapping

Michael undertook an assessment of the methodology employed for vegetation mapping as a means of assigning State and local ecological significance to freehold, leasehold and state controlled land. This project enabled Dr Ryan to identify the ‘building blocks’ of both the EPA’s Regional Ecosystem mapping and Local Government mapping and determined the advantages and disadvantages of each, with an objective of identifying appropriate mechanisms to identify and conserve significant vegetation communities.

Projects / employment prior to forming Gamut Consulting

Road Corridor Environmental Assessment (RCEA)

Michael wrote the GIS compatible methodology that enabled the collection and storage of data on ecological assets and corridor management issues within the road reserve for the 33,500 km of Queensland State-controlled roads. Michael subsequently implemented this methodology via field surveys for more than 3,500 km of these roads.

Townsville Field Training Area (TFTA) EIS and EMP

Michael was the Manager and author of the EIS and EMP for a road upgrade, airstrip extension and two major creek crossings within the TFTA. Detailed investigations were completed at Keelbottom Creek and Star River.

Environmental Impact Assessments / Review of Environmental Factors

Michael has been the Manager and author of more than 20 additional linear infrastructure assessments including the following studies: Townsville Port Access, Ipswich Motorway, Mt Lindsay Highway, Smith Street Extension, Hope Island Road, Mt Tamborine - The Sentinel, Gregory Developmental Road, Kuralboo Creek and Gilmore Pipeline (Cheepie to Adavale).

PRINCIPAL ADVISOR (ENVIRONMENT AND PLANNING) QUEENSLAND DEPARTMENT OF MAIN ROADS (MAY 1999 TO NOVEMBER 2000)

Dr Ryan's principal role was to manage the $1.2 M Technical Environment Program within the Department. This required the program management of over thirty-five road-related environmental projects, mentoring of graduate staff and direct project supervision of ten projects. Michael was also the Main Roads representative on several inter-government environmental committees including the Ministerial Committee on Net Gain 2010 and the Ministerial Committee that investigated the implications of the then soon to be enacted *Environment Protection and Biodiversity Conservation Act 1999*. Projects managed and/or supervised included:

Review of the Department's Road Project Environmental Management Processes Manual: This manual discusses the environmental documents to be prepared throughout the planning, design, construction and maintenance of a road project.

Compensatory Habitat Policy: Management of a project that identified the advantages and disadvantages of existing compensatory habitat policies so as to provide guidance to Main Road's Senior Management Group as to whether a similar policy should be adopted by Main Roads.

Revision of the Main Roads Environmental Legislation Register: This manual discusses all Commonwealth and State legislation relevant to road planning, design and construction. It provides a comprehensive reference guide for all legislative, permit and license requirements for Main Roads activities.

Revision of the Main Roads Cultural Heritage Manual: This manual discusses the preferred process for cultural heritage assessments for Main Roads. The revised manual was reviewed by the Environmental Protection Agency and accepted as appropriate for use by Main Roads in Queensland.

Waterways Guideline: This project aims to develop collaboration with the Department of Natural Resources in relation to permits under the *Water Act 2000*. Benchmarks were established so as to clearly identify and streamline the process for obtaining permits and licenses for construction activities.

Projects / employment prior to forming Gamut Consulting

Review of the Main Roads Environmental Management Specification: This specification (MRS11.51) represents the standard environmental specification for all Main Roads construction projects. Michael managed the review of this specification in an attempt to refine contractor's costing of environmental works.

Road Drainage Manual: Michael was on the management and technical committees for the development of this manual. The aim of the manual is to design and construct cross and longitudinal drainage structures in a practical, cost effective and environmentally sustainable manner.

Road Planning and Design Manual: Michael was the author of the Environmental Considerations chapter of this manual and technically reviewed the engineering and design chapters to ensure consistent and effective environmental outcomes in road design.

KBR (FORMERLY KINHILL), BRISBANE (SEPTEMBER 1996 TO MAY 1999)

As the Brisbane office's specialist fauna ecologist, Dr Ryan was involved in the following projects:

Kopps Road - Smith Street Extension

Michael was the manager and author for the Review of Environmental Factors for the proposed construction of a major connecting road between Smith Street and Kopps Road to the west of the Pacific Motorway.

Vegetation and Ecological Assessments, Ipswich City Council

Manager for two projects that provide ecological assessments and recovery plans to guide future Council management practices and land acquisitions.

Brisbane Technology Park, Eight Miles Plains

Principal author of an environmental assessment and rehabilitation programme for the proposed Stage II of the Brisbane Technology Park.

Mary River Sand and Gravel Extraction, Maryborough

Investigating the potential impacts associated with sand and gravel extraction in the Mary River on fauna.

Snapper Creek Dredging

Investigating the potential impacts on wader bird species associated with dredging in Snapper Creek.

Donnybrook, Caboolture Shire, Environmental Management Plans

Developing Environmental Management Plans for a vulnerable amphibian species and mammal species to mitigate impacts of a proposed development in an ecologically sensitive location.

Coolum Ridges, Maroochy Shire, Queensland

Designing and conducting a complete fauna survey in an area of proposed private subdivision.

Projects / employment prior to forming Gamut Consulting

Fauna Sensitive Road Design Publication

Michael was the author of the State Government publication: Fauna Sensitive Road Design - Volume 1 - Past and Existing Practices. This publication includes assessments of fauna movement pathways and provides recommendations to reduce highway impacts on native fauna.

PGT Pipeline, from south-central Queensland to North Brisbane

An extensive investigation of the proposed impact with respect to the environment associated with disturbance along a 480 km pipeline route.

CONSULTANT ECOLOGIST (1995 TO 1996)

Subconsultant for WBM Oceanics Australia on two projects. The first involved collation and review of existing information on and development of a sampling methodology for a Koala survey of the Buderim Mountain region. The second project involved mammal trapping and field identification of birds, mammals, reptiles and amphibians for a 4 week fauna survey of a site at Reedy Creek, Mudgeeraba.

UNIVERSITY OF QUEENSLAND (1993 TO 1995)

Dr Ryan was employed as Research Assistant on the following projects:

Revegetation advice for mining operations (Dr Clive Bell, Dr David Mulligan, the then Agriculture Department – now Centre for Mined Land Rehabilitation): Advice for environmental officers of Queensland's coal and bauxite mining operations (Weipa and Bowen Basin) on procedures for maximising forest revegetation following above-ground mining.

Green vegetable bug (Dr Gimme Walter, Entomology Department): Planning, experimental design and analysis of research on the ecology of the bug. Also assisted with practical classes in ecology, behaviour and genetics.

Queensland rainforest mites (Dr David Walter, Entomology Department): Field research to assess the biodiversity of mites in rainforest.

SELECT PUBLICATIONS

Ryan, M.A. and G.H. Walter (1992) Sound communication in *Nezara viridula* (L.) (Heteroptera: Pentatomidae): further evidence that signal communication is substrate- borne. *Experentia* **48**: 1112-1115.

Ryan, M.A. (1994) Damage to papaw trees by the banana-spotting bug, *Amblypelta lutescens lutescens* (Distant) (Hemiptera: Coreida), in north Queensland. *International Journal of Pest Management* **40(3)**: 280-282.

Ryan, M.A., C.J. Moore and G.H. Walter (1995) Individual variation in pheromone composition in *Nezara viridula* (Hemiptera: Pentatomidae): how valid is the basis for designating "pheromone strains"? *Comparative Biochemistry and Physiology* **111B(2)**: 189-193.

Ryan, M.A., A. Cokl and G.H. Walter (1996) Differences in vibratory sound communication between a Slovenian and an Australian population of *Nezara viridula* (L.) (Heteroptera: Pentatomidae). *Behavioural Processes* **36(2)**: 183-193.

Ryan, M.A. (1996) An investigation of discontinuities in the sexual behaviour of green vegetable bugs, *Nezara viridula* (Linnaeus) (Heteroptera: Pentatomidae). Doctor of Philosophy Thesis. University of Queensland. Australia.

Kinhill (1997) Brisbane Technology Park Stage II: Environmental Assessment and Rehabilitation Programme. Prepared for Brisbane City Council. Principal Author: Dr Michael Ryan.

Kinhill (1998) Kopps Road – Smith Street Extension Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan.

Queensland Department of Main Roads (1999) *Environmental Legislation Register – Version 2.* Principal Author: Dr Michael Ryan.

Queensland Department of Main Roads (2000) *Road Project Environmental Management Processes Manual – Version 2.* Principal Author: Dr Michael Ryan.

Queensland Department of Main Roads (2000) *Fauna Sensitive Road Design: Volume 1 – Past and Existing* Practices. Queensland Department of Main Roads, Technology and Environment Division. Brisbane. Principal Author: Dr Michael Ryan.

Kinhill (2001) Townsville Port Access Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan.

Kinhill (2001) Ipswich Motorway Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

Kinhill (2001) Tamil Nadu Road Sector Project, India: Feasibility Study and Sectoral Environmental Assessment. Prepared for the Government of India under World Bank funding. Principal Author of the Climate, Geology, Soils, Land Use, Fauna, Flora, Water Quality, Air Quality, Noise and Heritage sections: Dr Michael Ryan

Kinhill (2002) Mt Lindsay Highway Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2002) Gregory Developmental Road Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2003) Smith Street Extension Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2003) Townsville Field Training Area (TFTA) Keelbottom Creek and Star River: Environmental Impact Statement and Environmental Management Plan. Prepared for the Department of Defence. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2003) Rockhampton Airport Environmental Impact Statement and Environmental Management Plan. Prepared for the Rockhampton Regional Council. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2004) Hope Island Road Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

HLA-Envirosciences (2004) Mt Tamborine - The Sentinel Review of Environmental Factors. Prepared for the Queensland Department of Main Roads. Principal Author: Dr Michael Ryan

BHP Billiton (2009) Olympic Dam Expansion: Draft Environmental Impact Statement. Principal Author: Dr Michael Ryan

Ryan, M.A. (2009) Environmental Protection Through Leadership and Law. Presentation. China Mining 2010 Conference. Tianjin. China.

Ryan, M.A. (2010) The Expanding Role of an EIS Project Manager. Presentation. EIS For Resource Projects Conference. Brisbane. Queensland.

Wilkinson, L. and M.A. Ryan (2010) What Makes a Good Environmental Impact Statement: A Government Perspective / A Consultant's Perspective. Presentation. Environment Institute of Australia and New Zealand Conference. Wellington. New Zealand.

BHP Billiton (2011) Olympic Dam Expansion: Supplementary Environmental Impact Statement. Principal Author: Dr Michael Ryan

Ryan, M.A. (2011) Managing Environmental Impact Assessment Requirements. Presentation and Pre-conference Workshop. Environmental Management in Resources Conference. Perth. Western Australia.

BHP Billiton (2011) Proposed Yeelirrie Development: Environmental Review and Management Programme. Draft. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Uranium Projects Approval Process Guideline. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Olympic Dam EPBC Act Assessment Report – Pre- commitments. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Mount Isa Open Pit Pre-Feasibility Study: Environment Stakeholder Engagement Strategy. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Mount Isa Open Pit Pre-Feasibility Study: Environmental Design Criteria. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

Gamut Consulting (2012) Draft Terms of Reference for the Mount Isa Open Pit Project Environmental Impact Statement. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

Sagittarius Mines Incorporated and Gamut Consulting (2012) Tampakan Off-Lease Linear Infrastructure Project: Environmental and Social Impact Assessment. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

CQG Environmental (2013) Environmental Impact Statement: Gladstone Steel Plant Project. Prepared for Boulder Steel Limited. Principal Author of the Executive Summary, Hazard and Risk Assessment, Nature Conservation, Traffic Impact Assessment, Environmental Management Framework and Cumulative Effects chapters: Dr Michael Ryan

Ryan, M.A. (2013) Essentials Package for Successful Environmental Consulting. ISBN (hardcopy): 978-0-9874942-1-4. ISBN (electronic copy): 978-0-9874942-0-7

Ryan, M.A. (2013) How to Develop and Effective EIS. Presentation and Pre-Conference Workshop. Permit Approvals Queensland Conference. Brisbane. Queensland.

Gamut Consulting (2013) Olympic Dam Expansion Investigation Phase Study: Environmental Inputs. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Gamut Consulting (2013) Tampakan Copper-Gold Mine Off-Lease Infrastructure (OLI) Project: Addressing International Environmental and Social Sustainability Standards. Prepared for Xstrata Copper. Principal Author: Dr Michael Ryan

Gamut Consulting (2014) Olympic Dam Heap Leach Processing Environmental Benchmarking Study. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Gamut Consulting (2014) Olympic Dam Water Supply Government Engagement Strategy. Prepared for BHP Billiton. Principal Author: Dr Michael Ryan

Paul Gerard Finn

ACADEMIC QUALIFICATIONS

Doctor of Philosophy (2009)
School of Environment & Centre for Innovative Conservation Strategies, Griffith University
Scholarship: Strategic Partnerships with Industry, Research and Training (SPIRT); funded by Griffith University and The Federal Government (Environment Australia).

Bachelor of Science with First Class Honours (1996)
Australian School of Environmental Studies, Griffith University
Majoring in: Ecology and its Applications.

EMPLOYMENT HISTORY

Paul is a CEnvP (Ecology Specialist) with over 20 years' experience in project management, regulatory approvals and compliance, community consultation, research, environmental monitoring, experimental and statistical design, data management, analysis and interpretation, ecological and biodiversity assessment, fauna and flora surveys, and GIS mapping.

Paul has a background in ornithological research, obtaining his PhD in 2009, and has published a number of refereed and popular articles. Paul has collaborated on many research projects incorporating population biology, community ecology and conservation, and has presented his research at local and international conferences, workshops and public lectures.

Paul's consulting experience includes targeted threatened species surveys, species management plans, ecological impact assessment, legislation and environmental authority interpretation and negotiation with government agencies.

Currently Paul is working as a biodiversity technical advisor and ecology subject matter expert in the coal seam gas industry, managing ecological assessments and regulatory compliance, providing clarity on federal and state legislated species impact management and offsets, and delivering reports to support various approvals.

Principal Ecologist, Arrow Energy Pty Ltd (June 2013–present). Accountable for the delivery of technical advice and maintaining ecology standards in order to service exploration and appraisal, well delivery and the production of domestic gas.

Senior Ecologist, Sinclair Knight Merz (May 2012–May 2013). Delivered projects for clients in both the private and government sectors, related to infrastructure, energy and resources, environment and urban growth.

Technical Advisor, Holcim Australia Pty Ltd (July 2005–February 2013). Intertidal Expert (Water Mouse (*Xeromys myoides*) and Shorebirds) on the Technical Advisory Panel for an EPBC Act triggered sand extraction operation at Donnybrook, Queensland.

Senior Ecologist, RPS Group (February 2010–April 2012). Delivered projects for clients in both the private and government sectors, related to infrastructure, energy and resources, environment and urban growth.

Conservation Officer, Queensland Parks and Wildlife Service (October 2002–December 2009). Established and coordinated 'Seagrass-Watch', a community-based habitat monitoring program, in Moreton Bay Marine Park.

Doctor of Philosophy Candidate, Consultant Ecologist, Research Assistant and Tutor, Griffith University (January 1994–December 2009).

RELEVANT LICENCES and ATTAINMENTS

Rehabilitation (spotter-catcher) Permit (WA0041700) and Damage Mitigation Permit (WA0041640).

National accreditation in Responding to Wildlife Emergencies (AHCFAU301A).

Department of Environment and Science approved suitably qualified person under the *Flora Survey Guideline – Protected Plants*.

ASIC authority for working airside at the Brisbane Airport.

SELECTED PUBLICATIONS

1. **Finn, P.G.** and Catterall, C.P. 2022. Towards an efficient indicator of habitat quality for Eastern Curlews on their intertidal feeding areas. Australasian Journal of Environmental Management. DOI: 10.1080/14486563.2022.2084166. Published online: 12 July 2022; https://doi.org/10.1080/14486563.2022.2084166.
2. Lloyd, P., **Finn, P.G.** and Popple, L. 2021. Ten years of monitoring shorebird use of a mudflat at Brisbane Airport in Moreton Bay, Queensland. Stilt. 76, 64-73.
3. Fuller R., Milton D.A., Rothlisberg P., Clemens R.S., Coleman J., Murray K., Dhanjal-Adams K.L., Edwards D., **Finn P.G.**, Skilleter G., Stigner M. and Woodworth B.K. 2019. Migratory shorebirds of Moreton Bay. Pp. 431-444 in Tibbetts I.R., Rothlisberg P.C., Neil D.T., Homburg T.A., Brewer D.T., and Arthington A.H. (eds.) Moreton Bay Quandamooka & Catchment: Past, present, and future. The Moreton Bay Foundation. Brisbane, Australia. Available from: https://moretonbayfoundation.org/
4. **Finn, P.G.**, Udy, N.S., Baltais, S.J., Price, K. and Coles, L. 2010. Assessing the quality of seagrass data collected by community volunteers in Moreton Bay Marine Park, Australia. Environmental Conservation. 37, 83-89.
5. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2008. Prey versus substrate as determinants of habitat choice in a feeding shorebird. Estuarine, Coastal and Shelf Science. 80, 381-390.
6. **Finn, P.G.** 2007. Feeding ecology and habitat selection. Pp. 51-59 in Geering, A., Agnew, L. and Harding, S. (eds.) Shorebirds of Australia. CSIRO Publishing, Victoria.
7. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2007. Determinants of preferred intertidal feeding habitat for Eastern Curlew: A study at two spatial scales. Austral Ecology. 32, 131-144.
8. **Finn, P.G.**, Driscoll, P.V. and Catterall, C.P. 2002. Eastern Curlew numbers at high tide roosts versus low tide feeding grounds: a comparison at three spatial scales. Emu. 102, 233-239.
9. **Finn, P.G.**, Catterall, C.P. and Driscoll, P.V. 2001. The low tide distribution of Eastern Curlew on feeding grounds in Moreton Bay, Queensland. Stilt. 38, 9-17.
10. **Finn, P.G.** and Hughes, J.M. 2001. Helping Behaviour in Australian Magpies, *Gymnorhina tibicen*. Emu. 101, 57-63.
11. Jones, N.D. and **Finn, P.G.** 1999. Translocation of aggressive Australian Magpies: a preliminary assessment of a potential management action. Wildlife Research. 26, 271-279.

Curriculum Vitae- David James Stanton

Date of Birth: 10/ 04/ 1970

Business Address:

44 Henzell Terrace, Greenslopes, Qld, 4120.

Mob: 044 7822119

Email: davidstanton@3denvironmental.com.au

CURRENT POSITION

Principal Landscape Ecologist - 3D Environmental

ACADEMIC QUALIFICATIONS

BSc Hons: Geology / Biology/ Geomorphology (Hons Class 1-Geology) completed at James Cook University, 1993.

PROFESSIONAL CERTIFICATIONS

MEIANZ: Certified Environmental Practitioner – Ecology Specialist (Certification Number: 0906E)

PROFESSIONAL AWARDS

Planning Institute of Australia, Queensland Division (2005) '***Award of Excellence'*** for the Caboolture Shire Councils Bushfire and Hazard Assessment Study. The award was given in the categories of Disaster Mitigation and Biodiversity Conservation and Planning in recognition of work completed in the Caboolture Shire Vegetation Mapping Project, 2004.

Planning Institute of Australia, National Division (2006) '***National Award of Excellence'*** for the Caboolture Shire Councils Vegetation Mapping Project. National winner in the category of 'Biodiversity and Conservation Planning'

ACADEMIC AWARDS

Geological Society of Australia Gold Medallion (1993) for outstanding academic achievement in studies of earth science.

PROFESSIONAL SUMMARY

David has a professional career that spans 24 years, which including 3 years' working as regional exploration geologist in the Louisade Archipelago of PNG, He has extensive experience in the disciplines of resource mapping (geology and geomorphology), floristic assessment, groundwater and dependent ecosystems, conservation planning and impact and ecological risk assessment. His expertise has been utilised across several industry sectors which include mining, infrastructure as well as a consultant to government and indigenous organisations throughout Queensland, the Northern Territory, north-Western Australia and Papua New Guinea. David has particular expertise in landscape scale ecology and ecological processes including the relationships between vegetation geology, geomorphology, hydrology and hydrogeology. David has published vegetation mapping for the Wet Tropics World Heritage area and the Torres Strait Island's on behalf of the Australian Government and has worked extensively on the management of terrestrial biodiversity in northern Australia, co-authoring a number of technical papers on issues relating to landscape ecology and fire management.

PROJECT SUMMARY

ENVIRONMENTAL IMPACT ASSESSMENT FOR LINEAR INFRASTRUCTURE AND WATER

- **Northern Australia – Northern Territory**
  - **PNG to Queensland Gas Pipeline Project, Weipa to Gove Pipeline Lateral Biophysical Assessment:** Preparation of floristic mapping (1:25 000 scale), landform and geomorphic analysis and threatened flora assessment of the proposed Weipa (Qld) to Gove (NT) Lateral sections of the proposed pipeline. Included assessment of several pipeline landfall options in the Gove Peninsula / Nhulunbuy region of the Northern Territory. Enesar 2006.

- **AGL Petronas Corporation –PNG to Queensland Gas Pipeline Project:** Provision of botanical and landform assessments along sections of the proposed pipeline easement. Large sections were completed using helicopter survey with foot survey at selected localities. The subsequent reports for these sections provided the information necessary for incorporation into a broader environmental impact assessment. Enesar, 2005, 2006. Sections investigated included:
  - Landfall on Cape York to the Jardine River
  - Charters Towers to Muttaburra.
  - Stonehenge to Windorah
  - South-west of Windorah to Cameron's Corner on the QLD/ SA / NT junction.
- **TRIP Weir Project, Flinders River:** Floristic surveys over the 200 km^2 TRIP Weir Project inundation area and associated pipelines. Flinders River in the Gulf Plains Bioregional Area. Studies included assessment of potential threatened flora, review of RE Mapping and general floristic survey for the purpose of Environmental Impact Assessment. Stanbroke Holdings Ltd, November 2014 to May 2015.
- **Copperstring EIS:** Comprehensive floristic mapping (regional ecosystems and threatened ecological communities) at 1:40 000 scale of a 150 km^2 section of the Copperstring Powerline in the Mt Isa, Cloncurry and Selwyn Ranges sections of the proposed 1km wide study easement. Survey also included a flora and mapping survey of the Charters Towers, Pentland, Hughendon and Cloncurry sections of the proposed powerline alignment.

- **Wet Tropics – North-east Queensland**
  - **Ella Bay Integrated Resort Development:** Floristic baseline assessment of the proposed Ella Bay Integrated Resort development site within the Wet Tropics World Heritage Area.
  - **False Cape Development:** A detailed aerial photographic interpretation and classification of vegetation communities and regional ecosystems, including rare and threatened species search on the False Cape development site to the east of Cairns. HLA Envirosciences Pty Ltd, 2004.
  - **Powerlink –Cardstone Powerline Easement Study:** In conjunction with Peter Stanton, carried out an ecological and botanical assessment of the Cardstone – Kareeya powerline easement to determine the environmental impact of a proposed powerline upgrade. The study included a detailed aerial photographic interpretation and map at 1:25 000 scale. This formed part of a broader impact assessment commissioned by Powerlink through C&B Consultants. 2003.
  - **Main Roads Southern Access Planning:** Alongside Peter Stanton, mapped in detail the vegetation communities within the proposed access corridor south of Cairns using 1:7500 scale aerial photographs. The project assessed the presence of rare and threatened plant species and vegetation communities. Sub-contracted to Sinclair Knight Merz, 1997, 1998.
  - **Chevron Asiatic Gas Pipeline Project:** An aerial photographic interpretation of the botany of the Northern Cape York region. The project assisted in the location of a route for a proposed gas pipeline. Sub contracted to NSR consulting group through Peter Stanton. NSR Consulting Pty Ltd, 1997.
- **Central Queensland**
  - **Queensland Nitrates Pipeline Project:** Floristic survey along the 18 km length of the proposed Queensland Nitrates Gas Pipeline near Moura, southern Bowen Basin. Survey focused specifically on assessment of EPBC Act significance of vegetation communities encountered along the pipeline route as well as intensive searches for Protected Plants (following Protected Plants Survey Guidelines) within the project impact area. Contracted to Queensland Nitrates Pty Ltd (September 2014).
  - **Connors River Dam and Pipelines Environmental Impact Assessment:** Provision 1:20 000 scale vegetation mapping, baseline floristic assessment and environmental impact assessment of the proposed Connors River Dam inundation area and proposed pipelines. Brigalow Belt North Bioregion. Contracted to Sunwater, 2009-2012.
- **South-east Queensland**
  - **Gateway Motorway Assets and Expansion Project:** Floristic mapping and assessment of habitats potentially impacted by the Gateway Expansion Project, Brisbane, over a 12 km stretch of road alignment (September 2014).
  - **Traveston Crossing Dam –Terrestrial Flora Survey:** Provision of baseline floristic assessment and supplementary 1:10 000 scale vegetation mapping for the purpose of assessment of environmental impact. Queensland Water, 2006-2009.
  - **Wyaralong Dam –Terrestrial Flora Survey:** Provision of baseline floristic assessment and supplementary 1:10 000 scale vegetation mapping for the purpose of assessment of environmental impact. Sub-contracted to BAAM Pty Ltd on behalf of Queensland Water, 2006-2009.
  - **Emu Swamp Dam and Pipelines – Terrestrial Flora Survey:** Terrestrial floristic assessment of the proposed inundation area and pipeline routes. Emu Swamp on the Severne River, Stanthorpe.

ENVIRONMENTAL IMPACT ASSESSMENT AND CONSTRAINTS PLANNING FOR MINING

- **Northern Australia / Northern Territory**
  - **Ergon Energy – Mua Island Floristic Analysis:** Preparation of dossiers for 18 threatened flora species recorded on Mua Island (Torres Strait) to assist infrastructure planning and facilitate protected plant surveys. The report required comprehensive review of databases, compilation of ecological information and species photographs (contracted to Ergon Energy, 2016).
  - **MMG Century – Phantom Hills Prospect Floristic Baseline Survey:** Baseline floristic survey and vegetation mapping over the 150 km^2 Phantom Hills Prospect. North-west Highlands Bioregion (2014 Ongoing), 50 km east of the Queensland / Northern Territory border. Prepared for MMG Century.

- **Brigalow Belt**
  - **Arrow Surat Basin Advanced Exploration Project – Ecological Surveys**: Intensive floristic and vegetation mapping surveys over Arrow Energy's advanced project tenements in the region between Miles and Cecil Plains. Assessments were undertaken over a 2500 km^2 assessment area (contracted to Arrow Energy, 2016 – 2017).
  - **Arrow Bowen Basin Advanced Development Project – Ecological Surveys**: Intensive floristic and vegetation mapping surveys over Arrow Energy's advanced project tenements to the north of Moranbah. Detailed surveys were completed over a 450 km study area including the Roy's Hill and Lancewood gasfield development areas which are contiguous with the North Goonyella Mine ML boundary. Survey included comprehensive desktop assessments as well as the provision of both dry season and wet season survey reports. Contracted to Aecom Pty Ltd and GHD Pty Ltd on behalf of Arrow Energy (November 2014 to June 2015).
  - **Arrow Energy – Daandine Lease (PL230):** An assessment of EPBC values as they relate to flora and threatened ecological communities for Arrow's Daandine Lease (PL230) in the Surat Basin. Sub-contracted to Ecosmart Ecology 2014.
  - **Arrow –Surat Gas Project Supplementary EIS Study:** Preparation of a supplementary terrestrial ecology study including bio-condition assessments at selected sites and habitat mapping for the 80 flora and fauna species listed under state and federal legislation. Habitat mapping was undertaken for the purpose of biodiversity offset planning. Prepared for Coffey Environments, June 2013.
  - **Supplementary EIS Assessment of Arrow Energy's LNG Facility Site, Curtis Island (SEQ):** Review of EIS chapter and terrestrial ecology assessment of the proposed site facility to inform requests for supplementary information. Included assessment of terrestrial flora and fauna on mainland and island portions of the project. Prepared for Coffey Environments, June 2013.
  - **Acacia Coal / EPC1230:** Floristic baseline survey, preparation of 1:50 000 scale regional ecosystem and EIS assessment of the EPC 890 Resource Area to the south of Blackwater. Mapping was undertaken to accurately identify the distribution of regional ecosystems across the EPC to inform requirements for ecological offset (October 2013).
  - **Coffey Environments / Moultrie ESA Mapping:** Preparation of 1:50 000 scale regional ecosystem mapping over the Hillalong Resource Area, north-west of Nebo. Mapping was undertaken to accurately identify the distribution of Environmentally Sensitive Areas over the Mineral Development Lease (Coal). Revised mapping facilitated ecologically sensitive planning for a forthcoming exploratory drilling project (August 2013).
  - **Arrow Bowen Gas Project:** Floristic impact assessment including detailed baseline ecological assessment of the Arrow Energy's 7800 km2 petroleum lease and exploration tenements in the Northern Brigalow Belt, Queensland. The project involved revision of regional ecosystem mapping over a selected 1 000 km2 area at a scale of 1: 40 000 for the purposes of constraint analysis. Contracted to Arrow Energy, 2012.
  - **Surat Gas Project EIS - Arrow Energy:** Floristic impact assessment including detailed baseline ecological survey of the Arrow Energy's 8200 km2 petroleum lease and exploration tenements in the Southern Brigalow Belt, Queensland. The project involved revision of regional ecosystem mapping over a selected 1 800 km2 area at a scale of 1: 40 000 for the purposes of constraint analysis. Contracted to Coffey Environments, 2009 -2013.
  - **Byerwen Coal:** Floristic survey and mapping assessment of the Byerwen Coal exploration lease including project 1:50 000 scale revision of mapping over the 60km2 site. Byerwen Property in the Northern Brigalow Belt. Unidel 2010, 2012.

- **Curragh North Coal Development Project:** Provision of baseline floristic assessment, 1: 25 000 scale vegetation mapping and environmental impact assessment of the proposed Jellinbah development area (November, 2011).
- **MCG Resources:** Floristic survey and mapping assessment of the MCG Groups MLA's in the Blackwater area, the Brigalow Belt South Bioregion of central Queensland. The study area covered approximately 25 km2 as smaller sections of the larger MDL 152 (Curragh Extended and Curragh South). Contracted to Tecsol (2012).

- **Papua New Guinea**
  - **PNG Biomass Project:** Assessment of the 250km2 PNG Biomass (Markham Valley- Morobe Province) project for the purpose of forestry plantation. Assessment included detail floristic analysis, vegetation mapping and assessment of impacts against IFC Standards (BAAM P/L, Aligned Energy)
  - **Wafi-Golpu Gold-Copper Mine Project Terrestrial Flora and Fauna Assessment:** Floristic baseline assessment and environmental impact assessment for the Wafi-Golpu advanced exploration project. Contracted to BAAM Pty Ltd on behalf of Morobe Mining JV (February 2015 ongoing).
  - **Marengo PNG – Yandera Prospect Floristic Environmental Impact Assessment:** Ecological baseline study and Environmental Impact Assessment of habitats and species affected by development of the proposed Yandera Prospect, Bismarck Ranges, Marengo Province PNG. Included comprehensive analysis of ethnobotanical and faunal resources. Coffey Environments, 2012.
  - **Kantobo to Mubi River Road Project:** A survey of significant floristic values along an 11km section of proposed road alignment. The survey required assessment of floristic values associated with virgin lowland rainforest in the Southern Highlands/ Gulf Province, Papua New Guinea. Subcontracted to Coffey Environments, 2010.
  - **Solwara Project – East New Britain PNG:** Habitat assessment, floristic analysis and mapping of the 80km2 lease area on the East New Britain Coast-Papua New Guinea. Included comprehensive analysis of ethnobotanical and faunal resources. Contracted to Coffey Natural Systems, 2008.

- **Central Queensland Coast**
  - **McFarlane Oil Shale Project-Central Queensland:** Detailed baseline botanical assessment and environmental impact assessment of the 252km2 mineral lease area in the central Queensland Coast Bioregion. The project included 1:40 000 scale aerial photographic interpretation of regional ecosystems and vegetation communities. Contracted to URS Australia (2008 – 2009).
  - **Supplementary EIS Assessment of Arrow Energy's LNG Facility Site, Curtis Island (SEQ):** Review of EIS chapter and terrestrial ecology assessment of the proposed site facility to inform requests for supplementary information. Included assessment of terrestrial flora and fauna on mainland and island portions of the project. Prepared for Coffey Environments, June 2013.
  - **Stuart Oil Shale Floristic Impact Assessment:** Baseline floristic assessment, vegetation community/ regional ecosystem mapping and floristic impact assessment of the Stuart Oil Shale Project Area, Gladstone. Revision of RE mapping undertaken over a 120 km2 area at 1:25 000 scale. Queensland Energy Resources (QER), 2012.
  - **Red Mud Dams Vegetation Assessment:** Completion of an RE and vegetation community assessment of the Red Mud Dams area, Boyne Island. The map and complementary report was an aid to planning for future tailings disposal in the area. QAL (sub-contracted through BAAM Pty Ltd), 2005.

- **Desert Uplands**
  - **Eromanga Basin / Desert Uplands vegetation and floristic constraints analysis:** Provision of floristic and landform constraints analysis and mapping over a 5000km^2 ATP area to assist sensitive location of a proposed comprehensive seismic survey (500km of proposed survey line). Galilee Energy, 2010.

BIODIVERSITY OFFSET PLANNING AND ASSESSMENT

- **MMG Century – Lawn Hill Station Biodiversity Offsets Project:** Habitat biocondition and vegetation mapping assessment of a 6km stretch of river frontage on Lawn Hill Creek contiguous with Lawn Hill National Park on the Queensland / Northern Territory border. The assessment provided baseline information to assist preparation of a biodiversity offset plan for Lawn Hill Station (July 2014).
- **Exco Resources Biodiversity Offsets Project:** Habitat bio-condition, ecological equivalence assessment, vegetation mapping and general floristic survey of a 42 km^2 portion of Lawn Hill Station to identify suitable habit for Purple-necked Rock Wallaby.

MINESITE REHABILITATION MONITORING AND ASSESSMENT

- **MMG Century Rehabilitation Monitoring Project:** Implementation of a baseline monitoring program to assess rehabilitation progress on stabilised waste rock dumps. Prepared to identify trends in vegetation development toward the meeting of mine closure criteria. North-West Highlands (March 2014 ongoing).
- **Arrow Energy - Review of Environmental Authority Conditions for Rehabilitation, ATP 676:** A review of EA conditions for ATP 676 to assess the achievability of current EA requirements for vegetation rehabilitation. The review report was utilised for internal Arrow Energy purposes. Prepared with assistance from Vegetation Management Science (March 2014).

CONSERVATION PLANNING

- **North-eastern Australia**
  - **Wet Tropics Management Authority Vegetation Mapping Project:** A 1: 25 000 scale aerial photographic interpretation and complementary 1:50 000 map of the structural characteristics, vegetation communities and geology of the Wet Tropics Bioregion, an area of over 30 000 km2. The project required the detailed classification of both remnant and non- remnant vegetation communities and the completion of 38 resource management reports for various regions within the project area. During this time, expert advice was provided to the authority in regard to management aspects of the World Heritage Reserve. The completed mapping product forms the basis for RE mapping and assessment within the Wet Tropics Bioregion (incorporated into Version 5.2 digital RE data produced by EPA). (1997 – 2012, work is ongoing to date of publication expected in August 2012)
  - **Upper Bridge Creek Conservation Area Timber Assessment Report:** Provided an assessment of timber resoures within the 160 km^2 Upper Bridge Creek Conservation Area to the north of Hopevale. Project facilitated negotiations between Traditional Owners and the Queensland Government to agree to terms of transfer to Conservation Reserve. Contracted to DATSIMA (Qld Govt, April 2015).
  - **Mandingalbay Yidinji Lands Biodiversity Planning and Management Project:** Development of biodiversity and land management profile for the Mandingalbay – Yidinji Lands, Wet Tropics World Heritage Area. Biodiversity profile has been applied to guide land management programs for the 'Working on Country' ranger program. Contracted to Djunbunji Ltd. June 2013 ongoing.
  - **Torres Strait Island Biodiversity Planning Project:** Development of biodiversity and land management profiles for 14 selected islands in the Torres Strait, Northern Australia. Biodiversity profiles are being applied to guide land management programs for the 'Working on Country' ranger program. Contracted to Torres Strait Regional Authority, Australian Government). November 2010 to December 2012.
  - **Torres Strait Islands Regional Ecosystem and Vegetation Community Mapping**: A 1:25 000 aerial photographic interpretation of the vegetation, structural associations and regional ecosystems of the islands of the Torres Strait. Spatial data produced during the vegetation survey has been successfully incorporated into the Version 6.0 RE digital database produced by DERM. The survey and mapping project assessed a total land area of 860 km^2 within the Cape York Peninsula Bioregion (Contracted to Torres Strait Regional Authority, Australian Government).
  - **Queensland Herbarium – Wet Tropics Bioregion Regional Ecosystems Classification:** Expert advice provided to the Queensland Herbarium concerning descriptions and classification of regional ecosystems in the Wet Tropics Bioregion. Advice was specific to the release of revised regional ecosystem mapping throughout the state relevant to the implementation of Queensland's "Vegetation Management Act". Queensland Herbarium, 2009.
  - **Queensland Herbarium Non Remnant Vegetation Classification:** An assessment of the remnant status of highly disturbed vegetation communities within the Wet Tropics Bioregional zone, relevant to the implementation of Queensland's "Vegetation Management Act" EPA, 2004- 2005.
  - **Wet Tropics Management Authority Timber Resource Assessment Project (2004):** A resource and timber assessment of freehold tenure within the World Heritage area to provide a means to adequately assess landowner compensation claims. Wet Tropics Management Authority, 2004.
  - **Dawnvale Station Vegetation Mapping Project:** A land management report and detailed aerial photographic interpretation of vegetation within the Dawnvale Grazing Leasehold. The study was commissioned to assist traditional owners in their application for leasehold renewal. Centre for Appropriate Technology, 2001.
  - **Mt Molloy Vegetation and Land Systems Mapping:** Report on the environs of the Mt Molloy Wetlands including a 1:25 000 aerial photographic interpretation of landform, geomorphology and vegetation. Mitchell River Catchment Management Group, 1999.

- **Brigalow Belt / Central Queensland**
  - **Newlands Nature Refuge / Wollumbi Brigalow Conservation Reserve ecological assessment:** Detailed vegetation mapping and florisitic analysis of vegetation communities and regional ecosystems on the Newland Nature Refuge and Wollumbi Brigalow Conservation Reserve, Brigalow Belt North Bioregion (total area of 100km^2). The study was commissioned for compliance with EPBC offset requirements. XStrata Coal / Footprints Ecology, 2009.

- **South-east Queensland**
  - **Seqwater Advanced Offsets Project:** Identification of suitable advanced habitat offsets within Seqwater's water infrastructure estate in south-east Queensland. Assessment included the identification habitats suitable for offset at Ewan Maddock, North Pine and Hinze Dam sites to the north and south of Brisbane (contracted to GHD, 2017).
  - **Caboolture Shire Council Vegetation Mapping Project:** Detailed 1:25 000 scale and 1:10 000 scale mapping of vegetation communities, land zones, and regional ecosystems of the Caboolture Shire Council (SEQ) using aerial photograph analysis. Total project area of 1200 km2. The project included detailed floristic sampling of all intact communities identified and the development of a classification scheme to allow assessment of highly disturbed vegetation types. Contracted to Rob Friend and Associates, 2004.
  - **Reedy Creek Conservation Area (Agnes Waters):** Detailed 1:10 000 scale aerial photographic interpretation and map of the vegetation communities in the Reedy Creek Conservation Area relevant to conservation and fire management with a proposed eco-development site (Bush Heritage Trust, 2005).

FIRE / ECOLOGICAL MONITORING PROJECTS

- **Mandingalbay Yidinji / Djunbunji Aboriginal Corporation Fire Monitoring Project**: Implementation of a fire monitoring program to assess the ecological impacts of both wildfire and traditional burning practice on MY Lands. Wet Tropics Bioregion, Yarrabah, Cairns (January 2014 ongoing).
- **East Trinity Monitoring / Wetlands Rehabilitation Project:** Completion of a detailed mapping and flora survey on reclaimed estuarine wetland, including mapping and categorisation of secondary vegetation communities. The study was based aerial photograph interpretation (1:10 000 scale aerial photography). Department of Environment and Resource Management (DERM), 2002 to 2009.
- **Wet Tropics Phytophthora Mapping / Monitoring Project:** Contracted to map rainforest die back resulting from Phytophthora outbreak within the wet tropics rainforest communities. The study was completed with detailed 1:25000 aerial photographic interpretation over át risk' areas. James Cook University/Rainforest CRC (1999 - 2001).

FIRE PLANNING PROJECTS

- **Mandingalbay Yidinji / Djunbunji Aboriginal Corporation Fire Management Planning:** Development of a fire management strategy for Mandingalbay Yidinji Lands within the Wet Tropics World Heritage Area. Prepared for the purpose of engaging traditional owners in the on-ground management of traditional lands (October 2013 ongoing) and direct ecologically sensitive application of fire to the landscape.
- **Reedy Creek Conservation Reserve Fire Management:** Five-year review of the endorsed fire plan for the Reedy Creek Conservation Reserve, Agnes Water. Included recommendations to accommodate changes in the surrounding urban landscape whilst considering the results and lessons from the previous management period. Bush Heritage Trust 2014.
- **Torres Strait Island Fire Management Project:** Development of fire management plans for biodiversity conservation on Badu, Mua, Saibai, Boigu, Dauan, Mabuiag, Mer and Erub Islands in the Torres Strait. Work was completed in conjunction with Peter Stanton. Contracted to Torres Strait Regional Authority (2012 -2013).
- **Cape York Fire Project:** A fire scar and floristic structural mapping project to assess changes in vegetation communities that have resulted from shifting fire regimes over the past 30 years. Project utilised current and historical aerial photography for interpretation. Balkanu Cape York Land Development Agency (April to June 2003).

GROUNDWATER DEPENDENT ECOSYSTEMS / GAS MIGRATION ASSESSMENT AND MONITORING

- **GDE Site Characterisation – Arrow Surat Gas Project:** Implementation of GDE assessment execution plan involving characterisation of chosen GDE localities through drilling and bore construction (Sonic), isotope analysis of soil and xylem water and leaf water potential. Arrow Energy 2017 / 2018.

- **GDE Study Execution Plan – Arrow Surat Gas Project:** Execution plan for detailed characterisation of GDE's throughout the Surat Gas Project Area including plans for groundwater assessment, ecological characterisation, leaf, soil and groundwater sampling.
- **Groundwater Dependent Ecosystem (GDE) Assessment – Arrow Energy Surat Gas Project:** Detailed description, characterisation and mapping of GDEs throughout the Surat Gas Project assessment area. Study was commissioned to assist development of the Water Monitoring and Management Plan (WWMP). Contracted to Arrow Energy 2016 and 2017.
- **Banksia Beach Borefield – Groundwater Dependent Ecosystem (GDE) Monitoring:** Monitoring of wet coastal heath to detect impacts of groundwater drawdown on vegetation composition, structure and ecology. Biannual reporting includes an analysis of NDVI datasets to support assessments of vegetation condition. Seqwater (2016 ongoing).
- **Condamine River Gas Seeps Vegetation Monitoring:** Assessment of the impacts of gas migration into soil on the health and vigour of intact riparian vegetation on the Condamine River frontage. Required assessment of the current condition and status of vegetation as well as implementation of a long-term vegetation monitoring program.
- **Groundwater Dependent Ecosystem (GDE) Assessment – Arrow Energy Surat Gas Project:** An assessment of the potential groundwater dependency of ecosystems in Arrow Energy's Surat Project tenements to inform federal requirements for a Groundwater and GDE Management Plan. The project required detailed assessment and integration of groundwater, geology and ecological databases,spring characterisation and recommendations for an ongoing monitoring program (Arrow Energy 2016 ongoing).
- **Groundwater Dependent Ecosystem (GDE) Assessment – Arrow Energy Bowen Gas Project Development Area:** An assessment of the potential groundwater dependency of ecosystems in Arrow Energy's Bowen Gas Project tenements to inform federal requirements for a Groundwater and GDE Management Plan. The assessment focused on the potential groundwater dependency of ecosystems in areas contiguous with the North Goonyella, Suraji, Newlands and Suttor Creek Mining Lease areas
- with the focus on developing an ecological assessment program to monitor the effects of groundwater drawdown on vegetation condition (Coffey Environments 2015).
- **Sunshine Coast Regional Airport – GDE Assessment:** Assessment of the effects of altered groundwater hydrology on the ecology of wet heath and associated populations of the Endangered *Allocasuarina emuina*. Preliminary review of environmental conditions for the Sunshine Coast Airport Upgrade. Sub-contracted to BMT – WBM (June 2010).

LANDFORM / SOIL AND GEOMORPHOLOGY PROJECTS AND ASSESSMENTS

- **Mornington Wildlife Sanctuary Landform, Geology and Vegetation Community Mapping Project:** A 1: 50 000 aerial photograph interpretation and descriptive landform, soils geological and floristic mapping assessment of the Mornington Wildlife Sanctuary, Kimberley Region, Northwestern Australia. The report and complementary map provided a baseline study into the factors influencing the area's ecology and diversity. Assisted with preparation of vegetation maps for the property as well as preparation of a floristic inventory. Total survey and mapping area of 3 200 km^2. Contracted to Australian Wildlife Conservancy (2004).
- **Mt Zero Wildlife Sanctuary Landform and Geological Mapping Project:** A 1:25 000 scale aerial photographic interpretation, map, and descriptive report on land systems soils and geology of the Mt Zero/Taravale Wildlife Sanctuary, North Queensland. Total survey and mapping project area of 650 km^2.
- **Agnes Water Geomorphic and Land Zone analysis:** Provision of a geomorphic and soil assessment of a 300ha site south of Agnes Water. The study formed the basis for appraisal of regional ecosystems in the study area. EPA certified regional ecosystem mapping was successfully challenged. Mariner Awaken/ Midell Joint Venture, September 2009.
- **Geomorphological assessments on major river crossings on the proposed PNG to Queensland gas pipeline for the purpose of assessing crossing stability.**

GENERAL ECOLOGY, REHABILITATION AND VEGETATION MANAGEMENT ASSESSMENTS FOR DEVELOPMENT

- **Property Map of Assessable Vegetation:** Preparation of and application for a PMAV over the 250km2 Burdekin Downs property in the Einasleigh Uplands. Includes detailed field site survey, historical aerial photographic interpretation, preparation of supporting material and submission to DNRM. Burdekin Downs Pastoral Ltd, Charters Towers, 2017.
- **Ecological Assessment Report – Seton College, Brisbane**: Assessment of development impacts on the ecology of remnant woodland mapped as having High Ecological Sensitivity. Response to an information request by Brisbane City Council.

- **Vegetation Management Plan – Rehabilitation Plan, Hymix Concrete Batching Site, North Pine River:** Vegetation and Rehabilitation Management Plan for the 250 Bald Hills Road, a 10 ha former industrial site adjacent to the North Pine River to be rehabilitated under court order. Duggan and Hede Pty Ltd for Hymix Australia.
- **Ecological Assessment Report – Yandina Waste Disposal Facility (Sunshine Coast Regional Council):** Floristic survey and assessment of vegetation condition at proposed waste disposal facility, Yandina on the Sunshine Coast. Prepared for Sunshine Coast Regional Council on behalf of Duggan and Hede Pty Ltd (August 2014).
- **Ecological Assessment Report – Warwick Landfill:** Floristic survey and general ecological assessment of the proposed extension of the Warwick Landfill Site. Prepared for Duggan and Hede Pty Ltd (November 2013).
- **Wooyung Developments, NSW –** Ecological assessment of a proposed Eco-Tourism Facility at Wooyung Beach, Northern NSW. Assessment of a 100ha development site including mapping and assessment of Critically Endangered Littoral Rainforest communities, listed under the Federal and State (NSW) legislation.

WATERWAYS MANAGEMENT PROJECTS

- **Redlands Waterways Reach Management and Riparian Condition Assessment:** A reach and catchment characterisation including riparian habitat assessment, for waterways in the Redland Shire Council area (SEQ). The project involved aerial photograph classification of reach, and field assessment of riparian habitats (Hydrobiology, 2011).
- **Caboolture Waterways Management Project:** Provided a reach and catchment characterisation, including riparian habitat assessment, for waterways in the Caboolture Shire area (SEQ). The project involved aerial photograph classification of reach, and field assessment of riparian habitats (Natural Systems, 2006 - 2007).

EXPERT WITNESS

- Provision of expert advice to Rob Friend and Associates / Iwasaki Resorts in regard to charged breaches against the Vegetation Management Act. Evidence was presented for the defence in Queensland Planning and Environment Court Proceedings.
- Expert witness duties for the case of Queensland Government versus Strathmore Station in regard to charged breaches against the Vegetation Management Act. Contracted to Preston Law, Cairns. Trial is ongoing.

OTHER RELEVANT PROFESSIONAL EXPERIENCE

Feb. 1995 - August 1997

Regional Exploration Geologist – Louisade Archipelago P.N.G: The position required the development of remote epithermal gold prospects on Placer Dome's (now Barrick Gold Corporation) exploration tenements on Misima Island and regional areas. Major tasks included detailed geological mapping, remote sensing and reconnaissance drilling (diamond core). The supervision of exploratory drilling on advanced gold prospects, including resource delineation drilling in the mine vicinity, was also required on a regular basis.

Feb. 1994 - February 1995

Exploration Geologist - **Osborne Gold Mine:** The major task was to supervise the Osborne regional exploration program during the construction phase of the Osborne Cu-Au Mine (Mt Isa Inlier). Project requirements included the planning and implementation of exploratory drilling programs to test geophysical targets, supervision of RC and Diamond Core drilling rigs, logging of RC chips and diamond core. Project management tasks included the planning of a regional exploration program around a budget of $350K.

PEER REVIEWED PUBLICATIONS

Stanton J. P., Stanton D.J., Stott M. & Parsons M. (2014). Fire Exclusion and the Changing Landscape of Queensland's Wet Tropics Bioregion 1. The Extent and Pattern of Transition. Australian Forestry V77 No.1 51 – 57.

Stanton J. P., Parsons M., Stanton D.J.& Stott M. (2014). Fire Exclusion and the Changing Landscape of Queensland's Wet Tropics Bioregion 2. The Dynamics of Transition Forests and Implications for Management. Australian Forestry V77 No.1 58 – 68.

Fell D.G., Stanton D. J (2015). Vegetation and Flora of Mabuyag Island, Torres Strait, Queensland. Memoirs of the Queensland Museum, Volume 8, Part 1.

Stephenson PJ, Burch AT, Stanton DJ & Whitehead PW (1998). *Three long lava flows in north Queensland. Journal of Geophysical Research-Space Physics,* 103, 27359 – 27370.

SPECIALIST TECHNICAL TRAINING

Australian Groundwater School: Four-day intensive training course dealing with technical and management aspects of groundwater in an Australian context. Flinders University, Canberra, 2017.

PUBLISHED VEGETATION MAPPING

Stanton J. P and Stanton D. J (2005) *'Vegetation of the Wet Tropical Bioregion of North Queensland',* published at 1:50 000 scale in co-operation with the Wet Tropics Management Authority, Cairns, Queensland.

Stanton D.J, Fell D. F, Gooding D. O (2009). '*Vegetation of the Torres Strait and Kaurareg Islands'.* 1:25 000 scale vegetation mapping produced in co-operation with Torres Strait Regional Authority, Australian Government.

PRESENTATIONS

IAVCEI (International Association of Volcanology and Chemistry of the Earth's Interior) conference, Canberra 1993, "*Using Remote Sensing to Detect Geochemical Heterogeneity within the Kinrara Lava Flow, McBride Lava Province, N.Q."*

EIANZ conference '*Achieving Real Biodiversity Outcomes during the EIS Process*', April 2010. The presentation was titled ' *The Importance of Accurate Regional Ecosystem and Vegetation Mapping in the Assessment of Impact to Biodiversity*'.

ADDITIONAL RELEVANT SKILLS, INTERESTS and CERTIFICATIONS

- Proficient in the Tok Pisin PNG language
- Professional experience as a Lifeguard for Queensland Surf Life Saving Association.
- Former Queensland representative swimmer and current record holder for the Magnetic Island to Townsville swimming race.
- Senior First Aid Certificate Current.
- Above Ground Coal Core and Coal Seam Gas inductions
- Advanced 4wd training certification current.

REFERENCES

Steven Goosem: Principal Scientist, Wet Tropics Management Authority. Ph: 07 4052 0563: Email: steve.goosem@wetma.qld.gov.au

Barton Napier: Principal - Coffey Environments. Trenerry Crescent, Melbourne. Ph: 03 9473 1450. Email: Barton.Napier@coffey.com

Dale Mundraby: CEO Mandingalbay Yidinji Aboriginal Corporation. Ph: 07 4056 8283. Email: dale@djunbunji.com.au

MARK SANDERS

Position: Director/Principal Ecologist, EcoSmart Ecology Pty Ltd
Qualifications: Bachelor of Advanced Science (Zoology) (First Class Honours)

Areas of Expertise

- Environmental planning and constraints analysis
- Vertebrate fauna survey and identification
- Rapid assessment of terrestrial habitats
- Design and implementation of research projects, particularly monitoring programs
- Threatened species survey and assessment
- Wildlife management
- Biodiversity planning and offset management
- Scientific communication

Overview

Mark Sanders is a highly respected and well known ecologist with over 20 years field expertise and first-hand knowledge of more than 1600 of Australia's terrestrial vertebrate species. His enthusiasm for natural history has led to surveys in every state and territory within the Australian continent from across a vast range of habitats.

Mark combines his ecological knowledge and experience with strong industry understanding and management skills. His project-related experience has included linear infrastructure (roadways, rail corridors, transmission lines etc), mining (inc metalliferous and coal), oil and gas, energy and transport projects, and small and large scale infrastructure (town development, master plan projects, airports etc). He has also prepared management plans for threatened species and offset areas, and provided detailed assessment for regulatory review. His broad industry experience enables him to evaluate ecological resources and make effective strategy recommendations based on scientific understanding and industry knowledge.

Marks recent work has included a large-scale airport development located on the Sunshine Coast of Queensland. The work involved rapid ecological assessment to identify potential ecological constraints, targeted long-term (12+ months) research on high conservation taxa, and baseline (inventory) surveys. Multidisciplinary understanding has been fundamental in developing environmentally sustainable solutions, which has included evaluation and identification of offset priorities and targets. Due to the sensitive location and nature of the works, Mark has been required to regularly liaise with government bodies, research institutions and community groups, often requiring the communication of complex ecological issues.

Mark has extensive experience in remote area work, four-wheel drive training and maintenance skills and has worked with traditional land owners. His photography skills are renown, and his highly sort after images have been used in a variety of publications.

Professional History

2009 - present Director/Principal Ecologist
EcoSmart Ecology Pty Ltd

2008 Principal Ecologist
Matrixplus Consulting Pty Ltd

2005 - 2008 Senior Ecologist
BAAM Pty Ltd

2001 – 2005 Senior Ecologist
Australasian Research Consultants Pty Ltd, Brisbane Qld.

2000 Environmental Scientist
Blue Mountains Wilderness Trust, Sydney NSW.

Selected Project Experience

- Baseline (seasonal) inventory survey of terrestrial fauna at MMG Century, located near Lawn Hill National Park in north-west QLD, 2013-14,
- Fauna assessment and community fauna awareness project within the Mandingalby Yidinji IPA, Yarrabah, Cairns. Surveys involved teaching survey methods and sharing information with local Traditional Owners, 2013-14.
- Baseline (seasonal) inventory survey for terrestrial fauna on Curtis Island for Arrow Energy CSG, 2012/13. Works included the survey of mangrove communities, intertidal communities, headlands and coastal dune vegetation (e.g., littoral rainforest),
- Baseline terrestrial fauna survey at Pisolite Hills, north of Weipa, QLD, 2012-2013
- Baseline vertebrate assessment of the Red Mud Dam area, Boyne Island for QAL (2005). Works included coastal dune complex with littoral rainforest.
- Team leader for the (fauna) assessment of Arrow Energies Surat basin CSG tenements. Works included high-level assessment to establish areas of primary conservation value, and the development of a risk-based approach to infrastructure planning. 2010 to present
- Fauna survey for South Murrin Murrin mining operations, WA. 2012.
- Pest Management Action Plan – Feral Pig and Red Fox. Action Plan prepared for Redland Shire Council. June 2005.
- Team Leader for two successive flora and fauna surveys (2001 and 2003) for the North Curragh Coal Project, Central Queensland. The project included assessing and managing impacts on three Nationally Vulnerable species along a proposed transport corridor.
- A 6 day (5 night) survey in a remote area for Matrix Metals near Kajabbi in far north-west Queensland. The survey found several threatened species and added small range extensions for several common species.
- Project Manager and Team Leader for a comprehensive survey and assessment of environmental values of Tarong State Forest in south-eastern Queensland.
- Flora and fauna assessment of coastal vegetation in north-eastern NSW. The survey located eight threatened fauna species.
- Survey of flora and fauna species on a 400ha site near Mt Glorious, south-east Queensland. Habitats surveyed include rainforest, wet sclerophyll forest and dry sclerophyll forest.
- Team Leader for an intensive 10-day survey of an area north of Clermont, Central Queensland. Confirmed the presence of several Endangered Regional Ecosystems and Threatened species.
- An extensive 8 day baseline survey study for Selwyn Mines in the Selwyn Ranges. During the study, *Pseudantechinus mimulus* was discovered. This species has been seen on the mainland of Australia only five times since its description in 1906.

Targeted Surveys

- Ground Parrot Research (2012-2014 and 2017) at the Sunshine Coast Airport. Monthly works to establish habitat use and population size,
- Targeted Purple-necked Rock-wallaby research and monitoring; MMG Dugald River. Ongoing works,
- Targeted survey, including trapping and active searches, for the vulnerable Water Mouse (*Xeromys myoides*) around Port Curtis (Gladstone) including Curtis Island (2012). The works located a number of nesting holes and increased local knowledge/distribution of the species.
- Targeted survey and assessment of the distribution of the Brigalow Scalyfoot on Boyne Island (for Queensland Alumina) (2006).
- Targeted survey and management plan for the federally Vulnerable Black-breasted Button-quail, Boyne Island Gladstone (QAL, 2006). This work was commissioned following baseline surveys which rediscovered the species within littoral rainforest on coastal dunes. Prior to the discovery

the species had only been known in the local area from records in the early 1900's.

- Team leader for the survey of threatened wallum frogs (particularly Wallum Sedgefrog) near Caloundra, south-east Queensland (2012 – ongoing). Work included sampling tadpoles and water parameters to evaluate breeding success across a variety of pools located in a variegated and disturbed landscape.
- Assistant to field ecologist on a study into the population, distribution and abundance of Plains Wanderers (*Pedionomus torquatus*) in grasslands of southern central NSW.
- Field Team Leader in the assessment of the presence and extent of Black-breasted Button-quails (*Turnix melanogaster*) in Tarong State Forest, south-east Queensland.
- Microchiropteran bat fauna of Clermont Coal Project north of Emerald. The survey was designed to determine the presence/absence and distribution of the Little Pied Bat (*Chalinolobus picatus*) and Greater Long-eared Bat (*Nyctophilus timoriensis*).
- Team Leader for an assessment of the presence/absence of the Threatened *Delma torquata* in south-east Queensland.

Research and Monitoring

- Carpentarian Pseudantechinus (*Pseudantechinus mimulus*) research to establish best survey methods and evaluate their distribution. Co-supervisory role with the University of Sunshine Coast.
- Team leader for the twelve-month monitoring to determine area of occupancy and habitat preference of the vulnerable Ground Parrot, Sunshine Coast Airport, Marcoola.
- Research into the methods of habitat utilisation and differentiation between four sympatric species of low-foliage gleaning bird species (White-browed Scrubwren, Superb and Variegated Fairy Wren and the Southern Emu-wren).
- Leader of the team that developed a biannual monitoring program for Pacific Coal's Kestrel Project in central Queensland. The aims of the program are to determine the effect of cattle grazing and subsidence on biodiversity values of natural grasslands and riparian ecosystems. The program was specifically designed so that later publication of results would be possible.
- Design and implementation of biannual monitoring program to document the success of rehabilitation strategies at Peak Downs Coal Mine.
- Comprehensive 8 day fauna study for the Ernest Henry Copper/Gold Mine as part of their yearly monitoring program. Aims of the program are to statistically show the effect of rehabilitation techniques on facilitating recolonisation by fauna.
- Heavy metal accumulation in aquatic macro invertebrates at Ernest Henry Copper/Gold Mine.
- Development of a monitoring program of the Vulnerable Ornamental Snake (*Denisonia maculata*) including population estimates (micro-chips) and radio-tracking. In particular, the program was designed to determine the effect of a road through a known population and if specifically designed underpasses facilitated movement and flow within the population. The program was accepted by the Department of Environment and Heritage.
- Research into shelter site characteristics of the Purple-necked Rock-wallaby (*Petrogale purpureicollis*) during summer.

Selected Technical Papers

McNab, A., and **Sanders, M.G.** (2014). Consumption of exotic grass seeds (Poaceae: Cynodon dactylon by the Eastern Ground Parrot (*Pezoporus wallicus*). *The Queensland Naturalist* Vol 52, 82-84.

McNab, A., **Sanders, M.G.,** and Vanderduys, E. (2014). New records of blind snakes resembling the Robust Blind Snake Anilios ligatus (Peters 1879), on Cape York Peninsula, *Memoirs of the Queensland Museum*. 59, 8.

McNab, A., and **Sanders, M.G.** (2014). An occasional carnivore, Diadem Leaf-nosed Bat (*Hipposideros diadema reginae*). *The Australasian Bat Society Newsletter*.

Lloyd, P., **Sanders, M. G.,** Reis, T. and Abbott, A. (2013). Targeted trapping surveys shed new light on the distribution and habitat requirements of the Carpentarian Pseudantechinus (*Pseudantechinus mimulus*), a threatened dasyurid marsupial. *Australian Mammology*. **35**: 220-223.

Sanders, M. G., Filewood, L. W. and Fox, B. J. (2005). Differential use of habitat aids local coexistence of three species of wrens (Maluridae) and the White-browed Scurbwren *Sericornis frontalis*: Pardalotidae in Myall Lakes National Park. *The Australian Zoologist.* **33**: 223-232

Sanders, M.G. (2004). Notes on a mass aggregation of *Illyria burkei* (Goding & Froggatt) (Hemiptera: Cicadidae) in central Queensland. *The Australian Entomologist.* 31 (2):79-80

Sanders, M.G., and Slater, L. (2004) New habitat and distributional data for the Vulnerable *Pseudantechinus mimulus*. *Memoirs of the Queensland Museum* **49**: 740.

Macey P. C., McKiernan, C. and **Sanders M. G**. (2002). Is there any science in the Environmental Protection and Biodiversity Conservation Act 1999? A review of the Migratory Species List. Presentation for the 4th Environmental Engineering Conference, May 2002, Brisbane.

A full CV can be provided upon request.

RESUME

Name: Peter Thomas Hall

Address: Residential
6 Padmur Court

Currimundi Q.
4551
Mob 0421358411
Phone 07 54918176
E-mail; kemeheli@gmail.com

Qualifications:

Bachelor of Applied Science (Biology)
Central Queensland University
Completed 1995.

Certificate IV in Investigations.
June 2003 Moreton Institute of TAFE

Other skills and Qualifications.

DSEWPac Accredited Ecologist. (Terrestrial Flora and Fauna) 2012

Construction Industry OH&S Induction (White Card)

Experience in using GIS programs, (principally ESRI ArcGIS and GBM), and GPS technology.

Heavy Vehicle Driver's Licence

Agricultural Chemical Distribution and
Control Act, Operator's Licence (Restricted).

Level 2 Chainsaw Operator.
Computer and word processing skills.

Workplace Trainer Qualifications 2000

Advanced First Aid Remote Area Operations (refresher training) 2014

In Service Training: Communications Skills 1984

Fire Training 1986

Supervisor Training 1987

Law Enforcement School 1989

Forest Interpretation Workshop 1993

Recreation Training workshop 1994

Customer Service Training 1994

Summer School of Park Management
Canberra University 1995.

Public Speaking Course through Toastmasters
International 1998.

Aboriginal Cultural Heritage Awareness 1999 and 2004

Regional Ecosystem Training 1999 and 2002.

Map Amendment Request Training 2003

Tactical Communications 2004.

Detecting Deception 2004.

Decision Making Training 2005

Technical Report Writing 2005.

Acid Sulphate Soils Training 2005

QGC Induction 2011

4WD training and defensive driving 2011

Vehicle washdown and weed hygiene
certification (Certificate II in Conservation and Land
Management –National Code RTD20102) 2011

Origin Energy induction 2012

All Terrain Vehicle drivers' course. 2012

Remote area first aid 2012

\

Helicopter landing officer 2012

Erosion and Sediment Control Training 2012

Laing O'Rourke Induction 2013

WDS Induction 2013

Origin Energy Foundation Training 2014

Most Recent Salary: $100K including superannuation or $60/hour plus costs for contract work.

Employment History

January 2016 to present.

Contract Ecologist with Naturecall Environmental Pty Ltd.
This a contract position. Naturecall engages my services when they require specialised ecological advice.
I have worked on two projects in this role,

One was determining and mapping the extent of threatened grasslands on the Army Aviation Base at Oakey. The job included other ecological surveys as well.

The second job was mapping the occurrence of an endangered plant, *Melaleuca irbyana* on a sports reserve in Logan City Council.

April 2015 to present.

Consulting Ecologist with First Steps Environmental (employed on a casual basis).

Duties and responsibilities; principally conducting field surveys of native vegetation in North, West New South Wales under various codes relating to clearing for agricultural purposes under the *Native Vegetation Act 2003.*

June 2014 to April 2015

Field Environmental Advisor with Origin Energy.

Duties and role description; refer to my time in the same role January 2012 – September 2013

September 2013 to June 2014

Senior Vegetation Management Officer, Central West NRW Region.

Duties and role description; refer to my time in the same role January 2008 – March 2011

November 2012 until March 2014

Ecologist and expert witness with First Steps Environmental Pty Ltd, for the Turnbull Case, Croppa Creek. (This work was undertaken concurrently with other employment).

This case involved preparing an ecological report to address the federal *Environmental Protection and Biodiversity Protection Act* (*EPBC*) requirements of a tree clearing application over a large farming property near Moree in NSW.

Additionally, the case involved preparing an affidavit and giving evidence in the Sydney Land and Environment Court in the capacity of an expert witness ecologist for the Defence, in a tree clearing prosecution under the *Native Vegetation Act 2003.* The case was heard in March 2014.
The case had a favourable outcome for the client in that the Court considerably reduced the fine that the Office of Environment and Heritage (OEH) originally sought. Also, based on my affidavit, potential charges under the EPBC Act and for clearing an Endangered Ecological Community under *The National Parks and Wildlife Act 1974* were not pursued.
Details of the Land and Environment Court Judgement are available at the web address below.

http://www.caselaw.nsw.gov.au/decision/54a63ede3004de94513dc50f

In June 2014an appeal against the Remediation Directions imposed on the landholders by NSW Office and Heritage were also heard in the Sydney Land and Environment Court.
The Court directed that the expert witnesses for the Prosecution and Defence should agree on a compromise Remediation Plan. This plan formed the basis for the eventual Remediation Direction that was imposed by the Court.
Based on my evidence and negotiations with OEH, the Court agreed that rather than order remediation of the entire cleared area, the property owners should be allowed to restore offset areas to high ecological condition and continue to farm some of the unlawfully cleared areas in order to meet the costs of implementing the remediation plan.

The judgement is available at the link below.

http://www.caselaw.nsw.gov.au/decision/54a63ed53004de94513dc23c

January 2012 to present until September 2013

Field Environmental Advisor with First Steps Environmental Pty Ltd, contracted full time to Origin Energy.

Duties included;

- Conducting reports and pre-clearance surveys for properties where Origin intended to locate CSG gathering infrastructure.
- Field scouting disturbance footprints for infrastructure associated with the upstream gathering network for the Australia Pacific Liquefied Natural Gas (APLNG) project in SW Queensland.

- Field scouting disturbance footprints for infrastructure associated with exploration wells for APLNG.
- Skills required for field scouting and ecology/pre-clearance reports are, the ability to recognize plant and animal species, including weeds, in the field, ability to conduct watercourse assessments, the ability to recognise regional ecosystems and a basic knowledge of gas field design.
- Ability to recognise soil and geology types, together with a basic knowledge of gas field infrastructure construction and to use this knowledge to identify potential soil erosion issues.
- Writing and reviewing Environmental Constraints Assessments (ECA) capturing the results of field scouting assessed against the various bits of legislation pertaining to the APLNG project. These pieces of legislation and policy include, Queensland Government Environmental Approvals, The Co-ordinator General's Report, Federal Government Approvals, APLNG Environmental Management Plans and miscellaneous pieces of legislation and codes such as those pertaining to land access and Strategic Cropping Land.
- Writing and reviewing ecology reports and pre-clearance survey reports for individual properties.
- Carrying targeted species surveys for rare and threatened plants occurring within development areas as well as complete botanical assessments for disturbance sites.
- Conducting surveys to ground truth regional ecosystems and threatened ecological communities (as described in federal legislation)
- Delivering accredited Regional Ecosystem and Vegetation structure Training to Origin environmental staff.

While working in this role I consistently met Key Practice Indicator targets for the project.

<u>March 2011 until January 2012</u>

Land access consultant with Flinders Group, contracted to the Queensland Gas Corporation (GGC).

Duties included;

- Negotiating Consent to Enter Agreements with landholders on behalf of QGC, to allow coal seam gas exploration on their properties.
- Negotiating Compensation Agreements with landholders to ensure the interests of both landholders and QGC are addressed when determining compensation amounts.
- Ensuring all negotiations are consistent with the Qld Government Land Access Code – November 2010.
- Attending field operations to assess seismic, clear vegetation and carry out seismic operations to ensure compliance with landholder access rules, including certifying weed washdown procedures.
- Attending pegging parties to locate potential appraisal well sites to ensure landholder interests are addressed.
- Assisting in the preparation of Notices of Preliminary Activity and Notice of Intent to negotiate under the *Petroleum and Gas (Production and Safety) Act 2004* where a voluntary agreement with a landholder cannot be achieved.

- Serving as a contact for landholders to address issues with QGC.
- Acting as an advocate for landholders in their dealings with QGC.

January 2008 until March 2011

Senior Vegetation Management Officer, Central West NRW Region.
Duties included,

- Managing the technical, personnel management and training aspects of the Vegetation Management Program within the CW Region.
- The Vegetation Management Program assesses applications made under the *Vegetation Management Act 1999* and *The Integrated Planning Act 1995* for developments that involve the clearing, or potential clearing, of native vegetation. These applications include requests to clear for operational works, weed control, livestock fodder, and material change of use and reconfiguration of properties. The Vegetation Management Unit also assesses and provides comment on major projects, e.g. gas pipelines and major water infrastructure projects. The unit also assesses application for property maps of assessable vegetation (PMAVs), where landholders can produce individual maps showing the vegetation on their properties.
- Training and mentoring staff involved in vegetation management assessment.
- Undertaking desktop and field assessment of major project application through the use of GIS programs, aerial photographs satellite imagery and field observations.
- Providing policy advice and serving on policy development forums
- Answering queries from interested groups and individuals, including delivering addresses to industry groups.
- Dealing with complex inquiries and difficult clients.
- Drafting replies for ministerial correspondence on vegetation management issues.
- Assisting with budget preparation and forward planning.

January 2007 until January 2008.

Senior Vegetation Management Officer, Property Map of Assessable Vegetation (PMAV) Project.
This project involves clearing a backlog of PMAV applications in a short period of time.
Duties included

- managing and motivating staff involved in the project,
- monitoring progress of the project and preparing reports,
- Providing policy advice on PMAVs.

During this period I also relieved in the Vegetation Policy Unit in Brisbane.
Duties in this relieving period included,

- providing policy advice to staff throughout Queensland
- answering ministerial inquiries
- Developing policy positions for, and interpreting vegetation legislation.

January 2005 until January 2007.

Senior Natural Resource Officer (Regional Ecosystems) with the Queensland Department of Natural Resources & Mines, Vegetation Management Unit.

My duties under this position included;

1. Undertaking Regional Ecosystem Map amendments.
   This is done by;

- conducting field assessments of species present,
- sampling and measuring vegetation height and percentage crown cover using Queensland Herbarium guidelines to determine whether the vegetation in question is remnant or non-remnant as defined under *The Vegetation Management Act 199,*
- assessing aerial photos and satellite imagery to determine the clearing history of the vegetation in question. (Sometimes the imagery and or air photos can be used to determine the remnant status of an area without the need for a field survey).
- After gathering the evidence I prepare an assessment report to forward to the Queensland Herbarium. Part of the report process involves using a GIS program to prepare maps.

2. Managing the RE map amendment program within the Central West Region of Natural Resources. The Central West Region covers 28 shires and is roughly defined in the south by a line running from Gladstone to Birdsville, and in the north by a line running from Proserpine through Winton to the NT border.

Management duties included;

- maintaining a database of RE map amendment requests,
- checking assessment reports submitted by other officers,
- training other staff in vegetation structure, species identification and report preparation,
- preparing and supervising work programs to complete RE map amendments.

3. Providing expert advice to the public and other sections of the department on vegetation issues.

Examples of such advice;

- checking EI Statements for major projects and advising the assessment manager whether or not vegetation issues have been sufficiently addressed,
- assisting vegetation officers with RE and plant identification when assessing tree clearing permit applications,
- reporting on vegetation issues that arise from applications under *Integrated Planning Act* for subdivision or Material Change of Use,
- preparing statements and giving evidence in court hearings for prosecutions under vegetation legislation.
- Answering phone and counter queries from the public in regard to complex vegetation issues.
- Meeting with consultants and project managers for large development operations to discuss vegetation issues.
- Giving expert advice on plant identification and monitoring techniques for the Mount Morgan mine rehabilitation project.
- For my work on this project, I received a ‘Highly Commended” award from the Director General of the Department of Mines and Energy.

June 2001 until January 2005

Regional Investigator, Natural Resources & Mines Compliance Unit.

Duties included;

- Investigate suspected breaches of the *Vegetation Management Act 1999, The Land Act 1994, and The Integrated Planning Act 1995, The Water Act 2000, The Aboriginal Cultural Heritage Act 2003* and *Land Protection (Pest and Stock Route Management) Act 2002.*
- Undertaking site inspections and surveys, taking out warrants, interviewing suspected offenders, taking witness statements and preparing court briefs in the course of investigations.
- Acting as a prosecutor in Magistrate's Court callovers.
- Assisting Crown Law solicitors to prepare cases for hearings and giving evidence at such hearings.
- Prioritising, managing timelines and maintaining case files. Collecting and managing evidence that may be used as exhibits.
- Preparing rehabilitation plans and restoration orders for areas cleared illegally. Monitoring the rehabilitation of these areas.

During my time in this role I investigated and prosecuted some major contested cases.

Hall v Glasgow was an investigation into one of the largest area of illegally cleared endangered vegetation to be prosecuted under the *Vegetation Management 1999.* This case attracted media interest and was attended by Senator Len Harris.

All of the cases I investigated that proceeded to court resulted in a successful prosecution.

As well as the above mentioned legislation, I have gained familiarity with a number of other acts through gathering evidence as an ex officio investigator. These include the federal *Environmental Protection and Biodiversity Conservation Act,* and the Queensland *Environment Protection* and *Nature Conservation Acts.*

April 1999 until June 2001

Forestry Environmental Management Officer.
The purpose of this position was to monitor and audit logging operations and quarry sales on state land as per the Commonwealth National Forests Policy.

Specific tasks included;

- Conducting surveys prior to logging operations to identify rare, endangered and vulnerable species, cultural heritage sites, potential weed and pest animal infestation, potential threats to the interests of other operators and lessees and identifying threats to the aesthetic and recreational qualities of the land in question. These surveys were done by both field inspections and desktop analysis, i e consulting EPA databases and maps.
- Conducting environmental audits of ongoing operations to ensure that they complied with various industry codes. The codes stipulate how the operation should meet guidelines relating to soil erosion, watercourse protection, habitat tree retention, safety, cultural heritage, endangered, rare and vulnerable species, waste management, fire protection and protection of the remaining forest from logging damage.

- Preparing management plans for specific species. An example is a management plan I prepared for a vulnerable plant, *Acacia gittinsii.* The plan dictated measures that would allow logging operations in areas where this plant occurred, at the same time ensuring that the species was preserved. This plan was endorsed by EPA.
- Contributing to the development of industry codes under ISO 14001 standards.
- Conducting fauna and flora surveys on state forests.
- Reporting sightings of vulnerable, rare and threatened species for inclusion in the EPA database.

March 1993 until April 1999

Forest Ranger Recreation and Extension, Byfield.

This position involved the management of three camping and day use areas on Byfield State Forest, as well as other sites in the Central Queensland Region.

Byfield State Forest averaged 20,000 visitors per year.

Specific tasks included;

- Managing staff and contractors involved in construction, maintenance and servicing.
- Conducting patrols and law enforcement.
- Budgeting and planning.
- Managing capital works projects.
- Providing advisory services to landowners on forestry issues.
- Delivering talks to school and tertiary students and other interested groups.
- Writing a regular column for a local newspaper.
- In this position I spoke on behalf of the department in several television and radio interviews.

February 1979 until March 1993.

Forest Officer in various parts of Queensland.

During this time I was employed in North, South and Central Queensland in both native forests and plantations.

Among the tasks I performed in this role;

- Site design and preparation, weed control, pruning, planting, harvesting, control burning and fire protection in exotic pine and hoop pine plantations.
- Timber assessment, tree marking, log assessment, sale preparation and site rehabilitation in native forests including North Queensland rainforests.
- Supervising sales of round timber and quarry material, floral and seed harvesting, and grazing permits on state forests and other crown land.
- Forest inventory studies in plantations and native forests.
- Seed and pollen collections in plantations and native forests. Managing an artificial pollination program in exotic pines.
- Soil surveys to determine suitability for plantation establishment.

- Surveying.
- Prescribed burning and fire fighting.
- Law enforcement.

In 1991 I designed, implemented and supervised a program to monitor the harvesting of *Bowenia serrulata,* a plant used for floral arrangement.
The data gathered in this study is still used to determine harvesting levels for this resource.

Prior to 1979.

Grew up on rural properties near Clermont Qld and on Queensland's Sunshine Coast.

Worked as a stockman and sharefarmer during high school and afterward.

Origin referees

Les Merton — Field HSSE Superintendent (Approvals, Land and Stakeholder)
Origin Energy
PO Box 41
105 Murilla St
Miles Q 4415
t. 07 45580308
m. 0467769065
e. les.merton@originenergy.com.au

Anje Schimpf — Team Leader Approvals

Origin Energy
PO Box 41
105 Murilla St
Miles Q 4415
M 0477324678
anje.schimpf@originenergy.com.au

APPENDIX B

Surat Gas Project Terrestrial Ecology Report

EcoSmart Ecology

June 2017

SURAT GAS PROJECT

Terrestrial Ecology Report

PREPARED FOR ARROW ENERGY PTY LTD
June 2017

Surat Gas Project

Terrestrial Ecology Report

June 2017

ECOSMART ECOLOGY
48 Streeton Parade
Everton Park QLD 4053 Australia

Tel: +61 7 3162 1161

DOCUMENT CONTROL

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APPENDICES

EXECUTIVE SUMMARY

At the request of Arrow Energy, EcoSmart Ecology and 3D Environmental undertook seasonal terrestrial flora and fauna surveys throughout the Surat Gas Project study area. This study area has a total extent of 202,915 ha, which for the purposes of the ecological survey was divided into three distinct regions (Figure 2.1):

- The northern region encompassing an area of 7,601 ha located just south of Wandoan,
- A central region of 53,048 ha located to the north-east of Miles, and
- A southern region of 142,266 ha located to the west of Dalby

Remnant vegetation in the northern (Wandoan) region was sparse, representing 2.8% (164.7 ha) of the area. However large continuous patches of remnant vegetation are present within the central (67%; 35,554 ha) and southern (28.7%, 104,035.8 ha) regions. Survey effort predominantly focused on these later two regions.

Survey Methods

A desktop assessment was undertaken prior to field investigations to gather relevant information and literature for the Surat Gas Project study area. This work included a gap assessment to identify areas, species or features which required targeted or additional field survey.

The flora gap assessment rated areas of interest at a property scale as follows:

1. Priority 1 – Properties with mapped Endangered or Of Concern vegetation, prior records of EVNT Flora species, Protected Plant high risk trigger areas, mapped as Core Habitat Known in the SGP Supplementary EIS (3d Environmental 2013),
2. Priority 2 – Properties with well-preserved remnant vegetation, limited prior sampling and strong indications of habitat suitability for a range of threatened flora species although no prior records, and
3. Priority 3 – Properties with intact, least concern remnant vegetation not recognised as hosting populations of EVNT species or habitats of any specific legislative significance, and
4. Priority 4 – Properties subject to intensive sampling effort during previous survey events.

In total, 114 Priority 1, 74 Priority 2, 65 Priority 3 and 31 Priority 4 properties were identified. Field surveys aimed to sample vegetation on all priority 1 and priority 2 properties throughout the course of the 'wet' and 'dry' season surveys, though access limitations prevented sampling some properties (i.e. 86 of 114 Priority 1 and 66 of 74 Priority 2 properties were sampled).

The flora field survey was consistent with Queensland Herbarium standards (Neldner *et al* 2012) and included secondary, tertiary and quaternary sites. In total 218 secondary, 17 tertiary and 2,223 quaternary flora survey sites have been sampled throughout the Surat

Gas Project study area (including sites sampled in previous work identified during the desktop assessment).

The fauna gap assessment used sampling locations from existing works to identify large areas of remnant vegetation which had not been subject to previous fauna survey. Once identified, Broad Vegetation Group mapping by the Queensland Herbarium (version 3.0) was used to identify the location and extent of Broad Vegetation Groups at a 2 million scale. The contribution of each Broad Vegetation Group to the extent of remnant vegetation was calculated and theoretical trap effort distributed accordingly.

The terrestrial fauna surveys used a variety of recognised survey methods consistent with relevant federal and state survey guidelines. These included trapping (Elliot, pitfall, funnel and Harp), observation (spotlighting, bird survey, and active search), remote sensing (Anabat ultrasonic bat detection and camera trapping), and targeted methods (Koala [SAT] and Glossy Black Cockatoo ort searches, tripline, artificial shelter).

Desktop Results

The desktop assessment identified the following ecological values:

- Two major wetlands of High Ecological Significance; i) Lake Broadwater, a major lacustrine Wetland of National Significance and ii) Long Swamp, a palustrine wetland which follows a shallow sinuous path to the north of Lake Broadwater,
- Protected Plant 'High Risk Buffers' (see Section 4.1.3), and
- The following Environmentally Sensitive Areas:
    - Category A - National Parks and Conservation Parks, specifically Lake Broadwater Conservation Park (Lot 68/SP139357),
    - Category B – Regional Ecosystems scheduled as Endangered (Biodiversity Status) by Queensland Department of Environment and Heritage Protection, and
    - Category C – which includes the following:
        - Lake Broadwater Resources Reserve (Lot69/DY6009),
        - Regional Ecosystems with 'Of Concern' Biodiversity Status,
        - State Forest areas (detailed Section 2.3), and
        - Essential Habitat (see Section 4.1.2).

Flora Survey Results

The flora surveys identified three Threatened Ecological Communities listed under the *Environment Protection and Biodiversity Conservation Act 1999* within the study area including:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) (Endangered),
- Weeping Myall Woodlands (Endangered), and

- Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions (Endangered).

These communities occupied 954.3, 0.9 and 22.6 hectares respectively.

Twenty Regional Ecosystems were recorded, three are listed as Endangered and six as Of Concern, with the remainder being classed as Least Concern under the *Vegetation Management Act 1999*. Endangered Ecosystems include:

- Regional Ecosystem 11.3.1 – *Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains. Total extent within the study area = 217.5 hectares,
- Regional Ecosystem 11.4.3 - *Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains. Total extent within the study area = 388.7 hectares, and
- Regional Ecosystem 11.9.5. *Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks. Total extent within the study area = 4.3 hectares.

Of Concern Ecosystems include:

- Regional Ecosystem 11.3.17 - *Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains. Total extent within the study area = 213.5 hectares,
- Regional Ecosystem 11.3.2. *Eucalyptus populnea* woodland on alluvial plains. Total extent within the study area = 580.7 hectares,
- Regional Ecosystem 11.3.3c. Palustrine wetland (e.g. vegetated swamp). *Eucalyptus coolabah* woodland to open-woodland (to scattered trees) with a sedge or grass understorey in back swamps and old channels. Total extent within the study area = 26.8 hectares,
- Regional Ecosystem 11.3.4. *Eucalyptus tereticornis* and/or *Eucalyptus spp*. tall woodland on alluvial plains. Total extent within the study area = 898.6 hectares,
- Regional Ecosystem 11.9.7. *Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks. Total extent within the study area = 1.5 hectares, and
- Regional Ecosystem 11.9.10. *Eucalyptus populnea* open forest with a secondary tree layer of *Acacia harpophylla* and sometimes *Casuarina cristata* on fine-grained sedimentary rocks. Total extent within the study area = 15 hectares.

A total of 438 flora species were recorded during the flora surveys including 38 exotic species, 2 Conifers, 2 ferns, 90 grasses, 2 species of grasstree and a balance of trees, shrubs and forbs across 65 plant families.

Only one threatened flora species, *Philotheca sporadica* (Near Threatened under the *Nature Conservation Act 1992* and Vulnerable under the *Environment Protection and Biodiversity Conservation Act 1999*), has been recorded within the study area during previous assessments completed by Arrow Energy and the current 2016 – 2017 surveys. However database records (Herbrecs and Australia's Virtual Herbarium) indicate a number of

additional threatened species have been recorded either within the Surat Gas Project study area including:

- *Crytandra ciliata* (Near Threatened, *Nature Conservation Act 1992*),
- *Solanum papaverifolium* (Endangered, *Nature Conservation Act 1992*),
- *Fimbristylis vagans* (Endangered, *Nature Conservation Act 1992*), and
- *Digitaria porrecta* (Near Threatened, *Nature Conservation Act 1992*).

Based on historic records these four species are considered present, though it is noted that some have no contemporary records despite extensive searches in suitable habitat.

Fauna Survey Results

The terrestrial fauna surveys identified a total of 266 vertebrate species within the Surat Gas Project study area including 20 amphibians, 55 reptiles, 151 birds and 40 mammals.

The likelihood of thirty-nine threatened species known to occur within the local area (i.e. the study area plus a 50km buffer) was assessed based on record relevance (i.e., record location and date) and habitat suitability. Based on results from the current 2016-17 surveys, six were recognised as occurring within the study area including:

- *Strophurus taenicauda* (Golden-tailed Gecko) – Near Threatened, *Nature Conservation Act 1992,*
- *Hemiaspis daemeli* (Grey Snake) – Endangered, *Nature Conservation Act 1992,*
- *Calyptorhynchus lathami* (Glossy Black-Cockatoo) – Vulnerable, *Nature Conservation Act 1992,*
- *Phascolarctos cinereus* (Koala) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992,*
- *Petauroides volans* (Greater Glider) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992,* and
- *Nyctophilus corbeni* (South-eastern Long-eared Bat) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992.*

The following five species were assessed to be either likely or possible within the study area:

- *Jalmenus eubulus* (Pale Imperial Hairstreak) – Vulnerable, *Nature Conservation Act 1992*,
- *Acanthophis antarcticus* (Common Death Adder) – Vulnerable, *Nature Conservation Act 1992*,
- *Furina dunmalli* (Dunmall's Snake) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992,*
- *Rostratula australis* (Australian Painted Snipe) – Endangered, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992,* and

- *Grantiella picta* (Painted Honeyeater) – Vulnerable, *Environment Protection and Biodiversity Conservation Act 1999* and *Nature Conservation Act 1992.*

Three Migratory species, listed under the *Environment Protection and Biodiversity Conservation Act 1999*, were recorded during the 2016-17 surveys including:

- Rufous Fantail (*Rhipidura rufifrons*),
- White-throated Needletail (*Hirundapus caudacutus*), and
- Fork-tailed Swift (*Apus pacificus*).

Thirteen other Migratory species are known to occur, most are vagrants restricted to habitats around Lake Broadwater.

1.0 INTRODUCTION

Arrow Energy (Arrow) has received Federal and State government approval for its Environmental Impact Statement (EIS) for the Surat Gas Project (SGP). The approval includes Federal conditions requiring flora and fauna surveys in accordance with the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) survey guidelines (or as otherwise agreed with the Commonwealth Department of the Environment and Energy) and State (Department of Environment and Heritage Protection) survey guidelines.

To meet these obligations Arrow engaged EcoSmart Ecology, in conjunction with 3D Environmental, to undertake seasonal terrestrial flora and fauna surveys. This work aimed to:

- Complete detailed seasonal terrestrial ecological surveys sampling the range of habitats within the SGP study area and targeting likely threatened species to satisfy State and Federal survey guidelines. Surveys considered:
    - Environmentally Sensitive Areas (ESAs),
    - Wetlands and watercourses, particularly wetlands of High Ecological Significance,
    - Endangered or Of Concern Regional Ecosystems (REs), or Threatened Ecological Communities (TECs),
    - Essential Habitat,
    - Areas of high connectivity,
    - Protected plants high risk areas, and
    - *Core Habitat Known* and *Core Habitat Possible* identified in the SREIS for EPBC listed taxa.
- Validate and refine existing RE mapping, including wetlands of High Ecological Significance, and
- Refine *Core Habitat Known and Core Habitat Possible* mapping for *Environment Protection and Biodiversity Act 1999* (EPBC Act) and *Nature Conservation Act 1992* (NC Act) taxa.

This document supports a separate GIS package which includes revised RE mapping, location records of significant taxa and features, and revised threatened species habitat mapping (see Appendix A for list of contents).

2.0 STUDY AREA DESCRIPTION

2.1 STUDY AREA AND EXTENT

The SGP Study Area has a total extent of 202,915 ha, which for the purposes of this ecological study has been divided into three distinct regions (Figure 2.1):

- The northern region encompassing an area of 7,601 ha located just south of Wandoan,
- A central region of 53,048 ha located to the north-east of Miles, and
- A southern region of 142,266 ha to the west of Dalby

Remnant vegetation in the northern (Wandoan) region is sparse, representing 2.8% (164.7 ha) of the area. However large continuous patches of remnant vegetation are present within the central (67%; 35,554 ha) and southern (28.7%, 104,035.8 ha) regions, and as such, survey effort has predominantly focused on these later two regions.

2.2 GEOLOGY AND WATER RESOURCES

Geology

The SGP study area is characterised by relatively gentle topography. In the larger southern region, the dominant landform is the expansive alluvial deposits of the Condamine River. These deposits form a gently undulating fertile clay to sandy clay plain geologically referred to as the 'Condamine Alluvium' which covers the south-eastern portion of the SGP study area stretching northwards to near Chinchilla. The Condamine Alluvium is bound to the west by low hills formed by indurated exposures of the Kumbarrilla Beds, a thick sequence of Jurassic to Cretaceous aged sandstones and fine grained sedimentary rocks. Small indurated sandstone caprock occurs in some localities which form suppressed jump-ups and low mesas.

The Kumbarilla Beds outcrop dominates the central area, overlain in some localities by a weakly consolidated blanket of Tertiary aged alluvial and colluvial sediments to form a gently undulating landscape of low stony rises and gently incised gullies and intermittent streams.

A major change in topography occurs between the central (Miles) and northern (Wandoan) sections where a steep breakaway escarpment exposes the fine grain metasedimentary and volcanic rocks of the Injune Creek Group. The landscape in the vicinity of Wandoan has much more pronounced topography with low rounded hills formed on fine grained sedimentary rock with characteristic heavy clay soils and rounded rocky lag deposited on the soil surface.

Water Resources

Drainage systems in the SGP study area are divided into those contributing to the west flowing Condamine River (part of the Murray River Catchment) and the Dawson River catchment (part of the Fitzroy River catchment).

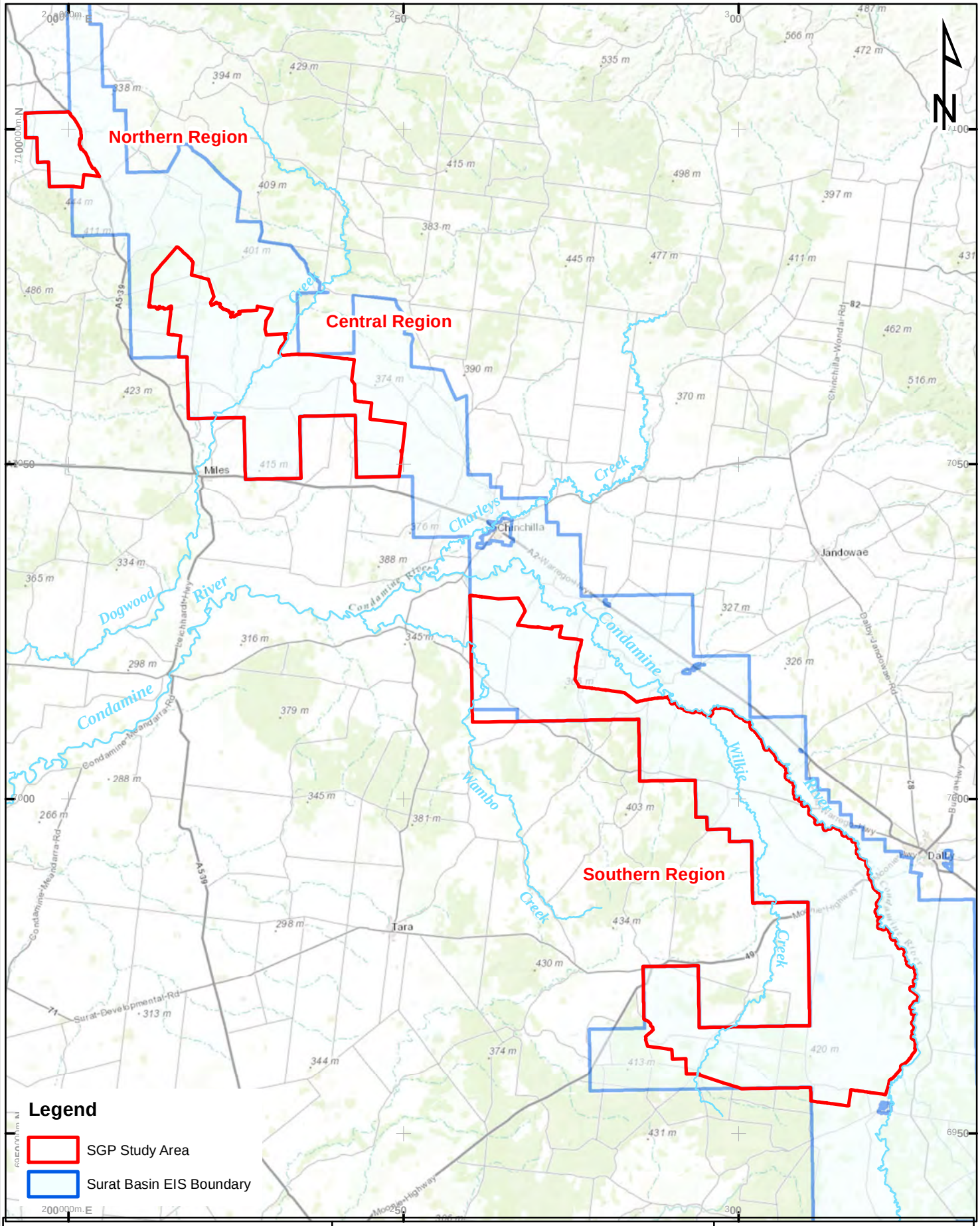

FIGURE 2.1 SGP study area location

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 23-Jun-17 A4

3D Environmental
Vegetation Assessment
& Mapping Specialists

P. O. Box 959
Kenmore, Qld 4069
Mobile: 0447 822 119

www.3denvironmental.com.au

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Within the SGP study area the Condamine River is by far the largest catchment, supplemented by the tributaries of Wambo, Wilkie, Charleys and Dogwood Creeks. The fertile alluvial soils of the Condamine River floodplain provide an extremely productive agricultural area that has been historically sustained and supplemented by an abundant source of groundwater within the underlying Condamine Alluvium aquifer.

In contrast, the Dawson River catchment forms only a minor portion of the study area and is characterised by Juandak Creek which flows through the township of Wandoan.

2.3 PROTECTED ESTATE

The SGP study area and nearby surrounds includes numerous State Forests and Conservation Reserves (Figure 2.2). In the southern (Dalby) region of the study area this includes:

- The Kumbarilla State Forest area (including the adjacent Waar Waar and Vickery State Forests), located immediately south of the Moonie Highway,
- Dunmore, Western Creek, and Boondandilla State Forest areas, which form a large continuous patch of remnant vegetation connected to the southern boundary of Kumbarilla State Forest, extending south to near the Gore Highway,
- Lake Broadwater Resource Reserve and Conservation Park, a small area of vegetation connected by remnant vegetation to Kumbarilla State Forest,
- Braemer State Forest to the north of the Moonie Highway, and
- Dalby State Forest just east of Kogan.

Together these areas of state forest, and intervening vegetation, form a large near-contiguous tract of remnant vegetation separated only by roads and highways.

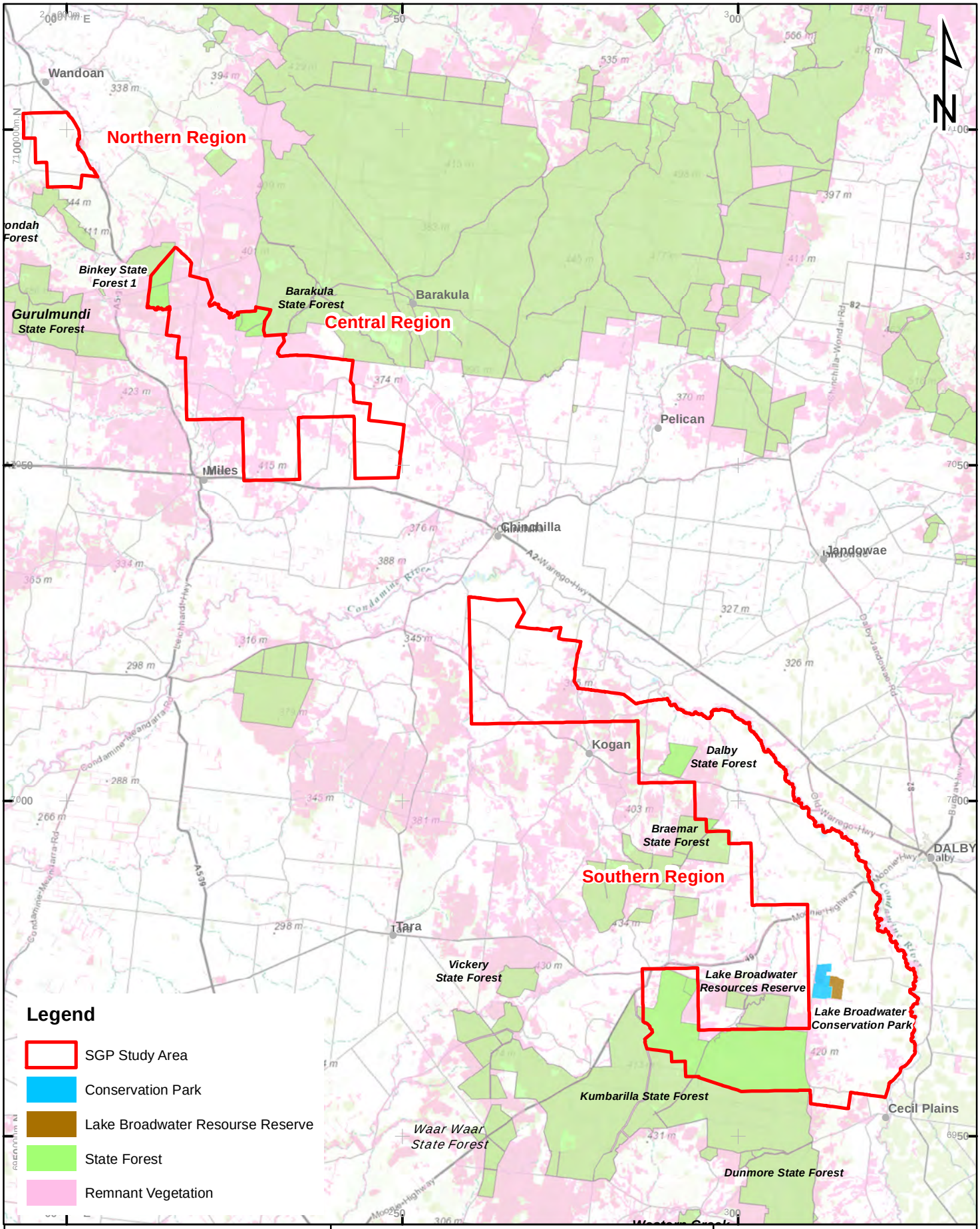
Protected Estate within or adjacent the central (Miles) region includes:

- Barakula State Forest to the immediate north-east,
- Blinkey State Forest 1 in the north of the SGP study area,
- Cherwondah State Forest to the north-west, and
- Gurulmundi State Forest to the west.

These forested areas and the intervening vegetation form a very large near-continuous patch of remnant vegetation separated only by roads and highways.

2.4 FIRE HISTORY

Vegetation within the SGP study area has been subjected to repeated fire events spaning several decades, though most fires have occurred between 2012 and 2014. With the exception of three, historic fires were limited in their extent (Figure 2.3) and, based on current vegetation condition, cool fires which did not cause extensive canopy death or damage. These cooler fires are likely to have little long-term impact on ecological values.



NOTES:
Biodiversity status of pre-clearing and 2015 remnant regional ecosystems - version 10.0 - South East Qld. Department of Science, Information Technology and Innovation

FIGURE 2.2 Protected Estate within and surrounding the SGP Study Area

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 23-Jun-17 A4

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Two hot wildfires, one extending from Barakula State Forest south to near Miles, and a second within Kumbarilla State Forest, affected large areas of vegetation in 2012. A third wildfire occurred in the eastern portion of Kumbarilla State forest in December of 2016 (i.e., between spring and summer sampling for this work).

These wildfires caused extensive canopy damage, and in many locations complete canopy loss. While the vegetation and habitat should recover in time (provided there are no subsequent wildfires), the damage will affect flora and fauna community composition with fire sensitive species likely to be absent for many decades.

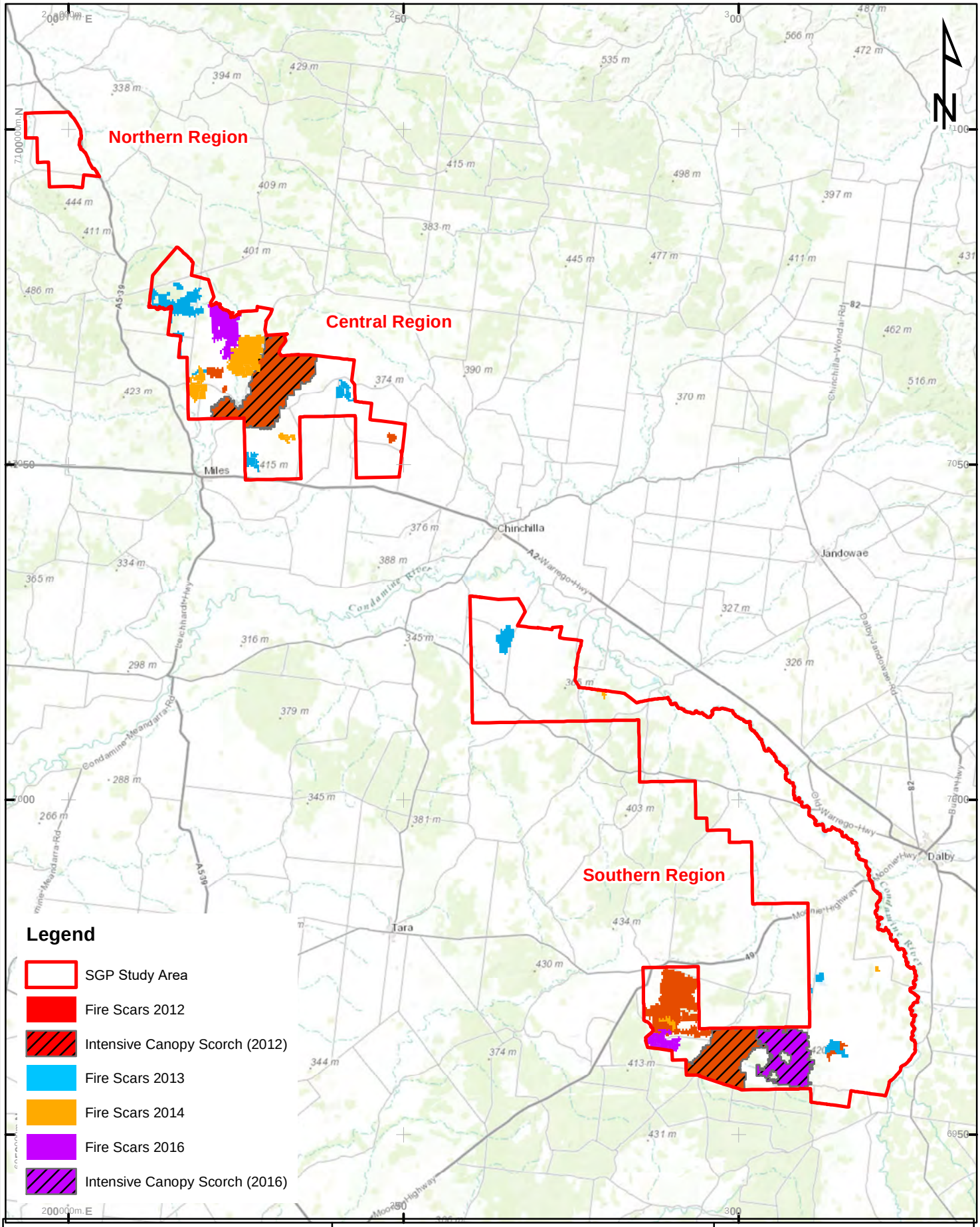

FIGURE 2.3 Historic fire scars within the SGP Study Area

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3.0 METHODS, SURVEY CONDITIONS AND LIMITATIONS

3.1 DESKTOP DATA

A detailed desktop review of available ecological information was undertaken as part of the SGP Supplementary EIS Terrestrial Ecology Assessment (3D Environmental/EcoSmart Ecology 2013). The results from this earlier assessment, as well as the data contained therein, has been used throughout this work. However several sources have been re-inspected to ensure the data is current. Data sourced during this work included:

- The Essential Habitat spatial layer,
- Birdlife atlas database, including geo-referenced data for threatened taxa,
- Wildnet database, including inspecting threatened species profile data to gather geo-referenced locations (where possible),
- The EPBC Act Protected Matters Search Tool,
- Queensland Herbarium Herbrecs database of vouchered specimen collections within a 50km buffer surrounding the assessment area,
- *Vegetation Management Act 1999* (VM Act) Status and Biodiversity Status of Pre-clearing and Remnant Regional Ecosystems Queensland - Version 10.0 (EHP 2015),
- Queensland Wetland Data Version 4.0 (EHP 2016),
- Matters of State Environmental Significance datasets (EHP 2014),
- Australia's Virtual Herbarium (AVH 2016) for vouchered specimen records sourced from a number of Australian Herbarium,
- Nature Conservation Act protected plants flora survey trigger map spatial layer – Version 4.1 (EHP 2016),
- Prior flora and fauna assessment within or in close proximity to the SGP study area including:
    - The SGP EIS Terrestrial Ecology Specialist Report (3D Environmental 2011),
    - The SGP Supplementary EIS Terrestrial Ecology Specialist Report (3D Environmental 2013),
    - Surat Gas Pipeline Project surveys (Aecom 2009) and addition field data collected by various consultants including Ecosure, RPS and SKM between 2009 and 2013, and
    - The Daandine CGPF and Daandine Phase 1 Projects (EcoSmart Ecology 2014a, b).

The assessment included a compilation of survey data from prior surveys.

3.2 Flora Field Survey Methods

Flora surveys were conducted under license Number WISP10337Grey011 (non-protected estate), TWB/14/2016 (State Forests) and WITK17580216 (Lake Broadwater National Park). Table 3.1 provides details of the survey team.

Table 3.1. Terrestrial Fauna Field Team Qualifications and Experience

Name	Qualifications	Exp (yrs)	Role	Survey
David Stanton	BSc (Hons)	22	Team leader/field ecologist	Dry/wet season
Paul Williams	BSc (Hons), PhD (Ecology)	22+	Team leader/field ecologist	Dry/wet season
David Fell	Associate Diploma of Applied Science	25+	Team leader/field ecologist	Dry
Eleanor Collins	BSc (Hons)	22+	Field Ecologist	Dry/wet season
Peter Wagner	BSc (Hons), MSc	5+	Team leader/field ecologist	Wet season
Lincoln Smith	BSc (Env)	15	Field ecologist	Dry/wet season
Bill Hoskins	BSc (Hons). Grad Dip Environmental Rehabilitation	30+	Field ecologist	Dry/wet season

3.2.1 Survey Overview and Site Selection

Prior to field surveys the 284 properties which make up the SGP study area were assessed using desktop resources for:

- The presence and extent of remnant vegetation,
- The presence of 'Of Concern' or 'Endangered' REs under the VM Act or TECs under the EPBC Act,
- Prior records of threatened flora taxa on, or in close proximity to, the property including Protected Plant high risk trigger areas,
- The quality of habitat including disturbance, vegetation structure and contiguity with larger remnant patches, and
- The spatial location and intensity of prior floristic surveys (see Section 3.1)

With the further aid of aerial imagery, properties were prioritised for access based on the following criteria:

5. Priority 1 – Properties with mapped Endangered or Of Concern vegetation, prior records of EVNT Flora species, Protected Plant high risk trigger areas, mapped as Core Habitat Known in the SGP Supplementary EIS (3d Environmental 2013),
6. Priority 2 – Properties with well-preserved remnant vegetation, limited prior sampling and strong indications of habitat suitability for a range of threatened flora species although no prior records,

7. Priority 3 – Properties with intact, least concern remnant vegetation not recognised as hosting populations of EVNT species or habitats of any specific legislative significance, and
8. Properties subject to intensive sampling effort during previous survey events.

In total, 114 Priority 1, 74 Priority 2, 65 Priority 3 and 31 Priority 4 properties were identified. While the field assessment aimed to sample all Priority 1 and Priority 2 properties throughout the course of the 'dry' and 'wet' season surveys, not all of these were able to be sampled due to access limitations (i.e. 86 of the 114 (or 75%) Priority 1 and 66 of the 74 (89%) Priority 2 properties were sampled).

3.2.2 Flora Survey Techniques

Surveys collected floristic data consistent with Queensland Herbarium standards (Neldner *et al* 2012) and included secondary, tertiary and quaternary sites. The location of these sites was selected using aerial photograph analysis, or opportunistically during traverse, to ensure that the field survey targeted a representative range of habitats.

Secondary sites consisting of 50 m x 10 m plots were located within the vegetation to avoid sampling across community boundaries. Crown intercept transects were extended to 100 m for the purpose of providing sufficient data for reference sites where an assessment of remnant / non-remnant status was required. Full species lists for all strata were established during the secondary sampling procedure, and supplemented by a detailed search of the nearby vicinity. The abundance of all species within the plot was recorded by stem counts, or by visual assessment as a 1-5 cover-abundance ranking using the braun-blanquet method (Neldner *et al.* 2012). Groundcover was assessed using five 1x1 m subplots placed at 10 m intervals along transects with visual cover estimations of dominant species. Ecological and structural data together with full species lists were compiled. In some instances identification to species level was not possible due to the lack of fertile material, particularly for grasses. Unidentified species were classified to the next highest denominator (typically genus level) and would account for <1% of all identifications.

Tertiary sites were completed in a similar fashion to the secondary procedure, although non-woody species were not recorded. Quaternary sites included a description of floristic structure, composition, and associated landform, and were used specifically for the purpose of mapping unit verification.

During the 'dry' season survey (September 2016) a total of 896 floristic survey sites were established including 58 secondary, 1 tertiary and 837 quaternary survey points. The wet season assessment completed in early February 2017 (plus an additional 3 day survey in late March 2017) resulted in a further 47 secondary and 682 quaternary survey points. In total, 1,625 floristic survey sites were established by 3D Environmental during this work, and combined with previous works, a total of 2,458 locations have been subject to structured floristic survey within the SGP study area (Table 3.2). The distribution of these survey points in relation to survey events is shown in Figure 3.1.

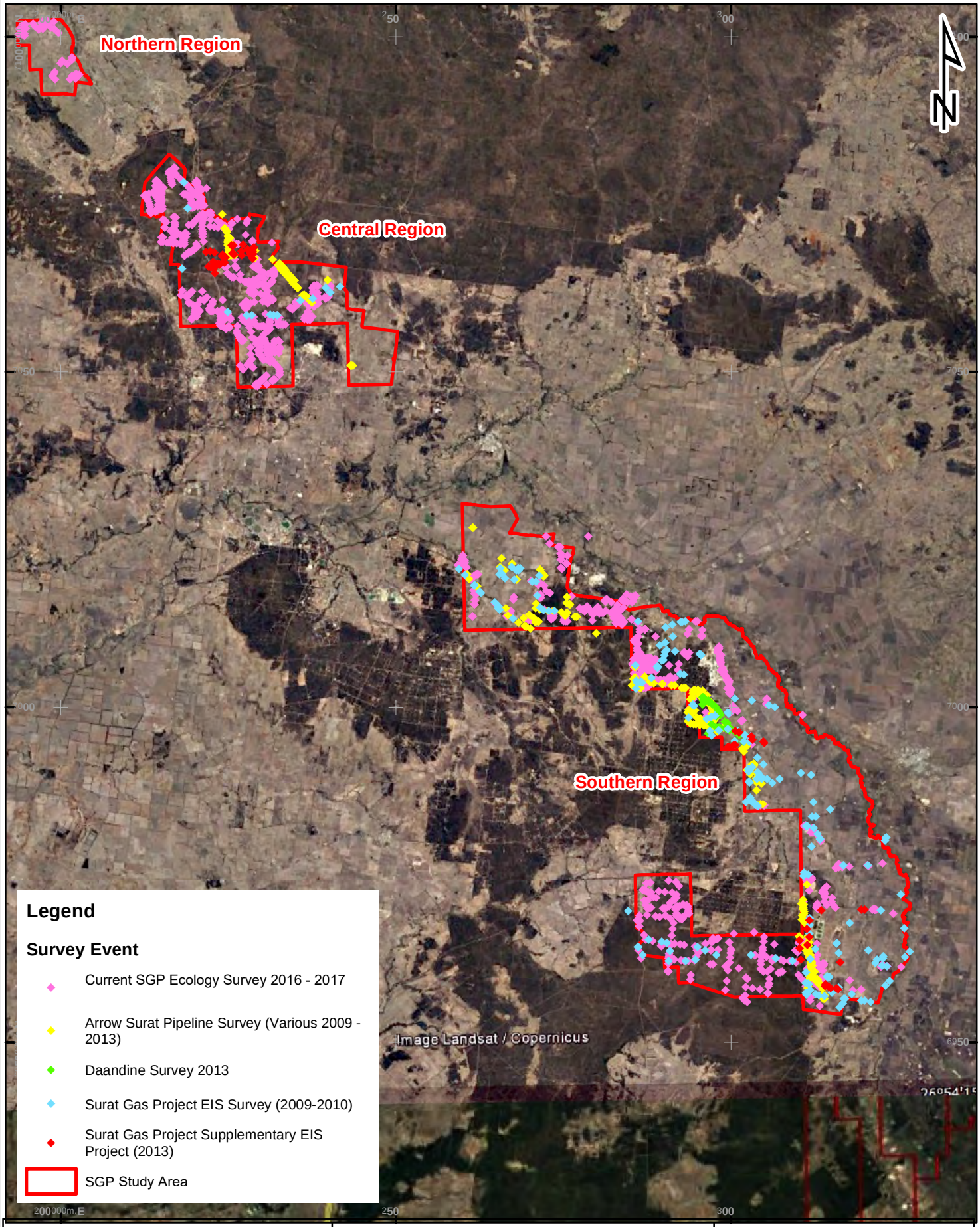

FIGURE 3.1 Floristic survey locations within the SGP Study Area

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0 12 24 36 48
Kilometers

Scale 1:750,000 | **Drawn By** DG | **Date** 21-May-17 | A4

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Table 3.2. The contribution of individual floristic surveys to overall survey effort within the SGP study area

Survey/Project	Year	Seasonal Effort	Undertaken By	No of Survey Sites			Total Sites
				Sec	Tert	Quat	
Current SGP Ecology Survey	2016	Dry	ESE/3DE*	58	1	837	896
Current SGP Ecology Survey	2017	Wet	ESE/3DE	47	0	682	729
Daandine CGPF and Phase 1 Project (EcoSmart Ecology 2014a, b)	2014	Late Wet	ESE/3DE	5	1	32	38
Surat EIS (3d Environmental 2011)	2009/10	Dry/Wet	3DE	46	2	170	218
SGP Supp. EIS (3d Environmental 2013)	2013	Wet	3DE	28	3	37	68
Arrow Surat Pipeline (Aecom 2009 - 2013)	2009/13	Mostly Wet	Ecosure/ Aecom	34	10	465	509
Totals				**218**	**17**	**2,223**	**2,458**

*EcoSmart Ecology and 3D Environmental

3.2.3 Mapping Scale and Attributes

Vegetation linework was established at a scale of 1:25,000 providing an accuracy of hard boundaries of +/-25 m and a minimum polygon size of 0.5 ha. A polygon of 0.5 ha represents the minimum patch size threshold for both the Brigalow and Weeping Myall Woodlands Ecological Communities, listed an Endangered under the EPBC Act and known to occur within the SGP Ecology Survey area.

A seamless GIS dataset has been produced to incorporate mapped REs, TECs and habitat mapping for all threatened species (flora and fauna) known from the study area including the mapping of Core Habitat Known and Possible. The habitat mapping will assist in locating future project infrastructure to minimise impacts and the determination of offset requirements where avoidance cannot be achieved.

GIS shapefiles of all floristic survey sites within the surveyed area have been provided to Arrow in a separate package to accompany this report, which also includes the locations and findings of previous and current survey efforts.

3.3 FAUNA FIELD SURVEY METHODS

Fauna surveys were conducted under licenses WISP14610914 (non-protected estate), TWB/14/2016 (State Forests) and WITK17580216 (Lake Broadwater National Park). Table 3.3 below provides details of the terrestrial fauna survey team's qualifications and experience.

Table 3.3. Terrestrial Fauna Field Team Qualifications and Experience

Name	Qual	Exp (yrs)	Role	Survey
Mark Sanders	BSc (Hons)	20+	Team leader/field ecologist	Dry/wet
Terry Reis	BSc (Hons)	22+	Team leader/field ecologist	Dry/wet
Greg Ford	B. App. Sc.; Grad. Dip. Res. Mgt.	25	Team leader/field ecologist	Dry/wet
Dr Ed Meyer	BSc (Hons), PhD (Zoology)	20+	Team leader/field ecologist	Dry/wet
Angus McNab	BSc (Hons), MSc.	10+	Field ecologist	Dry
Anders Zimny	BSc (Hons)	8+	Field ecologist	Dry
Dr Katrine Lowe	BSc (Hons), PhD	10+	Field ecologist	Dry/wet
Lincoln Smith	BSc (Env)	15	Field ecologist	Dry/wet
Jesse Rowland	BSc (Env Man)	10+	Field ecologist	Wet
Kate Grundy	BSc (Hons)	7+	Field ecologist	Wet

3.3.1 Stratification, Survey Design and Site Selection

3.3.1.1 Spatial Stratification

Remnant vegetation mapping shows the bulk of land within the northern region of the SGP study area is cleared, with remaining vegetation fragmented and minor in extent. The likelihood of significant terrestrial fauna values within this section is greatly reduced, lessening the need for detailed seasonal surveys. Further, those threatened taxa most likely to occur in these fragmented areas (e.g., Squatter Pigeon, Painted Honeyeater) can be detected using rapid survey methods. Detailed trapping was not therefore deemed necessary for the northern region of the SGP study area. By contrast the central and southern regions retain large areas of remnant vegetation, and while some detailed fauna work has occurred, fauna values in these two regions remains poorly known.

Within the central and southern regions areas of vegetation with little, or no, historic survey effort was identified by overlaying the locations of previous fauna work (see Section 3.1) on pre-existing RE mapping (Queensland Herbarium V10.0) (Figure 3.2). The identified areas were the focus of the current SGP fauna survey.

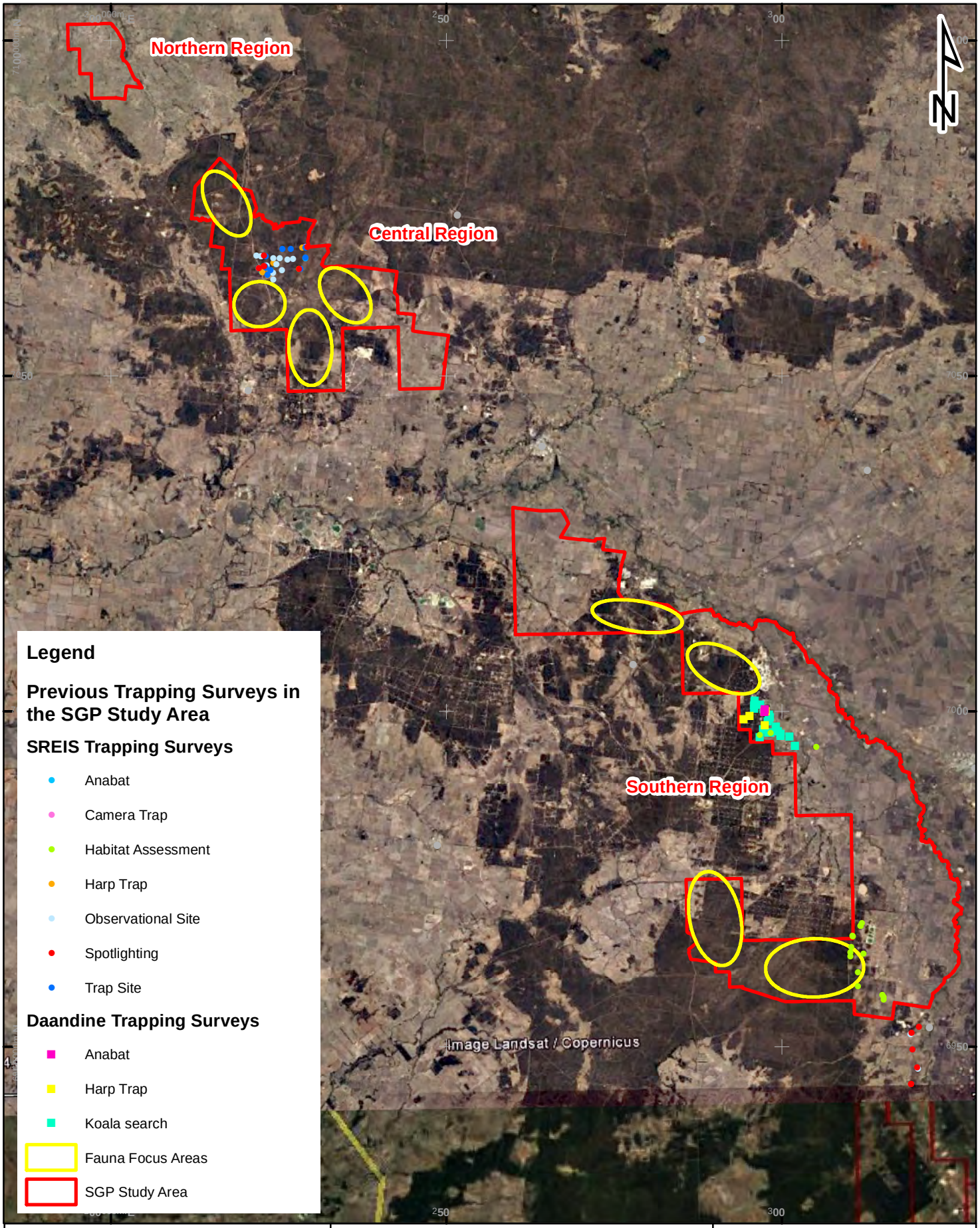

FIGURE 3.2 Previous fauna survey locations within the SGP Study Area

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 23-Jun-17 A4

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While Lake Broadwater National Park lies within the SGP study area, it was not the focus of detailed works. Frequent surveys are conducted in the National Park by Griffith University, and the area has been frequently visited by EcoSmart Ecology staff over many years. The fauna communities and values within the National Park are well documented and understood. All observations within the Park during this survey were taken ad-hoc.

3.3.1.2 Habitat Stratification

To stratify the trapping program and encapsulate habitat variety, Broad Vegetation Group (BVG) mapping by the Queensland Herbarium (version 3.0) was used to identify the location and extent of BVGs[1] at the 2 million (2M) scale. The contribution of each BVG to the extent of remnant vegetation was calculated and theoretical trap effort distributed accordingly.

3.3.1.3 Survey Design

Having completed the above spatial and habitat analyses, a survey program was developed to fill the identified gaps and included:

- A five-day pilot study (August 2016) to visually inspect the SGP study area, identify survey constraints, and locate possible detailed fauna trap sites,
- Two, 12-day detailed surveys were completed, one during the 'dry' (September 2016) and one during the 'wet' (February/March 2016) season, by four teams (eight ecologists/survey). Each team serviced 10 detailed trap sites over the 12 days, with each trap site operational for four consecutive nights, and
- A three-day follow-up survey (March 2016) to sample fragmented habitats (including habitats for Squatter Pigeon, Painted Honeyeater and Yakka Skink), habitats not subject to effort during the detailed surveys (e.g., wetlands), or areas which may not have been otherwise inspected.

3.3.1.4 Survey Site Selection

Detailed Survey Sites

The location of detailed survey sites (which included Elliot, Pitfall, Funnel, white-flash camera, detailed bird survey, spotlight, active searches, Spot Assessment Technique (SAT) searches) were determined during the pilot study, which used the above spatial and BVG stratification, as well as considering:

- Landholder access constraints - access was not granted to some parcels of land, while others had stringent conditions preventing ease of movement on or off the property,
- Travel logistics and limitations, trap sites must be located so they could be cleared before 9.00 am each morning,
- Any notable geomorphological features such as rock outcrops, caves etc,
- Habitats likely to support specially protected species, and

[1] as described in Nelder *et al* 2015.

- Vegetation condition and in particular fire scaring (see Section 2.4).

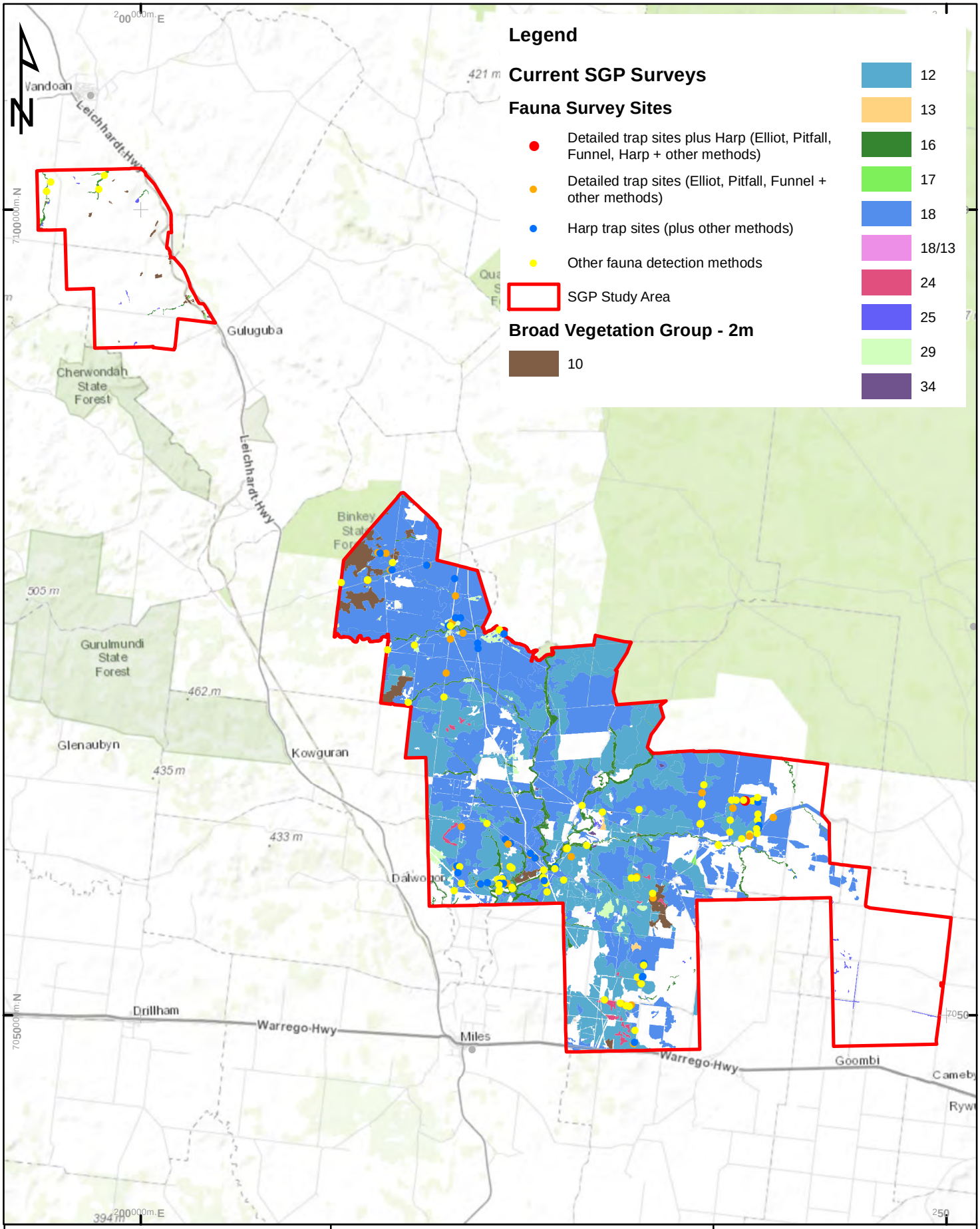
Once selected, each site was inspected and approved by traditional owners to ensure trapping activities would not impact upon indigenous cultural values. As no pitfall trapping could occur without prior cultural heritage assessment, trap site locations could not be relocated after the pilot study. The pilot study occurred prior to the flora investigations and did not account for any subsequent vegetation mapping changes.

Where possible trap sites were surveyed during both the 'dry' and 'wet' season, though in some cases this was not possible without compromising spatial or BVG representation. Trap site effort within each BVG is documented in Table 3.4 and trap locations are shown in Figure 3.3a and b.

Table 3.4. Number of trap sites by BVG based on ground-truthed vegetation mapping

BVG[#]	Description	Mapped Extent (ha)[+]	No. Detailed sites*	No. Target Sites
10	*Corymbia citriodora* dominated open forests to woodlands on undulating to hilly terrain	1,040 (1.3%)	2	2
12	Dry eucalypt woodlands to open woodlands, mostly on shallow soils in hilly terrain (mainly on sandstone and weathered rocks)	22,186 (28.6%)	23	49
13	Dry to moist eucalypt woodlands and open forests, mainly on undulating to hilly terrain of mainly metamorphic and acid igneous rocks	5,448 (7.0%)	4	17
16	*Eucalyptus* spp. dominated open forest and woodlands drainage lines and alluvial plains	3,211 (4.1%)	4	27
17	*Eucalyptus populnea* or *E. melanophloia* (or *E. whitei*) dry woodlands to open woodlands on sandplains or depositional plains	1,189 (1.5%)	0	5
18	Dry eucalypt woodlands to open woodlands primarily on sandplains or depositional plains	41,158 (53.0%)	43**	90**
24	*Acacia* spp. on residuals. Species include *A. clivicola*, *A. sibirica*, *A. shirleyi*, *A. microsperma*, *A. catenulata*, *Acacia rhodoxylon*	176 (0.2%)	0	0
25	*Acacia harpophylla* sometimes with *Casuarina cristata* open forests to woodlands on heavy clay soils	886 (1.1%)	0	3
29	Heathlands and associated scrubs and shrublands on coastal dunefields and inland rocky substrates	467 (0.6%)	1	2
30	*Astrebla* spp. (mitchell grass), *Dichanthium* spp. (bluegrass) tussock grasslands	0 (0%)	0	1***
34	Wetlands. Swamps (wooded or otherwise) and lakes (permanent or ephemeral), claypans. Includes fringing woodlands and shrublands	630 (0.8%)	0	3
18/13	Mixed community of BVGs 18 and 13.	1,233 (1.6%)	3	1
N/A	Non-remnant regrowth	N/A		3
	Total	77,624	80	203

[+]BVG extent and trap position with relation to BVG based on 3DE ground-truthed mapping.
*Replicated sites are counted twice, once for each survey.
**Includes one detailed site and two target sites placed in advanced regrowth.
***An area of derived grassland previously mapped as remnant by the Queensland Herbarium.



NOTES:
Other methods includes one or more of the following techniques; opportunistic bird survey, spotlight, active search, Anabat, remote sensor camera, and/or Glossy Black Cockatoo and Koala signs/scat searches.

FIGURE 3.3A Detailed fauna trapping sites within the SGP Study Area - Northern and Central Regions

Client ARROW ENERGY

0 5 10 15 20
Kilometers

Scale	1:312,525	Drawn By	DG	Date	23-Jun-17	A4

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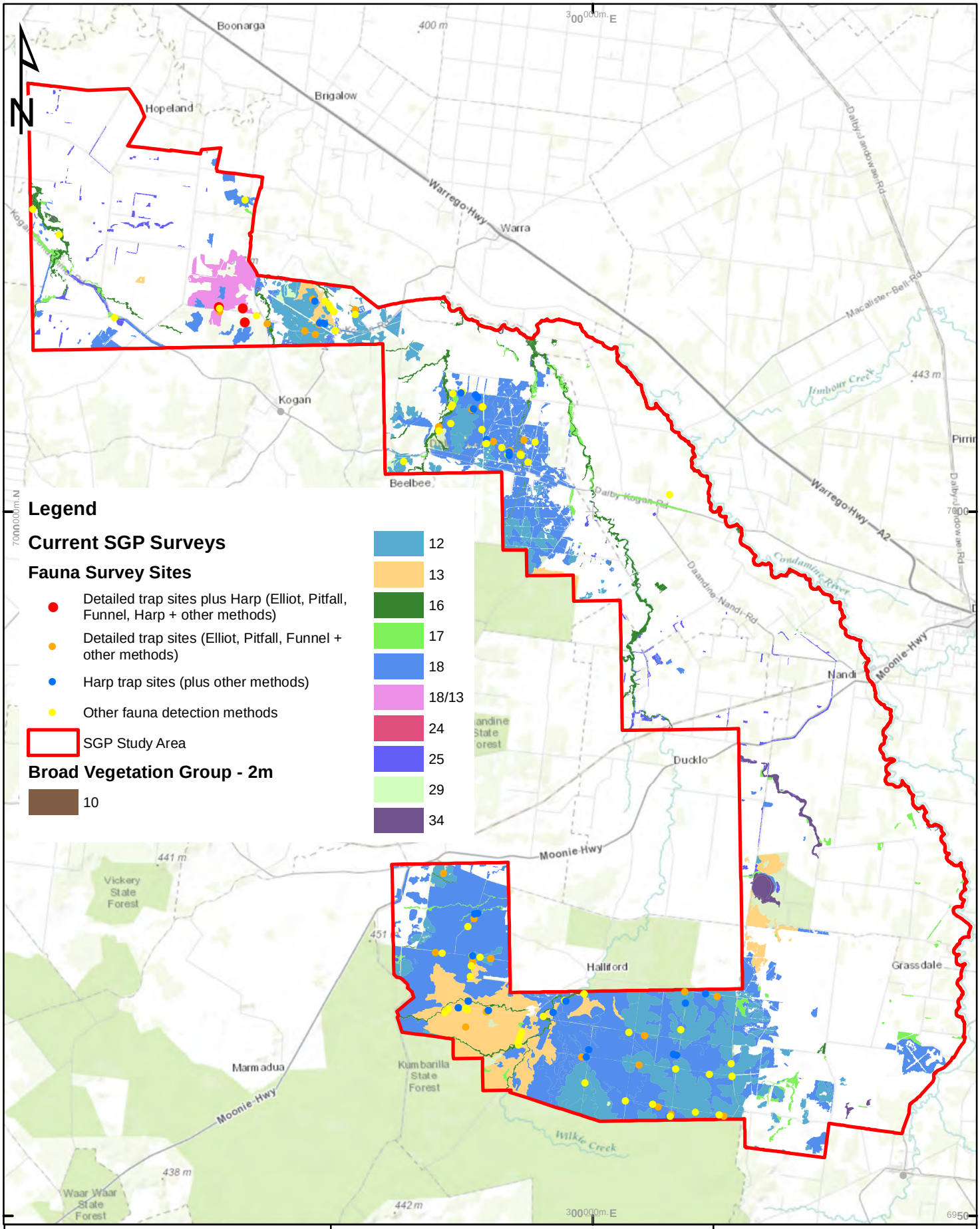

N O T E S:
Other methods includes one or more of the following techniques; opportunistic bird survey, spotlight, active search, Anabat, remote sensor camera, and/or Glossy Black Cockatoo and Koala signs/scat searches.

FIGURE 3.3B Detailed fauna trapping sites within the SGP Study Area - Southern Region

Client ARROW ENERGY

0 5 10 15 20
Kilometers

Scale 1:357,316 **Drawn By** DG **Date** 23-Jun-17 A4

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The allocation of actual detailed fauna survey sites across the BVG's varied slightly from 'theoretical' due to survey constraints (e.g., travel times, access conditions, and recent fire damage) and changes to RE mapping following the flora investigations. No detailed trap sites were located in five BVG's (17, 24, 25, 30 or 34):

- Detailed trap sites where positioned in areas mapped as BVG 17 during the pilot study (based on Queensland Herbarium mapping). Mapping inaccuracies were corrected by ground-truthed assessment and resulted in no detailed trap sites remaining in BVG 17. Due to cultural heritage restrictions, the pre-survey selected trap locations could not be altered to account for these changes (see discussion above),
- It was not until vegetation mapping and fauna surveys had been completed that BVG 24 was identified within the SGP study area,
- While the existing RE mapping showed patches of accessible Brigalow (BVG 25), field inspection found these areas to be incorrect. Rather, Brigalow was restricted to small, usually linear, fragments which were often separated from other vegetation by considerable distance. Travel logistics prevented trapping these habitats in detail, though sampling using rapid survey methods (e.g., bird survey, habitat search) was undertaken during a three-day follow-up survey,
- Queensland Herbarium mapping showed a small are of BVG 30 which was separated from other vegetation by considerable distance. Travel logistics prevented trapping of this habitat. The vegetation was altered following the completion of the flora surveys to 'derived grassland' and does not therefore represent a remnant community, and
- Surface water and the risk of possible flooding prevents trapping (particularly pitfall) in wetlands (BVG 34), though wetland locations were sampled using other survey methods (e.g., bird survey and active search).

Those BVG not subject to detailed trapping represent only a very small portion of remnant vegetation within the SGP study area (representing only 3.6% of total remnant vegetation).

Targeted Survey Sites

Targeted survey sites were used throughout the survey to supplement data collected at the detailed survey sites. Methods used at targeted sites varied from site to site and could include one or more of the following: opportunistic bird survey, spotlight, white- or black-flash camera, Harp trap, active search, SAT search, Glossy Black Cockatoo search, and Anabat. Two target sites included tripline over waterbodies to target michrochiropteran bats and artificial shelter to detect grassland reptiles.

Targeted sites are used to sample BVG that cannot be sampled by trapping (see above), or to increase spatial representation.

3.3.1.5 Contingency Survey

In December 2016 a wildfire roared through the eastern portion of the SGP study area in the Kumbarilla State Forest, significantly damaging the vegetation and habitat (Photo 1). The affected area included the five detailed fauna sites that were to be surveyed in March

2017 (i.e., the 'wet' season survey). A one-day contingency survey was undertaken in February 2017 to select new survey locations in the eastern area of the study area and gain the necessary cultural clearance. The locations of new trap sites were constrained by the extent and damage of both the December 2016 and 2012 wildfires (see Section 2.4 for fire extent).

Photo 1. Fire scaring following the December 2016 wildfire in the south-east portion of the SGP study area (i.e., Kumbarilla State Forest) (photo taken during the February contingency survey)

3.3.2 Survey Techniques

The terrestrial fauna surveys used a variety of recognised survey methods consistent with relevant federal and state survey guidelines. These included trapping (Elliot, pitfall, funnel and Harp), observation (spotlighting, bird survey, and active search), remote sensing (Anabat ultrasonic bat detection and camera trapping), and targeted methods (Koala [SAT] and Glossy Black Cockatoo ort searches, tripline, artificial shelter). These methods, detailed below, were replicated in both the dry and wet season survey unless otherwise indicated.

3.3.2.1 Fauna Trapping

Fauna trapping includes Elliot, pitfall, funnel and harp trapping. With the exception of Harp trapping, all trap methods remain at a designated location for the duration of the survey. These locations are the detailed fauna survey sites discussed in Section 3.3.1. Twenty detailed fauna sites (designated with a prefix of 'Det' in the associated GIS package) were operational within both the central and southern regions four consecutive nights during both the 'dry' (October) and 'wet' (March) season survey. The location of detailed trap sites is shown in Figure 3.3a and b. A summary of trap effort is provided in Section 3.3.3.

Elliot, Pitfall and Funnel Trapping

Pitfall trapping consisted of four 20L buckets and two drift fences set in a T configuration. Six funnel traps, positioned in pairs at the end of each fence, augmented the pitfall traps. This configuration is consistent with Eyre *et al* (2012) and resulted in a survey effort of 1276 bucket nights[2] and 1,914 funnel nights.

Ten Elliot traps, positioned approximately five to ten meters apart, were located in the vegetation immediately surrounding each pitfall/funnel array. Each Elliot trap was baited with a combination of peanut butter, rolled oats, and vanilla essence. Elliot survey effort was 3,190 nights[2].

All trapping sites were visited twice daily, once in the morning and once in the late afternoon. Animals were identified and released at the site of capture.

Harp Trapping

Insectivorous (microchiropteran) bat capture using harp traps was undertaken along flyways, which are linear clearings through vegetation such as tracks and creeks. Flyways are not necessarily located in areas suitable for other trapping methods, and as such, harp trapping did not coincide with pitfall, funnel or Elliot techniques. Unlike other trapping methods, harp traps are not used in a single location over consecutive nights but rather moved to a new location each night. Due to flyway width, two harp traps were placed at each harp trap location, side-by-side.

While each 'dry' and 'wet' season survey aimed to have 16 harp traps operational for three nights within both the central and southern areas, the lack of flyways and adverse weather reduced trap effort. Total harp survey effort was 86 harp nights (43 locations) in the 'dry' season survey and 78 harp nights (39 locations) during the 'wet' season survey.

3.3.2.2 Observation Based Detection

Observation based detection methods included bird survey (detailed bird survey and opportunistic bird survey), nocturnal spotlighting, and active searches. These methods are used at each trap site in both the 'dry' and 'wet' season survey, as well as additional locations as indicated in Figure 3.3a and b. Opportunistic bird surveys and active searching was also undertaken during the follow-up survey.

Bird Surveys

Detailed bird surveys were undertaken on two separate mornings at each detailed trap site, typically before 9am. Each survey took 30 minutes, but less time may have been spent if bird activity was poor, with the balance of time spent at the site whenever bird activity was high. Thus, a minimum of one hour birding over a minimum of two mornings was dedicated to detailed bird survey at each trap site. During each survey the maximum number of

[2] One trap site (4 buckets, 6 funnels and 10 Elliots) was closed for one night during the 'wet' season survey at the central region (see Section 3.5.1).

individuals for each species was recorded, though no abundance was noted if heard calling in the far distance or seen as flying-over. Total detailed bird survey effort was 80hrs.

Opportunistic bird surveys of an indeterminate period, but usually approximating 20 minutes, were undertaken at additional survey locations (Figure 3.3a and b). These surveys were not replicated and typically occurred between the hours of 9 and 11 am. Unlike detailed bird surveys, opportunistic bird surveys did not attempt to record the number of individuals, but rather only recorded species as 'present'. Opportunistic bird survey effort was approximately 8hrs during the 'dry' season, 13hrs during the 'wet season' and 5hrs during the follow-up survey (26hrs total).

Nocturnal (spotlighting) Surveys

Nocturnal foot-based surveys included two observers walking through habitats spotlighting for arboreal mammals, including small and medium sized terrestrial mammals, frogs, geckoes, nocturnal snakes and birds. Animals were detected by eye shine, call, or direct observation. Surveys typically lasted between 30-60 min per site, and were conducted by between two and three observers. Nocturnal foot surveys were undertaken at each trap site, as well as other locations. Nocturnal spotlight effort was approximately 72hrs during the 'dry' season and 68hrs during the 'wet' season.

Active Search

Active searches of habitats were undertaken at each trap site as well as additional locations. Active habitat searches involved two observers spending 30 minutes rolling rocks and logs, searching debris, inspecting trees for scratches and searching for scats or feeding remains. Greater Glider and Koala scats (or signs), and Glossy Black Cockatoo feeding remains (orts) were noted during the search.

Active searching was undertaken for approximately 56hrs/region during the 'dry' season and 64hrs/region during the 'wet season' (excluding the north region). Five hours of active search was also conducted during the follow-up survey.

Opportunistic Observations

Opportunistic observations of fauna not previously noted or infrequently observed were recorded throughout the surveys. Sightings were recorded from direct observation, or from indirect signs such as scats, tracks, scratch marks, nests, feeding indicators, or remains. Opportunistic observations were also used while traversing the SGP study area in a vehicle, a method recognised as suitable for detecting Squatter Pigeon. Traverses made by the flora teams, who are familiar with Squatter Pigeons, have been included within the traverse survey effort. It is estimated that 160hrs of traversing was undertaken in both the 'dry' and 'wet' season surveys (320hrs total) and 18hrs in the follow-up survey. An additional 700hrs of traverse through the SGP study area was undertaken during the pilot study, two flora surveys and the contingency survey.

3.3.2.3 Automatic Detection Methods

Ultrasonic bat call detectors and remote sensors cameras were used in both the 'dry' and 'wet' season surveys.

Ultrasonic Bat Call Detection

Ultrasonic calls of microchiropteran bats were recorded using ANABAT devices selectively positioned across the central and southern regions of the SGP study area. The ANABAT devices were set to record from dusk till dawn and sampled a new location each night. Locations were selected based on the likelihood of high bat activity, such as along flyways or over water bodies. Total Anabat survey effort was 33 Anabat nights in the 'dry' season (17 in the central region and 16 in the southern) and 35 Anabat nights in the 'wet' season (17 Anabat nights in the central region and 18 in the southern region). Recordings were analysed by Greg Ford.

Remote Sensor Cameras

Remote sensor cameras were used to survey small to large terrestrial vertebrates and is preferred over cage or hair-tube trapping as it is non-invasive, allows for greater detection rates, whilst minimising stress on animals (de Bondi *et al*. 2010; Claridge *et al*. 2010; Meek *et al*. 2012). Further, camera traps are effective for many species which are difficult to capture using cage or hair tubes (Vine *et al*. 2009; Robley *et al*. 2010).

Twenty-four white-flash cameras (Reconyx HC550) were in operation over four consecutive nights in both the central and southern regions during the 'dry' and 'wet' season surveys. One of these white-flash cameras was positioned in proximity to each detailed trap site (n=20), while another four were located at random positions. An additional 12 cameras were operational at one site (A7_Det06) for two consecutive nights during the follow-up survey. Each camera was baited by smearing quantities of peanut butter and Macadamia oil on the ground within the detection zone. Total white-flash camera effort was 396 camera nights.

In addition to the white-flash cameras, four black-flash (infra-red) cameras were located within the central and southern regions and baited with peanut butter, Macadamia oil and chicken wings. These cameras, which are intended to target exotic pests, were located near a track or road and were operational for four consecutive nights. Total black-flash camera effort was 64 camera nights.

3.3.2.4 Targeted Detection

Targeted detection methods included targeted searches for Koala evidence (scratches and scats) and Glossy Black Cockatoo feeding remains (called orts) as well as the use of artificial shelter.

Targeted Searches

Targeted searches were used for detecting Greater Glider, Koala and Glossy Black Cockatoo in areas of suitable habitat. Koala detection was based on the SAT method (Phillips and Callaghan 2011), but due to high densities of non-koala feed trees and only requiring confirmation of Koala presence, the method was modified to include twenty eucalypt trees

(rather than 30 trees of any species) or Koala evidence, whichever occurred first. Greater Glider scats were also noted during SAT searches. In total two SAT searches were undertaken in the northern region, 50 in the central region and 57 in the southern region during the surveys.

Searches were also conducted under stands of Allocasuarina for Glossy Black Cockatoo feeding remains (orts). *Allocasuarina inophloia, A. cristata* and *A. litoralis* are the primary food tree of this species in the Southern Brigalow Belt. Ort searches were conducted until 20 feed trees had been searched or feeding remains located. Searches were only conducted in suitable habitat, which was greatly reduced following a wildfire in the best areas of habitat prior to the 'wet' season survey. In total, nine dedicated ort searches were undertaken during the surveys.

Artificial Shelter

Nine hardwood tiles, approximately 40x40x4 cm in size, were scattered throughout the only area of mapped native grassland within the SGP study area[3]. These artificial shelters were positioned during the 'dry' season survey and later collected during the 'wet' season survey, allowing them to remain in-situ for approximately 20 weeks. The tiles were collected in the early morning, when ambient temperatures were low, to increase the likelihood of reptile capture. This method is frequently used to detect grassland reptiles (Sadlier *et al.* 2011).

3.3.3 Summary of Fauna Survey Effort

Table 3.5 provides a summary of 2016-2017 fauna survey effort within the SGP study area. Appendix B compares the survey effort with EPBC survey guidelines, which are intended to be applied to small areas of interest. The application of these guidelines across large areas (as required in this project) will result in an unachievable survey effort.

3.4 Assessing Likely occurrence of Threatened Taxa

While an assessment of the likely occurrence of threatened taxa was completed for the approved EIS (3d Environmental and EcoSmart Ecology 2011), this assessment was based on data available in 2011. Since this assessment was completed the conservation status of several species has changed, and it is possible that new populations have been discovered or previously known populations are no longer present. A new assessment has therefore been undertaken.

The likelihood that individual threatened species could occur within the study area over the life of operation is based on habitat (existence and quality as assessed during field investigations) and existing record relevance (the number of records, record date, and proximity to the SGP study area). Each species is ranked as present, likely, possible, unlikely, or transient base on criteria outlined in Table 3.6.

[3] Mapped as remnant by Queensland Herbarium but re-classed as non-remnant vegetation during this work.

Table 3.5. Terrestrial Fauna Survey Effort.

Method	Unit	'Dry' season (Oct)	'Wet' Season (Mar)	Follow-up (Mar)	TOTAL
Pitfall	Trap nights	640	636		1276
Funnel		960	954		1914
Elliot		1600	1590		3190
Harp		86	78		164
Anabat		36	33		69
Camera trap (white-flash)		186	186	24	396
Camera trap (black-flash)					64
Active Search	Person hrs	56.25	64	5	125.25
Detailed Bird		40	40		80
Opportunistic Bird		8	13	5	26
Foot Spotlight		71.75	68		139.75
Vehicle Spotlight		9.58	17.5		27.08
Traverse (fauna surveys)		160	160	18	338
Traverse (flora surveys & other)		Includes traverses during the pilot study, dry (Sept) and wet (Feb) season flora surveys and the contingency survey			700
SAT	Sites	60	43	8	111
GBC ort search		8	3		11

Table 3.6. Assessment guidelines for determining species likelihood

Likelihood	Criteria	Probability
Present	Recorded within and/or immediately adjacent study area during this work. Likely resident populations of these species are known from within the SGP study area within the last 10 years.	100%
Likely	Suitable habitat within or adjacent the study area; numerous relevant records (less than 20 years old and within 10 km) from desktop assessment.	>80%
Possible	Suitable habitat within or adjacent the study area; numerous records from desktop assessment study area but records > 10 km away or 20-50 years old. OR Marginal habitat within or adjacent the study area; few, but recent (<20 yrs), records within 10 km of study area.	10-80%
Unlikely	Little suitable habitat or habitat marginal; few records from desktop assessment, usually >50years old, and records > 10 km from study area.	<10%
Transient	Species highly mobile and known to occasionally appear in areas away from known population centres (usually birds). These species could occur sporadically over time (i.e., >10% likelihood), but records and observations are unlikely to represent an established population worthy of special protection. This category does not include species which might occur seasonally or frequently.	N/A

3.5 SURVEY CONDITIONS AND LIMITATIONS

3.5.1 Survey Conditions

August Pilot Survey

The pilot survey was conducted between the 29th August and 2nd September 2016. Chinchilla received a total of 117 mm of rain between the 15th and 20th of September resulting in the presence of some surface water during the pilot survey. Maximum daily temperatures during the survey ranged from 23°C (31st Aug) to 27°C (2nd Sept), while minimum overnight temperatures ranged between 3.2°C (29th Sept) and 14.9°C.

'Dry' Season Surveys

The 'dry' season flora surveys were conducted between the 12th and 23rd September 2016 working progressively north from Kumbarilla State Forest toward Wandoan over the 12 day period. Significant rainfall occurred during the survey with 152.4mm of rainfall recorded in Miles between September 15th to September 22nd and 63.5mm recorded at Dalby (Bureau of Meteorology data) for the same period. This caused localised flooding, limiting access to foot traverses on a large number of properties.

The 'dry' season fauna surveys were conducted between the 18th and 28th October 2016, with works concentrating on the central region (Miles) on the 18th and 22nd October, and the southern region (Dalby) between the 23rd and 27th October. Accumulative rainfall at Miles in the months (Jun – Oct) prior to the work was 260mm, while 259mm of rain fell at Dalby over the same period.

During the fauna 'dry' season survey Miles received 10.8mm, 0.8mm and 6.0mm of rainfall on the 18th, 21st and 23rd of October. However this rainfall was patchy and affected only some areas within the SGP study area. The storm front which moved through on the 21st of October coincided with nocturnal spotlighting, and while the SGP study area did not receive rain, lighting, thunder and high humidity was widespread. These conditions promote nocturnal fauna activity and ideal conditions for nocturnal fauna searches.

Minimum overnight temperatures during the fauna survey ranged between 5.0°C (24th) and 17.7°C 22nd). Spotlighting coincided with minimum overnight temperatures of between 12.9°C and 17.7°C while working in the central region, but due to a wide-spread cold front, dropped to ~ 5.0°C before recovering to 11.2°C while surveying the southern region.

'Wet' Season Surveys

Wet season flora surveys were completed between February 6th and 18th 2017. This period coincided with extremely hot weather where the initial 9 days of survey had maximum temperatures exceeding 43°. The conditions both slowed the rate of field surveys as well as wilted some groundcover forb species and caused general scorching of groundcovers in some habitats. This may have resulted in an under-sampling of total floristic diversity in some habitats, particularly grassy woodlands.

'Wet' season fauna surveys were undertaken between the 7th and 16th March 2017 (inclusive) with works commencing on the southern (Dalby) region (7th-11th) and finishing

in the central (Miles) region (12th-16th). A total of 213mm of rainfall was recorded at Miles, and 273mm at Dalby, in the months preceding the work (Nov 16-Mar 17).

Temperatures at Miles during the fauna survey ranged from a minimum of 14.2°C on one night and a minimum of 18.8 °C thereafter, to a maximum of 35 °C. Rainfall fell over three nights at Miles totalling 18.8mm, however rainfall was patchy with some areas receiving much greater rainfall events causing localised flooding. This flooding caused the closure of some traps (i.e., A02_Det05 was abandoned after three nights) due to access concerns.

Temperatures at Dalby during the fauna survey ranged from a minimum of 14.8 °C to a maximum of 33.2 °C. No rain fell while surveying the southern region.

3.5.2 Survey Limitations

While unlikely to have significantly affected the results of this work, the following limitations are recognised:

- Floristic surveys were hampered by extremely wet weather during the 'dry' (September) season survey meaning access was restricted in some localities and nearly all unsealed roads were impassable for a period of several days. This reduced site coverage in the first stage of the survey.
- Access was not possible to a small subset of properties. Generally this is unlikely to have affected survey results as surveys on adjacent land allowed assessment of a similar vegetation/habitat unit. However it is possible that some smaller features, such as wetlands or waterbodies, may have been overlooked.
- 'Dry' season fauna surveys conducted in the southern (Dalby) region coincided with unseasonably cold night temperatures. Temperatures quickly dropped to near 12-13°C within the first hour after sunset. These conditions, which affected only two nights of survey effort in the southern region, are largely unsuitable for the detection of a variety of fauna species, particularly nocturnal reptiles and bats.
- The coincidence of extremely hot weather with the 'wet' season flora survey effort may have resulted in the under-sampling of some of the more sensitive grass and forb species in woodland habitats. Of the EVNT species, this may have reduced the effectiveness of searches for the grass species *Digitaria porrecta*. The 'Endangered' forb species *Solanum papaverifolium* was observed flowering in populations observed outside the assessment area during the wet season survey and the effectiveness of searches for this species are not expected to have been affected.
- Rainfall was experienced during both the 'dry' season and 'wet' season fauna surveys in the central (Miles) region. However no rain fell while undertaking fauna surveys in the southern region (Dalby) and this is likely to have affected frog activity and detectability in the region.
- An extreme wildfire impacted the eastern portion of the southern region (Kumbarilla SF) prior to the 'wet' season survey. This affected the spatial distribution of trap effort within Kumbarilla State forest, but did not affect BVG representation. The fire inhibited surveys over the impacted area during the 'wet' season.

4.0 RESULTS

4.1 DESKTOP RESULTS

4.1.1 Wetlands of High Ecological Significance

The SGP study area contains an extensive mosaic of palustrine wetland habitats, many of which are associated with the Condamine River floodplain. Across Queensland, comprehensive mapping has been undertaken to identify Wetland Management Areas (WMAs) which categorise wetlands as either General Ecological Significance (GES) or High Ecological Significance (HES). These units include habitats associated with RE 11.3.27, 11.3.25 and RE 11.4.3a.

Wetland Management Areas are of specific relevance to the project, requiring adherence to appropriate management buffers and specific mitigation measures. The location of Wetland Management Areas in the SGP study area is shown in Figure 4.1. Two major wetlands of HES occur within the SGP study area; i) Lake Broadwater, a major lacustrine Wetland of National Significance and ii) Long Swamp, a palustrine wetland which follows a shallow sinuous path to the north of Lake Broadwater. Further characterisation of these habitats based on field assessment is provided in Section 4.1.1.

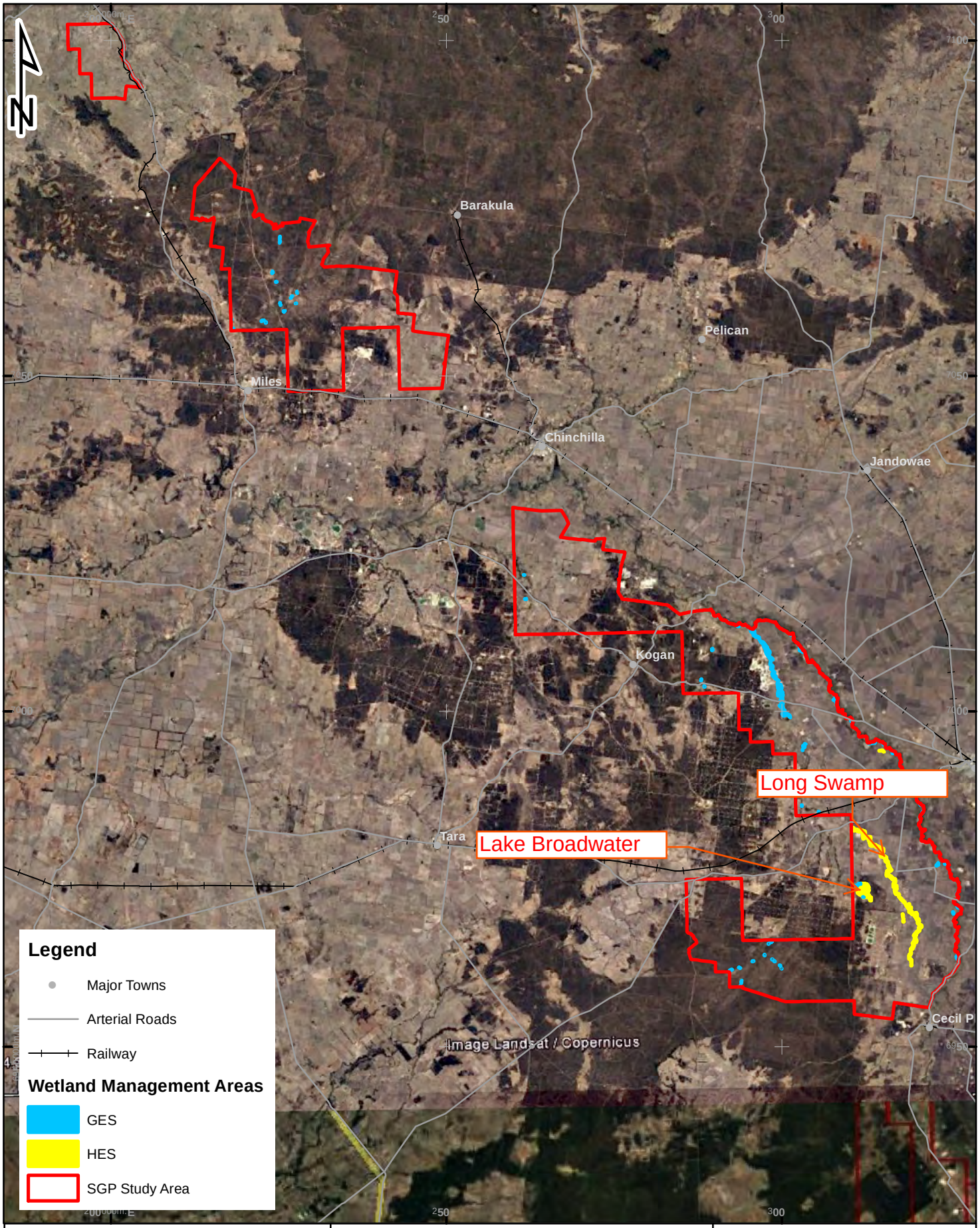
4.1.2 Essential Habitat

The essential habitat layer (Version 4.41; available at http://qldspatial.information.qld.gov.au/catalogue/custom/search.page?q=essential+habitat) represents the most up-to-date essential habitat available. This layer however, is updated infrequently by the Queensland Government and at the time of preparing this report included essential habitat for species no longer specially protected under Queensland legislation (and therefore includes areas that should no longer constitute essential habitat). Unfortunately, recent government changes require property by property examination of Essential Habitat, which limits its use for assessments over large areas encompassing many properties and areas of essential habitat. Closer examination will be required in the future to assess essential habitat values.

4.1.3 Protected Plant 'High Risk' Buffers

A 'High Risk' plant buffer protects plants listed as Endangered, Vulnerable and Near Threatened under the NC Act. These protected areas are generated by placing a 2km wide buffer around confirmed locations of individuals to show where protected plant species are considered likely to be present.

The locations of High Risk buffers for protected plants that were assessed in accordance with Flora Survey Guidelines – Protected Plants (DEHP 2016) during SGP Surveys are shown in Figure 4.2.



NOTES:
Queensland wetland data version 4 (2016)

FIGURE 4.1 Wetland Management Areas within the SGP Study Area

Client ARROW ENERGY

0 5 10 15 20
Kilometers

Scale 1:750,000 | **Drawn By** DG | **Date** 23-Jun-17 | A4

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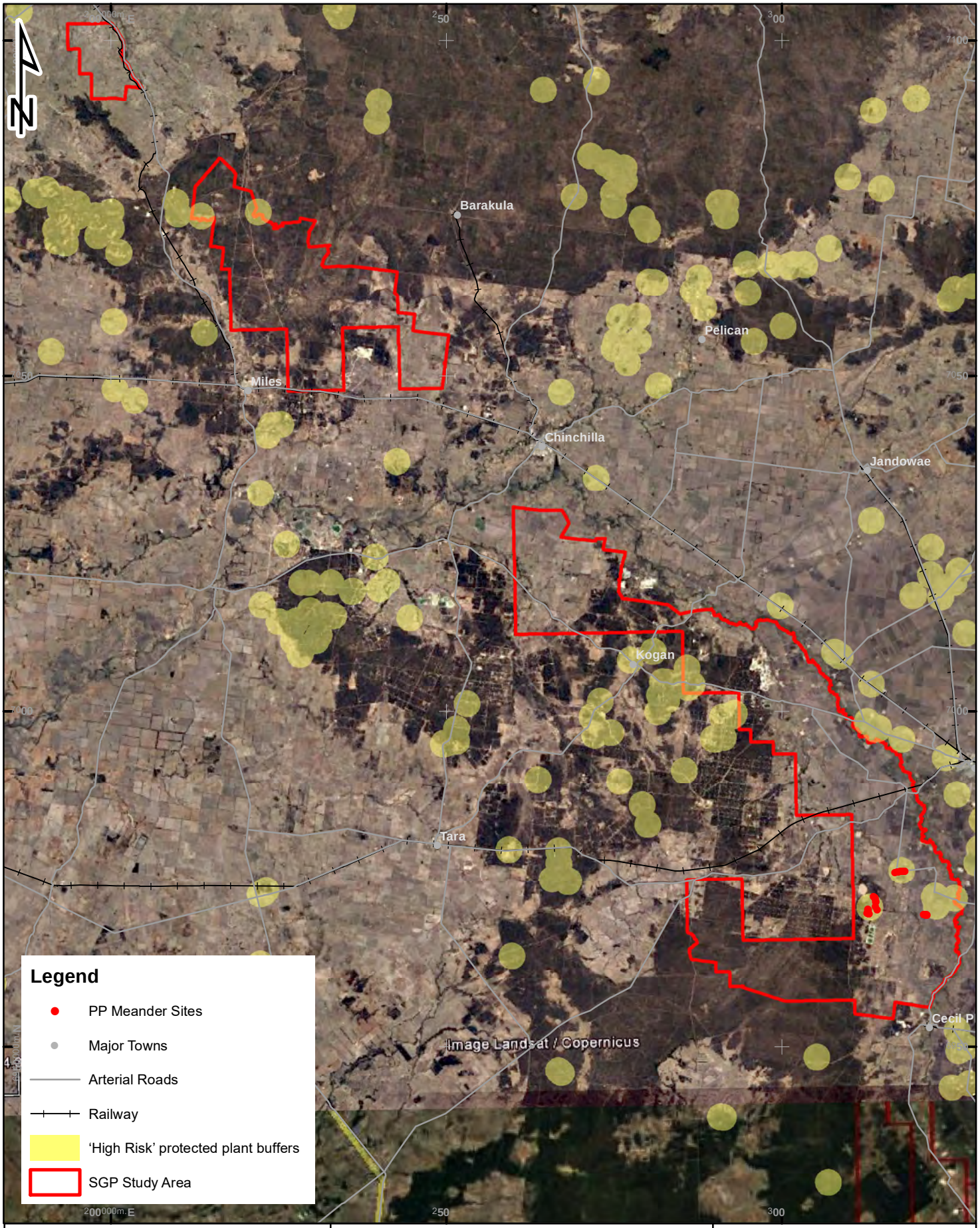

FIGURE 4.2 'High Risk' protected plant buffers assessed during SGP Study

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 24-Jun-17 A4

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4.1.4 Environmentally Sensitive Areas

Environmentally Sensitive Areas relevant to the SGP study area include:

- Category A - National Parks and Conservation Parks, specifically Lake Broadwater Conservation Park (Lot 68/SP139357),
- Category B - REs scheduled as Endangered (Biodiversity Status) by Queensland Department of Environment and Heritage Protection (DEHP), and
- Category C – which includes the following:
    - Lake Broadwater Resources Reserve (Lot69/DY6009),
    - Regional Ecosystems with 'Of Concern' Biodiversity Status,
    - State Forest areas as previously detailed in Section 2.3, and
    - Essential Habitat as described in Section 4.1.2.

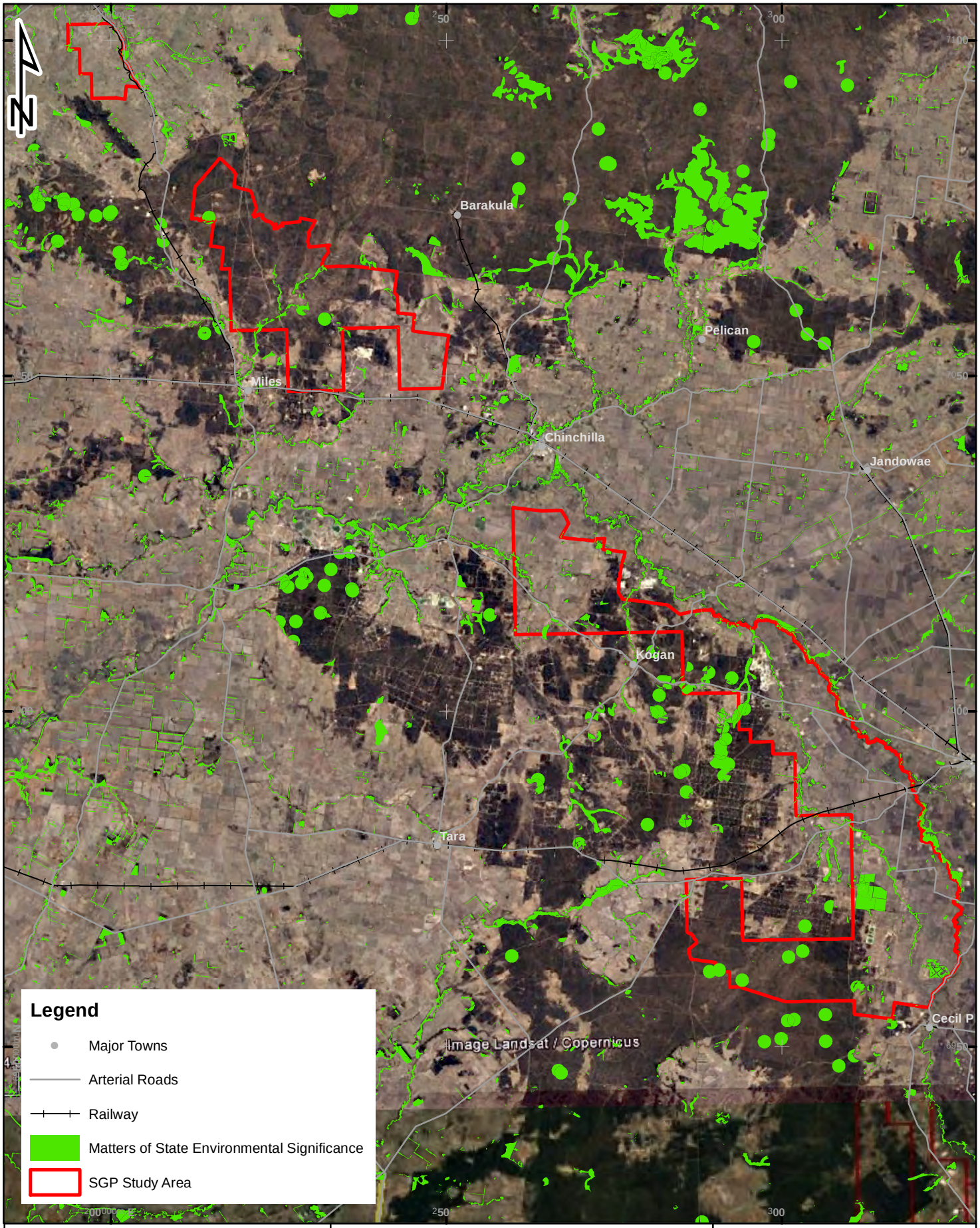
It should be noted that a property designated as a Category A ESA based on tenure overrides any attribution of ESA status based on vegetation composition (i.e. Of Concern and Endangered Biodiversity Status).

4.1.5 Matters of State Environmental Significance

Impacts to Matters of State Environmental Significance (MSES) may trigger a requirement for offsets under the Queensland Environmental Offsets Policy (Version 1.1). Within the SGP assessment area, the following features may be considered MSES:

- Areas or habitats that contains plants that are Endangered or Vulnerable wildlife (including those within protected plant High Risk buffers,
- Habitat (e.g. foraging, roosting, nesting or breeding habitat) for an animal that is Endangered, Vulnerable or a Special Least Concern animal,
- Remnant Endangered REs,
- Remnant Of Concern REs,
- Least Concern REs intersecting a watercourse or associated with a wetland,
- VM Act wetland habitats,
- National Parks and Nature Refuges, and
- Connectivity (as calculated using the Landscape Fragmentation and Connectivity (LFC) tool)

The Queensland Government has mapped MSES throughout the SGP study area and more broadly throughout Queensland with a comprehensive MSES dataset (DEHP 2014). MSES in the assessment area, as per DEHP (2014) is shown in Figure 4.3. It should be noted that this data excludes those areas identified in the current survey as habitat for protected animals or plants.



Legend

- Major Towns
- Arterial Roads
- Railway
- Matters of State Environmental Significance
- SGP Study Area

NOTES:
Matters of State environmental significance (version 4.1), Queensland Government

FIGURE 4.3 MSES in the SGP Study Area based on DEHP 2014.

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale	Drawn By	Date	
1:750,000	DG	24-Jun-17	A4

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4.1.6 Threatened Flora and Fauna

Examination of relevant databases and literature (see Section 3.1) identified threatened flora and fauna species recorded within 50km of the SGP study area, or having some possibility of occurring. While a long list of threatened species are known to occur within the SGP study area, not all are likely to occur with frequency, but rather, records may represent species which have become locally extinct or individuals which periodically appear but do not represent a permanent or seasonal population (i.e., particularly mobile fauna species). Closer analysis (see Appendix C) recognises a subset as being resident (i.e., present), or considered likely/possible. Present, or taxa likely to occur, are assessed further in Sections 4.2.3 (flora) and 4.3.1 (fauna) and have been provided detailed habitat maps in the attached GIS package.

4.2 TERRESTRIAL FLORA RESULTS

4.2.1 Threatened Ecological Communities and Regional Ecosystems

4.2.1.1 Threatened Ecological Communities

Past and present flora surveys have identified three TECs listed under the EPBC Act within the SGP study area. These communities are:

- Brigalow (*Acacia harpophylla* dominant and co-dominant) (Endangered),
- Weeping Myall Woodlands (Endangered), and
- Coolibah – Black Box Woodlands of the Darling Riverine Plains and Brigalow Belt South Bioregions (Endangered).

The spatial extent of these TECs within each of the three regions of the SGP study area are provided in Table 4.1 and their locations show in Figure 4.4.

Table 4.1. Spatial extent of TECs within the SGP study area

TEC	Area (ha) / SGP study area region			Total Area (ha)
	North	Central	South	
Brigalow (*Acacia harpophylla* dominant and co-dominant)	16.6	66.8	870.9	954.3
Weeping Myall Woodlands	0	0	0.9	0.9
Coolibah – Black Box Woodlands	0	0	22.6	22.6

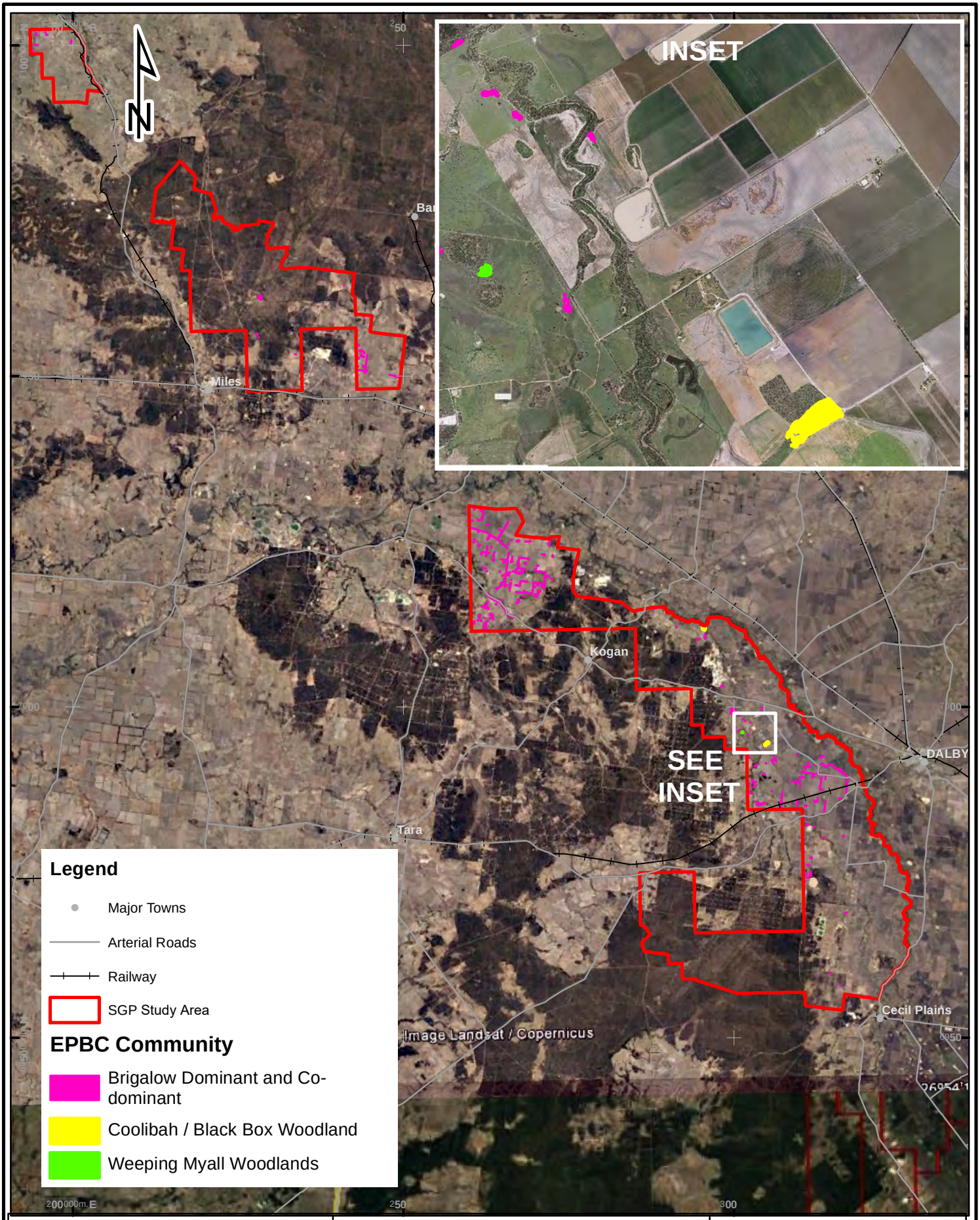

FIGURE 4.4 Threatened Ecological Communities within the SGP Study Area.

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0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 14-May-17 A4

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4.2.1.2 Regional Ecosystems:

Of the 20 REs recorded within the SGP study area, three are listed as Endangered and six as Of Concern, with the remainder being Least Concern under the VM Act. The extent of each RE within the three regions of the SGP study area is provided in Table 4.2 and their spatial distribution based on VM Act is shown in Figure 4.5 to Figure 4.7 and biodiversity status (as surrogate for ESA status) shown in Figure 4.8 to Figure 4.10. A detailed description for each RE listed as occurring within the SGP study area is provided within Appendix D.

It should be noted that heterogeneous polygons of RE11.3.25 and 11.3.4 are often mapped along riparian corridors, represented as either 'Of Concern Dominant' or 'Of Concern Sub-dominant' (under the VM Act) dependent on relative proportion. This is the result of scale limitations where large numbers of contiguous riparian polygons fall below the 0.5ha mapping threshold.

Table 4.2. Regional Ecosystem extent within the three regions of the SGP study area.

RE	Description	VM Act Stat.	Biodiversity Stat.	Extent by region (ha)		
				North	Central	South
11.3.1	*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains.	E	E	7.7	14.8	195.0
11.3.14	*Eucalyptus* spp., *Angophora* spp., *Callitris* spp. woodland on alluvial plains.	LC	NCAP	0	127.1	205.23
11.3.17	*Eucalyptus populnea* woodland with *Acacia harpophylla* and/or *Casuarina cristata* on alluvial plains.	OC	E	12.3	0	201.2
11.3.18	*Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii* shrubby woodland on alluvium.	LC	NCAP	0	0	418.4
11.3.2	*Eucalyptus populnea* woodland on alluvial plains.	OC	OC	9.9	3.0	580.7
11.3.25	*Eucalyptus tereticornis* or *Eucalyptus camaldulensis* woodland fringing drainage lines.	LC	OC	61.6	804.23	778.7
	11.3.25g: Seasonal vegetation associated with larger waterholes and areas of open water.			3.8	-	-
11.3.26	*Eucalyptus moluccana* or *E. microcarpa* woodland to open forest on margins of alluvial plains.	LC	NCAP	0	18.3	7.1
11.3.27	11.3.27a: Palustrine wetland (e.g. vegetated swamp). Mixed grassland or sedgeland with areas of open water +/- aquatic species.	LC	OC	0	36.1	256.5
	11.3.27d: Palustrine wetland *Eucalyptus camaldulensis* and/or *Eucalyptus tereticornis* woodland			1.5	0	15.15

RE	Description	VM Act Stat.	Biodiversity Stat.	Extent by region (ha)		
				North	Central	South
	11.3.27f: *Eucalyptus coolabah* and/or *E. tereticornis* open woodland to woodland fringing swamps.			0	0	320.8
11.3.3	11.3.3c: Palustrine wetland (e.g. vegetated swamp). Eucalyptus coolabah woodland to open-woodland (to scattered trees) with a sedge or grass understorey in back swamps and old channels.	OC	OC	0	0	26.82
11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains.	OC	OC	5.8	476.3	898.61
11.4.3	*Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains	E	E	0	0	388.7
	11.4.3a: Palustrine wetland (e.g. vegetated swamp). *Melaleuca bracteata* woodland associated with *Acacia harpophylla* communities.			0	0	56.64
11.5.1	11.5.1: *Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii* woodland on Cainozoic sand plains/remnant surfaces	LC	NCAP	0	17,972.06	18,607.9
	11.5.1a: *Eucalyptus populnea* woodland with *Allocasuarina luehmannii* low tree layer.			0	23.2	327.7
11.5.20	*Eucalyptus moluccana* and/or *E. microcarpa/E. pilligaensis*[4] ± *E. crebra* woodland on Cainozoic sand plains.	LC	NCAP	0	20.9	6635.7
11.5.21	*Corymbia bloxsomei* ± *Callitris glaucophylla* ± *Eucalyptus crebra* ± *Angophora leiocarpa* woodland on Cainozoic sand plains/remnant surfaces.	LC	NCAP	0	2,238.9	0
11.5.4	*Eucalyptus chloroclada, Callitris glaucophylla, C. endlicheri, Angophora leiocarpa* woodland on Cainozoic sand plains and/or remnant surfaces	LC	NCAP	0	287.4	2941
11.7.4	*Eucalyptus decorticans* and/or *Eucalyptus* spp., *Corymbia* spp., *Acacia* spp., *Lysicarpus angustifolius* on Cainozoic lateritic duricrust.	LC	NCAP	0	176.4	0
11.7.5	Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.	LC	NCAP	0	5,669.9	7243.6
	11.7.5b: *Acacia aprepta* shrubland.			0	371.2	95.4

[4] *E. pilligaensis* has been recently consumed within the broader reclassification of *E. woollsiana.*

RE	Description	VM Act Stat.	Biodiversity Stat.	Extent by region (ha)		
				North	Central	South
11.7.6	*Corymbia citriodora* or *Eucalyptus crebra* woodland on Cainozoic lateritic duricrust.	LC	NCAP	0	950.8	5.3
11.7.7	*Eucalyptus fibrosa* subsp. *nubila* ± *Corymbia* spp. ± *Eucalyptus* spp. on Cainozoic lateritic duricrust.	LC	NCAP	0	6,297.2	2,988.5
11.9.2	*Eucalyptus melanophloia* +/- *E. orgadophila* woodland on fine-grained sedimentary rocks	LC	NCAP	48.27	0	0
11.9.5	*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks.	E	E	4.3	0	0
11.9.7	*Eucalyptus populnea, Eremophila mitchellii* shrubby woodland on fine-grained sedimentary rocks	OC	OC	1.5	0	0
11.9.10	*Eucalyptus populnea* open forest with a secondary tree layer of *Acacia harpophylla* and sometimes *Casuarina cristata* on fine-grained sedimentary rocks	OC	E	15	0	0

E = Endangered, OC = Of Concern, LC = Least Concern, NCAP = No Concern at Present

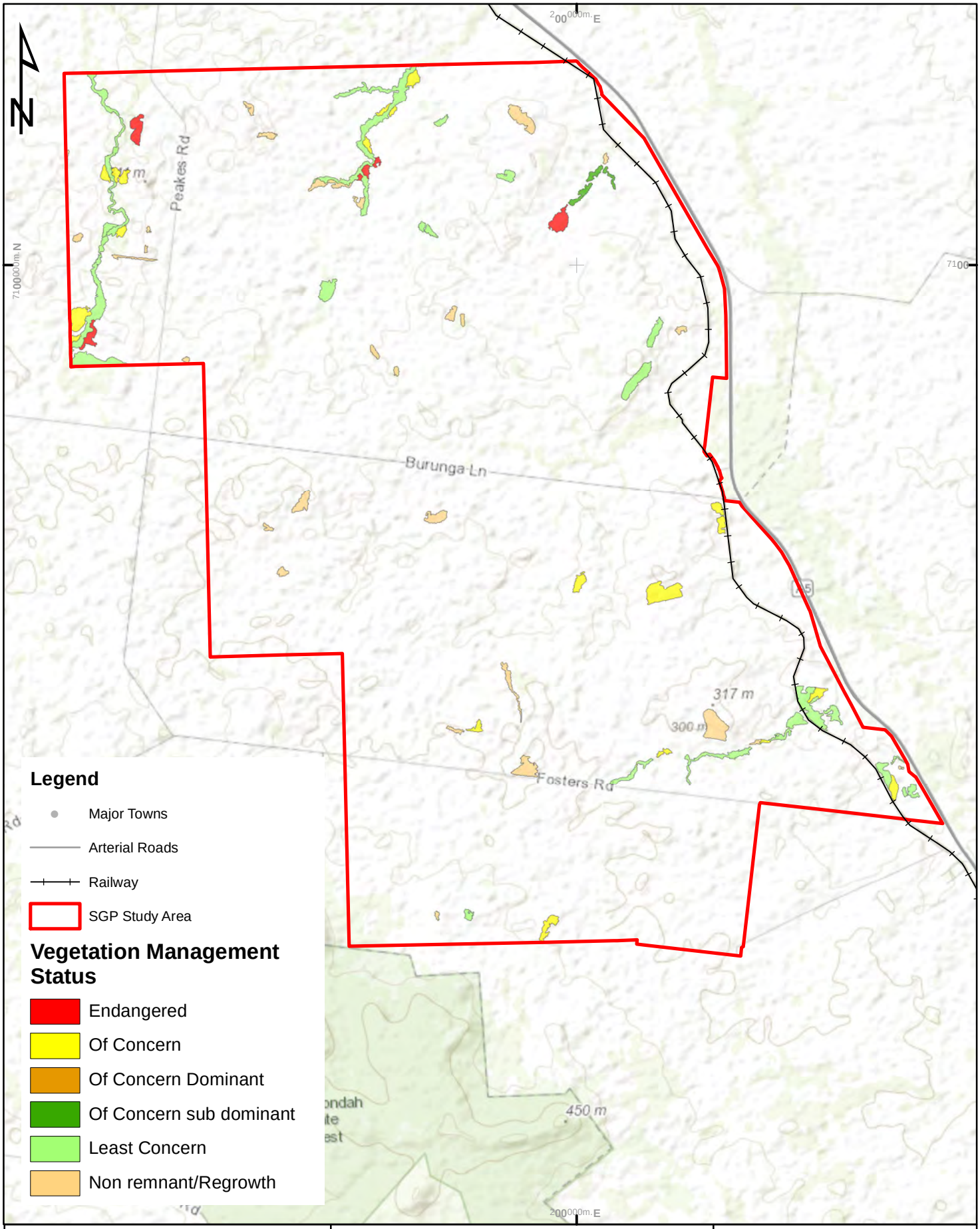

FIGURE 4.5 Endangered, Of Concern, and Least Concern REs within the northern region of the SGP Study Area

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0 1 2 3 4
Kilometers

Scale	1:63,440	Drawn By	DG	Date	25-Jun-17	A4

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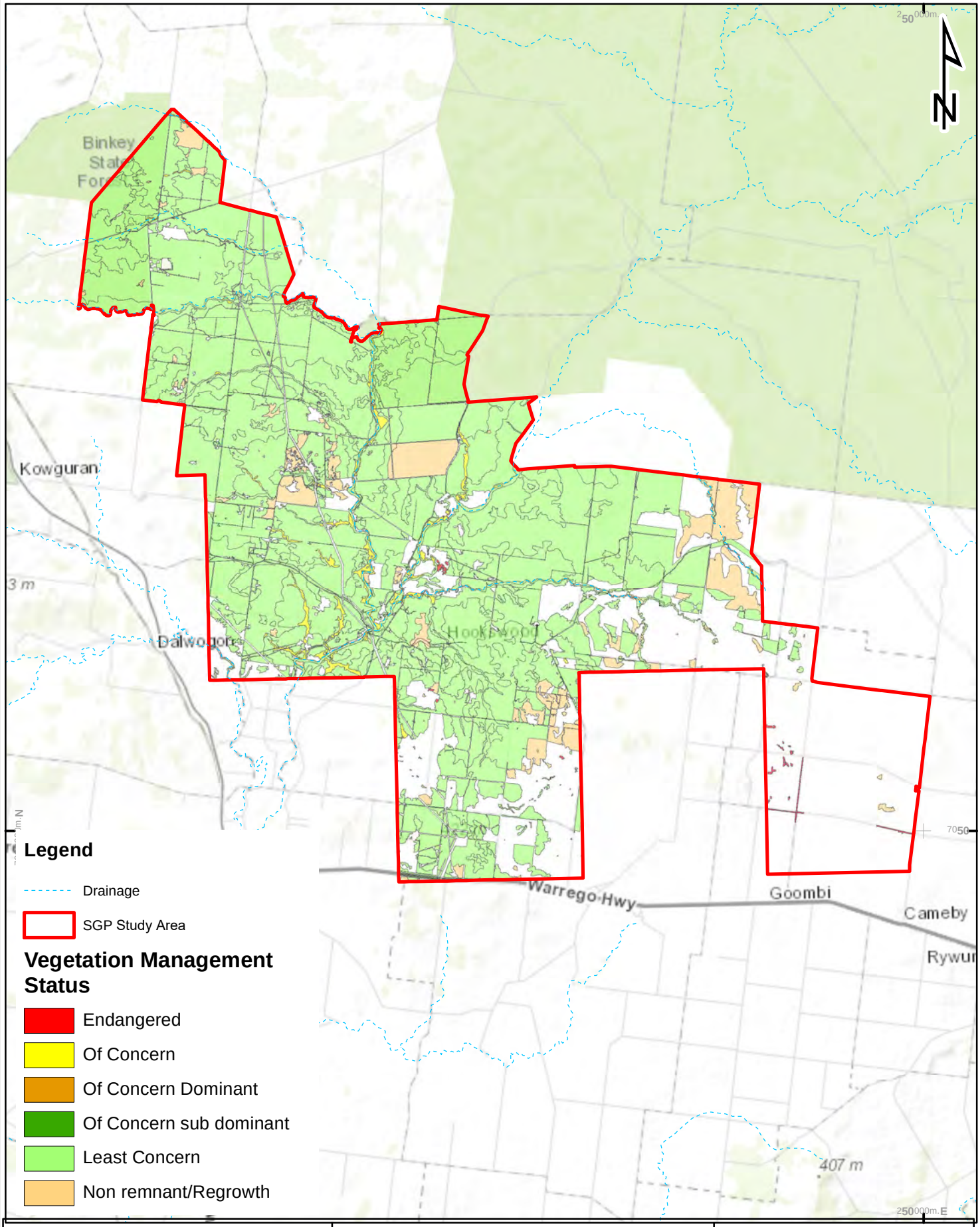

FIGURE 4.6 Endangered, Of Concern, and Least Concern REs within the central region of the SGP Study Area

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0 4 8 12 16
Kilometers

Scale 1:226,000 | **Drawn By** DG | **Date** 21-May-17 | A4

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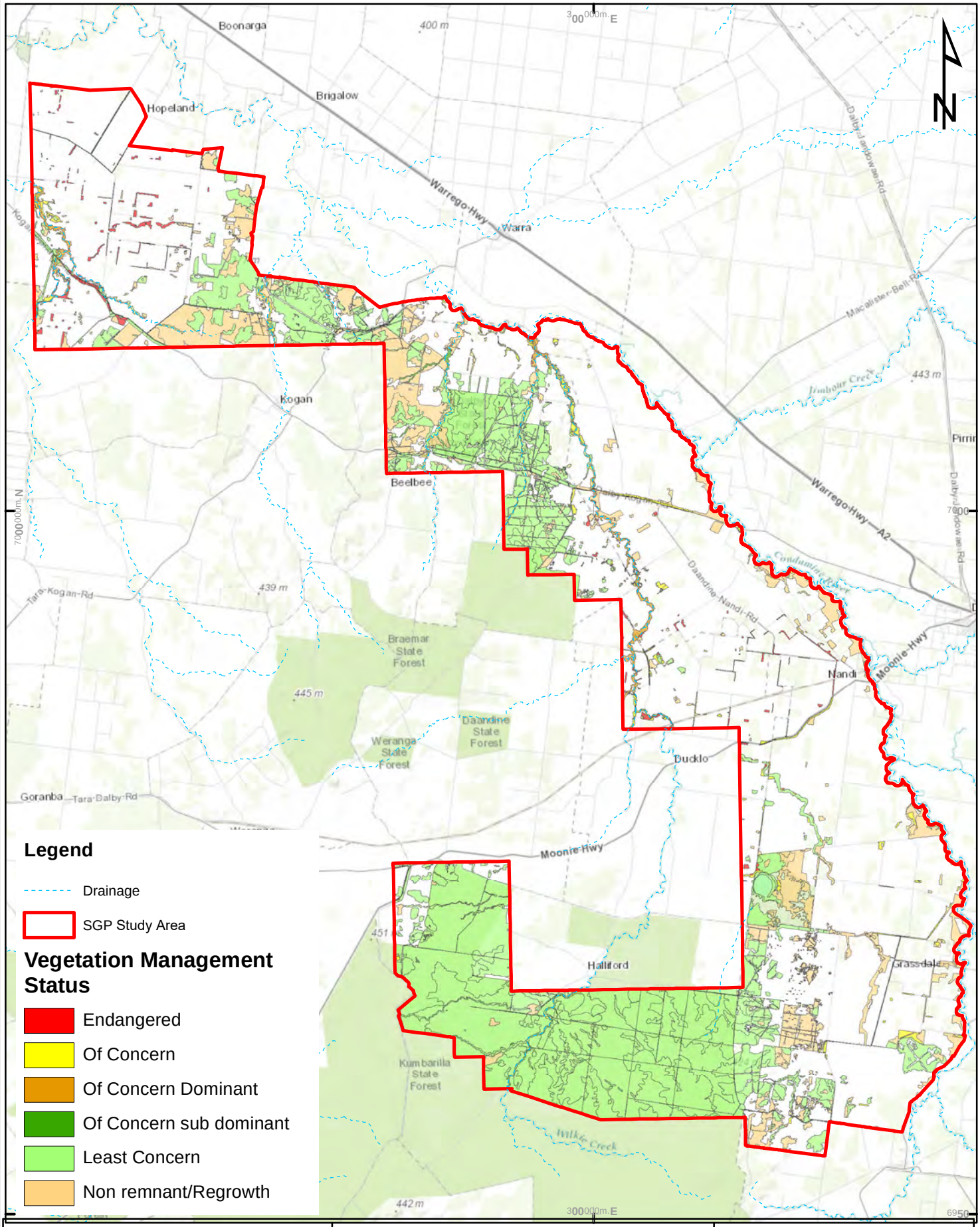

FIGURE 4.7 Endangered, Of Concern, and Least Concern REs within the southern region of the SGP Study Area

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0 4 8 12 16
Kilometers

Scale 1:357,316 | **Drawn By** DG | **Date** 21-May-17 | A4

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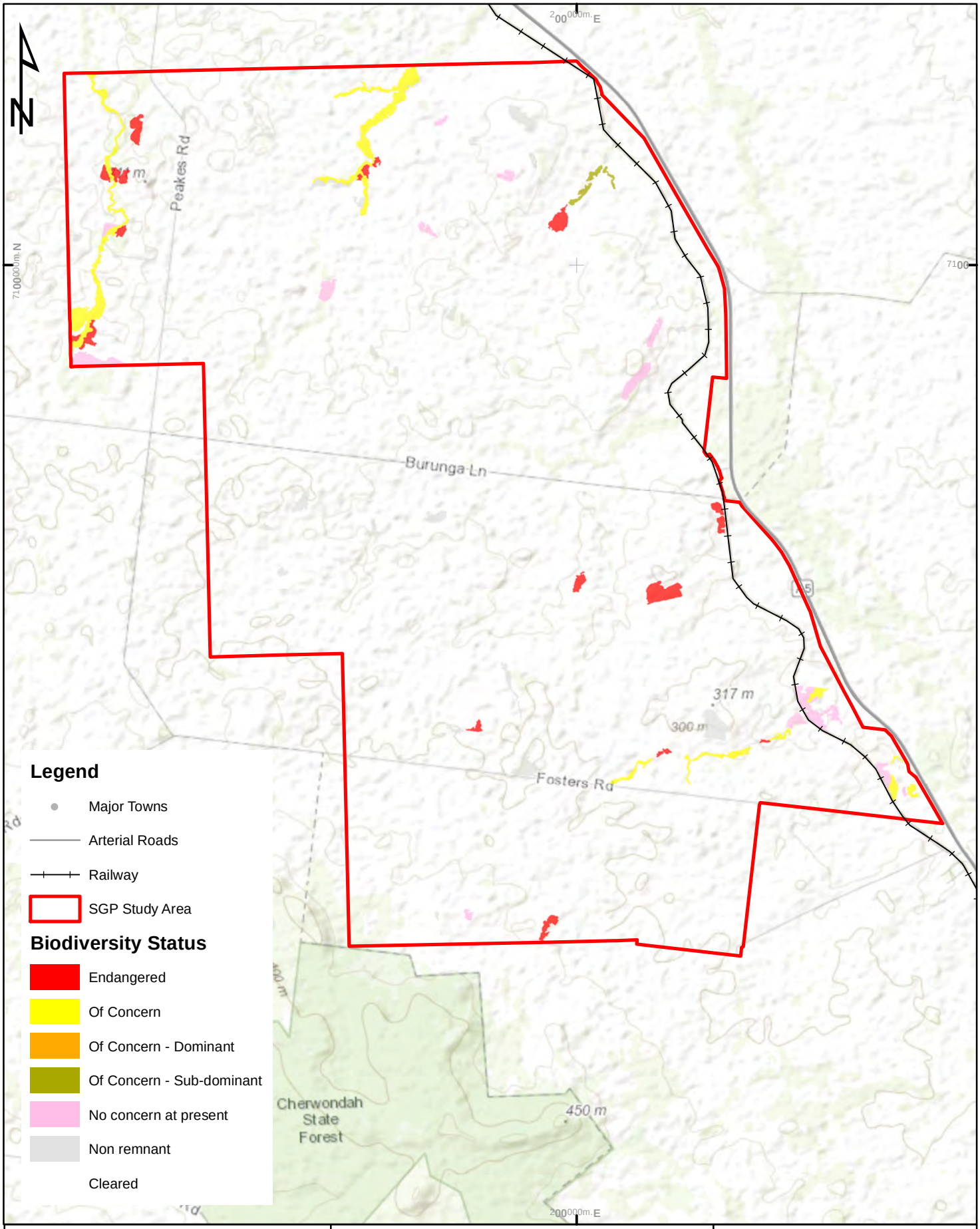

FIGURE 4.8 Biodiversity Status of Regional Ecosystems in the northern region of the SGP Study Area.

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0 1 2 3 4
Kilometers

Scale 1:63,440 | **Drawn By** DG | **Date** 25-Jun-17 | A4

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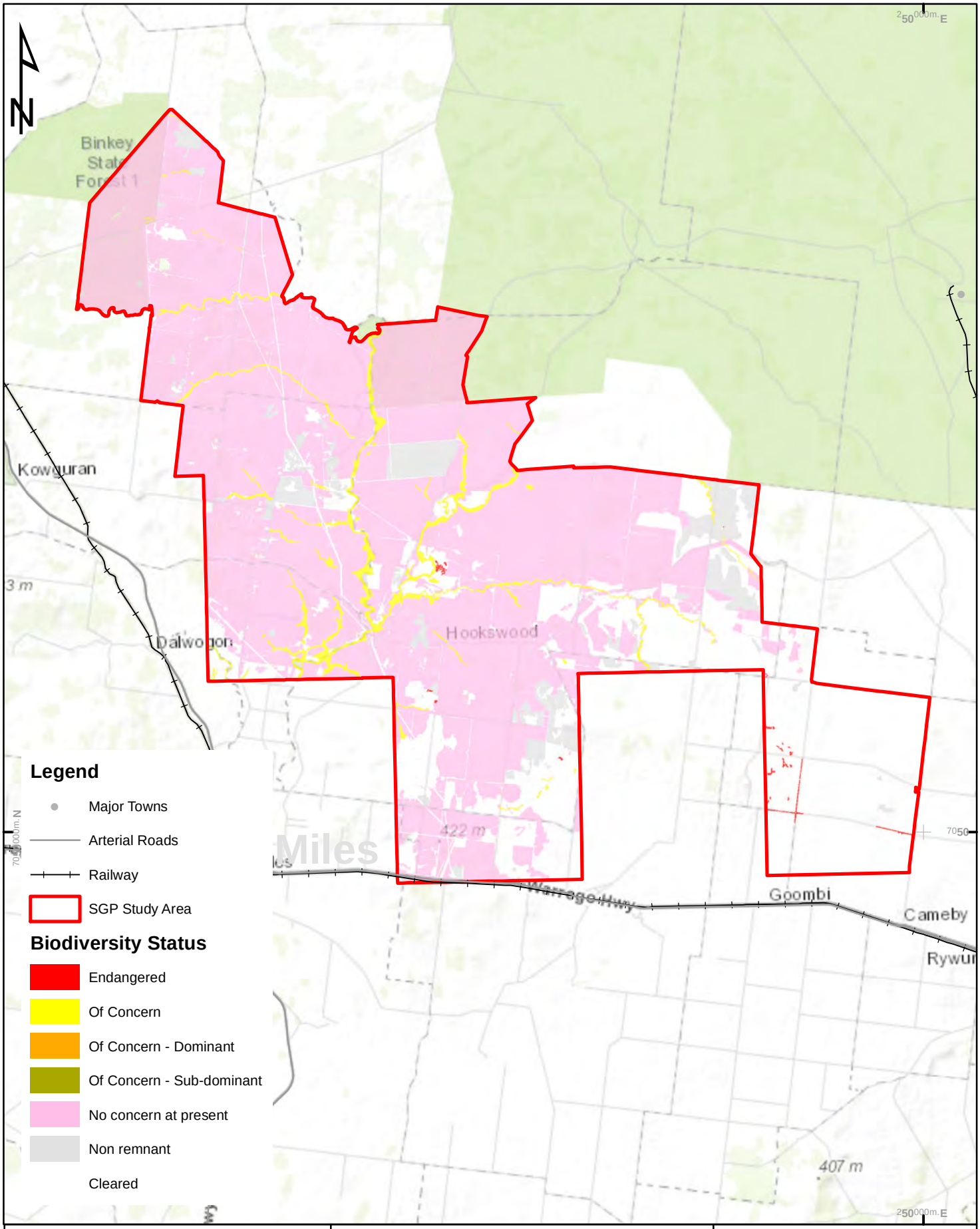

FIGURE 4.9 Biodiversity Status of Regional Ecosystems in the central region of the SGP Study Area.

Client ARROW ENERGY

0 4 8 12 16
Kilometers

Scale 1:226,000 | **Drawn By** DG | **Date** 25-Jun-17 | A4

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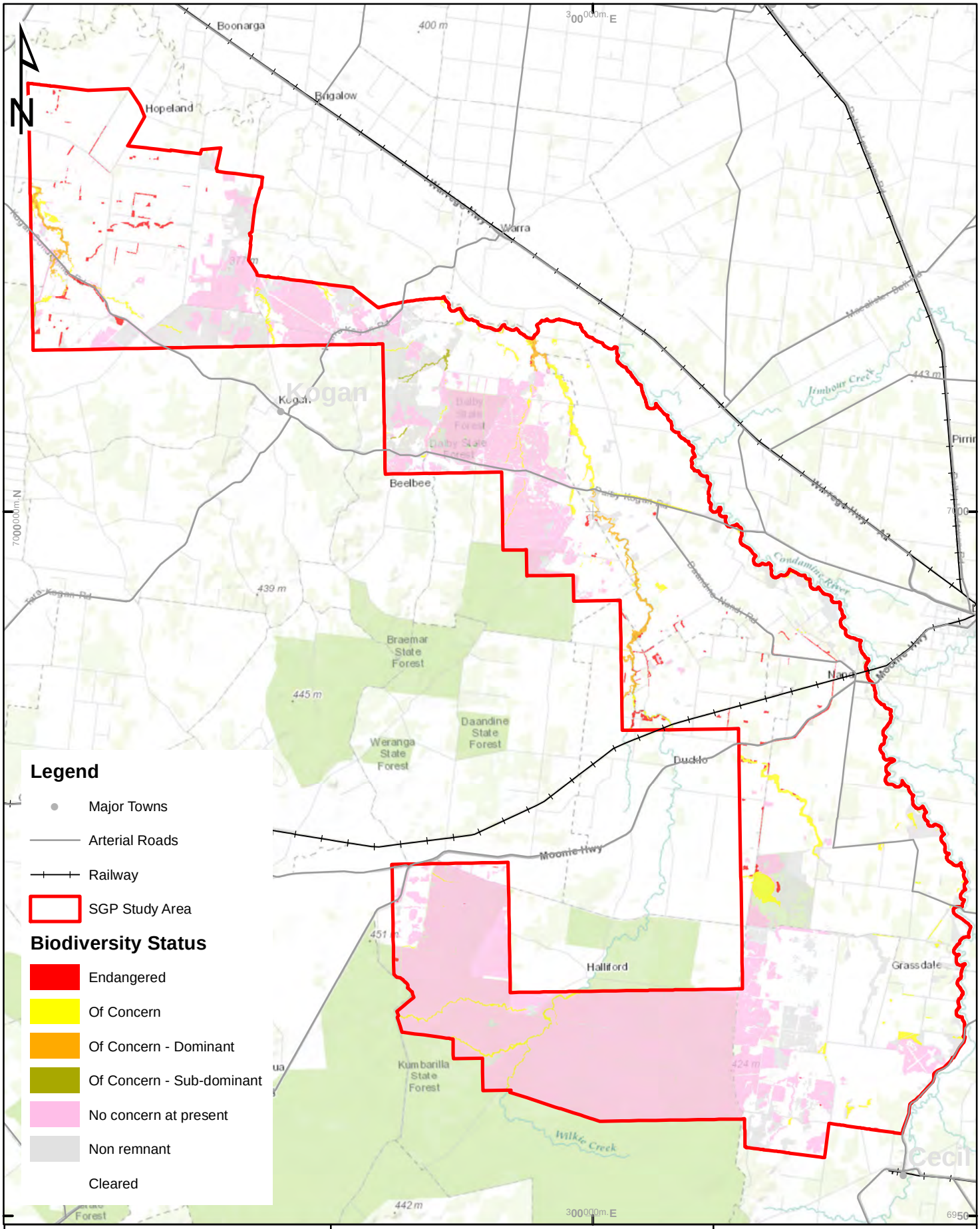

FIGURE 4.10 Biodiversity Status of Regional Ecosystems in the southern region of the SGP Study Area.

Client ARROW ENERGY

0 6 12 18 24
Kilometers

Scale 1:357,316 **Drawn By** DG **Date** 25-Jun-17 A4

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4.2.2 Flora Diversity

A total of 438 flora species were recorded during the SGP study area flora surveys including:

- 38 exotic species
- 2 Conifers
- 2 ferns
- 90 grasses
- 2 species of grasstree
- A balance of trees, shrubs and forbs across 65 plant families.

The highest floristic diversity was associated with RE 11.5.1 where 100 species were recorded across all survey sites. The high diversity would be in part due to the REs considerable extent and variation in floristic structure.

4.2.3 Threatened Flora Species Likelihood Assessments

Only one threatened flora species, *Philotheca sporadica* (Near Threatened NC Act; Vulnerable EPBC Act) has been recorded during assessments completed by Arrow Energy, including the current 2016 – 2017 survey event. However database records (Herbrecs and Australia's Virtual Herbarium) indicate a number of additional EVNT species have been previously recorded either in or adjacent to the SGP study area. These species include *Crytandra ciliata* (Near Threatened NC Act); *Solanum papaverifolium* (Endangered NC Act), *Fimbristylis vagans* (Endangered NC Act) and *Digitaria porrecta* (Near Threatened NC Act). Some of these records are relatively old and there are no contemporary records despite extensive searches in suitable habitat. *Digitaria porrecta*, for example has not been recorded from within the SGP study area since 1995, and *Fimbristylis vagans* was last recorded from the Lake Broadwater area in 1984.

Figure 4.11 identifies the locations of all EVNT species records contained within 1km of the SGP study area boundary based on Herbarium records and a range of surveys undertaken on behalf of Arrow Energy.

Whilst only five EVNT flora species are considered known or likely to be present within the SGP study area, an additional 31 species are known from the regional area (i.e. within a 50km buffer of the SGP study area boundary). An analysis of the likelihood of these species occurring is provided in Appendix C which identifies an additional 14 species that may possibly occur within the SGP study area (Table 4.3). In general, species with records greater than 25km from the SGP study area were considered unlikely unless large tracts of sparsely surveyed habitat was present.

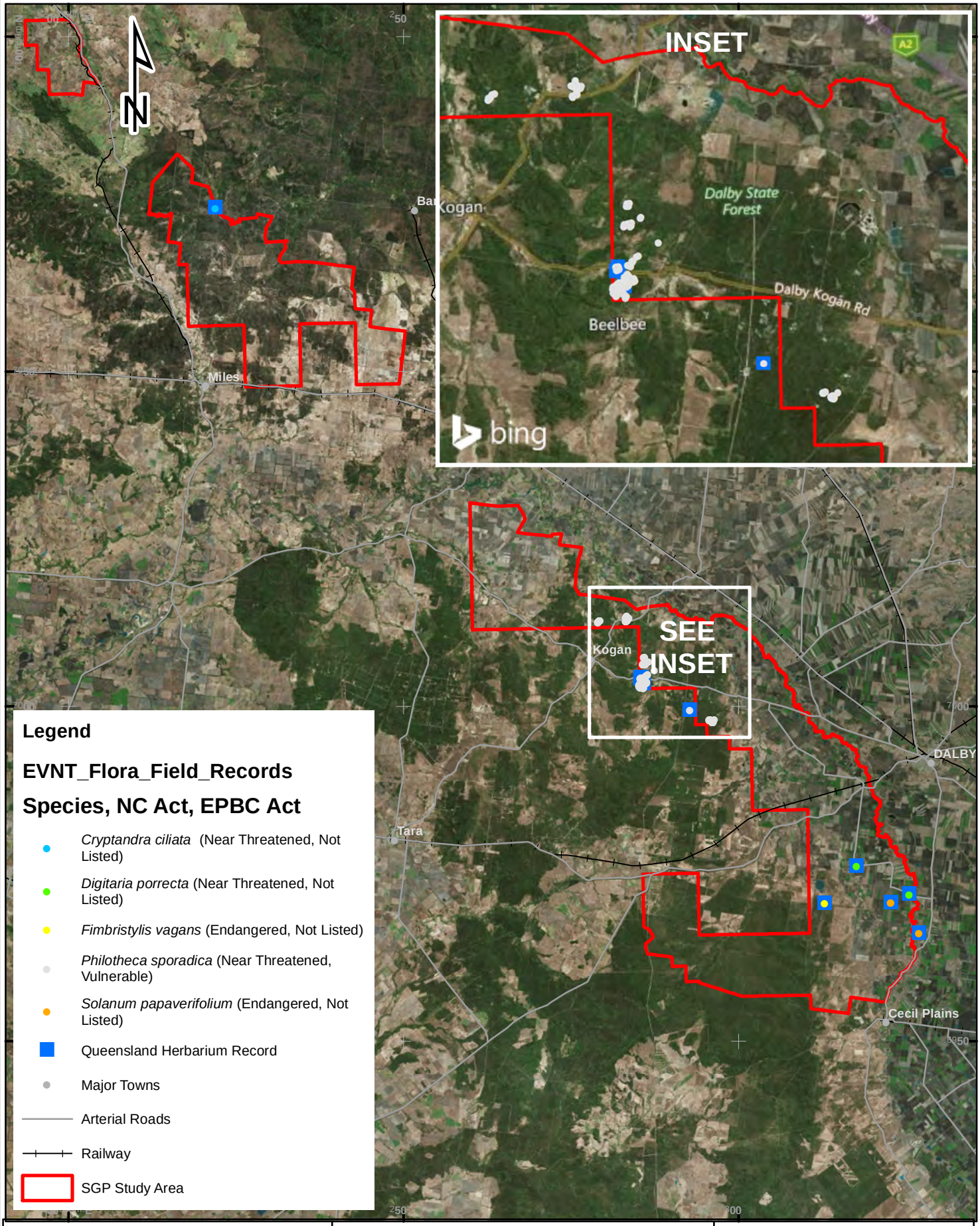

FIGURE 4.11 Survey records of EVNT flora species from within the SGP Study Area.

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 24-Jun-17 A4

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Table 4.3. Likelihood assessment for Threatened flora species in the SGP study area.

Scientific Name	Common Name	EPBC Status	NC Status	Likelihood
Shrubs and Trees				
Philotheca sporadica	Kogan waxflower	V	NT	Present
Acacia barakulensis	Waaje wattle	-	V	Possible
Acacia curranii	Curly-bark wattle	V	V	Possible
Acacia handonis	Hando's wattle	V	V	Possible
Callitris baileyi	Bailey's cypress	-	NT	Possible
Calytrix gurulmundensis	Gurulmundi fringe myrtle	V	V	Possible
Micromyrtus carinata	Gurulmundi heath myrtle	-	E	Possible
Eucalyptus curtisii	Plunkett mallee	-	NT	Possible
Acacia lauta	Tara wattle	V	V	Unlikely
Acacia wardellii	Wardell's wattle	-	NT	Unlikely
Cadellia pentastylis	Ooline	V	V	Unlikely
Denhamia parviflora	Small-leaved denhamia	V	V	Unlikely
Eucalyptus argophloia	Chinchilla white gum	V	V	Unlikely
Eucalyptus virens	Shiny-leaved ironbark	V	V	Unlikely
Grasses and Sedges				
Digitaria porrecta	Finger panic grass	-	NT	Present
Fimbristylis vagans	NA	-	E	Present
Homopholis belsonii	Belson's panic	V	E	Possible
Cyperus clarus	-	-	V	Unlikely
Herbs and Orchids				
Solanum papaverifolium	-	-	E	Present
Cymbonotus maidenii	-	-	E	Possible
Picris barbarorum	-	-	V	Possible
Rutidosis lanata	-	-	NT	Possible
Solanum stenopterum	-	-	V	Possible
Xerothamnella herbacea	Xerothamnella	E	E	Possible
Cryptandra ciliata	-	-	NT	Likely
Thesium australe	Austral toadflax	V	V	Possible
Pomaderris coomingalensis	-	-	E	Unlikely

E = Endangered; V = Vulnerable; NT = Near Threatened

Further discussion regarding threatened flora taxa considered possible, likely or present from the SGP study area is provided in Appendix E. The appendix includes the criteria used to develop individual species habitat maps in the associated GIS product, and an assessment of the mapping accuracy for predicting the species habitat/extent. Table 4.4 shows the extent of habitat available to each species based on the GIS mapping product.

Table 4.4. The extent of mapped habitat for Threatened flora species present or possibly occurring within the SGP study area.

Scientific Name	Common Name	Status		Habitat extent in SGP (ha)*		
		EPBC	NCA	CHK	CHP	GH
Acacia barakulensis	Waaje wattle	V	-	0	0	33,811.2
Acacia curranii	Curly-bark wattle	V	V	0	0	33,811.2
Acacia handonis	Hando's wattle	V	V	0	0	33,811.2
Callitris baileyi	Bailey's cypress	NT	-	0	0	33,811.2
Cryptandra ciliata	NA	.	-	103.4	-	33,707.8
Calytrix gurulmundensis	Gurulmundi fringe myrtle	V	V	0	0	13,096.5
Cymbonotus maidenii	NA	E	-	0	0	3,677.6
Digitaria porrecta	Finger panic grass	NT	-	99.8	0	3,675.5
Eucalyptus curtisii	Plunkett mallee	NT	-	0	0	24,167.5
Fimbristylis vagans	NA	V	-	5.3	499.1	3,181.7
Homopholis belsonii	Belson's panic	V	V	0	19.3	1,206.9
Micromyrtus carinata	Gurulmundi heath myrtle	E	-	0	0	6,217.0
Philotheca sporadica	Kogan waxflower	NT	V	1,574.5	2,213.0	20,308.0
Picris barbarorum	NA	V	-	0	0	3,788.9
Rutidosis lanata	NA	-	NT	0	0	3,393.9
Solanum papaverifolium	NA	E	-	2.9	0	3,672.2
Solanum stenopterum	NA	E	-	0	0	2,764.5
Thesium australe	Austral Toadflax	V	V	0	0	526.7

*CHN = Core Habitat Known, CHP = Core Habitat Possible and GH = General Habitat

4.2.4 Exotic Flora Species

Of the 38 exotic species recorded during the assessment, five are listed as Restricted Invasive Plants under Queensland's Biosecurity Act 2014 meaning that they cannot be given away, sold, or released into the environment without a permit. The majority of these plants are from the Cactus (Cactaceae) family which includes the genera of Opuntia and Harissia. African lovegrass (Eragrostis curvula), whilst not listed as a restricted plant in Queensland is considered a 'High Priority Weed' under the Western Downs Regional Council Pest Management Plan (2011 to 2015). The species was also abundant in the study area, particularly in southern portions in the vicinity of Dalby. A summary of significant pest plants recorded during the survey is provided in Table 4.5.

Table 4.5. Summary of declared weeds and weeds of national significance (WONS) known to occur in the study area from database searches and field survey.

Scientific Name **Common Name**	**Category***	**Significantly Infested Res**	**Comments**
Opuntia tomentosa Velvet tree pear	3/WONS	11.3.1, 11.3.4, 11.4.3, 11.3.17, 11.9.5.	Dense infestations of velvet tree pear were universally associated with brigalow habitats wihere it formed up to 15% cover in the taller shrub layers. The plant was also scattered throughout the majority of habitats although infestations considerably less vigorous on soils of lower fertility.
Opuntia stricta Prickly pear	3/WONS	Occurs at low to moderate levels throughout all ecosystems	Scattered individuals occur throughout all habitats although the species in more abundant in regional ecosystems with fertile alluvial soils.
Opuntia aurantiaca Tiger pear	3/WONS	11.3.1, 11.3.2, 11.3.4, 11.3.14, 11.3.17, 11.3.18, 11.3.25, 11.4.3, 11.9.5 and non-remnant habitats	Dense infestations typically recorded adjacent to or within brigalow habitats where it formed up to 10% ground cover in patches. Particularly heavy infestations associated with the riparian margins of Wilkie Creek.
Harrisia martiniii Harrisia cactus	3	Mostly Brigalow habitats including REs 11.3.1 11.3.17, 11.4.3 and 11.9.5.	Most commonly associated with brigalow habitats where it typically formed cover of < 5%. Tends to be less common and in lower abundance than tiger pear in infested habitats.
Bryophyllum delagoensis Mother of millions	3	Generally in riparian ecosystems including REs 11.3.2, 11.3.4, 11.3.25.	Dense infestations of >50% groundcover recorded in REs 11.3.25 and 11.3.17 adjacent to Wilkie Creek and Braemar Creeks. Scattered infestations recorded on drainage lines throughout the SGP study area.
Eragrostis curvula African love grass**	N/A	Mostly non-remnant habitats, particularly roadside margins with sandy soils.	An aggressive coloniser that is most typically associated with roadside margins although extends into remnant woodland habitats in the vicinity of Dalby.

*As per Queensland's Biosecurity Act 2014 / Weed of National Significance; ** Priority plant in the Western Downs Regional Council Pest Management Plan 2011 – 2015.

4.3 TERRESTRIAL FAUNA RESULTS

Terrestrial fauna surveys for this work identified a total of 266 vertebrate species[5] within the SGP study area including 20 amphibians, 55 reptiles, 151 birds and 40 mammals (Appendix F). Based on available database sources and previous works, one species was recorded for the first time within the region of the SGP study area (i.e., the SGP and ~50km buffer), the Pink-tongue Lizard (*Cyclodomorphus gerrardii*). An investigation of previous records (WildNet) revealed three records east of Toowoomba, one due south of the SGP study area (located on the southern side of the Gore Highway) and two within Southwood National Park (approximately 85km west of the SGP study area).

A number of species recorded during the surveys are at, or near, their distributional limit including Green Tree Snake (*Dendrelaphis punctulata*), Cotton Pygmy-goose (*Nettapus coromandelianus*), Yellow-tailed Black Cockatoo (*Calyptorhynchus funereus*), Azure Kingfisher (*Ceyx azureus*), White-naped Honeyeater (*Melithreptus lunatus*), Scarlet Honeyeater (*Myzomela sanguinolenta*), Rufous Fantail (*Rhipidura rufifrons*), Broad-toed Feathertail Glider (*Acrobates frontalis*) and Yellow-footed Antechinus (*Antechinus flavipes*).

Other notable observations include two Amalosia geckos, which while most closely resembling *A. jacovae*, lacked the distinctive toe webbing diagnostic to the species. According to current knowledge, neither *A. rhombifera* or *A. jacovae* occur in the Miles region (Wilson 2015), and the captured individuals had a mix of both characteristics. Subject to further study, these individuals may be assigned to one of these two taxa, extending their current range, or prove to be a new undescribed taxon. One individual was submitted to the Queensland Museum.

Recent taxonomic work on *Carlia pectoralis* (Open-litter Rainbow Skink) found the species to be a composite of three distinct taxa (Hoskin and Couper 2012). Two of these newly described species, *C. rubigo* and *C. pectoralis*, have the potential to occur within the SGP study area. Our field studies assigned most individuals to *C. rubigo*, though several individuals matched the description of *C. pectoralis*. However numerous captured animals had a mix of characters and could not be assigned to either species.

Eleven of the 266 identified species (4%) are non-native introduced species (Table 4.9, Appendix F).

4.3.1 Likely Threatened Terrestrial Fauna Species

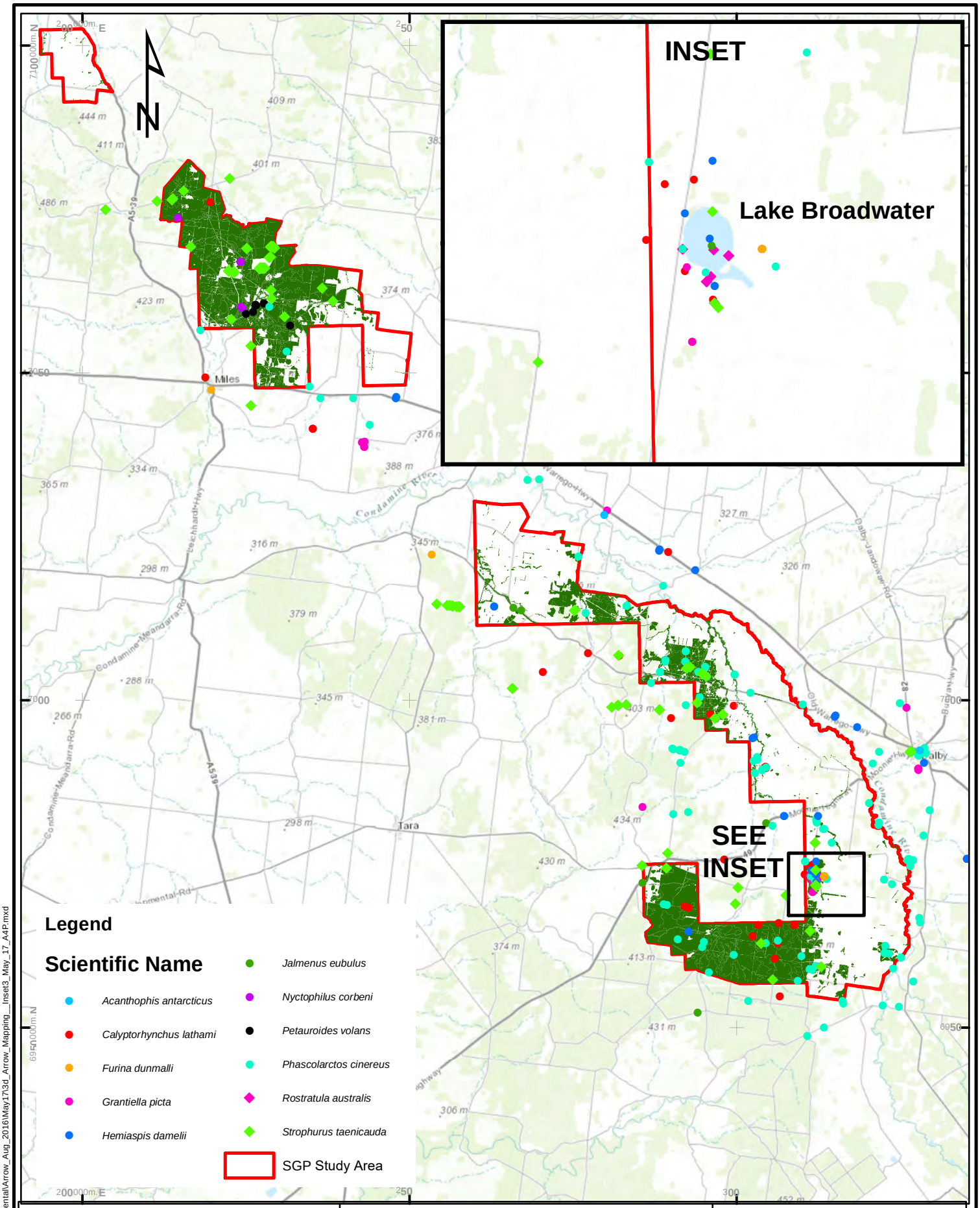
Database searches including the EPBC Act Online Protected Matters Search Tool have identified 39 threatened species as occurring, or potentially having habitat, within the SGP study area (Table 4.6). An assessment of these species based on record relevance and habitat suitability (see Appendix C) suggests 11 are present, or have potential to occur.

[5] Species totals discussed in this text do not include unidentified taxa (e.g., *Uperoleia* sp.), but do include recognisable taxa of taxonomic uncertainty (e.g., *Amalosia sp. cf. jacovae*).

Table 4.6. Likelihood assessment for Threatened fauna species in the SGP study area.

Scientific Name	Common Name	EPBC Status	NC Status	Likelihood
BUTTERFLIES				
Jalmenus eubulus	Pale Imperial Hairstreak	-	Vul	Likely
REPTILES				
Rheodytes leukops	Fitzroy River turtle	Vul	Vul	Unlikely
Elseya albagula	Southern snapping turtle	CEnd	End	Unlikely
Strophurus taenicauda	Golden-tailed Gecko	-	NT	Present
Delma torquata	Collared Delma	Vul	Vul	Unlikely
Anomalopus mackayi	Long-legged Worm-skink	Vul	End	Unlikely
Egernia rugosa	Yakka Skink	Vul	Vul	Unlikely
Tympanocryptis condaminensis	Condamine earless dragon	End	End	Unlikely
Aspidites ramsayi	Woma	-	NT	Unlikely
Acanthophis antarcticus	Common Death Adder	-	Vul	Possible
Furina dunmalli	Dunmall's Snake	Vul	Vul	Possible
Hemiaspis daemeli	Grey Snake	-	End	Present
Denisonia maculata	Ornamental Snake	Vul	Vul	Unlikely
BIRDS				
Botaurus poiciloptilus	Australasian Bittern	End	LC	Unlikely
Calidris ferruginea	Curlew Sandpiper	C End	End	Transient
Limosa lapponica baueri	Bar-tailed Godwit	Vul	Vul	Unlikely
Rostratula australis	Australian Painted Snipe	End	Vul	Possible
Pedionomus torquatus	Plains Wanderer	C End	Vul	Unlikely
Turnix melanogaster	Black-breasted Button-quail	Vul	Vul	Unlikely
Falco hypoleucos	Grey Falcon	-	Vul	Unlikely
Erythrotriorchis radiatus	Red Goshawk	Vul	End	Unlikely
Geophaps scripta scripta	Squatter Pigeon (southern)	Vul	Vul	Transient
Calyptorhynchus lathami	Glossy Black-Cockatoo	-	Vul	Present
Lophochroa leadbeateri	Major Mitchell Cockatoo	-	Vul	Unlikely
Lathamus discolor	Swift Parrot	End	End	Unlikely
Ninox strenua	Powerful Owl	-	Vul	Unlikely
Grantiella picta	Painted Honeyeater	Vul	Vul	Possible
Anthochaera phrygia	Regent Honeyeater	C End	End	Unlikely
Poephila cincta cincta	Black-throated Finch	End	End	Unlikely
MAMMALS				
Dasyurus hallucatus	Northern Quoll	End	LC	Unlikely
Dasyurus maculata maculata	Spotted-tailed Quoll	End	Vul	Unlikely
Phascolarctos cinereus	Koala	Vul	Vul	Present
Petauroides volans	Greater Glider	Vul	Vul	Present
Petrogale penicillata	Brush-tailed Rock-wallaby	Vul	Vul	Unlikely
Pteropus poliocephalus	Grey-headed Flying-fox	Vul	LC	Unlikely
Macroderma gigas	Ghost Bat	Vul	End	Unlikely
Chalinolobus dwyeri	Large Pied Bat	Vul	Vul	Unlikely
Nyctophilus corbeni	South-eastern Long-eared Bat	Vul	Vul	Present
Pseudomys australis	Plains Rat	Vul	End	Unlikely

The of EVNT records detected during the current surveys are shown in Figure 4.12.



Vegetation_Management_Status

Remnant Vegetation

FIGURE 4.12 Survey records of EVNT fauna species from within the SGP Study Area Region

Client ARROW ENERGY

0 12 24 36 48
Kilometers

Scale 1:750,000 **Drawn By** DG **Date** 23-May-17 A4

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Many threatened species considered in the original SGP EIS (3d Environmental 2011) are no longer specially protected including Rough Collared Frog (*Cyclorana verrucosa*), Brigalow Scalyfoot (*Paradelma orientalis*), Grey Goshawk (*Accipiter novaehollandiae*), Black-necked Stork (*Ephippiorhynchus asiaticus*), Square-tailed Kite (*Lophoictinia isura*), Black-chinned Honeyeater (*Melithreptus gularis*), Turquoise Parrot (*Neophema pulchella*), Cotton Pygmy-goose (*Nettapus coromandelianus*), and Little Pied Bat (*Chalinolobus picatus*).

Profiles for Threatened fauna considered to be possible, likely or present from the study area are provided in Appendix G. The profiles include the criteria used to develop individual species habitat maps in the associated GIS package, and an assessment of mapping accuracy. Table 4.7 shows the extent of habitat available to each species based on the GIS mapping product.

Table 4.7. The extent of mapped habitat for Threatened fauna species present or possibly occurring within the SGP study area.

Scientific Name **Common Name**	**Status**		**Habitat extent (ha) in SGP by region***			**Likelihood**
	EPBC	**NCA**	**CHK**	**CHP**	**GH**	
Jalmenus eubulus Pale Imperial Hairstreak	-	Vul	0	869.4	0	Likely
Strophurus taenicauda Golden-tailed Gecko	-	NT	7,160.3	74,649.4	1,341.5	Present
Acanthophis antarcticus Common Death Adder	-	Vul	69.81	72,052.9	1,550.6	Possible
Furina dunmalli Dumnall's Snake	Vul	Vul	297.9	71,463.1	6,504.8	Possible
Hemiaspis daemeli Grey Snake	-	End	939.6	9,280.7	44,189.4	Present
Rostratula australis Australian Painted Snipe	End	Vul	266.5	223.3	0	Possible
Calyptorhynchus lathami Glossy Black Cockatoo	-	Vul	5,165.3	1,852.8	35.1	Present
Grantiella picta Painted Honeyeater	Vul	Vul	696.5	863.6	359	Possible
Phascolarctos cinereus Koala	Vul	Vul	8,187.4	5,015.36	71,949.8	Present
Petauroides volans Greater Glider	Vul	Vul	324.7	3,413.8	1,914.1	Present
Nyctophilus corbeni South-eastern Long-eared Bat	Vul	Vul	3,531.4	55,836.2	26,146.0	Present

*CHN = Core Habitat Known, CHP = Core Habitat Possible and GH = General Habitat

4.3.2 Migratory Fauna Species

Three Migratory species, listed under the EPBC Act, were recorded during the 2016-17 SGP surveys (Table 4.8). Other species have been historically recorded within the SGP study area, predominantly from Lake Broadwater (Figure 4.13) which is likely to be significant habitat for Migratory taxa. A discussion on the likelihood of each species occurring in the SGP study area over Life of Operation (approximately 25 years) is also provided in Table 4.8.

Table 4.8. Migratory species recorded within the SGP study area

Scientific Name Common Name	ESE 2016-17	DB Recs	Discussion
Gallinago hardwickii Latham's Snipe		X	The Latham's Snipe frequents Lake Broadwater, with only on other record restricted to a small dam in the southern region of the SGP study area. While it has potential to occur throughout the SGP study area on suitable dams, swamps and flooded paddocks, best habitat is largely limited to Lake Broadwater and Long Swamp. These two locations should be considered 'Important Habitat' as defined in Department of Environment, Water, Heritage and Arts 2009).
Limosa lapponica Bar-tailed Godwit		X	The Bar-tailed Godwit has been recorded twice from Lake Broadwater in 1985 and 1987. It is a vagrant species unlikely to occur within the SGP study area during Life of Operation. Lake Broadwater represents the only area of suitable habitat within the SGP study area.
Limosa limosa Black-tailed Godwit		X	The Black-tailed Godwit has been recorded once from Lake Broadwater in 1995. It is a vagrant species unlikely to occur within the SGP study area during Life of Operation. Lake Broadwater represents the only area of suitable habitat within the SGP study area.
Numenius phaeopus Whimbrel		X	The Whimbrel has been recorded only once from Lake Broadwater in 1990. It is a vagrant species unlikely to occur within the SGP study area during Life of Operation. Lake Broadwater represents the only area of suitable habitat within the SGP study area.
Tringa nebularia Common Greenshank		X	Common Greenshank is only known at Lake Broadwater where the most recent observation occurred in 2007. It is a vagrant which has a very low probability of occurring within the SGP study area during Life of Operation. The only area of suitable habitat occurs at Lake Broadwater.
Calidris ferruginea Curlew Sandpiper		X	The Curlew Sandpiper has been recorded on seven occasions within the SGP study area, all but one at Lake Broadwater. The most recent record (2007) is from an artificial dam approximately 6.5km SSE of Lake Broadwater. All other records predate 1995. It is likely the species will appear at Lake Broadwater during SGP operations, but is unlikely elsewhere. These vagrant individuals will not represent a significant population.
Plegadis falcinellus Glossy Ibis		X	The Glossy Ibis has been frequently recorded at Lake Broadwater. Lake Broadwater and Long Swamp represent the best areas of habitat within the SGP study area, and at these locations the species is expected to occur over Life of Operation. Alternative habitat is scarce, but the species could possibly occur in other wetlands or flooded paddocks.
Tringa stagnatilis Marsh Sandpiper		X	Marsh Sandpipers have been recorded semi-frequently at Lake Broadwater where it was last observed in 2007. It is possible this species could occur within Lake Broadwater during Life of Operation, but is unlikely to occur elsewhere due to lack of suitable habitat.

Scientific Name Common Name	ESE 2016-17	DB Recs	Discussion
Myiagra cyanoleuca Satin Flycatcher		X	A single Satin Flycatcher has been recorded within the central region of the SGP study area in 1997. It is a vagrant species and is unlikely to occur over Life of Operation.
Calidris acuminata Sharp-tailed Sandpiper		X	Sharp-tailed Sandpipers are recorded semi-frequently at Lake Broadwater where it was last observed in 2009. This species could occur at Lake Broadwater or possible Long Swamp during Life of Operation. While habitat elsewhere is limited, there is some potential for the species to occur in smaller farm dams, wetlands and flooded paddocks.
Tringa glareola Wood Sandpiper		X	The Wood Sandpiper has been recorded once from Lake Broadwater in 1995. It is a vagrant species that is unlikely to occur during Life of Operation or away from the Lake.
Gelochelidon nilotica Gull-billed Tern		X	Gull-billed Terns have been recorded on only nine occasions within the SGP study area, most recently in 2013. In all but two occasions the species has been recorded at Lake Broadwater. There is some possibility the species could sporadically appear on isolated waterbodies, but on balance it is only likely to occur infrequently at Lake Broadwater.
Chlidonias leucopterus White-winged Black Tern		X	The White-winged Black Tern has been recorded once from Lake Broadwater in 1995. It is a vagrant species that is unlikely to occur during Life of Operation or away from either Lake Broadwater or Long Swamp. It typically only occurs around larger waterbodies, wetlands or swamps.
Hirundapus caudacutus White-throated Needletail	X	X	Recorded at seven separate locations during the 2016-17 ESE surveys, all within the central region. These records represent large foraging flocks moving across the region. Records are also present in databases. Being aerial in nature, this species can occur over both natural and modified landscapes (including urban cities), though large stands of forest may be important for roosting. The species is likely to frequently occur throughout the SGP study area.
Apus pacificus For-tailed Swift	X	X	Recorded at fourteen separate locations during the 2016-17 ESE surveys. Known from an additional 14 records in databases. Strictly aerial in nature, they can occur over modified landscapes (including tilled crops and urbanisation) though large tracts of woodland may be a key habitat requirement (Department of Environment 2015). They will occur throughout the SGP study area.
Rhipidura rufifrons Rufous Fantail	X	X	Recorded at four locations during the current surveys, all within or adjacent Dalby State Forest. The species has also been recorded at six other locations in databases, also only within the southern region of the SGP study area. Habitats within the SGP study area are marginal, the species prefers rainforest or wet sclerophyll forests. These records approximate the limit of the species western extent (only four records further west, all <100km of the SGP study area), and therefore their populations could be considered 'Important' as defined under the MNES impact assessment guidelines (Department of Environment 2013).

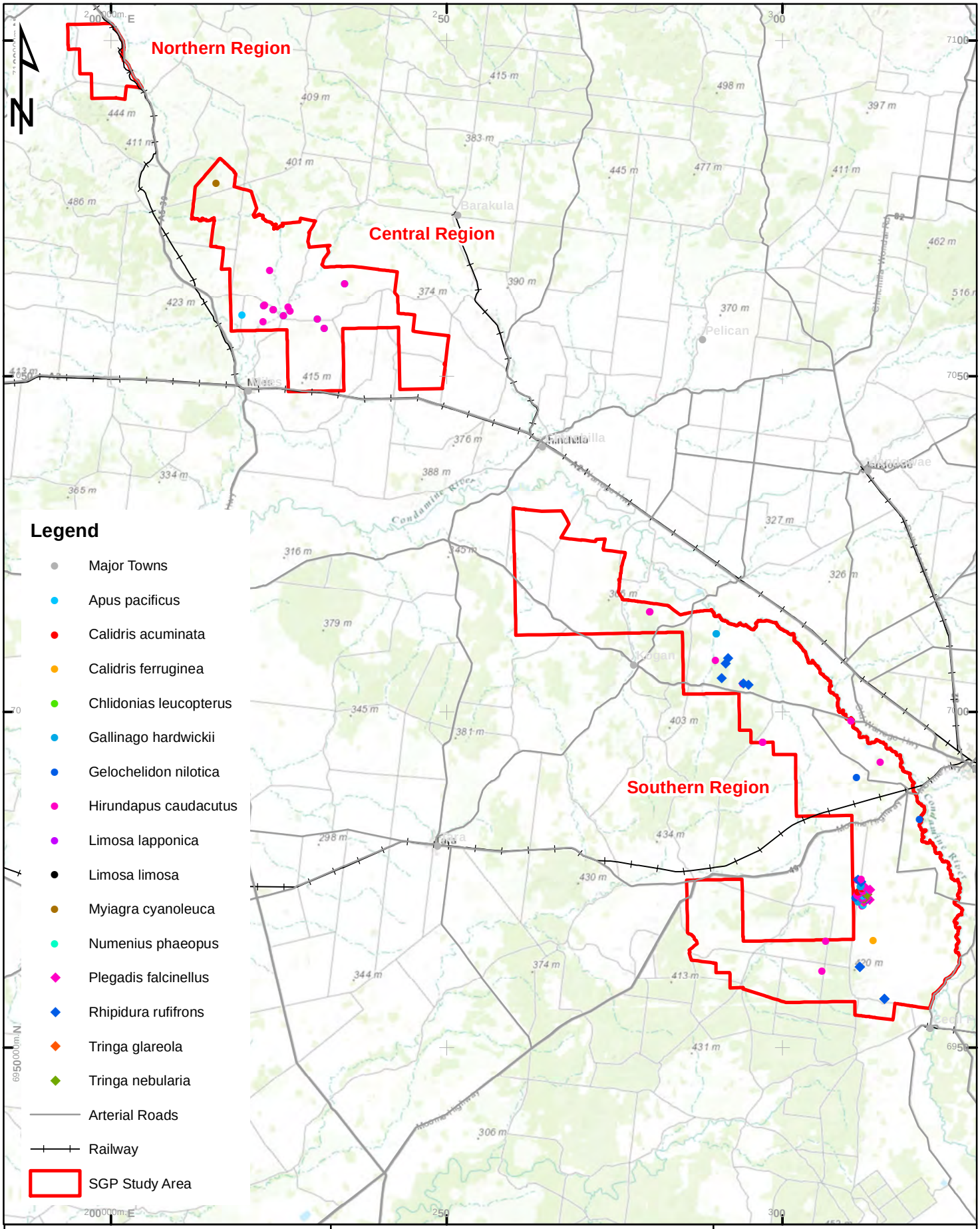

FIGURE 4.13 Migratory species records within the SGP Study Area

Client ARROW ENERGY

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Kilometers

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4.3.3 Exotic Pest Species

Feral pest species known to occur within the SGP study area are discussed in Table 4.9.

Table 4.9. Exotic pest species known from the SGP study area

Scientific Name Common Name	Recorded during ESE surveys	Discussion
Sus scrofa Feral Pig	Y	While only a handful of individuals were observed, feral pig evidence was commonly encountered. Evidence of pig activity was at its highest in locations with water or damp soils (e.g., creeklines and gullies), particularly in the larger tracks of forest. They are likely to be throughout the SGP study area. Predation, habitat destruction, competition and disease transmission by Feral Pigs is a Key Threatening Process under the EPBC Act.
Rhinella marina Cane Toad	Y	Cane Toads are common in the northern portion of the SGP study area, being frequently recorded north of the Dalby-Kogan Rd. South of this road they become increasingly less abundant, only one individual was recorded south of the Moonie Highway. A similar pattern is apparent in database records. The biological effects, including lethal toxic ingestion, caused by Cane Toads is a Key Threatening Process under the EPBC Act.
Canus lupus familiaris/dingo Dog/dingo	Y	Dogs/dingos and their signs were frequently observed during the survey and the species is likely to be widespread throughout the SGP study area. Highest densities may occur within larger tracts of vegetation away from grazing land where they are more likely to be actively hunted and controlled.
Felis catus Feral Cat	Y	Feral Cats were noted at 12 locations during the surveys and will be abundant and widespread within the SGP study area. Feral Cats pose a significant threat to biodiversity and predation by Feral Cats is a Key Threatening Process under the EPBC Act.
Oryctolagus cuniculus European Rabbit	Y	Rabbits are uncommon within the SGP study area. They were recorded four times during these surveys, and have only been recorded at two other locations within databases.
Lepus europeaus Brown Hare	N	Brown Hares are infrequently encountered within the SGP study area. Individuals were observed on only two occasions during these surveys, and the species has been recorded only eight times within the SGP study area in other databases.
Sturnus vulgaris Common Starling	N	Common Starlings are abundant in modified land along the Condamine River. They are largely absent from the heavily wooded areas covering most of the SGP study area.
Sturnus tristis Common Myna	Y	Within the SGP study area Common Mynas have a similar distribution to Common Starlings, being abundant in modified lands along the Condamine River and rare elsewhere.
Columba livia Rock Dove	Y	Rock Doves have not been frequently recorded within the SGP study area. They are usually more abundant around larger urban centres, but can be found in surrounding farmlands. They have only been noted from the southern region of the SGP study area, and in most cases in modified land along the Condamine River.

Scientific Name Common Name	Recorded during ESE surveys	Discussion
Mus musculus House Mouse	Y	House Mice have been recorded throughout the SGP study area. While they are likely to be most abundant in modified agricultural areas and adjacent remnant vegetation, they can occur from within large tracts of native vegetation.
Streptopelia chinensis Spotted Dove	N	Rare recorded from the SGP study area; all historic records (4) noted from Lake Broadwater between 2003 and 2009.
Rattus rattus Black Rat	N	Likely to be more abundant than suggested by the few database records. Likely to be largely restricted to around human dwellings and occupied centres.
Vulpes vulpes Red Fox	Y	Records of the Red Fox are restricted to the southern region of the SGP study area where grazing land is widespread. While they will have lower abundance in large continuous tracts of vegetation, they are likely to occur throughout the SGP study area. Red Foxes pose a significant threat to biodiversity and predation by European Red Fox is a listed Threatened Process under the EPBC Act.
Passer domesticus House Sparrow	N	House Sparrows will be largely restricted to urban towns. Currently they occur infrequently in the SGP study area, and are most likely to turn up in the southern region along the Condamine River where large-scale land clearing has occurred.
Unidentified Deer Species	Y	An unidentified species of deer was briefly observed during the March surveys north of Kogan. While unmistakably a deer, the species could not be identified. This is the first deer record within the region (i.e., SGP study area + 50km buffer).

5.0 HABITAT CONDITION

5.1 CONDITION OF WETLANDS INCLUDING LONG SWAMP

A relatively complex system of floodplain wetlands occurs in the southern region of the SGP study area, generally associated with sinuous overflows of the Condamine River and its larger tributaries. The southern region also contains Lake Broadwater, a seasonal water feature that is recognised nationally for its natural values, being significant at a national and state level. The lake is listed on the Directory of Important Wetlands and is recognised as being a rare example of a semi-permanent freshwater lake in the bioregional area (Blackman *et al*. 1999, EHP 2006) The Lake is fringed by an open forest of River Red Gum (*Eucalyptus camaldulensis*) (RE 11.3.27d) which is broadest (approx. 200m) around the north-eastern portion of the lake. Habitats surrounding the lake are generally in good condition.

The numerous flood plain wetlands are almost universally heavily infested with Lippia (*Phyla canescens*) during seasonal drying periods. This severely limits the ability of native aquatic species to re-colonise these areas during wetter, more favourable seasons.

Long Swamp is a sinuous hydrological feature (overland flow path) that flows across the Condamine Alluvium in a north-westerly direction to the east and north of Lake Broadwater, before joining with Wilkie Creek to the west. The feature occupies a broad depression on the alluvium with the central portion of the depression formed by heavy clay. Surface water is present seasonally and following dry spells the associated vertosol soils form deep hummocks and cracks. There was no flow, nor any significant pooled water within Long swamp during the field visits, despite heavy recent rains. These observations together with the observations of deep, open cracks in the central swamp channel soil surface confirmed that the feature is only active during significant flooding.

At Long Swamp the vegetation is predominantly native, although exotic groundcovers predominant in some localities. The canopy is formed by tall, broadly spaced River Red Gum (*Eucalyptus camaldulensis*) at approximately 15 - 30% cover with Poplar Box (*Eucalyptus populnea*) forming on the swampy margins. The canopy is significantly stressed in some areas with signs of senescence and foliage loss. The noted senescence is possibly due to historic groundwater drawdown for irrigation (Kath *et al.* 2014; 3d Environmental, 2017) although may have been further compounded by surface water extraction.

Four secondary vegetation survey sites were completed within Long Swamp during the dry season survey (DS21, DS22, DS26, DS31 completed when the swamp was dry). At these locations exotic vegetation cover contributed an average of 15% to the total groundcover, and formed 39% of the total living groundcover. Common native species included Nardoo (*Marsilea drummondii*), Water Chestnut (*Eleocharis dulcis*) and scattered native grasses including *Panicum decompositum*. Lippia (*Phylla canescens*) was the most abundant exotic forb blanketing the clay soils, particularly where grazing pressure is most intense. It should be noted that groundcover composition will vary seasonally with native aquatic sedges, particularly Water Chestnut, becoming dominant during periods of standing surface water.

Photo 2. Long Swamp with characteristic Red Gum showing moderates signs of stress as suggested by foliage loss.

5.2 General Habitat Condition

The SGP study area incorporates a number of landscapes, ranging from the broad river flood plains centred on the Condamine River and its associated tributaries, rolling hills on fine grained sedimentary rocks in the Wandoan (northern) area, rangeland woodlands formed on skeletal rocky soils, and ironstone jump ups and extensive tracts of ironbark dominant woodland associated with older Tertiary / Cainozoic plains. The impacts of land use vary across the landscape dependant largely on the fertility of the underlying substrate.

The productivity of the alluvial clay soils on the Condamine River floodplain, collectively referred to as the Condamine River Alluvium (CRA), has resulted in heavy utilisation of these areas for agricultural purposes, predominantly tilled cropping. Floodplain vegetation is generally restricted to the immediate river channel and associated flood pockets, with scattered areas on crown or council owned land and as isolated fragments adjacent to floodplain overflows and swamps. Long-term abstraction of groundwater associated with the CRA, has lowered groundwater levels by up to 25m in some localities (Kath *et. al.* 2014). It is understood that Arrow is currently investigating the presence and connectivity of perched aquifers and deeper aquifers in this area. The loss of water from the rooting zone of deeper rooted species such as River Red Gum (*Eucalyptus camaldulensis*) and Poplar Box (*Eucalyptus populnea*) has resulted in severe loss of canopy vigour and dieback in some localities. It is expected that based on

historic groundwater levels (take from Arrow well baseline assessments), maximum tree rooting depth would not have exceeded 15m across the dominant portion of the CRA. The reduction of canopy vigour has resulted in increased light penetration, coupled with the impact of grazing, which has resulted in pervasive displacement of native groundcovers by exotic species such as Green Panic (*Megathyrsus maximum var. trichoglume*) and Lippia (*Phylla canescens*).

Brigalow communities (RE 11.3.1, RE 11.4.3 and RE 11.9.5) and Brigalow/Eucalypt associations (RE 11.3.17) have been cleared to the margins of adjacent vegetation types and generally exist as small unviable remnants, slivers along the margins of riparian forest types, or as secondary forests with limited structural complexity or floristic diversity. Native ground covers, although naturally sparse in these communities are often displaced by exotic species including Prickly Pear (*Opuntia stricta*), Mother of Millions (*Bryophyllum delagoense*) and Harrisia Cactus (*Harrisia martinii*). Dense infestations of velvet tree pear are typical in brigalow habitats forming up to 20% cover in the taller shrub layer of many occurrences. Despite their extent, brigalow patches can still have significant value for several threatened fauna species including the Pale Imperial Hairstreak (*Jalmenus eubulus*) and Painted Honeyeater (*Grantiella picta*).

Although ecosystem types on soils of low fertility, typically those REs associated with land zones 5 and 7, form the largest and most continuous tracts of vegetation in the study area, these ecosystems have invariably been heavily utilised for their timber resources with varying degrees of impact. In particular, habitats dominated by the Narrow-leaf Ironbark species *Eucalyptus crebra, E. elegans* and *E. woollsiana* (RE 11.5.1, 11.5.4, 11.7.4 and 11.5.20) have been logged to a degree that all mature canopy trees have been removed. The remaining vegetation comprises of secondary growth with a thickened shrub layer forming the canopy. Examination of 1981 aerial photography for the SGP study area demonstrates closely spaced rip-lines through large areas of remnant vegetation indicating the intensity of historical timber extraction practices.

The impact of logging is also evident in the majority of state forests within the SGP study area including Braemar SF, Kumbarilla SF to the west of Dalby and Barakula SF to the north of Chinchilla. However from general observation these logging regimes have been less severe than those applied on freehold land.

A number of ecosystems appear more resilient to landscape-wide processes of degradation. In particular *Eucalyptus fibrosa subsp. nubila* forest communities (RE11.7.7) have, in general, a better-preserved canopy structure, a greater number of mature canopy trees, and fewer large canopy gaps. This preservation is likely to be due to the quality and usefulness of the timber resource rather than an inherent ability to recover from disturbance.

While, on balance, the State Forests have retained greater conservation value than vegetation on freehold land, the future of these areas may be affected by changes to fire regime. Within the last 10 years, three extremely hot fires have affected large expanses of State Forest within the SGP study area, and in the case of Kumbarilla State Forest on more than one occasion (see Section 2.4). These hot fires can cause significant damage to the canopy and vegetation composition (by removing fire-sensitive species). It is likely the vegetation will take many decades to fully recovery after a significant wildfire. The frequency and intensity of wildfires are predicted to increase due to climate change (Williams *et al.* 2001), possibly leading to possible broad-scale vegetation changes.

In the northern portion of the SGP study area surrounding Wandoan, the arable clay soils and favourable nature of the gently undulating landscape has promoted widespread land clearing for an intensive cattle grazing land use. Only scattered vestiges of remnant vegetation remain including degraded patches of brigalow and riparian remnants adjacent to drainage lines. These patches have invariably suffered from canopy disturbance and invasion of exotic groundcovers, most notably Buffel Grass (*Cenchrus ciliaris*) and Green Panic (*Megathyrsus maximus var. trichoglume*).

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Appendix A.
GIS Package Contents

Contents of the associated Geodatabase package are outlined in the below table.

Geodatabase Dataset	Contents	Notes
Vegetation		
Arrow_Vegetation	RE mapping, TEC mapping and Threatened species habitat mapping (Core Habitat Possible, General Habitat).	Primary vegetation mapping database which identifies vegetation type in terms of Regional Ecosystem, Threatened Ecological Community and Conservation Status under relevant state and federal legislation. Provides the basis for mapping of EVNT fauna habitats based on vegetation type.
Core Habitat		
Core_Habitat_Flora	Core Habitat Known for all possible, likely or Present flora species	Overlaps the Threatened species mapping in Arrow_Vegetation dataset but takes priority.
Core_Habitat_Fauna	Core Habitat Known for all possible, likely or Present fauna species	Overlaps the Threatened species mapping in Arrow_Vegetation dataset but takes priority.
Ecological Survey Sites		
Flora_Survey_Sites	Compilation of all Secondary, Tertiary, Quaternary and Observation sites collected in floristic ecology surveys commissioned by Arrow Energy since 2009.	Included records from Surat Gas Pipeline Assessments, EIS and Supplementary EIS assessments as well as survey points from the recent 2016 – 2017 surveys.
ESE_Survey_Sites	Location of fauna survey methods completed during current surveys (2016-17)	SGP advanced exploration project works
Daandine_Trapping_Surveys	Location of fauna survey methods completed during Daandine fauna assessments (2014)	Ecosmart Ecology 2014.
SREIS_Trapping _Surveys	Location of fauna survey methods completed during Surat Gas Project supplementary EIS (2013).	3D Environmental (2013)
EVNT_Flora_and_Fauna_Field_Records		
EVNT_Fauna_Field_Records	Terrestrial fauna survey results collected during the current work	Error vetted. Includes geo-referenced sightings and opportunistic records without coordinates. Where opportunistic records have been recorded without specific dates the first day of the survey has been attributed.

Geodatabase Dataset	Contents	Notes
EVNT_Flora_Field_Records	Terrestrial flora survey results for both recent and historical collections in the SGP study area.	Includes EVNT records for all Arrow commissioned survey works from 2009 onwards plus Queensland Herbarium records within the SGP study area.
Herbrecs_SGP_25km_Buffer	Queensland Herbarium database records for EVNT flora species recorded within a 25+km buffer surrounding the SGP assessment area	Queensland Herbarium records within both the SGP and adjacent areas.
Additional Datasets		
ESE+DB_Recs_SGP	All coordinate based fauna records from both database sources and this work within the SGP.	No error vetting and duplicate records likely. Includes only geo-references sightings
SGP_EVNT_Recs	All known Threatened fauna species records within the SGP + 10km buffer	

Appendix B.
Fauna Survey Effort Compared to EPBC Survey Guidelines

The table below details the recommended survey effort for EPBC threatened taxa compared to survey effort achieved during this work. Note that the recommended EPBC survey effort is based on small project sites.

Scientific Name Common Name	Guideline Requirements							Adjusted for Habitat Extent			ESE Effort
	Survey Period	Techniques	Value	Effort	Min Duration	Area unit	Notes	Possible BVG's	Extent (ha)	Required effort (approx)	
Delma torquata Collared Delma	Late spring/ summer	Primarily hand searches.	primary	No documented species-specific survey effort. Large survey areas (> 50ha) must include sampling of distinct vegetation types and provide good spatial coverage. Documentation must include justification of survey effort.				10,12, 13,16, 25	32,771	N/A	122.75 hrs
		Pitfall traps	supp								1276 trap nights
Anomalopus mackayi	Late spring/ summer	Active search (when possible)	primary					30	0	N/A	125.25 hrs
		Pitfall traps	primary								1,276 trap nights
		Artificial shelter	primary								Nine shelters
Tympanocryptis condamiensis Condamine Earless Dragon	Late spring/ summer	Pitfall traps	primary					30	0	N/A	1,276 trap nights
Furina dunmalli Dunmall's Snake	Late spring/ summer	Active search	primary					10,12, 13,16, 17,18, 25,30, 34	76,351	N/A	122.75 hrs
	Late spring/ summer	Pitfall traps	primary								1276 trap nights
	Late spring/ summer	Road driving	supp								48 hrs
Anthochaera phrygia Regent Honeyeater	Breeding season	Area search	primary	20hrs	10 days	< 50ha		13,16, 17,18, 34	15,239	6,095hrs	106 hrs bird survey + 1038 hrs site traverse
	Peak flowering	Targeted searches	primary	20hrs	10 days	-				6,095hrs	NIL
Grantiella picta Painted Honeyeater	No survey guidelines							25	176	N/A	106 hrs bird survey + 1038 hrs site traverse
Rostrulata australis Australian Painted Snipe	-	Transect/ area search	primary	10 hrs	3 days	< 50ha		34	1,233	147hrs	106 hrs bird survey + 1038 hrs site traverse (NIL in suitable habitat)

Scientific Name Common Name	Guideline Requirements							Adjusted for Habitat Extent			ESE Effort
	Survey Period	Techniques	Value	Effort	Min Duration	Area unit	Notes	Possible BVG's	Extent (ha)	Required effort (approx)	
	-	Targeted stationary watches	suppl	10 hrs	5 days	< 50ha				147hrs	NIL
Geophaps scripta scripta Squatter Pigeon	-	Transect/ area search	primary	15hrs	3 days	< 50ha		10,12, 13,16, 17,18, 25,29, 30,34	35,660	1,548hrs	106 hrs bird survey
	-	Flush survey	primary	10hrs	3 days	< 50ha				7,132hrs	1038 hrs site traverse
Petauroides volans Greater Glider	No survey guidelines							13,16, 17,18, 34	52,239	N/A	139.75 hrs foot-based + 27.08 hrs vehicle-based spotlight
Phascolarctos cinereus Koala	-	Indirect signs (scratch/ scat).	primary	No specific survey effort documented. Surveys must undertaken to 'maximise the chance of detection'				13,16, 17,18, 34	52,239	N/A	122.75 hrs active search + 111 SAT searches
	Aug-Jan	direct observation (search/ spotlight)	supp								139.75 hrs foot-based + 27.08 hrs vehicle-based spotlight
Nyctophilus corbeni South-eastern Long-eared Bat	Not cold nights	Harp nets	primary	20 nights	>=5 nights	< 50ha	Mutually exclusive (i.e., don't need both harp *and* mist nets)	10,12, 13,16, 17,18, 25	75,118	30,047 trap nights	164 trap nights
	Not cold nights	Mist nest	primary	20 nights	>=5 nights	< 50ha					NIL
Chalinolobus dwyeri Large Pied Bat	Not cold nights	Unattended Anabat	primary	16 nights	4 nights	< 50ha		10,12, 13,16, 17,18, 25	75,118	24,038 nights	69 Anabat nights
	Not cold nights	Attended Anabat	primary	6 hrs	3 nights	< 50ha				9,014hrs	NIL
	Not cold nights	harp	supplementary	16 nights	4 nights	< 50ha	Useful near possible roosts			24,038 trap nights	164 trap nights
Dasyurus maculata Spotted-tailed Quoll	-	Active searches	primary	2hrs	1 day	5ha	Recommendation for	10,12, 13,20	28,674	11,469hrs	122.75 hrs active search

Scientific Name Common Name	Guideline Requirements							Adjusted for Habitat Extent			ESE Effort
	Survey Period	Techniques	Value	Effort	Min Duration	Area unit	Notes	Possible BVG's	Extent (ha)	Required effort (approx)	
	-	Hair-tubes	primary	40 tubes	14 nights	5ha	small sites. No guideline for larger sites			3,211,488 trap nights	NIL
	-	Camera trap	primary	10 nights	14 nights	1ha				4,014,360 trap nights	460 camera nights

Appendix C. Threatened Species Likelihood Assessments

The table below lists flora and fauna species that either known from within 50 km of the SGP or have been identified in the EPBC online Protected Matters search. The Likelihood assessment has been based on the SGP having a Life of Operation of approximately 25 years. Mobile fauna species which could occur within the SGP over this timeframe, but are unlikely to represent a permanent population or a population relying on the SGP for its long-term viability (vagrants) are assessed as 'Transient'.

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
FLORA						
Philotheca sporadica Kogan Waxflower	NT	Vul	Based on field survey observation, the species is universally restricted to open scalds and low *Eucalyptus exserta* dominant woodlands associated with RE11.7.4.	The extent of habitat including known, core habitat possible and general habitat has been provided within the attached GIS package	There are 11 known populations, seven occur on road verges, seven extend onto freehold land and one population is within Braemar State Forest (Halford 1995c in TSSC 2008j). The extent of known populations and habitat has been expanded considerably as a result of the current assessment.	Present
Acacia barakulensis Waaje Wattle	Vul	-	HERBRECS specimen records indicate species is associated with woodland and shrubland habitats formed by *Eucalyptus tenuipes, Corymbia trachyphloia, Calytrix gurulmundensis, and Triodia mitchellii.* Habitat is consistent with RE 11.7.4, 11.7.5, 11.7.6, and 11.7.7.	The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package. The species is considered to possibly occur based on suitability of habitat in the SGP and contiguity of adjacent habitats	Herbrecs identifies 5 confirmed populations 28 km to the north-east of the SGP study area within Barakula State Forest.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Acacia curranii Curly Bark Wattle	Vul	Vul	Plants are known to occur in shrubby heaths, dry sclerophyll forests and semi-arid woodlands where they can occur as widely scattered thickets in very species-rich heathy scrub with emergent eucalypts (Pickard 1995c, Threatened Species Scientific Committee 2008). Curly-bark wattle grows on sandy clay soils that are poorly drained on weathered sandstone (Pickard 1995c).	The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package. The species is considered to possibly occur based on suitability of habitat in the SGP and contiguity of adjacent habitats	Sixteen local populations are recorded in Herbrecs with the nearest population 11 km west of the SGP study area with Gurulmundi State Forest (excluding low precision records).	Possible
Acacia handonis Hando ‘s Wattle	Vul	Vul	Hando’s wattle has only been collected on rocky ridges and slopes on sandstone-derived geology in eucalypt woodland and open forest. The vegetation it grows within is a shrubby woodland of *Eucalyptus fibrosa subsp. nubila, Eucalyptus watsoniana subsp. watsoniana, Lysicarpus angustifolius*, and Allocasuarina inophloia (Halford 1995). This is consistent with RE11.7.7	The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package. The species is considered to possibly occur based on suitability of habitat in the SGP and contiguity of adjacent habitats	Seventeen local populations are recorded in Herbrecs with the nearest population 35 km east of the SGP study area within Barakula SF (54 km west-north-west of Miles)	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Callitris bayleyii Bailey's Callitris	NT	-	A 3D Environmental survey record associated with the Surat EIS (3D Environmental 2011) confirms its presence in low open forest (11-15m) of *Eucalyptus exserta, E. crebra* and *Callitris glaucophylla* with a mid-dense shrubby understorey dominated by *Micromyrtus sessilis with Acacia crassa, Alphitonia excelsa,* and *Petalostigma pubescens*. Habitat typical of RE11.7.4	Extensive tracts of suitable habitat occur in the central portion of the SGP area. The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package.	Nearest local record is 2.6 km west of the SGP study area (40 km north of Miles) in Gurulmundi State Forest.	Possible
Calytrix gurulmundensis Gurulmundi Fringe Myrtle	Vul	Vul	Gurulmundi fringe myrtle has been recorded growing in patches of shrubland on very shallow soils (EPA 2002). Soils are lateritic sandstone ridges, which contain yellow sandy-clay that retains moisture (Williams 1979). Vegetation is predominately eucalypt, acacia, casuarina dense shrublands with spinifex, and spinifex grassland with scattered shrubs. This habitat description is consistent with RE 11.7.5 (shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks).	Suitable habitats include patches of RE11.7.5 and RE11.7.4 in to the west and north-west of the central assessment area. The extent of habitat including core habitat possible and general habitat has been provided within the attached GIS package.	Nearest local record is 12 km west of the SGP study area (30 km north of Miles) within Gurulmundi State Forest. A population also exists in Waaje Scientific Reserve 36 km east of Wandoan.	Possible
Micromyrtus carinata	E	-	Herbrecs records indicate suitable habitat in heathland and low woodland typical of REs 11.7.4 and 11.7.5.	Estimated extent of suitable habitat within the SGP provided in GIS package.	Nearest Herbarium Record is 10km north-west of Miles and 4 km west of the SGP study area on the Wyona Property.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Eucalyptus curtisii Plunkett Mallee	NT	-	Lateritic sandstone and sandstone rises/ridges and slopes often with *Eucalyptus exserta, E. fibrosa* subsp. *nubila, Corymbia trachyphloia,* and *Callitris glaucophylla*. Typical habitats include RE11.7.7, 11.7.5 and 11.7.5.	Has potential to occur throughout the SGP study area in suitable habitats. Estimated extent of suitable habitat within the SGP provided in GIS package.	Numerous local records mostly west of the SGP study area with the nearest record 2.5 km west of the SGP study area and 35km north of Miles	Possible
Acacia lauta Tara Wattle	Vul	Vul	Associated with sandy soils hosting ironbark woodland. Known populations have been mapped within REs 11.7.7, 11.7.4 and 11.7.5. These REs provide a representative mix of shrubland and woodland of which ironbark (*Eucalyptus crebra, Eucalyptus sideroxylon or Eucalyptus fibrosa)* forms a dominant to sub-dominant component (TSSC 2008o).	Populations are localised to the area surrounding Tara and Inglewood. Due to a lack of survey record following comprehensive survey, this species is considered unlikely to occur.	Nearest record is 20km west of the Kumbarilla State Forest in the vicinity of Tara (64 km west of Dalby).	Unlikely
Acacia wardellii	NT	-	The species inhabits gravelly soils on shallow weathered sandstone in eucalypt woodland (Pedley, 1978). Herbrecs data (EHP 2013) indicates typical habitats including RE 11.7.4, RE 11.7.7 and RE 11.7.5.	Potential habitats include REs 11.7.4 and 11.7.7 to in the vicinity of Kogan although extensive ground survey in this locality suggest a new population within the SGP is unlikely.	Three populations recorded all approximately 16 km west of the SGP study area and 25 km west of Chinchilla. Greater than 30km west of the nearest suitable habitat near Kogan.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Cadellia pentastylis Ooline	Vul	Vul	Ooline grows in semi-evergreen vine thickets, brigalow and occasionally in adjacent eucalypt woodland, where it maybe locally dominant in the canopy layer or occur as an emergent (TSSC 2008e) and also residual trees in cleared paddocks. Substrates include clay plains, sandstone and residual ridges (Eddie 2007).	Although Ooline occupies a range of substrates, local records are located in sandstone ravines in Gurulmundi State Forest. There are no known similar habitats in the SGP study area.	Nearest local record is 23 km west of the SGP study area and 50 km NE of Miles, No other local records.	Unlikely
Denhamia parviflora Small-leaved Denhamia	Vul	Vul	Small-leaved Denhamia grows in semi-evergreen vine thickets, vine scrubs and brigalow (*Acacia harpophylla*) softwood communities on fertile, red brown sandy clay loam hillslopes and crests (DNR 2000).	Suitable habitat and substrate within the assessment area is extremely limited.	2 pre-1985 records located to the east of Chinchilla, approximately 20 km east of the SGP study area.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Eucalyptus argophloia Chinchilla white gum	Vul	Vul	The existing natural population exists largely in highly disturbed regrowth vegetation with associated tree species including brigalow (*Acacia harpophylla*), grey box (*Eucalyptus molluccana/ Eucalyptus microcarpa*) white cypress pine (*Callitris glauca*) and poplar box (*Eucalyptus populnea*). The tree is associated with red loams, grey brown clays and clay loams of moderate to high fertility (Boland et al. 2006). According to TSSC (2008p), no known populations occur in vegetation classified as remnant under the VM Act.	Suitable red high fertility loamy substrates have not been identified in the assessment area.	Nine records located east of the SGP study area with the nearest population 25 km from the SGP boundary and 18 km north-west of Chinchilla	Unlikely
Eucalyptus virens Shiny-leaved Ironbark	Vul	Vul	The species is known to inhabit plateaus and sandstone escarpments and sandy soils which form low rises. Based on Herbrecs data (EHP 2013), populations are mapped as occurring in association with REs11.7.7, 11.7.4. 11.7.5, 11.7.6 and11.5.1, all associated with residual soils.	Suitable habitat present although extensive field survey did not identify any new populations.	Extremely localised population with 2 records from the vicinity of Tara, 9 km west of the SGP study area (64 km west of Dalby).	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Digitaria porrecta Finger Panic Grass	NT	-	Finger panic grass grows in grasslands, woodlands and open forests with a grassy understory, on black soil plains of the Darling Downs, and lighter textured soils to the west (Goodland 2000; Fensham 1998). Fensham (1998) found it is most abundant in grassland, but is "relatively unspecific" in its habitat preference. It is not restricted to high quality native grasslands, but also grows along roadsides and can be found in highly disturbed sites.	The most suitable habitats are associated with derived grassland habitats, typically associated with roadside easements between Chinchilla and Cecil Plains.	Two records within the SGP study area , both in non-remnant derived grasslands adjacent to roadside easements between Dalby and Cecil Plains. Both records collected in 1995. A further 15 records within 25 km east of the SGP study area boundary.	Present
Fimbristylis vagans	E	-	A sedge to 80cm tall that that fringes ephemeral watercourses and lagoons on alluvium.	A large number of potential habitats associated with swamps and drainage lines.	A single record from the SGP study area associated with the swampy inlet of Lake Broadwater. Has not been recorded or collected since 1984.	Present
Homopholis belsonii	E	V	Belson's panic prefers moderate to highly fertile soils, especially those derived from basalt and fertile alluvial flats. It is generally associated with poplar box and brigalow woodlands on light red/brown earths (Fensham and Fairfax 1997, Goodland 2000). It is most likely to be associated with RE11.3.1, 11.3.17, 11.4.3, 11.9.5, 11.9.10.	Regional ecosystems associated with heavy clay, typically brigalow. Scattered remnants of REs 11.3.1, 11.3.17, 11.4.3, 11.9.5, 11.9.10 occur throughout the SGP EIS Area.	A considerable number of records to the east of Dalby with the nearest 12 km from the eastern boundary of the SGP study area. Two records within 8 km of the boundary of the northern study region within 10 km of Wandoan.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Cyperus clarus	V	-	Known from heavy soils with records from remnant and disturbed *Eucalyptus orgadophila* woodland on basaltic soils and grassland on heavy alluvium.	Limited suitable remnant habitat in the assessment area and the species is not known to be associated with non-remnant habitats.	A single 1995 herbarium record exists in the Jandowae area, 18 km east of the SGP study area and 25 km north of Dalby.	Unlikely
Solanum papaverifolium	E	-	Occurs in wetter (swampy) areas of grasslands or open eucalypt woodland on heavy alluvial soils (Goodland 2000). The species is often recorded in non-remnant habitat.	Suitable habitat occurs within derived grassland and associated woodlands typically associated with roadside reserves.	Two records contained within the SGP study area to the south of Dalby with an large number of herbarium records to the east of the SGP study area between Chinchilla and Dalby.	Present
Cymbonotus maidenii	E	-	The species is associated with a range of remnant and non-remnant habits with records occurring on disturbed roadside drains, native and derived grasslands. It is typically associated with heavy brown to grey cracking clay soils (Holland & Funk 2006).	Suitable habitat occurs within derived grassland habitats to the south of Dalby.	Five Herbrecs specimens recorded within 10 m of the eastern boundary of the SGP study area, mostly in the Cecil Plains / Millmerran Area including collections on road reserves on the Cecil Plains - Millmerran Road.	Possible
Picris barbarorum	V	-	Known from native grassland (12.3.21) of Dichanthium sericeum in stock routes, road reserves adjacent to disturbed areas such as cultivated paddocks and road and rail lines on black clay soil.	Potential habitat associated with derived grassland in road reserves to the north and south of Dalby.	Four herbarium records within 5km of the SGP study area with the nearest less than 2 km from the assessment area boundary, 14km north-west of Dalby.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Rutidosis lanata	NT	-	Mainly found in roadside vegetation of Acacia and Eucalypt woodland/open forest on red sandy ridges and clay flats between 280-320m altitude adjacent to cleared or partly cleared grazing and cropping land (DNR 2000).	Most likely to be recorded within REs 11.3.4, 11.3.2 and 11.3.3 in the vicinity of Chinchilla although may occur in these habitats throughout the entire project area.	Eight Herbarium records within 20 km from the SGP study area, all recorded in the Miles / Chinchilla area.	Possible
Solanum stenopterum	V	-	Occurs in disturbed grassland, *Casuarina cristata* forest or *Eucalyptus populnea* woodland on clay soils (Bean 2004).	Derived grassland, Brigalow and grassy woodlands of *Eucalyptus populnea* between Dalby and Cecil Plains.	Known to occur in non-remnant grassland approximately 7.5km south of Dalby; 3.5 km east of Cecil Plains in a roadside gravel pit; and approximately 6 km south east of Cecil Plains in remnant Eucalyptus populnea woodland on alluvium (11.3.2). All herbarium records outside SGP study area.	Possible
Xerothamnella herbacea	E	E	Occurs in remnant and disturbed brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) dominated communities in shaded situations, often in leaf litter (TSSC 2008n).	Numerous brigalow habitats (RE11.3.1, 11.4.3, 11.9.5), both remnant and disturbed have potential to host this species.	Two herbarium records to within 20km of the SGP Boundary, 20km to the east and north of Chincilla.	Possible
Cryptandra ciliata	NT	-	Suitable habitat in eucalypt dominated woodland, lancewood (Acacia shirleyi) woodland and Triodia grassland on rocky on low lateritic and sandstone ridges. Habitat in the PDA is consistent with RE 11.7.5, 11.7.4, 11.7.6, 11.5.1, 11.5.4, 11.5.21.	Woodlands in the Chinchilla / Miles region in the Central assessment area provide for potential habitat for the species.	Three herbarium records within 5km of the assessment area boundary with a single record within 1km of the eastern boundary, 30km to the north of Miles.	Possible

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Pomaderris coomingalensis	E	-	Occurs in Eucalyptus and Callitris woodland in shallow sandy soil or Eucalyptus woodland on hard sandstone jump ups. Herbarium records (DERM 2011) include woodland of narrow leaved ironbark (*Eucalyptus crebra*) and *E. fibrosa subsp nubila*.	Extensive areas of potential habitat in the Kogan / Kumbarilla areas in RE11.5.1, 11.7.4 and 11.7.7.	A single record to then west of Kumbarilla State forest, 10km from the west of the SGP study area. Not recorded in field surveys despite extensive survey effort in suitable habitat	Unlikely
Thesium australe Austral toadflax	V	V	Austral toadflax has been collected within popular box (*Eucalyptus populnea*) woodland on alluvial flats (RE 11.3.2) north-west of Dalby, within the project development area.	Most likely to occur on habitats formed on heavy clay associated with the Condamine Alluvium. RE11.3.2 provides the most suitable habitat within the assessment area.	Two herbarium records within 10km of the SGP study area, with the nearest record 2.7k east of the eastern SGP study area boundary, 25km north west of Dalby.	Possible
FAUNA						
Jalmenus eubulus Pale imperial hairstreak	Vul	-	Restricted to Brigalow (*Acacia harpophylla*)-dominated woodlands and open-forests, particularly those areas with Belah (*Casuarina cristata*), emergent eucalypts such as *Eucalyptus populnea* and understorey shrubs (Breitfuss and Hill 2003; Eastwood et al. 2008).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Three records are located within the SGP, the most recent of which is nearly 20 years old. An additional five records are within 10km of the SGP boundary. The species requires targeted surveys to detect, even during suitable conditions. Current number of records are likely to underestimate abundance and distribution	Likely
Rheodytes leukops Fitzroy River turtle	Vul	Vul	Reliant on faster flowing riffle habitats and generally does not move far from them within its home range (Tucker et al. 2001)	No suitable habitat within the SGP.	Only found in the Fitzroy River catchment. No records within 50km of the SGP boundary.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Elseya albagula Southern snapping turtle	End	CE	Restricted to clear, flowing, well-oxygenated waters with the Fitzroy, Mary and Burnett Rivers and associated smaller drainages (Todd et al. 2013).	No suitable habitat within the SGP.	No records within 50km of the SGP boundary and not known to occur outside the Fitzroy, Mary and Burnett River catchments.	Unlikely
Strophurus taenicauda Golden-tailed gecko	NT	-	Found mainly in association with brigalow (Acacia harpophylla), cypress (Callitris spp.) and ironbark (Eucalyptus spp.).	Recorded during surveys. Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present
Delma torquata Collared delma	Vul	Vul	Rocky areas associated with dry open forest, and brigalow	Some suitable habitat for the species exists within the SGP, however, rarely recorded within the Brigalow Belt.	No records within 50km of the SGP boundary.	Unlikely
Anomalopus mackayi Long-legged worm-skink	Vul	End	Open grasslands with cracking black soil.	Marginal habitat (derived grasslands) for the species exists within the SGP, particularly in the southern region.	No records within the SGP; one record within 10km of the SGP. Most recent records (<20 years old) centred around Oakey and the Dalby. Never recorded west of the Condamine River.	Unlikely
Egernia rugosa Yakka skink	Vul	Vul	Usually occurs on well-drained, coarse, gritty soils in the vicinity of low ranges, foothills and undulating terrain (Wilson and Swan 2008; Richardson 2006), but can also be found on loam and clay soils (Eddie 2012).	Some suitable habitat for the species exists within the SGP, though the bulk is marginal or unsuitable.	Limited records within the region, one old historic record from within 25km of the SG, and anecdotally said to have been recently recorded somewhere in Barakula SF.	Unlikely
Tympanocryptis condaminensis Condamine Earless Dragon	End	End	Open grasslands and cropland with cracking black soil	Marginal habitat (derived grasslands) for the species exists within the SGP, particularly in the southern region.	Closest record 20km from SGP. No records known west of the Condamine River.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Aspidites ramsayi Woma	NT	-	Open habitats, brigalow and mulga woodlands, spinifex deserts	Some suitable habitat for the species exists within the SGP.	No records of the species within 50 km of the SGP. SGP outside species typical range.	Unlikely
Acanthophis antarcticus Common Death Adder	Vul	-	Found in a wide variety of habitats, including rainforest, open woodland, shrubland and heath (Wilson and Swan 2003).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Two records of the species are located within 5km of the SGP boundary, including one from 2015.	Possible
Furina dunmalli Dunmall's snake	Vul	Vul	Wide range of habitats, including forests and woodlands dominated by brigalow (*Acacia harpophylla*) and other Acacia spp., cypress (*Callitris* spp.) or bulloak (*Allocasuarina luehmannii*) on black alluvial cracking clay and clay loams (Covacevich *et al*. 1988; Stephenson and Schmida 2008).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Two old records (i.e. >20 years) exist in the southern portion of the SGP. An additional two records are located within 8km outside the SGP area, with the most recent record from 2000.	Possible
Hemiaspis damelii Grey snake	End	-	Inhabits dry eucalypt forest and occasionally pasture, favouring areas of cracking, flood-prone soils along floodplains and near watercourses within the Brigalow Belt (Wilson 2005).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Denisonia maculata Ornamental Snake	Vul	Vul	Found in Brigalow (*Acacia harpophylla*), Gidgee (*A. cambagei*), Blackwood (*A. argyrodendron*) or Coolibah (*Eucalyptus coolabah*)-dominated vegetation communities; can occur in regrowth. Typically associated with black soils (particularly gilgai).	Some suitable habitat for the species exists within the SGP, though suitable remnant habitat is typically fragmented and isolated.	No records within 50km of the SGP boundary. SGP considered outside species typically range.	Unlikely
Botaurus poiciloptilus Australasian Bittern	LC	End	Freshwater wetlands with dense vegetation, particularly reeds and sedges.	There are scattered areas of suitable habitat (i.e. ephemeral waterbodies with dense fringing vegetation in the western portion of Lake Broadwater and Long Swamp). However, these areas are marginal for the species.	Three records exist within 50km of the project area, with the most recent being in 1999. This species is highly vagrant and would be a very rare visitor to the SGP area.	Unlikely
Calidris ferruginea Curlew Sandpiper	End	CE	Saline and freshwater wetlands, saltmarshes, estuaries, mudflats. Prefers areas with exposed mud for foraging.	Estimated extent of suitable habitat within the SGP provided in GIS package.	Four records known from the southern section of the SGP, three at Lake Broadwater. While it is likely to occur at Lake Broadwater, the species has a low probability of occur at other locations within the SGP during Life of Operation.	Transient
Limosa lapponica baueri Bar-tailed Godwit	Vul	Vul	Saline and freshwater wetlands, saltmarshes, estuaries, mudflats. Prefers areas with exposed mud for foraging, usually within proximity to the coast.	Only likely at Lake Broadwater.	With the exception of two pre-1900 records, this species has been recorded on only three occasions between 1980 and 1987. All records are from Lake Broadwater	Unlikely/ Transient

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Rostratula australis Australian Painted Snipe	Vul	End	Found in a wide range of habitats including ephemeral swamps, dams, rice paddocks, waterlogged grasslands, roadside drains and even brackish waterways (Marchant and Higgins 1993).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Six records known from the southern section of the SGP, in the vicinity of Lake Broadwater. The species could occur with the SGP Life of Operation, though most likely restricted to these two areas.	Possible
Pedionomus torquatus Plains-wanderer	Vul	Vul	Open grasslands with patches of bare ground, low sparse shrublands	There is little suitable habitat within the SGP.	Outside of known range and all records are old (ie. >40 years).	Unlikely
Turnix melanogaster Black-breasted button-quail	Vul	Vul	Leaf litter in drier rainforests, vine thickets, lantana on rainforest edges, hoop pine plantation	There is no suitable habitat within the SGP.	Known from state forests north of, but connected to, Barakula State Forest. No known record from the SGP.	Unlikely
Falco hypoleucos Grey Falcon	NT	-	Lightly treed inland plains, gibber deserts, pastoral lands	Open areas of grazing land and derived grasslands might be considered marginal habitat.	Rarely recorded within the Brigalow Belt. The species does not occur with any frequency in the Project Area.	Unlikely
Erythrotriorchis radiata Red goshawk	End	Vul	Open forests, woodlands, wetlands, rainforest fringes	Suitable habitat for the species exists within the SGP.	One record from within the southern portion of the SGP and an addition three records within 20km of the SGP boundary. All records are old (i.e. >30 years) and the species rarely recorded in the Brigalow Belt.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Geophaps scripta scripta Squatter Pigeon	Vul	Vul	Occurs mainly in dry grassy eucalypt woodlands and open forests and also inhabits cypress pine (Callitris spp.) and Acacia dominated woodlands (Frith 1982)	Suitable habitat for the species exists within the SGP.	Two records exist within the SGP in the central region of the SGP, the most recent in 2012. Despite suitable habitat being present, this species is likely to vagrant, with individuals not representing a resident or seasonal population. May sporadically occur in the northern and central regions of the SGP during Life of Operation.	Transient
Calyptorhynchus lathami Glossy black-cockatoo	Vul	-	Inhabits woodlands and forests that have abundant Allocasuarina species and abundant large hollows suitable for nesting. Many populations are restricted to remnant vegetation within hills and gullies surrounded by agricultural land (Higgins 1999).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present
Lophochroa leadbeateri Major Mitchell's cockatoo	Vul	-	Sparsely timbered open grasslands, *Callitris* and *Casuarina* woodlands, mulga woodlands, trees in proximity to watercourses	Some areas of habitat SGP are marginal. Large areas are unsuitable.	Two records exist within the project site in the Lake Broadwater area. However, these records are more than 30 years old and indicate the species does not occur in the area with any frequency.	Unlikely
Lathamus discolour Swift parrot	End	CE	Flowering trees in forests and woodlands	Suitable habitat for the species exists within the SGP.	Records known from outside the SGP and are more than 50 years old. Any possible current or future occurrence would be of vagrant individuals.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Ninox strenua Powerful owl	Vul	-	Eucalypt forests on ranges with densely vegetated gullies, drier and lower elevation forest with sufficient prey and large hollows	Suitable habitat for the species exists within the SGP.	No records within the SGP and all records are old (i.e. >20 years). Rarely recorded within the Brigalow Belt.	Unlikely
Anthochaera phrygia Regent Honeyeater	End	CE	Forests and woodlands of ironbark, box, swamp mahoghany and river oak.	Suitable habitat for the species exists within the SGP.	Only two records exist within 10km of the SGP. Vagrant within the southern Brigalow Belt.	Unlikely
Grantiella picta Painted honeyeater	Vul	Vul	Found mainly in dry open woodlands and forests, particularly box-ironbark woodlands. It may also occur in riparian forest, on plains with scattered eucalypts and in remnant trees on farmland and their occurrence is strongly associated with mistletoe.	Estimated extent of suitable habitat within the SGP provided in GIS package.	Three records within the SGP in the southern portion near Lake Broadwater, and several records located within 10km of the SGP boundary, including records from the past few years. Likely to occur within the SGP infrequently.	Possible
Poephila cincta cincta Black-throated finch	End	End	Grassy scrublands, woodlands, dunes, Pandanus near water	Most areas of open woodland or grassland are heavily grassed and dominated by exotic grasses. Some areas of derived grassland may be suitable.	No longer occurs within local area or region. One record exists of the species within 10 km of the Project Area, however, this record is more than 50 years old.	Unlikely
Dasyurus hallucatus Northern Quoll	LC	End	Most common in rocky eucalypt woodland and open forest within 200 kilometres of the coast.	Some suitable habitat for the species exists within the SGP	No records within 50km of the SGP.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Dasyurus maculatus maculatus Spotted-tailed quoll	Vul	End	Inhabits a variety of forested habitats including subtropical and temperate rainforests, vine thickets, wet and dry sclerophyll forests, woodland and coastal scrub.	Some suitable habitat for the species exists within the SGP	Three records within the SGP and several within 20km of the SGP boundary, however, all records are old (i.e. >20 years), with the exception of a confirmed sighting of an injured animal near Tara within the past 5 years. This was likely a transient individual. The current status of this species in the Brigalow Belt is uncertain, and transient individuals may occur throughout the SGP, although this would a rare occasion.	Unlikely
Petauroides volans Greater Glider	Vul	Vul	Mainly restricted to eucalypt forests and woodlands where they typically occur in highest abundance in taller, montane, moist eucalypt forests with larger, relatively old trees and abundant hollows (Eyre 2004). In areas west of the Great Dividing Range, they are found in low woodlands (McKay 2008).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Phascolarctos cinereus Koala	Vul	Vul	Found in a diversity of habitats including temperate, sub-tropical and tropical forest, woodland and semi-arid communities, and sclerophyll forest, on foothills, plains and in coastal areas (Dyck & Stratham 2008). On the western side of the Great Dividing Range at the western edges of their range, the species is often associated with riparian vegetation although are not restricted to them (Melzer et al. 2000; Sullivan et al. 2003).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present
Petrogale penicillata Brush-tailed Rock-wallaby	Vul	Vul	Inhabits rock piles and cliff lines in vegetation ranging from rainforest to dry sclerophyll forests.	No suitable habitat for the species exists within the SGP	No records within 50km of the SGP.	Unlikely
Pteropus poliocephalus Grey-headed flying-fox	LC	Vul	Foraging habitat includes rainforests, open eucalypt forests, woodlands, Melaleuca swamps and Banksia woodlands. Roosts are commonly within dense vegetation close to water, primarily rainforest patches, stands of Melaleuca, mangroves or riparian vegetation (Nelson 1965).	Suitable foraging habitat for the species exists within the SGP.	Three records within 50km of SGP, including records from 2011. Individuals are known to occasionally use a seasonal flying-fox camp along Myall Creek in Dalby. The species is a typically a vagrant west of the Great Dividing Range and would be a rare visitor to the SGP.	Unlikely
Macroderma gigas Ghost Bat	End	Vul	Habitats used for foraging vary from dry open woodlands to tropical rainforests (Wilmer 2012).	Suitable foraging habitat for the species exists within the SGP.	One very old record (i.e. >200 years) outside of the SGP. Presumed locally extinct in the area.	Unlikely

Scientific Name Common Name	Status[#]		Typical Habitat	Habitat within the SGP	Local Records	Likelihood Assessment
	NCA	EPBC				
Chalinolobus dwyeri Large-eared Pied Bat	Vul	Vul	Often observed along ecotones on rainforest edges or in association with sandstone escarpments (DoE 2017).	No suitable habitat for the species exists within the SGP.	No records within 50km of the SGP.	Unlikely
Nyctophilus corbeni South-eastern long-eared bat	Vul	Vul	Found more commonly in box/ironbark/cypress pine woodland on sandy soils. It also occurs in bulloak (*Allocasuarina luehmannii*), brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) communities (Turbill and Ellis 2006; Churchill 2008).	Estimated extent of suitable habitat within the SGP provided in GIS package.	Recorded during surveys.	Present
Pseudomys australis Plains Rat	End	Vul	Cracking clay depressions and small drainage lines on arid gibber plains, and vast, cracking clay plains (Van Dyck et al 2013).	No suitable habitat for the species exists within the SGP	One very old record (i.e. >100 years) within 10km outside of the SGP. Presumed locally extinct in the area.	Unlikely

[#] LC = Least Concern, NT = Near Threatened, Vul = Vulnerable, E = Endangered, CE = Critically Endangered, Mig = Migratory

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Appendix D.
Threatened Ecological Communities and Regional Ecosystem Descriptions

THREATENED ECOLOGICAL COMMUNITIES

Brigalow Dominant and Co-dominant

Status

Endangered EPBC Act: Component Regional Ecosystem 11.3.1, 11.4.3/11.4.3a, 11.9.5 Endangered under the VM Act and Biodiversity Act.

Total number of survey sites:

70 Sites in Total (RE11.3.1- 11 Secondary, 23 Quaternary; RE11.4.3 - 8 Secondary, 19 Quaternary; 11.9.5 – 2 Secondary, 7 Quaternary).

Within the SGP assessment area, the Brigalow Dominant and Co-dominant Ecological Community comprises the following REs:

- RE11.3.1 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on alluvial plains)
- RE11.4.3/ 11.4.3a *Acacia harpophylla* and/or *Casuarina cristata* shrubby open forest on Cainozoic clay plains)
- RE11.9.5 (*Acacia harpophylla* and/or *Casuarina cristata* open forest on fine-grained sedimentary rocks)

Other relevant habitats included in the ecological community include Brigalow regrowth >15 yrs old which have similarly been mapped under the Brigalow ecological community.

Regional Ecosystem 11.3.1

The ecosystem has been highly fragmented throughout its range, generally existing as linear remnants within roadside reserves and stock routes. The most extensive occurrences are located on the floodplain of the Condamine River and Wilkie Creek to the west of Dalby with scattered occurrences occurring throughout the broader project development area. Typical canopy heights range from 15 to 23 m in better preserved examples where projected canopy covers range 30 to 60%. Whilst *Acacia harpophylla* generally forms the dominant canopy, *Casuarina cristata* predominates in some locations. Typical sub-canopy trees include *Acacia harpophylla,* and *Casuarina cristata* with shrubby layers often dominated by *Geijera parviflora, Pittosporum angustifolium, Melaleuca bracteata, Alectryon oleofolious* subsp*. elongatus, Alectryon diversifolius, Elaeodendron australe* var*. integrifolium, Ehretia membranifolium,* and *Optuntia stricta*.* Ground cover percentage is variable with typical species being *Paspalidium caespitosum, Ancistrachne uncinulata, Aristida* spp., *Enychleana tomentosa, Rhagodia spinescens, Einadia hastata,* and *Solanum parvifolium,* although *Harissia martinii** and *Bryophyllum delagoense** may be typically abundant.

Community condition is typically poor, a testament to edge effects created by massive fragmentation. The class 2 declared weed species prickly pear (*Opuntia stricta),* velvet pear (*Opuntia tomentosa)* and harissa cactus (*Harissia martini)* are highly prominent in shrub and ground layers and frequent canopy gaps, caused by canopy dieback and senescence in the absence of recruitment is a compounding problem.

Tall brigalow woodland (RE11.3.1) on the alluvial plain of Wilkie Creek (Site AS138).

Regional Ecosystem 11.4.3

The distinction between RE11.3.1 and RE11.4.3 is based largely on landscape position rather than any recognisable floristic expression. RE11.3.1 by definition, occupies alluvial landforms, and as such is associated with flood plains, river terraces and associated drainage depressions and swamps. The heavy clay soils associated with land zone (LZ) 4 are raised above the influence of current river systems and in the majority cases, this provides the only basis for distinction. Both ecosystems occupy heavy clay soils with shrink and swell properties (vertosols) and gilgai micro-topography.

The productivity of the associated soil types has resulted in extensive fragmentation of this ecosystem and remaining occurrences are generally highly fragmented and isolated. Intact examples are generally associated with with stock routes where the remnants, although linear, are generally continuous with adjacent ecosystems. The Chinchilla Sporting Shooters Club (which is located on the Chinchilla Sands Local Fossil Fauna Site) hosts one of the better preserved and more extensive examples observed with the project development area. In this location *Acacia harpopylla* forms the dominant canopy to 25 m, mixed to varying degrees with *Casuarina cristata* with a predominant canopy cover ranging from 30% to 60% dependant largely on habitat condition. The sub-canopy is typically formed by *Acacia harpophylla* and *Casuarina cristata* mixed with a range of vine thicket shrubs and trees including *Geijera parviflora, Ehretia membranifolia, Alectryon oleofolia* subsp*. elongatus* and *Carissa ovata.*

The classification also includes RE11.4.3a, a wetland community formed by *Eucalyptus woollsiana* with a sub-canopy formed by *Melaleuca bracteata* (Site AQ163). A relatively extensive area is mapped within PL 253 (in the Linc-Energy operational area) although this area was assessed remotely and requires ground truthing to confirm the true nature of the habitat for confirmation.

The community is degraded throughout much of its range with sub-canopy layers often dominated by *Opuntia spp.* and *Harissia martini.* Canopy dieback, although a natural feature of the brigalow community, is severe in some locations. Excessive light penetration through a dramatically reduced canopy cover has further promoted the invasion of exotic species into the ground cover and shrub layers.

Well-developed woodland of Acacia harpophylla and Casuarina cristata characteristic of RE11.4.3.

Regional Ecosystem 11.9.5

This ecosystem was sampled in one locality to the west of Wandoan where it formed an open forest of *Acacia harpophlla* mixing with *Casuarina cristata* and emergent of *Brachychiton rupestris*. The canopy typically form 60% cover and canopy heights reaching 23m. Shrub layers are typically mid-dense and predominantly occupied by *geijera parviflora, Eremophila mitchellii* and *Santalum lanceolatum*. RE11.9.5 forms small scattered remnants throughout the rolling sedimentary landscapes of the Wandoan region in the northern portion of the SGP assessment area.

Fragmented patch of RE11.9.5 in the Wandoan area.

Weeping Myall Woodlands

Status

Endangered EPBC Act (Not Represented in VM Act)

Total Number of Survey Sites

2 Secondary

In Queensland, the Weeping Myall Woodlands TEC is known to occur as small patches within REs 11.3.2 and 11.3.28 (DEWHA, 2009a), although the latter ecosystem is not known to occur in the project development area. The best-preserved examples are typically associated with road reserves and stock routes although the community is not considered to form woodland communities of sufficient extent to be consistently separated as an ecosystem. As such, the community is not recognised as an individual ecosystem within the framework of Queensland's VM Act. The patchy nature of the community also makes delineation difficult, hence the ecological community may be easily overlooked. Based on descriptions provided by DEWHA (2009a) and TSSC (2008t), the following applies to the Weeping Myall Woodlands TEC:

- The Weeping Myall Woodlands TEC range from open woodlands to woodlands, generally 4 to 12m high. The overstorey is dominated by weeping myall (*Acacia pendula*) trees and in

some cases this species may be the only tree canopy species. Other common names for weeping myall include myall, boree, balaar, nilyah, bastard gidgee, and silver leaf boree.

- Other woodland species may also form part of the overstorey of the ecological community. These include: western rosewood (*Alectryon oleifolius* subsp. *elongatus*); poplar box (*Eucalyptus populnea*); or black box (*Eucalyptus largiflorens*). Grey mistletoe (*Amyema quandang*) commonly occurs on the branches of weeping myall trees throughout the ecological community's range.
- The Weeping Myall Woodlands ecological community can naturally occur either as a grassy or a shrubby woodland. However, the understorey often includes an open layer of shrubs over a ground layer which includes a diversity of grasses and forbs. The ground layers can vary in species composition and cover depending on past and current grazing regimes, and the occurrence of recent rain.

The following condition thresholds for the Weeping Myall Ecological Community apply based on DEWHA (2009):

- The patch of woodland must be at least 0.5 ha (5000 m²) in size.
- The overstorey must have at least 5 per cent tree canopy cover or at least 25 dead or defoliated mature weeping myall trees per hectare.
- The tree canopy must be dominated (at least 50 per cent of trees present) by living, dead or defoliated weeping myall trees.
- The patch has more than two layers of regenerating weeping myall present.

A single occurrence of the Weeping Myall Ecological Community was observed in the Theten area although the habitat was was not recorded within any other location within the SGP assessment area. The observed community formed a low open woodland with canopy heights ranging from 6 m to 10 m with a lower shrub layer at 3m to 6m, merging with a lower shrub layer. The projected canopy cover of the community was formed by 55 % cover of weeping myall (*Acacia pendula)* with scattered eucalypts including poplar box (*Eucalyptus populnea)* forming less than four % of the upper strata. Ground cover is formed by predominantly native graminoids and soils were moist, becoming saturated in depressions. The community was fringed by regrowth woodland of Poplar Box and Queensland Blue Gum (*Eucalyptus tereticornis)* although there is no clear indication that the ecological community originally occurred within RE 11.3.2. The extent of the ecological community at this location was 0.85 ha, well within patch size thresholds. Regional distribution mapping provided by DEWHA (2009) indicates the greatest likelihood for occurence of the Weeping Myall TC is in a band that stretches from Roma to Blackall, west of the project development area meaning that any occurrences are highly significant, representing the eastern limits of the ecological community distribution.

The Weeping Myall TEC in the Theten area (survey site GB82).

Coolibah – Black Box Woodland

Status

Endangered EPBC Act: Component Regional Ecosystems 11.3.3 (Of Concern VM Act and Biodiversity Status)

Total number of survey sites across project area

3 Sites in Total (3 Secondary).

The Coolibah – Black Box Woodlands TEC represents occurrences of one type of eucalypt woodland where *Eucalyptus coolabah* subsp. *coolabah* (coolibah) and/or *Eucalyptus largiflorens* (black box) are the dominant canopy species and where the understory tends to be grassy (TSSC 2011a). The condition thresholds to identify the ecological community are provided below (from TSSC 2011b):

- Patch size: The minimum patch size is 5 ha which may include areas of native vegetation that may be naturally open or contain regrowth.
- The crown cover of trees must be > 8 %.
- Coolibah and coolibah and/or black box in the tree canopy must be present in the patch that are either mature trees with a DBH > 30cm; are coppiced trees with a main stem > 20cm or; hollow bearing trees.
- The ecological community must have a ground-cover in which 10% or more contains native graminoids, herbs or shrubs.

Whilst RE11.3.3 is mapped relatively broadly in certified regional ecosystem mapping (Version 8.0, 2017) in the Chinchilla region, and Eucalyptus coolibah occurs as a component tree in riparian habitats of the Condamine River, the majority of these patches are considered too small or degraded to provide representation of the TEC. A few minor occurrences are however identified on the Theten property and the adjacent habitats of Wilkie Creek where they occupy a combined area of 23 ha with the largest patch covering an area of 10ha. Typical canopy heights range from 10 – 15m and up to 40 % projected canopy cover. Ground layers are dominated by native species (> 60 %) including a range of native graminoids and forbs (*Eleacharis spp. Walwhelleya subxerophila* and *Marsilea drummondii* predominate). Exotic species, which form < 20% of the ground cover are dominated by lippia *(Phyla canescens).* The habitat typically occupies broad drainage depressions and overflow channels on major watercourses.

Coolibah / Black Box Woodland Ecological Community (RE11.3.3) on Theten (survey site GB74 _ 2433)

OTHER ENDANGERED/OF CONCERN REGIONAL ECOSYSTEMS

Regional Ecosystem 11.3.17

Eucalyptus populnea woodland with Acacia harpophylla and/or Casuarina cristata on alluvial plains

Status

VMA Status: Endangered

Biodiversity Status: Endangered

Total number of survey sites across project area

15 Sites in Total (1 Secondary and 14 Quaternary / Observation).

This community occurs on alluvial plains, typically near watercourses with the largest representations in the southern survey area in the Lake Broadwater Region. The habitat is also mapped in the northern assessment area near Wandoan. In a typical occurences, the canopy is dominated by Poplar Box (*Eucalyptus populnea*) and ranges between 16-26m in height with a mean PPC of 40%. Additional trees in the canopy layer are Belah (*Casuarina cristata*), Brigalow (*Acacia harpophylla)* and occasional Grey Box (*Eucalyptus woollsiana*). The second tree layer is well developed and comprises the above canopy species together with Western Rosewood (*Alectryon oleofolius*), Weeping Pittosporum (*Pittosporum angustifolium*) Sally Wattle (*Acacia salicina*), *Casuarina cristata* and other associated species including *Callitris glaucophylla, Alectryon oleofolius* subsp*. elongatus*, *Melaleuca bracteata,* and *Alphitonia excelsa.* The shrub layer is typically dominated by a sparse cover of *Geijera parviflora, Citurs glauca, Capparis mitchellii,* and *Elaeodendron australe* var*. integrifolium*. Exotic ground covers, in particular Lippia (*Phyla canescens**) in the south and Buffel Grass (*Cenchrus ciliaris*Green Panic (*Megathyrsus maximus var. trichoglume)* contribute to approximately 50% of the overall cover, with scattered infestations of Harissa Cactus (*Harissia martini**), Noogoora Bur (*Xanthium occidentale**), and Mayne's Pest (*Verbena aristigera**), African Love Grass (*Eragrostis curvula**), Paspalum (*Pasplalum dilatatum**), and Giant Panic (*Magathrysus maximus* var. *maximus**). Native grasses and sedges dominate the cover.

Degraded patch of RE11.3.17 in the Wandoan region (Site DS155_300).

Regional Ecosystem 11.3.2

Eucalyptus populnea woodland on alluvial plains.

Status

VMA Status: Of concern

Biodiversity Status: Of concern

Total number of survey sites across project area

54 Sites in Total (9 Secondary and 45 Quaternary / Observation).

This community is consistently dominated by poplar box (*Eucalyptus populnea*) with a canopy height ranging between 10-16m and a mean crown cover of 41%. Associated canopy trees may include Queensland Blue Gum (*Eucalyptus tereticornis*) and Moreton Bay Ash (*Corymbia tessellaris*). A sparse second tree layer comprises the above canopy species. The shrub layer is generally poorly developed with scattered poplar box saplings and occasional shrubs of velvet pear (*Opuntia tomentosa**).

The groundcover is often weedy, affected by infestations of Buffel Grass (*Cenchrus* ciliaris), African Love Grass (*Eragrostis curvula**), Lippia (*Phyla canescens*), Mayne's pest (*Verbena aristigera**), Harissa Cactus (*Harissia martini**) and Mother of Millions (*Bryophyllum*

delagoense) in some localities, which contribute to a mean exotic cover of 35% across all survey sites. Dominant graminoid species include *Aristida caput-medusae, Aristida acuta, Chloris truncata, Dichanthium sericeum* subsp*. sericeum, Digitaria brownii, Eulalia aurea,* and *Paspalidium* sp., with common native herbs of *Chrysocephalum apiculatum, Cheilanthes sieberi, Cyanthillium cinereum, Desmodium campylocaulon, Rostellularia adscendens,* and *Wahlenbergia communis*.

There is often some evidence of selective thinning of the canopy species, although large mature trees remain throughout with evidence of canopy recruitment in the shrub layers in most habitats.

Well preserved representation of RE11.3.2 in the Central Assessment Area (Site DS132_275).

Regional Ecosystem 11.3.4

Eucalyptus tereticornis and/or Eucalyptus spp. tall woodland on alluvial plains.

Status

VMA Status: Of concern

Biodiversity Status: Of concern

Total number of survey sites across project area

52 Sites in Total (12 Secondary and 40 Quaternary / Observation).

This ecosystem occurs on seasonally flooded alluvial plains associated with both minor and major drainage lines. The canopy height ranges between 14-24m and a mean crown cover of 28 - 45%. A typical representation is dominated by Queensland blue gum *(Eucalyptus tereticornis)* and rough-barked apple *(Angophora floribunda)* mixed with other species including Moreton Bay Ash (*Corymbia tessellaris)* and occasional Poplar Box (*Eucalyptus populnea)*. The relative proportions of these tree varies with rough-barked apple dominant in some habitats, particularly along the frontage of Wambo Creek.

The second tree layer is sparse and comprises the above canopy species together with *Acacia salicinia* and kurrajong (*Brachychiton populnea*). The shrub layer ranges between 1-4 m in height with a mean cover of 22%. Dominant species are Moon Wattle (*Acacia semilunata*) in the northern area with frequent Yellow Tea Tree (*Leptospermum polygalifolium*), Black Wattle (*Acacia leiocalyx),* Glory Wattle *(Acacia spectabilis),* Wilga *(Geijera parviflora),* and Paper Bark *(Melaleuca decora).*

The ground layer is variable ranging from good condition in the habitats surrounding Miles to highly degraded in habitats associated with the Condamine River Flood Plain in the Dalby region. Typical native groundcover species include *Lomandra longifolia, Aristida caput-medusae, Aristida acuta, Chloris truncata, Dichanthium sericeum* subsp*. sericeum, Digitaria brownii, Eulalia aurea, Gahnia aspera, Heteropogon contortus, Juncus continuus.,* and *Paspalidium* sp., with common native herbs including *Chrysocephalum apiculatum, Cheilanthes sieberi, Cyanthillium cinereum, Desmodium campylocaulon, Dianella longifolia* var*. longifolia, Rostellularia adscendens,* and *Wahlenbergia communis*. Exotic species associated with this regional ecosystem include Green Panic (*Panicum maximum var. trichoglume)* limited to scattered occurrences Mayne's Pest (*Verbena aristigera**), Buffel Grass (*Pennisetum ciliare**) and Liverseed Grass (*Urochloa mosambicensis**).

There is some evidence of selective thinning in many locations and canopy recruitment is lacking in some habitats along the Condamine River where grazing pressure is particularly high. Heavily grazed fringe of RE11.3.4 along the Condamine River

Heavily grazed fringe of RE11.3.4 along the Condamine River

Regional Ecosystem 11.3.25

Eucalyptus camaldulensis or Eucalyptus tereticornis open-forest to woodland. Occurs on fringing levees and banks of major rivers and drainage lines of alluvial plains.

Status

VMA Status: Least concern

Biodiversity Status: Of concern

Total number of survey sites across project area

130 Sites in Total (17 Secondary, 4 Tertiary and 109 Quaternary / Observation).

Maximum development of RE11.3.25 is associated with the riparian margins of the lines of Condamine River and larger tributaries such as Wilkie Creek. The ecosystem however occurs broadly throughout the SGP assessment areas where it fringes both major and minor drainage lines. At its maximum development, canopy heights range from 23 - 33 metres and a mean crown cover of 46%. Dominant canopy trees are River Red Gum (*Eucalyptus camaldulensis* and Queensland Blue Gum *(Eucalyptus tereticornis),* Rough Barked Apple (*Angophora floribunda*) and Moreton Bay Ash (*Corymbia tessellaris*). A sparse sub-canopy is dominated by the above species with occasional willow wattle (*Acacia salicina*) and cooba (*Acacia*

stenophylla). Shrub cover is very sparse (0-5% cover) with scattered willow wattle, cooba and prickly mimosa (*Acacia farnesiana**). The sparse ground cover which averages at 23% is attributed to scouring of groundcover species from recent flood events. Mean cover is dominated by exotic species with grasses such as Green Panic (*Megathyrsus maximus var. trichoglume**), Purple Top Rhodes (*Chloris virgata**), and Couch Grass (*Cynodon dactylon**). Saltwater Couch (*Sporobolus virginicus)* was also a dominant cover on some sections of Wilkie Creek, being an indication of salinity. Natives such as Mat rush (*Lomandra longifolia*) and Blady Grass (*Imperata cylindrica*) characterise the native component of the groundcover in most habitats examined.

Weedy representation of RE11.3.25 on the Condamine River.

Regional Ecosystem 11.3.27

Palustrine wetland (vegetated swamp).

Status

VMA Status: Least concern

Biodiversity Status: Of concern

Total number of survey sites across project area

28 Sites in Total (7 Secondary, 21 Quaternary / Observation).

Floodplain wetlands are generally associated with the flood overflow channels characteristic of the flood plains of major river systems throughout the SGP assessment area. The wetlands play an important hydrological role, facilitating nutrient exchange between aquatic and terrestrial ecosystems during periods of seasonal overbank flow. The Condamine River floodplain hosts a complex wetland system with RE11.3.27 forming mosaics with RE11.3.25, 11.3.2 and 11.3.4 throughout its entire length with a variety of wetland types recognised.

Lake Broadwater, mapped as RE11.3.27a (Freshwater Lake) is a seasonal water feature that is recognised nationally for its natural values, being significant at a national and state level. The lake is listed on the Directory of Important Wetlands and is recognised as being a rare example of a semi-permanent freshwater lake in the bioregional area (Blackman *et al.* 1999).

Long Swamp, a similar vegetated wetland ecosystem that discharges on a seasonal basis into Wilkie Creek. Representation of the feature as RE11.3.2 in Certified RE Mapping (DERM 2009b) is incorrect with field survey confirming features typical of RE11.3.27d (palustrine wetland). Long Swamp is heavily utilised for irrigation purposes which has undoubtedly affected hydrological function, species composition of the ground layers, the vigour of the canopy trees and reduced its overall biodiversity values. Long Swamp is a sinuous hydrological feature (overland flow path) that flows across the Condamine Alluvium in a north-westerly direction to the east and north of Lake Broadwater, before joining with Wilkie Creek to the west. The feature occupies a broad depression on the alluvium with the central portion of the depression formed by heavy clay. Surface water is present seasonally and following dry spells the associated vertosol soils form deep hummocks and cracks. There was no flow, nor any significant pooled water within Long swamp during the field visits, despite heavy recent rains. These observations together with the observations of deep, open cracks in the central swamp channel soil surface confirmed that the feature is only active during flooding.

Vegetation is predominantly native with although exotic groundcovers predominant in some localities. The canopy is formed by tall, broadly spaced River Red Gum (*Eucalyptus camaldulensis)* at approximately 15 - 30% cover with Poplar Box (*Eucalyptus populnea)* forming on the swampy margins. The canopy is significantly stressed in some areas with signs of senescence and foliage loss in the Red Gums which predominate the canopy. The noted senescence can largely be attributed to historic groundwater drawdown in shallow sandy alluvial aquifers, compounded by surface water extraction for irrigation (Kath et al 2014; 3D Environmental 2016).

Of the four secondary vegetation survey sites completed during the dry season survey (DS21, DS22, DS26, DS31 completed when the swamp was dry), exotic vegetation cover contributed on average to 15% to the total groundcover, and formed 39% of the total living groundcover mixing with native species including Nardoo (*Marsilea drummondii),* Water Chestnut (*Eleocharis dulcis)* and scattered native grasses including *Panicum decompositum*. Lippia (*Phylla canescens)* was the most abundant exotic forb blanketing the clay soils, particularly where grazing pressure is most intense. It should be noted that groundcover composition will vary seasonally with native aquatic sedges, particularly Water Chestnut becoming dominant during periods of standing surface water.

Long Swamp with characteristic River Red Gum (*Eucalyptus camaldulensis)* showing moderates signs of stress as suggested by foliage loss.

The most extensive of the wetland types is RE11.3.27c which forms by the extensive floodplain system of channel overflows and anabranches that are seasonally activated during periods of overbank flow. The regional ecosystem sub-type is associated with the alluvial depressions along the Condamine River floodplain. It is a palustrine wetland ecosystem with an overstorey of scattered River Red Gum over a sedgeland groundcover with semi-permanent water. The composition of the ground cover is simple and limited to Water Chestnut (*Eleocharis plana),* Juncus (*Juncus continuus)* with scattered native herbs such as Lesser joyweed (*Alternanthera denticulata*) and Eclipta (*Eclipta prostrata*). Infestations of Lippia (*Phyla canescens*) occur throughout the ecosystem, although are generally only evident when wetlands are dry.

Overflow channel of the Condamine River providing representation of RE11.3.27c. The system was seasonally dry and ground cover was dominated by a dense infestation of Lippia.

Regional Ecosystem 11.9.7

Acacia harpophylla, Eucalyptus populnea open forest on fine-grained sedimentary rocks

Status

VMA Status: Of Concern

Biodiversity Status: Endangered

Total number of survey sites across project area

1 Quaternary

A single small polygon of 1.5ha is located in the northern assessment area, representing a remnant sliver that runs along a footslope, contiguous with remnant riparian vegetation on a creek line. The canopy has been fragmented with a cover of up to 30% and canopy heights range from 18 to 23m. The sub-canopy and shrub layers are sparse, typically < 5% cover formed by Wilga (*Geijera parviflora*) and Sandalwood (*Santalum lanceolatum*). Whilst the habitat has been subject to heavy grazing, the ground covers are predominantly native and are formed by *Themeda triandra, Dicanthium sericeum, Paspalideum caespitosum, and Chloris ventricosa.*

Regional Ecosystem 11.9.10

Acacia harpophylla, Eucalyptus populnea open forest on fine-grained sedimentary rocks

Status

VMA Status: Of Concern

Biodiversity Status: Endangered

Total number of survey sites across project area

3 Sites in Total (3 Quaternary)

Small scattered remnants are located in the northern assessment area with the fragmented landscapes surrounding Wandoan where patch sizes are typically 1 to 2ha. The ecosystem exists in small remnants that are isolated from larger patches of remnant vegetation. Canopy heights are generally in the range of 9 to 16m with up to 35 % projected canopy cover formed by *Eucalyptus populnea* and a sub-canopy of *Acacia harpophylla, Casuarina cristata* and occasional *Callitris glaucophylla*. Shrub layers are sparse (10 – 20%) dominated by *Geijera parviflora, Eremophila mitchellii* and *Atalaya hemiglauca.* Ground covers are formed by a mix of native and exotic species including *Paspalidium caespitosum, Sporobolus creber, Aristida ramosa, Capparis lasiantha, Sclerolaena sp., Enchylaena tomentosa, Sida sp., Nyssanthes diffusa, Senecio brigalowensis, Salsola australis, Bothriochloa decipiens, Enteropogon acicularis, Aristida calycina, Enteropogon ramosus, Sporobolus caroli* and patches of Buffel Grass (*Cenchrus ciliaris).*

Regional ecosystem 11.9.10 at Site Q69_631 near Wandoan.

LEAST CONCERN REGIONAL ECOSYSTEMS

Regional Ecosystem 11.3.14

Eucalyptus tereticornis and/or Eucalyptus spp. tall woodland on alluvial plains.

Status

VMA Status: Least Concern

Biodiversity Status: No Concern at Present

Total number of survey sites across project area

31 Sites in Total (8 Secondary, 1 Tertiary and 22 Quaternary / Observation).

This ecosystem is associated with both shallow alluvial depressions and sandy rises on flood plains where it is characterised by mix of eucalyptus species including River Red Gum (*Eucalyptus camaldulensis),* Rough Barked Apple (*Angophora floribunda),* Smooth Barked Apple (*Angophora leiocarpa)* and an often dense to mid-dense sub-canopy of *Callitris glaucophylla*. Sub-canopy is variable although habitats on sandy substrates are often characterised by a mid-dense sub-canopy of *Callitris glaucophylla* and Black Wattle (*Acacia leiocalyx).* The canopy height ranges between 18-26m and canopy cover that ranges from 40 to 65%. Ground covers are generally intact, formed by dense swards of Blady Grass (*Imperata*

cylindrica), Reed Grass (*Arundinella nepalensis), Heteropogon contortus* and often dense cover of Mat-rush (*Lomandra longifolia).*

RE11.3.14 associated with a sandy rise above the Condamine River Flood Plain (AS12_2346)

Regional Ecosystem 11.3.18

Eucalyptus populnea, Callitris glaucophylla, Allocasuarina luehmannii shrubby woodland on alluvium

Status

VMA Status: Least Concern

Biodiversity Status: No Concern at Present

Total number of survey sites across project area

13 Sites in Total (2 Secondary, 11 Quaternary / Observation).

Regional ecosystem RE 11.3.18 is restricted to the southern assessment area where it occupies sandy alluvial associated with largely with ephemeral watercourses. Canopy heights range from 12 – 23m with typical canopy cover of 35 – 45%. The dominant canopy tree is Poplar Box (*Eucalyptus populnea)* with occasional Moreton Bay Ash (*Corymbia tessellaris),* Rough Barked Apple (*Angophora floribunda)* and Narrow leafed Ironbark (*Eucalyptus crebra).* The sub-canopy and shrub layer is universally occupied by a dense to mid-dense sub-canopy of White Cypress (*Callitris glaucophylla)* and less abundant Bulloke (*Allocasuarina leuhmannii)* with Sally Wattle (*Acacia salicinia)* and Black Wattle (*Acacia leiocalyx)* generally associated. Ground cover is typically native, often with dense mats of Matrush (*Lomandra longifolia)* and native grasses including *Chrysopogon fallax,* Kangaroo Grass (*Themeda triandra), Chloris truncata,* Black Spear Grass (*Heteropogon contortus)* and *Aristida caput-medusae* in areas of poorer soil. African Love Grass (*Eragrostis curvula)* is prominent in some occurrences south of Dalby and Mother of Millions forms a dense infestation in habitats associated with Braemar Creek.

RE11.3.18 at site on a broad drainage channel in the Tipton Area (GB101_2402)

Regional Ecosystem 11.3.26

Eucalyptus moluccana or E. microcarpa woodland to open forest on margins of alluvial plains.

Status

VMA Status: Least Concern

Biodiversity Status: No Concern at Present

Total number of survey sites across project area

8 Sites in Total (3 Secondary, 5 Quaternary / Observation).

Small areas (25ha in total) occur in the southern and central assessment areas on broad loamy flats formed from alluvial outwash. Canopy heights range from 12 – 22m with typical canopy cover ranging from 25 to 55%. The dominant canopy tree is Grey Box (*Eucalyptus woollsiana)* occasionally with scattered Poplar Box (*Eucalyptus populnea)* in the sub-canopy. Shrub layers are typically sparse formed by Grey Box, *Acacia semilunata* and Bulloke (*Allocasuarina leuhmannii).* The ground layer is also sparse with up to 40% living cover of *Eragrostis bimaculate, Aristida caput-medusae, Gahnia aspera,* Variable Sword Sedge (*Lepidosperma laterale)* and the low shrub *Dodonaea macrossanii*. Regional Ecosystem 11.3.26 provides habitat for the Endangered sedge *Fimbristylis vagans* in the Lake Broadwater area.

Regional Ecosystem 11.5.1

Eucalyptus crebra, Callitris glaucophylla, Angophora leiocarpa, Allocasuarina luehmannii woodland on Cainozoic sand plains/remnant surfaces.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

542 Sites in Total (30 Secondary, 2 Tertiary, 510 Quaternary / Observation).

Regional Ecosystem 11.5.1, including sub-type 11.5.1a is the most extensive habitat type in the SGP assessment area. The ecosystem occurs on loamy to sandy clay soils which are associated with extensive areas of broad, flat to gently undulating plains. The typical canopy height ranges between 10-22m and a mean crown cover of 37%. It is dominated by Narrow Leaf Ironbark *(Eucalyptus crebra / Eucalyptus elegans)* with associated Smooth Barked Apple *(Angophora leiocarpa),* White Cypress *(Callitris glaucophylla)* and Poplar Box *(Eucalyptus populnea).* Where Poplar Box is dominant, the ecosystem is mapped as RE11.5.1a. A sparse second tree layer has an average height of 8.5m and is dominated by White Cypress (*Callitris glaucophylla*) and Bulloke (*Alloacasuarina Luehmannii)* with less frequent narrow leaf ironbark.

A diverse upper shrub layer ranges between 5-30% in cover with a mean height of 4%. Bulloke and White Cypress predominate across all sites surveyed. Other typical species are Moon Wattle (*Acacia semilunata*), *Acacia ixiophylla, Melaleuca decora, Acacia apprepta, Acacia crassa* subsp. *crassa*, *Acacia* l*eiocalyx*, *Acacia spectabilis*, *Petalostigma pubescens, Alphitonia excelsa,*

Grevillea striata, and *Ozanthamnus diosmifolius.* The lower shrub layer averaging at 2m in height and 18.5 % in cover, is similarly diverse comprising species which include *Leucopogon* sp.*, Callitris glaucophylla*, *Acacia crassa* subsp*. crassa* and *Allocasuarina Luehmannii.*

Diversity of the the ground layer varies dependent on disturbance history and grazing regimes although in tends to be relatively diverse. Dominant species include *Aristida caput-medusae, Fimbristylis dichotoma, Chrysopogon fallax, Cyanthillium cinereum, Dodonaea macrossanii, Panicum decompositum, and Themeda triandra.* Frequent species include *Aristida calycina, Commelina lanceolata, Eragrostis sororia, Goodenia* sp. and *Lomandra multiforla*. Naturalised species are limited to scattered occurrences of *Melinus repens*, Opuntia stricta**, *Opuntia tomentosa**, *Paspalum dilatatum** and *Pennisetum ciliare*.*

Most occurrences have been moderately to heavily logged with selective targeting of the Narrow Leaf Ironbark.

Typical occurrence of RE11.5.1 in Kumbarilla State Forest. Habitat in this location is in good condition.

Regional Ecosystem 11.5.4

Eucalyptus chloroclada, Callitris glaucophylla, C. endlicheri, Angophora leiocarpa woodland on Cainozoic sand plains and/or remnant surfaces

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

55 Sites in Total (2 Secondary, 53 Quaternary / Observation).

Regional Ecosystem 11.5.4 shares floristic similarities with RE11.5.1 merging in regard to floristic attributes and landform associations. The ecosystem tends to occur on sandier soils than RE11.5.1, often occupying low sandy rises. The canopy height tends to vary with examples of lower stature ranging in height between 10-22m with some taller representations in Kumbarilla State Forest attaining heights of up to 30m. Crown cover values range from Canopy cover also tends to vary ranging from 30 to 60%. Smooth Bark Apple (*Angophora leiocarpa)* and Dirty Gum (*Eucalyptus chloroclada)* are the dominant species with Narrow Leaf Ironbark *(Eucalyptus crebra)* generally present*. A sparse to mid-dense second tree layer has an average height of 8.5m and is generally present attaining heights of 12m and dominated by Smooth Barked Apple, Dirty Gum and White Cypress (Callitris glaucophylla),* Budgeroo (*Lysicarpus angustifolius),* Stringy Bark She-oak (*Allocasuarina inophloia), Melaleuca decora* with less frequent Bulloke *(Alloacasuarina Luehmannii).*

Shrub layers are generally dominated by White Cypress, Budgeroo, Stringy Bark She-oak, *Acacia ixiophylla, Melaleuca decora, Acacia crassa subsp. crassa, Acacia leiocalyx, Acacia spectabilis, Petalostigma pubescens, Alphitonia excelsa* and *Acacia semilunata* in the northern occurrences.

Ground cover tends to be sparse to mid-dense (15 to 40% living cover) with dominant species include *Aristida caput-medusae, Ancistrachne uncinellata, Gahnia aspera, Lomandra multflora, Aristida ramosa, Aristida salicinia* and Grass Tree (*Xanthorrhoea johnsonii*) in some localities.

Representative structure of RE11.5.4 in Kumbarilla State Forest with sparse canopy cover.

Regional Ecosystem 11.5.20

Eucalyptus moluccana and/or E. microcarpa/ E. pilligaensis +/- E. crebra woodland on Cainozoic sand plains.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

80 Sites in Total (8 Secondary, 72 Quaternary / Observation).

Regional ecosystem 11.5.20 is represented most abundantly in the southern assessment area, particularly Kumbarilla State Forest by a woodland of 16-23m in height. Grey Box (*Eucalyptus woollsiana*) is the dominant species, occasionally with associated narrow leaf ironbark (*E. crebra*). Canopy species also occur in the second tree layer with bull oak (*Allocasuarina Luehmannii*) and psydrax (*Psydrax* sp.).

A typically sparse native groundcover (15 – 25% cover) is dominated by Many-Headed Wire Grass (*Aristida caput-medusae),* Barbed Wire Grass *(Aristida calycina),* Love Grass (*Eragrostis*

lacunaria), barbed wire grass *(Cymbopogon refractus),* Paspalidium *(Paspalidium distans),* and Windmill Grass (*Chloris truncata*) and *Gahnia aspera*.

This ecosystem has almost universally been subject to heavy logging regimes greatly simplified the original habitat structure.

Regional ecosystem 11.5.20 in the Kumbarilla State Forest with heavily modified structure through timber extraction and Grazing.

Regional Ecosystem 11.5.21

Corymbia bloxsomei +/- Callitris glaucophylla +/- Eucalyptus crebra +/- Angophora leiocarpa woodland on Cainozoic sand plains/remnant surfaces.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

62 Sites in Total (7 Secondary, 1 Tertiary, 54 Quaternary / Observation).

This woodland ecosystem generally occupies sandier localities on Tertiary age plains. The canopy height ranges between 14-23m and a mean crown cover of 32%. It is dominated by yellow bloodwood *(Corymbia bloxsomei)* in association with smooth barked apple *(Angophora*

leiocarpa), narrow leaf ironbark *(Eucalyptus crebra),* Queensland blue gum *(Eucalyptus tereticornis),* and white cypress *(Callitris glaucophylla).*

The second tree layer is poorly formed and often absent with white cypress, bull oak (*Allocasuarina luehmanii*) and occasional narrow leaf ironbark. The shrub layer ranges between 1-5 m in height with a very sparse cover average of 11%. Characteristic species are *Acacia spectabilis*, *Callitris glaucophylla*, *Allocasuarina Luehmannii*. Others include *Acacia amblygona, Acacia ixiophylla, Eucalyptus crebra, Hakea purpuea, Leptospermum polygalifolium, Leucopogon sp., Micromyrtus sessilis, Opuntia tomentosa *,* and *Xylomelum cunninghamianum.*

The ground layer is in good condition with a mean PFC of 62%, and comprises native species which include *Triodia scariosa, Aristida caput-medusae, Brachyscome sp., Cheilanthes sieberi, Chrysocephalum apiculatum, Cymbopogon refractus, Dianella brevipedunculata, Eragrostis sp., Eulaia aurea, Fimbristylis dichotoma, Homoranthus melanostictus, Lomandra leucocephala subsp. leucocephala, Murdannia graminea, Pimelea novae-hollandaei, Pleurocarpaea sp., Tricoryne elatior and Xanthorrhoea johnsonii* which forms a dominant cover in some localities.

The habitat is generally well preserved with limited disturbance evident in most representations.

Regional ecosystem 11.5.21 in Barakula State Forest, central assessment area.

Regional Ecosystem 11.7.2

Acacia spp. woodland on Cainozoic lateritic duricrust. Scarp retreat zone

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

25 Sites in Total (5 Secondary, 20 Quaternary / Observation).

Regional ecosystem 11.7.2 occupies areas of extremely shallow soil, typically growing on rudosols formed on indurated sandstones in the central assessment area. The habitat is dominated by Lancewood (*Acacia shirleyi)* although have other species scattered throughout its canopy including *Eucalyptus fibrosa subsp. nubile,* Narrow Leaf Ironbark (*Eucalyptus crebra*) and Queensland Peppermint (*Eucalyptus exserta).* Canopy heights range from 14-23m and crown cover varies between 30 to 80%.

The second tree layer is often absent or sparse Lancewood. The upper shrub layer is formed by Lancewood, *Alphitonia excelsa, Ehretia membranifolia,* Bitter Bark (*Alstonia constricta)* while the lower layer consists of *Dodonaea biloba, D. macrossanii, Prostanthera cryptandroides subsp. euphrasioides. Leucopogon sp., Dodonaea triangularis* and *Acacia triptera.*

The ground layer generally retains near natural condition with up to 70% cover of wiry grasses include *Ancistrachne uncinellata* and *Thyridolepis mitchelliana.* The habitat is generally well preserved although clearing and timber harvesting affects some localities.

Tall straight stand of Lancewood characteristic of RE11.7.2

Regional Ecosystem 11.7.4

Eucalyptus decorticans and/or Eucalyptus spp., Corymbia spp., Acacia spp., Lysicarpus angustifolius on lateritic duricrust.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

538 Sites in Total (20 Secondary, 4 Tertiary, 514 Quaternary / Observation).

An extensive habitat type within the central and southern assessment areas. This woodland ecosystem is restricted to low hills and rises where soils are shallow and gravelly ridges. Characteristic species in the canopy are Queensland peppermint (*Eucalyptus exserta),* Brown Bloodwood (*Eucalyptus trachyphloia)* and Smooth Barked Apple *(Angophora leiocarpa)* with less frequent White Cypress *(Callitris glaucophylla),* Narrow Leaf Ironbark *(Eucalyptus crebra)* and Lancewood (*Acacia shirleyi*). The canopy height ranges from 11 – 18m and average crown cover is around 40%.

A well-developed second tree layer has an average cover of around 50% and comprises Queensland Peppermint, Miles Mulga (*Acacia apprepta),* White Cypress, False Mahogany *(Eucalyptus rubiginosa),* Stringy Bark Sheoak (*Allocasuarina inophloia)* and Budgeroo *(Lysicarpus angustifolius).* Tall shrubs of *Acacia crassa* subsp*. crassa, Acacia julifera*, and *Acacia semilunata* dominate a sparse upper shrub layer. A distinct yet very sparse lower shrub layer features a range of low shrubs in particular *Leucopogon* sp*., Westringea cheellii, Acacia conferta,* and *Micromyrtus sessilis.*

The ground layer is mid dense and diverse with 42 species recorded. The native graminoids, include *Ancistrachne uncinellata, Thyridolepis mitchelliana, Aristida calycina, Aristida caput-medusae, Eragrostis sororia, Panicum decompositum, Scleria sphacelata* and *Triodia scariosa* occupy the predominant living groundcover with the remainder of cover comprising perennial native herbs such as *Brunoniella acaulis, Cheilanthes sieberi, Goodenia sp*. and *Pleurocarpaea sp.* The woodland ecosystem generally retains good condition although some timber extraction is evident and severe fire damage is evident in Kumbarilla State Forest and some portions of the central assessment area to the north-west of Miles.

Typical structure of RE11.7.4 in the central assessment area (Site AG313_129).

Regional Ecosystem 11.7.5

Shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

15 Sites in Total (2 Secondary, 13 Quaternary / Observation).

This shrubland ecosystem is restricted to shallow sandy soils on the surface of lateritic duricrust. Although most commonly found around Barakula State Forest in the central assessment area, small patches also occur in the south within Kumbarilla State Forest. The habitat is typified by a mid-dense upper shrub layer of Broombush (*Melaleuca uncinata*) or *Melaleuca nodosa* forms the ecological dominant layer with scattered Miles Mulga (*Acacia apprepta),* micromyrtus *(Micromyrtus sessilis),* Budgeroo (*Lysicarpus angustifolius)* and emergent White Cypress *(Callitris glaucophylla)* and Yellowjacket (*Corymbia bloxomeii).* A distinct lower shrub layer is also dominated by Broombush and Micromyrtus in association with dodder laurel *(Cassytha*

pubsecens), Leucopogon sp. (GBS3/7), Hakea purpurea, Pimelea nova-anglica, and *Callitris glaucophylla.*

In comparison to woodland habitats this shrubland ecosystem is depauperate in species. Low species diversity is reflected in the ground layer that supports a limited number of grasses including Spinifex (*Triodia scariosa*), *Aristida leichardtiana, Aristida ramose, Panicum decompositum, Panicum queenslandicum, Paspalidium distans* and the herbs *Cheilanthes sieberi, Drosera indica, Cassytha filiformis,* and *Boronia bipinnata.*

Recently burnt heath in Kumbarilla State Forest with dominant *Melaleuca uncinnata.*

Regional Ecosystem 11.7.6

Corymbia citriodora or *Eucalyptus crebra* woodland on Cainozoic lateritic duricrust.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

17 Sites in Total (5 Secondary, 12 Quaternary / Observation).

Regional ecosystem 11.7.6 is largely restricted to the central assessment area to the north of Miles. This woodland to open forest ecosystem typically occurs on hills and ridge crests hills

with associated shallow gravelly soils. Spotted Gum *(Corymbia citriodora)* characterises the habitat and forms a relatively tall, continuous canopy cover up to 25m tall and cover ranging from 40 to 70%. Associated species include Narrow Leaf Ironbark *(Eucalyptus crebra)* Brown Bloodwood (*Eucalyptus trachyphloia)* and Smooth Barked Apple *(Angophora leiocarpa)* with less frequent White Cypress *(Callitris glaucophylla),* and Lancewood (*Acacia shirleyi*) although these are more commonly associated with a sparse sub-canopy layer forming 15 to 25% cover.

Tall shrubs of *Acacia crassa subsp. crassa, Alphitonia excelsa, Acacia semilunata, Acacia conferta* and *Allocasuarina leuhmanni* dominate a sparse shrub layer. Lower shrub layers are also sparse and are formed by *Dodonaea macrossanii, Mirbellia pungens, Acacia melliodora, Prostranthera sp., Westringea cheellii, Acacia conferta, Callitrix tetragona* and *Leucopogon muticus*.

The ground layer is mid dense and generally diverse with native covers including *Arundinella nepalensis, Ancistrachne uncinellata, Thyridolepis mitchelliana, Gahnia aspera, Lomandra leucocephala, Lomandra multiflora, Aristida calycina, Aristida caput-medusae, Eragrostis sororia, Panicum decompositum, Scleria sphacelata* and *Triodia scariosa*.

A heavily logged representation of RE11.7.6 in the central assessment area.

Regional Ecosystem 11.7.7

Eucalyptus fibrosa subsp. nubila +/- Corymbia spp. +/- Eucalyptus spp. on lateritic duricrust.

Status

VMA Status: Least concern

Biodiversity Status: No concern at present

Total number of survey sites across project area

212 Sites in Total (16 Secondary, 2 Tertiary, 194 Quaternary / Observation).

This widespread and relatively abundant woodland and open forest ecosystem occurs on low hills and ranges formed from deeply weathered sediments. Soils are shallow with sandy and gravelly surface horizons. Blue Leaved Ironbark (*Eucalyptus fibrosa* subsp*. nubila)* forms a distinct canopy which ranges between 11 and 25m in height. The canopy may also include Narrow Leaf Ironbark (*E. crebra* and *E. elegans*), Queensland peppermint (*E. exserta*) and white cypress (*Callitris glaucophylla*). These species also characterize a distinct yet discontinuous second tree layer. *Eucalyptus elegans* dominates the canopy in restricted locations although *Eucalyptus fibrosa* is always present.

Scattered tall shrubs such as *Acacia semilunata, Acacia conferta* and *Callitris glaucophylla* form a sparse to very sparse upper shrub layer. The lower shrub layer is similarly sparse and poorly formed and also comprises *Leucopogon* sp., *Acacia ixiophylla, Acacia muelleriana, Hakea purpurea* and *Westringea cheelii*.

The native species dominated ground layer is mid dense with grasses such as *Eulalea aurea, Paspalidium* sp., *Chloris truncata* and *Gahnia aspera* forming the majority of the cover. Characteristic native herbs and low herbaceous shrubs are *Dodonaea macrossanii, Dianella longifolia var. longifolia, Cheilanthes sieberi, Boronia bipinnata*, and *Brunoniella acaulis*.

Regional Ecosystem 11.7.7 on Girraween, central assessment area.

Regional Ecosystem 11.9.2

Eucalyptus melanophloia +/- E. orgadophila woodland on fine-grained sedimentary rocks

Status

VMA Status: Of Concern

Biodiversity Status: Endangered

Total number of survey sites across project area

1 Quaternary Site

Only a few, scattered remnants of this regional ecosystem are mapped in the northern assessment area to the north of Miles. The habitat is invariably dominated by a sparse canopy layer of Silver Leaf Ironbark (*Eucalyptus melanophloia)* with a mid-dense sub-canopy and shrub layer of White Cypress Pine. Canopy heights generally do not exceed 10m which is in part testament to a repetitive and heavy disturbance regime. There is limited canopy recruitment in these fragments and a significant portion of the original Silver Leaf Ironbark canopy layer is suffering from dieback and senescence. Ground covers are universally displaced by exotic Buffel Grass (*Cenchrus ciliaris).*

An extremely degraded patch of Callitris regrowth with scattered Silver Leaf Ironbark. The habitat in non-remnant in this location although remnants of the original ecosystem (RE11.9.2) are preserved in the vicinity.

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Appendix E.
Present, Likely or Possible Threatened Flora Species Profiles and Mapping Criteria

TREES AND SHRUBS

Kogan Waxflower (*Philotheca sporadica*)

Status

Near Threatened (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

Philotheca sporadica is a Queensland and bioregional endemic known from south-east Queensland, from just north of Tara, to approximately 12 km east of Kogan (TSSC 2008j). Of the 11 known populations, seven occur on road verges, seven extend onto freehold land and one population is within Braemar State Forest (Halford 1995c in TSSC 2008j).

The majority of records are in low open forest and woodland of *Acacia burrowii, Eucalyptus exserta, Eucalyptus crebra, Eucalyptus fibrosa subsp. nubila* and *Callitris glaucophylla* (Halford 1995 in TSSC 2008j), and also on residual hills which are remnants of laterised Cretaceous sandstones, where the soils are shallow, uniform sandy loams to clay loams of extremely low fertility and poor condition (TSSC 2008j). Field survey indicates that the species occurs almost exclusively within RE 11.7.4 (*Eucalyptus decorticans and/or Eucalyptus spp., Corymbia spp., Acacia spp., Lysicarpus angustifolius* on *lateritic duricrust*) and possibly RE11.7.5 with a few individual plants overlapping with RE11.7.7. The species has a tendency to form dense, locally restricted populations, particularly on scalded areas with limited soil

Known Threats to the Species

This species is threatened by clearing, particularly localised populations that might be impacted by well pads and linear infrastructure.

Records Relevant to the SGP

Six localised populations are identified within the assessment area to the east of Kogan, both within both private land and State Forest. Populations may cover extensive areas although the margins of populations are generally discrete.

Rule(s) for Habitat Mapping:

1. The species will most likely occur within a 25km wide buffer surrounding Kogan although cannot be discounted as occurring within suitable habitats throughout the SGP assessment area.
2. REs 11.7.4 and 11.7.7 are classified as "Core habitat Possible" within 25km from Kogan.
3. Regrowth habits (non-remnant) derived from RE11.7.4 within 25km from Kogan are classified as "General Habitat'.
4. All "Core Habitat Possible" and "General Habitat" within 1km of a recent (1980+), accurate (± 100m) record is reclassified as "Core Habitat Known".
5. The remaining areas of RE11.7.4 throughout the SGP assessment area are classified as "General Habitat"
6. All other areas are classified as "Absence Suspected".

Mapping Confidence

The detailed ground surveys undertaken throughout habitats for this species in the SGP area and highly localised populations gives habitat mapping is presented with high confidence.

Photograph: David Stanton

Waaje Wattle (Acacia barakulensis)

Status

Vulnerable (NC Act)

Distribution and Habitat

Waaje Wattle is a Queensland and bioregional endemic that is Restricted to Barakula State Forest north of Chinchilla where it grows on sandy soils in eucalypt communities in the Waaje Wildflower Area (Lithgow 1997, Chinchilla Field Naturalists Club 1997, Maslin 2001).

HERBRECS specimen records indicate habitat in flat gently undulating plains on the crest of the slope on deep yellow loamy sand soil derived from sandstone or laterite. Vegetation is tall shrubland with *Eucalyptus tenuipes, Corymbia trachyphloia, Calytrix gurulmundensis*, and *Triodia mitchellii* (DEHP 2017). Habitat is consistent with RE 11.7.4, 11.7.5, 11.7.6, and 11.7.7. Survey records identified the species in woodland of narrow leaf ironbark (*Eucalyptus crebra*) + smooth barked apple (*Angophora leioclada*) + white cypress pine (*Callitris*

glaucophylla) with a subcanopy of white cypress and bulloak (*Allocasuarina luehmanii*) on old loamy plains (RE 11.5.1, 11.5.4, 11.5.21).

Ecology

Similarity to many Acacias, there is a likelihood that Acacia barakulensis will respond to disturbance, or populations rejuvenated by fire. Knowledge of the species biology and response to disturbances such as habitat fragmentation, changed fire regimes and edge effects requires is poorly understood.

Known Threats to the Species

The species may be impacted by habitat clearing or fragmentation that leads to changes in fire frequency and intensity. As known populations are well away from the SGP assessment area impacts are more likely to be generated during forestry operations.

Records Relevant to the SGP

Herbrecs identifies 5 confirmed populations 28 km to the north-east of the SGP area within Barakula State Forest. Due to contiguity of habitats between populations and the SGP assessment area, it is considered possible that the species may occur.

General Rule(s) for Habitat Mapping:

1. The species will only likely occur in the Central assessment area.
2. Within the central area of the SGP, RE's 11.5.1, 11.5.14, 11.5.21, 11.7.4, 11.7.5, 11.7.6 and 11.7.7 are mapped as "General Habitat" due to lack of local records.

Mapping Confidence

Due to the relatively broad habitat tolerances, mapping of general habitat is considered to be of moderate accuracy.

Curly-bark Wattle (*Acacia curranii*)

Status

Vulnerable (NC Act)

Distribution and Habitat

The only known Queensland population occurs in and adjacent to the Gurulmundi State Forest area of the Darling Downs, approximately 65 km north-west of Chinchilla (Pedley 1987; Maslin 2001). The Gurulmundi population is restricted to an area of less than 20 km diameter and represents a highly disjunct northern limit of distribution with southern populations in NSW.

Plants are known to occur in shrubby heaths, dry sclerophyll forests and semi-arid woodlands where they can occur as widely scattered thickets in very species-rich heathy scrub with emergent eucalypts (Pickard 1995c, Threatened Species Scientific Committee 2008a). The Gurlumundi population has been reported as growing in dense "groves" (Pedley 1987). Queensland collections of curly-bark wattle, recorded in Herbrecs, mostly occur within areas

mapped by the Queensland Herbarium as Regional Ecosystem 11.7.5; shrubland with *Calytrix* spp., *Hakea* spp., *Kunzea* spp., *Micromyrtus* spp., *Acacia* spp., *Melaleuca* spp. and a spinifex grass layer, on natural scalds on deeply weathered sedimentary rocks.

Ecology

The typical life span of curly-bark wattle is unknown, but it is probably similar to many other shrubby *Acacia* species in being a moderately long-lived shrub of 10 to 30 years. It has been recorded flowering during August and September, with pods maturing several months later (Pedley 1987). As a hard-seeded legume, the soil-stored seed reserves of *A. curranii* are likely to be long lived (i.e. > 10 years). The observed abundant regeneration via seedlings after fire suggests *Acacia curranii* will also germinate seedlings following mechanical disturbance of the topsoil, although repeated soil disturbance would kill the seedlings that germinate after any initial disturbance. The impact of stock grazing is unknown, but damage from grazing by feral goats has been observed (Cohn 1995).

Known Threats to the Species

Grazing, browsing and trampling of adult and seedling plants by feral goats and rabbits (and to less an extent by stock, and macropods). This may be facilitated installation of well ponds which artificially increases watering points for feral animals. Additional threats include clearing of vegetation for road widening, gravel extraction and mining

Records Relevant to the SGP

Sixteen records of the species are confirmed in Herbrecs with the nearest population 11 km west of the SGP area with Gurulmundi State Forest (excluding low precision records).

General Rule(s) for Habitat Mapping:

1. The species will only occur in the central portion of the SGP assessment area to the north of Miles.
2. In the absence of survey records within the SGP area, RE11.7.5, 11.7.4, 11.7.7 in the potential area of occurrences have been allocated as "General Habitat".

3. All other regional ecosystems, regrowth and cleared areas are mapped as "Absence Suspected".

Mapping Confidence

High mapping confidence is applied to be species based on the revised mapping boundaries and detailed on-ground assessment.

Curly-bark wattle (*Acacia curranii).* Photograph M. Fagg, Australian National Botanical Gardens

Hando's Wattle (*Acacia handonis*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act Act)

Distribution and Habitat

Hando's wattle has an extremely restricted occurrence, being known only from the Barakula State Forest, approximately 40 km north of Chinchilla (Maslin 2001). This population of Hando's wattle was considered to occur in three adjacent areas and was estimated in 1994 to contain around 10 080 individuals over approximately 28 ha (Halford 1995b). The extent of population was considered to have broadened within the Barakula State Forest between the initial collections in 1978 and 1997 (Lithgow, 1997).

Hando's wattle has only been collected on rocky ridges and slopes on sandstone-derived geology in eucalypt woodland and open forest (Maslin 2001). The vegetation it grows within is a shrubby woodland of *Eucalyptus fibrosa* subsp. *nubila*, *Eucalyptus watsoniana* subsp. *watsoniana, Lysicarpus angustifolius,* and *Allocasuarina inophloia* (Halford 1995). The descriptions of the habitat from which it has been collected are consistent with the regional ecosystem mapping for its locations. This is, primarily RE 11.7.7: *Eucalyptus fibrosa* subsp. *nubila* +/- *Corymbia* spp. +/- *Eucalyptus* spp. on lateritic duricrust. One collection is also recorded in RE 11.7.6: *Corymbia citriodora* or *Eucalyptus crebra* woodland on lateritic duricrust.

Ecology

The life span of Hando's wattle plants in the wild is unknown, but they live for about 10 years in cultivation (Hando 2007). Plants have been collected in flower in July, August and September, and with pods in August, September and November. As a hard-seeded legume, the soil-stored seed reserves of Hando's wattle are likely to be long lived (i.e. > 10 years). The response to fire by Hando's wattle has not been well studied. However, it is suggested that it regenerates well from seed following burning (DNR 2000).

Known Threats to the Species

Inappropriate fire regimes, habitat destruction, disturbance from timber harvesting, inappropriate grazing regimes (DNR 2000) are considered the major threats to *Acacia handonis* populations. Halford (1995b) suggested the main threat to Hando's wattle was

inappropriate fire regimes. That is, fires that are too frequent, intense fires, or complete fire exclusion.

Records Relevant to the SGP

Seventeen records in Herbrecs with the nearest population 35 km east of the SGP assessment area within Barakula SF.

Rule(s) for Habitat Mapping:

Regional Ecosystems 11.7.4, 11.7.5, 11.7.6, 11.7.7 and 11.5.1 in the Central region of the SGP (North of Miles) should be classed as "General Habitat" on account of the intensive survey undertaken in the assessment area

Mapping Confidence

High mapping confidence is applied to be species based on the revised mapping boundaries and detailed on-ground assessment.

Photograph M. Fagg, Australian National Botanical Gardens.

Bailey's Callitris (*Callitris baileyii*)

Status

Near Threatened (NC Act)

Distribution and Habitat

In Queensland, Baileys Cypress occurs from the state border to Goomeri in the north and west to the Bunya Mountains. The distribution is predominantly within the Southeast

Queensland bioregion extending into the Brigalow Belt near the bioregional boundary (EHP 2017b). The species also occurs in the drier ranges of NSW.

Typical habitat is open woodland and woodland of *Eucalyptus exserta*, *E. crebra* and *Callitris glaucophylla* with a mid-dense shrubby understorey typical of RE11.7.4. Stanley & Ross (1983) describe its habitat as eucalypt woodland, with ironbark, blue gum and spotted gum on rocky slopes, hilly or mountainous areas, in shallow and often clay soils.

Ecology

Little is known concerning the ecology of this species. Male and female flowers occur on the same tree and fruiting has been recorded all year round.

Known Threats to the Species

This species is threatened by direct loss as a result of clearing as well as inappropriate fire regimes.

Records Relevant to the SGP

Nearest local record is 2.6 km west of the SGP assessment area (40 km north of Miles) in Gurulmundi State Forest. The record was collected during SGP EIS studies in 2011.

Rule(s) for Habitat Mapping:

REs 11.5.1, 11.7.4, 11.7.5, 11.7.6 and 11.7.7 in the Gurulmundi area to the north of Chinchilla (-27.75) in the Central Assessment Area should be considered "General Habitat". Any subsequent collections of the species should be buffered by 1km and General Habitat re-assigned to "Core Habitat Known". Other habitats should be assigned to "Absence Suspected".

Mapping Confidence

The general nature of habitat for this species makes preferred habitats relatively easy to predict and habitat mapping for the species is considered to have high to moderate confidence.

Gurulmundi Fringe Myrtle (*Callitrix gurulmundensis)*

Status

Vulnerable (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

The species is endemic to the Gurulmundi and Barakula areas north of Chinchilla (Halford 1996). Gurulmundi fringe myrtle has been recorded growing in patches of shrubland on very shallow soils. Soils are lateritic sandstone ridges, which contain yellow sandy-clay that retains moisture (Williams 1979). Vegetation is predominately eucalypt, acacia, casuarina dense shrublands with spinifex, and spinifex grassland with scattered shrubs. This habitat description is consistent with RE 11.7.5 (shrubland on natural scalds on deeply weathered coarse-grained sedimentary rocks). The coordinates of Gurulmundi fringe myrtle collections

derived from Herbrecs place them in areas mapped by as RE11.7.4, 11.7.5, 11.7.6 and 11.7.7.

Ecology

The life span of Gurulmundi fringe myrtle is unknown, but it is likely to live for at least a decade. Flowers have been recorded from June to October (Halford 1996). Plants as small as 15 cm tall have been observed to flower (Williams 1979). Gurulmundi fringe myrtle can be quite common at sites where it grows, being described in several collection labels as abundant or co-dominant at the collection site (AVH 2013a).

Known Threats to the Species

Clearing, disturbance for track creation and maintenance and inappropriate fire regimes are the key threats to habitat for this species. At least one population is identified as having been damaged in the past due to gravel extraction (Williams 1979).

Records Relevant to the SGP

The nearest local record is 12 km west of the SGP assessment area (30 km north of Miles) within Gurulmundi State Forest. A population also exists in Waaje Scientific Reserve 36 km east of Wandoan.

Rule(s) for Habitat Mapping:

REs 11.5.1, 11.7.4, 11.7.5, 11.7.6 and 11.7.7 in the Gurulmundi area to the north of Chinchilla (-27.75) in the Central Assessment Area should be considered "General Habitat". Any subsequent collections of the species should be buffered by 1km and General Habitat re-assigned to "Core Habitat Known". Other habitats should be assigned to "Absence Suspected

Mapping Confidence

High mapping confidence is applied to be species based on the revised mapping boundaries and detailed on-ground assessment that did not locate any additional populations.

Gurulmundi fringe myrtle (*Calytrix gurulmundensis)* foliage and flower. Copyright © Boobook

Gurulmundi Heath-myrtle (*Micromyrtus carinata*)

Status

Endangered (NC Act)

Distribution and Habitat

Endemic to Queensland, *Micromyrtus carinata* is known only from the Gurulmundi State Forest 40 km to the north of Miles with a sub-population also located on the Wyona Property 10km to the north of Miles (Herbrecs).

Herbarium records indicate *Micromyrtus carinata* is associated with landscapes formed on lateritised sediments with an upper soil layer of red to yellow sand (DEHP 2017c). Associated regional ecosystems include inhabits the tops of laterised ridges, on shallow to deep, yellow or red sands. Associated habthitats include heath and shrubland (RE11.7.5) and low woodland dominated by *Eucalyptus exserta, Corymbia trachyphloia* and *Callitris glaucophylla* (RE11.7.4).

Ecology

Little is known regarding the ecology of this species. Bean (1997) suggest that it likely flowers at any time in response to rain although fruits and flowers have been collected between May and October (DEHP 2017c).

Known Threats to the Species

The species is considered to be threatened by mining activity, gravel extraction and inappropriate fire regimes (Bean, 1997, DEHP 2017c).

Records Relevant to the SGP

Nearest Herbarium Record is 10km north-west of Miles and 4 km west of the SGP assessment area on the Wyona Property. The major population of the species occurs in Gurulmundi State Forest 12km west of the SGP assessment area (Herbrecs)

Rule(s) for Habitat Mapping:

REs 11.7.4 and 11.7.5 in the Gurulmundi area to the north of Chinchilla (-27.75) in the Central Assessment Area should be considered "General Habitat". Any subsequent collections of the species should be buffered by 1km and General Habitat re-assigned to "Core Habitat Known". Other habitats should be assigned to "Absence Suspected

Mapping Confidence

High mapping confidence is applied to be species based on the revised mapping boundaries and detailed on-ground assessment that did not locate any additional populations.

Plunkett Mallee (*Eucalyptus curtisii*)

Status

Near Threatened (NC Act)

Distribution and Habitat

The plant is scattered but nowhere common occurring on coastal hinterland to 80 km north and south of Brisbane and inland over 300 km north west to the Dalby and Miles districts (DNR 2000). Occurs in the Burnett, Leichhardt, Moreton and Darling Downs pastoral districts (Bostock and Holland 2016). Conserved in Expedition Range, Robinson Gorge and Isla Gorge National Parks (Brooker and Kleinig 2004).

DEHP (2017d) suggests *Eucalyptus curtisii* has two growth forms that occur in different habitats with a shorter shorter mallee associated with shrublands dominanted by banksia in poorly drained lowland sites with a larger growth occurring as scattered individuals on better drained soils in the more open areas of mixed eucalypt forests. The species is most typically associated with lateritised landscapes within regional ecosystems 11.7.4 and 11.7.5. Commonly associated species include *C. trachyphloia, Eucalyptus exserta* and *Callitris endlicheri* and less commonly associated with *E. fibrosa*.

Ecology

Flowering of *Eucalyptus curtisii* has been recorded between the months of September and November, and fruiting occurs throughout the year (Queensland Herbarium, 2012 cited in DEHP 2017d). Response to fire is not documented.

Known Threats to the Species

Known threatening process related largely to clearing, timber harvesting and inappropriate grazing and fire regimes.

Records Relevant to the SGP

Numerous local records mostly west of the SGP with the nearest record 2.5 km west of the SGP assessment area and 35km north of Miles. A number of records in Kumbarilla State Forest to the south although well outside the SGP assessment area.

Rule(s) for Habitat Mapping:

Eucalyptus curtisii may occur throughout the entire assessment area. Through the assessment area, REs 11.7.2, 11.7.4, 11.7.5, 11.7.6 and 11.7.7 should be classified as "General Habitat" in recognition of the extensive survey effort undertaken. All other REs and non-remnant vegetation should be classified as "Absence Suspected".

Mapping Confidence

Due to the extensive survey effort and known habitat preferences, mapping of *Eucalyptus curtisii* is attributed as having a high degree of confidence.

GRASSES AND SEDGES

Finger Panic Grass (*Digitaria porrecta*)

Status

Near Threatened (NC Act)

Distribution and Habitat

Finger panic grass is known from four disjunct areas extending over 1000 km across NSW and Queensland. The Queensland distribution includes broad populations in the Nebo district; the Central Highlands between Springsure and Rolleston; and from Jandowae south to Warwick. In NSW, it is known from near Inverell, south to the Liverpool Plains near Coonabarabran and Werris Creek (TSSC 2008f).

Finger panic grass grows in grasslands, woodlands and open forests with a grassy understory, on black soil plains of the Darling Downs, and lighter textured soils to the west (Goodland 2000; Fensham 1998). Fensham (1998) found it is most abundant in grassland, but is "relatively unspecific" in its habitat preference. It is not restricted to high quality native grasslands, but also grows along roadsides and can be found in highly disturbed sites (Goodland 2000). Finger panic grass been recorded inside the project development area, within roadside remnant grasslands on dark cracking clay plains (RE11.3.21); poplar box (*E.*

populnea) open forest and woodland with grassy understorey, on dark cracking clay plain (RE11.3.2); and along disturbed railway reserves on dark cracking clay soils (EHP 2013). The primary habitats for this species in the project development area are RE11.3.2, RE 11.3.21 and non-remnant derived grasslands.

Ecology

Finger panic grass is a spreading perennial that can reproduce vegetatively (Halford 1995a). Older clumps are reported to die in the centre, with the outer edges of the clump becoming separate plants. Seeds drop to the ground when mature, but appear to have a six month to one year dormancy prior to germinating (Halford 1995a). This is similar to some other sub - tropical grasses, such as black spear grass, and delays germination until the wet season rains. The species produces fertile material from March to April (TSSC 2008f).

Known Threats to the Species

The grassland habitat for this species has been heavily fragmented by clearing for agriculture, and sowing of exotic pasture grasses that can replace finger panic grass. It is mainly restricted to stock routes and road reserves and threatened by degradation from mechanical disturbance, invasive weeds and inappropriate grazing regimes. Goodland (2000) notes that finger panic grass can withstand disturbance, although populations decline where introduced species (e.g. Rhodes grass) become dominant.

Records Relevant to the SGP

Two records within the SGP assessment area, both in non-remnant derived grasslands adjacent to roadside easements between Dalby and Cecil Plains. Both records collected in 1995. A further 15 records within 25km east of the SGP boundary.

Rule(s) for Habitat Mapping:

1. The species is most likely to occur on heavy clay soils associated with the Condamine Alluvium although may occur throughout the entire assessment area.
2. Regional Ecosystem 11.3.2 should be treated as "General Habitat".
3. Derived native grassland where it is associated with the Condamine Alluvium or other heavy clay soil should be considered "General Habitat".
4. High precision (+/- 500m) species records should be buffered by 1km and all General Habitat upgraded to "Core Habitat Known".
5. All other remnant vegetation in the project development area and all cleared agricultural and grazing land should be treated as "Absence Suspected".

Mapping Confidence

Digitaria porrecta has relatively predictable habitat preferences and with the availability of project scale mapping (1:50 000), it is considered that the habitat mapping has a high level of confidence. It should be noted that no records of the species have been formally documented since 1995 and

Fimbristylis vagans

Status

Endangered (NC Act)

Distribution and Habitat

A little-known Queensland and bioregional endemic restricted to the Darling Downs district between Lake Broadwater and Nudley Creek area (30 km NE of Chinchilla) (DERM 2011). The species occupies habitats that fringe ephemeral watercourses and lagoons on alluvium. Typical regional ecosystems include RE11.3.2, 11.3.4, 11.3.14 and 11.3.26 where they fringe watercourses and wetlands (RE11.3.27). The species is not known to be associated with non-remnant habitats.

Ecology

Species ecology is poorly documented although like most species associated with wetland habitats, is likely to be a seasonally dependent species that flowers and reproduces following rainfall.

Known Threats to the Species

Threats are poorly documented although major threats are likely to be associated with damage created by feral animals, particularly pigs and intensive grazing.

Records Relevant to the SGP

A single herbarium record from the SGP assessment area associated with the swampy inlet of Lake Broadwater. The species has not been recorded or collected since 1984.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area.
2. "Core Habitat Possible" includes the wetland fringe of Lake Broadwater characterised by RE11.3.27f and wetland habitats of Long Swamp.
3. REs 11.3.2, 11.3.3, 11.3.4, 11.3.25 and 11.3.26 throughout the broader SGP assessment area is classified as "General Habitat".
4. All Core Habitat Possible and General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
5. All remaining remnant and non-remnant vegetation is mapped as "Absence Suspected".

Mapping Confidence

Habitat characteristics for this species are well understood and can be matched to regional ecosystem descriptions. The mapping is considered to be highly accurate.

Belson's Panic (Homopholis belsonii)

Status

Endangered (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

In Queensland, major populations occur on the Darling Downs near Oakey, Jondaryan, Bowenville, Dalby, Acland, Sabine, Quinalow, Goombungee, Gurulmundi and Millmerran, and further west between Miles and Roma (Goodland 2000). Also known from the north-western slopes and plains of NSW (TSSC 2008g).

Belson's panic prefers moderate to highly fertile soils, especially those derived from basalt and fertile alluvial flats. It is generally associated with poplar box and brigalow woodlands on light red/brown earths (Fensham and Fairfax 1997, Goodland 2000). Based on Herbrecs specimens, the species is most commonly associated with habitats on heavy clay soils, particularly those dominated by Brigalow including REs 11.3.1, 11.3.17, 11.4.3, 11.9.5 ad 11.9.10. Herbarium records also indicate some potential for the species to overlap with RE11.3.2.

Belson's panic is also capable of growing within disturbed habitats. Of the 22 collections within the study area, 15 (68%) are located in non-remnant areas such as roadside easements. It has been seen growing among fallen timber at the base of trees or shrubs, among branches and the bottom of netting fences (TSSC 2008g).

Ecology

Belson's panic tends to grow in shade under trees, but can grow in cleared regrowth. As a rhizomatous perennial grass, it probably is capable of living for many years, and to have some tolerance to fire and at least low levels of grazing. It is reported to spread out very rapidly (Menkins 1998). Flowers have been recorded between February and May (Sharp and Simon 2002).

Known Threats to the Species

Loss of habitat from vegetation clearing, pasture improvement, and overgrazing is a major threatening process (TSSC 2008g). Belson's panic declines in abundance with grazing pressure and appears to grow best under tree or shrub cover. Roadside populations are threatened by invasion of pasture grasses such as green panic (Megathyrsus maximus var. trichoglume), and road works (Goodland 2000), however it is known to re-colonise disturbed areas if tree cover is available (Menkins 1998 in TSSC 2008g).

Records Relevant to the SGP

A considerable number of records to the east of Dalby with the nearest 12km from the eastern boundary of the SGP assessment area. Two records within 8km of the boundary of the northern assessment area within 10km of Wandoan.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area although is most likely to occur in Brigalow associated habitats in the northern assessment area.

2. Regional Ecosystems 11.9.5, 11.9.10 and 11.3.17 including derived non-remnant regrowth is mapped as "Core Habitat Possible" in the northern assessment area.
3. REs 11.3.1, 11.3.17, 11.4.3 and 11.9.5 including non-remnant derived regrowth in central and southern portions of the SGP assessment area are classified as "General Habitat"

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Belson's panic (*Homopholis belsonii)*. Copyright © Boobook

FORBS AND HERBS

Solanum papaverifolium

Status

Endangered (NC Act)

Distribution and Habitat

Recorded in the Darling Downs from between Jimbour and Warwick, where it is known from three locations (Bean 2004). Known from a number of very old records in the Dalby-Cecil Plains area. Goodland (2000) reports two populations west of Dalby on the Warrego Highway before Kogan Rd), and large populations up to 100m extent off Cecil Plains Rd. Known in NSW north from Inverell to Quirindi and Singleton area and west to Narrabrii and Moree (Bean 2004). Occurs in wetter (swampy) areas of grasslands or open eucalypt woodland on heavy alluvial soils (Goodland 2000, Bean 2004).

Ecology

Little is documented on the ecology of the species. It has been observed flowering thoughout the year and populations are most likely rejuvenated following rainfall.

Known Threats to the Species

The species occurs on soils utilised by intensive agriculture and remains on roadside reserves and stock routes. Populations remain threatened by habitat destruction, weed invasion, and roadworks (Goodland 2000, Bean 2004).

Records Relevant to the SGP

Two records are contained within the SGP assessment area to the south of Dalby with an large number of herbarium records to the east of the SGP assessment area between Chinchilla and Dalby.

Rule(s) for Habitat Mapping:

1. The species is most likely to occur on habitat formed by heavy clay soils associated in particular with the Condamine Alluvium.
2. Regional Ecosystems 11.3.2 and Derived Native Grassland (non-remnant) provide the most suitable habitats for the species. Where these habitats occur on the alluvial landforms to the west and south of Dalby, they are mapped as "General Habitat".
3. All General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
4. All remaining remnant and non-remnant vegetation is mapped as "Absence Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Solanum papaverifolium (Photograph David Stanton).

Solanum stenopterum

Status

Vulnerable (NC Act)

Distribution and Habitat

Recorded in Queensland from Gayndah in the Burnett Pastoral district to Moonie and west to Glenmorgan and Yuleba (Bean 2004, Bostock and Holland 2016). Known in NSW from Ashford (Bean 2004). The species is Known to occur in non-remnant grassland approximately 7.5km south of Dalby; 3.5km east of Cecil Plains in a roadside gravel pit; and approximately 6km south east of Cecil Plains in remnant Eucalyptus populnea woodland on alluvium (11.3.2).

Ecology

Little is documented on the ecology of the species although similar to many solanum species in the Brigalow Belt, likely flowers at multiple times throughout the year in response to rainfall events.

Known Threats to the Species

The species occurs on soils utilised by intensive agriculture and occurs on roadside reserves. Populations remain threatened by habitat destruction from land clearing, agricultural practices, weed invasion, roadworks and roadside maintenance (Bean 2004).

Records Relevant to the SGP

Known to occur in non-remnant grassland approximately 7.5km south of Dalby; 3.5km east of Cecil Plains in a roadside gravel pit; and approximately 6km south east of Cecil Plains in remnant Eucalyptus populnea woodland on alluvium (11.3.2). All herbarium records are outside SGP assessment area.

Rule(s) for Habitat Mapping:

1. REs 11.3.2, 11.3.1 and 11.3.17 to the west and south of Dalby should be classed as "General Habitat" on account of comprehensive surveys.
2. Derived grasslands on alluvium and regrowth vegetation derived from the aforementioned REs

All other remnant vegetation and cleared agricultural land in the project development area should be treated as "Absence Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Cymbonotus maidenii

Status

Endangered (NC Act)

Distribution and Habitat

The species occurs in scattered populations throughout central areas of NSW and in southern inland districts as far west as Mitchell (Holland and Funk, 2006).

The species is associated with a range of remnant and non-remnant habits with records occurring on disturbed roadside drains, native and derived grasslands. It is typically associated with heavy brown to grey cracking clay soils (Holland & Funk 2006). Habitats favoured by the species are RE11.3.21 from which it is known to occur. The woodland RE11.3.2 and derived native grassland also present potential habitat for the species. It can however occur in a range of highly disturbed locations and hence its occurrence may not be readily predicted.

Ecology

Other than being a perennial, very little is known about this species although, though as a daisy it is probably fairly short-lived (e.g. living < 5 years). The species is known to flower throughout the year but most prominently in spring, possibly in response to rainfall. The

seeds are likely to be wind dispersed, which should assist colonisation. It has the ability to survive along disturbed roadsides in in other highly disturbed habitats.

Known Threats to the Species

The species is threatened by roadside clearing and herbicide drift. It may also be threatened by invasion of exotic species of which lippia (*Phyla canescens)* and green panic (*Megathyrsus maximus var. pubiglumis)* pose the most immediate threat.

Records Relevant to the SGP

Five Herbrecs specimens recorded within 10 km of the eastern boundary of the SGP assessment area, mostly in the Cecil Plains / Millmerran Area including collections on road reserves on the Cecil Plains - Millmerran Road.

Rule(s) for Habitat Mapping:

The species is most likely to occur from the Dalby area (-27.00) south to Millmerran (-27.9) generally on the Condamine Alluvium. RE 11.3.2 and associated derived grasslands occuring between in this area should be treated as "general habitat".

All other remnant vegetation and cleared agricultural land in the project development area should be treated as "absence suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence. There may however be a number of potential habitats adjacent to roadsides that are beyond mapping resolution.

Picris barbarorum

Status

Vulnerable (NC Act)

Distribution and Habitat

Occurs from the Darling Downs and Warrego pastoral districts in southern Queensland (Bostock & Holland 2016), to north of the north-west plains of NSW. Herbrecs data indicates that in the Darling Downs, it has a restricted distribution but may be locally abundant along roadsides. Known to occur from the Jandowae, Macalister, Norwin locailities and along the Warrego highway west of Dalby.

Herbrecs specimens indicate occurrence in native grassland (12.3.21) of Dichanthium sericeum in stock routes, road reserves adjacent to disturbed areas such as cultivated paddocks and road and rail lines on black clay soil (DERM 2011).

Ecology

Very little is known about this species although, though as a daisy it is probably fairly short-lived (e.g. living < 5 years). Flowering period is not documented although it is likely to be re-invigorated in response to rainfall, particularly in the spring period.

Known Threats to the Species

Vouchered records of Plains Picris suggest that the annual herb may be tolerant of light disturbance. Its known occurrence on roadsides suggest it may be impacted by roadworks. In similarity to Picris evae it may well be intolerant of grazing and capable of surviving other forms of disturbance.

Records Relevant to the SGP

Four herbarium records within 5km of the SGP assessment area with the nearest less than 2 km from the assessment area boundary, 14km north-west of Dalby.

Rule(s) for Habitat Mapping:

The following REs and habitats should be classified as "General Habitat" where they area association with the Condamine Alluvium.

1. RE 11.3.2 and derived regrowth vegetation.
2. Non-remnant derived native grasslands

All other remnant vegetation in the SGP Assessment area and cleared agricultural and grazing land should be treated as "absence suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence. There may however be a number of potential habitats adjacent to roadsides that are beyond mapping resolution.

Rutidosis lanata

Status

Vulnerable (NC Act)

Distribution and Habitat

Endemic to south central Queensland from near Jackson to Hannaford on the western Darling Downs (DNR 2000). Mainly found in roadside vegetation of Acacia and Eucalypt woodland/open forest on red sandy ridges and clay flats between 280-320m altitude adjacent to cleared or partly cleared grazing and cropping land (DNR 2000). Based on Herbrecs notes, associated vegetation includes open grassy woodland of *Eucalyptus populnea* with *Eremophila mitchellii; Acacia harpophylla, Casuarina cristata*, and *Eucalyptus woollsiana* woodland on reddish-brown loamy clay; remnant *Acacia harpophylla, Eucalyptus coolabah,*

Eucalyptus populnea open forest on alluvium clay loam and gentle sedimentary rises; and in cleared areas along powerlines adjoining *Acacia aprepta* thicket.

Ecology

Rutidosis lanata flowers and fruits from October to March and produces a soil-stored seed bank that lasts for less than one year (DEHP 2017e; Pollock, 1997).

Known Threats to the Species

The species and habitat are known to be threatened by clearing with possible threats of inappropriate grazing, road verge maintenance, and habitat disturbance by weeds and introduced pastures (DNR 2000).

Records Relevant to the SGP

Eight Herbarium records within 20km from the the SGP Assessment area, all recorded in the Miles / Chinchilla area.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire project area although is more likely north from Chinchilla based on vouchered herbarium records. Throughout the assessment area, the following REs should be treated as 'General Habitat'; 11.3.4, 11.3.2, 11.3.17, 11.9.5 and 11.9.7.
2. All other remnant vegetation in the project development area, regrowth vegetation and cleared agricultural land should be treated as "Absence Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Xerothamnella herbacea

Status

Endangered (NC Act): Endangered (EPBC Act)

Distribution and Habitat

Xerothamnella herbacea is known from seven locations between Goondiwindi and Theodore. Scattered populations occur to the north-east of Chinchilla (between Chinchilla and Boondooma Lake), within Palmgrove and Expedition National Parks to the southwest of Moura. Two isolated population occur between Goondiwindi and Millmerran.

Occurs in remnant and disturbed Brigalow (Acacia harpophylla) and Belah (Casuarina cristata) dominated communities in shaded situations, often in leaf litter (TSSC 2008n). The species is associated with Brigalow dominated communities, preferring shady locations where it grows in leaf litter (TSSC 2008n). The plant often occurs in gilgais in vertic clay soils (vertosols) and is known to occur in non-remnant and highly disturbed habitats. Regional

ecosystems associated with this species are typically dominated by Brigalow or Belah and include REs 11.3.1, 11.4.3 and 11.9.5.

Ecology

Little is known in regard to the ecology of *Xerothamnella herbacea* although it can live for a few years and establish vegetatively by rooting from nodes along stems.

Known Threats to the Species

The species is threatened by competition from invasive grasses such as green panic (Megathyrsus maximus var. pubiglumis) and to a lesser extent buffel grass (Cenchrus ciliaris) either by direct competition or by increasing the fuel load and altering fire regimes. Potential threats include road widening and maintenance activities, surface erosion, and grazing and trampling by cattle and native macropods (TSSC 2008n).

Records Relevant to the SGP

Two herbarium records to within 20km of the SGP Boundary, 20km to the east and north of Chinchilla.

Rule(s) for Habitat Mapping:

The species may occur throughout the entire project area where it may be associated with Brigalow dominant habitats. Throughout the assessment area, the following REs and any derived regrowth Brigalow > 15 yrs age should be treated as 'General Habitat'; 11.3.1, 11.4.3 and 11.9.5.

All other remnant vegetation in the project development area, regrowth vegetation and cleared agricultural land should be treated as "Absence Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

Xerothamnella herbacea. Photograph Copyright © Boobook

Cryptandra ciliata

Status

Near Threatened (NC Act)

Distribution and Habitat

Restricted to the Gurulmundi, Barakula and Cracow areas of south-eastern Queensland (Chinchilla Field Naturalists Club 1997, DNR 2000). Typical habitat is eucalypt dominant woodland, lancewood (*Acacia shirleyi*) woodland and Triodia grassland on rocky on low lateritic and sandstone ridges. Habitat in the PDA is consistent with RE 11.7.5, 11.7.4, 11.7.6, 11.5.1, 11.5.4, 11.5.21.

Ecology

There is little documented information on the ecology of this species.

Known Threats to the Species

DNR (2000) indicate that the species and habitat is possibly threatened by clearing associated with gravel extraction. Other potential threats may include road construction and maintenance, and inappropriate fire regimes.

Records Relevant to the SGP

Three herbarium records within 5km of the assessment area boundary with a single record within 1km of the eastern boundary, 30km to the north of Miles.

Rule(s) for Habitat Mapping:

1. The species is only likely to occur in the central portion of the SGP assessment area where the following REs should be treated as "General Habitat"; 11.5.1, 11.5.4, 11.5.21, 11.7.4, 11.7.5, 11.7.6 and 11.7.7.
2. All General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
3. All other remnant vegetation in the project development area, regrowth vegetation and cleared agricultural land should be treated as "Absence Suspected".

Mapping Confidence

Due to the general habitat requirements, intensity of the field survey and detailed mapping revision available, mapping is considered to have a high degree of confidence.

Austral Toadflax (*Thesium australe*)

Status

Vulnerable (NC Act): Vulnerable (EPBC Act)

Distribution and Habitat

Historical collections (including the late 1800's) were made from Tasmania, but it is now considered extinct in that state (DSE, 2003). Austral Toadflax occurs in eastern Victoria, NSW and southern Queensland. The majority of southern Queensland collections are from the Darling Downs and Moreton districts (Bostock and Holland 2016). The Dalby area represents the species western limits on the Darling Downs.

Austral toadflax has been collected within popular box (*Eucalyptus populnea*) woodland on alluvial flats (RE 11.3.2) north-west of Dalby, within the project development area. Other Herbarium collection records of Austral toadflax are from along roadsides, mountain coolibah (*Eucalyptus orgadophila*) grassy open woodlands with kangaroo grass (*Themeda triandra*) and Queensland blue grass (*Dichanthium sericeum*). RE11.3.2 in the Dalby region is considered the most likely habitat in the SGP assessment area.

Ecology

A root parasite of kangaroo grass (Themeda triandra) and other grasses, Austral toadflax lives for at least two years. Flowers have been recorded from spring to autumn with fruit developing in summer. Austral toadflax has been observed to germinate prolifically after fire and also after drought. The species is relatively short lived, persisting up to two years after germination (Department of Sustainability and Environment (DSE) 2003).

Known Threats to the Species

Populations in road reserves are threatened by roadwork and maintenance activities such as spraying, grading, slashing, by inappropriate grazing and burning regimes, and weed infestation (Goodland 2000). The species is known to be susceptible to rabbit, horse and cattle grazing but able to tolerate light, non-continuous cattle grazing. Populations of the species are thought to be declining. Austral toadflax cannot survive beneath a dense shaded

canopy (Griffith, 1992), nor is it likely to be capable of surviving dense infestations of exotic grass.

Records Relevant to the SGP

Two herbarium records within 10km of the SGP assessment area, with the nearest record 2.7k east of the eastern SGP assessment area boundary, 25km north west of Dalby.

Rule(s) for Habitat Mapping:

Intact representation of Poplar Box dominant woodland (RE11.3.2) associated with the Condamine River Alluvium (Condamine River Floodplain) should be treated as "General Habitat'. All other REs, non-remnant regrowth and cultivated areas should be treated as "Absense Suspected".

Mapping Confidence

Due to the relatively specific habitat requirements, detailed survey throughout the assessment area and resolution of the revised mapping database, mapping is considered to have a high degree of confidence.

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Appendix F.
Recorded Vertebrate Fauna List

List of Terrestrial Vertebrate Fauna Recorded during the 2016-17 SGP surveys

GROUP		Status		SGP Region		
Scientific Name	**Common Name**	**EPBC**	**NCA**	**Sth**	**Cnt**	**Nth**
AMPHIBIAN						
Crinia parinsignifera	Beeping froglet		LC	X	X	
Pseudophryne major	Great brown broodfrog		LC		X	
Uperoleia laevigata	Eastern toadlet		LC	X		
Uperoleia rugosa	Chubby toadlet		LC	X	X	
Uperoleia sp.			LC	X	X	
Limnodynastes fletcheri	Barking marsh frog		LC		X	
Limnodynastes salmini	Salmon-striped frog		LC		X	
Limnodynastes tasmaniensis	Spotted marsh frog		LC	X	X	
Limnodynastes terraereginae	Scarlet-sided pobblebonk		LC	X	X	
Neobatrachus sudellae	Meeowing frog		LC	X	X	
Notaden bennettii	Holy cross frog		LC		X	
Platyplectrum ornatum	Ornate burrowing frog		LC	X	X	
Cyclorana alboguttata	Greenstripe frog		LC	X	X	
Cyclorana brevipes	Superb collared frog		LC		X	
Cyclorana novaehollandiae	Eastern snapping frog		LC	X	X	
Litoria caerulea	Green tree frog		LC	X	X	
Litoria fallax	Eastern sedge frog		LC	X	X	
Litoria latopalmata	Broad-palmed rocketfrog		LC	X	X	
Litoria peronii	Emerald-spotted treefrog		LC	X	X	
Litoria rubella	Ruddy treefrog		LC	X	X	
Rhinella marina	Cane toad		I	X	X	
Amphibian Total	20			16	20	0
REPTILE						
Underwoodisaurus milii	Thick-tailed gecko		LC	X	X	
Amalosia sp. cf. jacovae			LC		X	
Amalosia sp. cf. rhombifer			LC		X	
Diplodactylus vittatus	Eastern stone gecko		LC	X	X	
Lucasium steindachneri	Box-pattern gecko		LC	X	X	
Nebulifera robusta	Robust velvet gecko		LC	X	X	
Oedura tryoni	Southern spotted velvet gecko		LC		X	
Strophurus taenicauda	Golden-tailed gecko		**NT**	X	X	
Gehyra dubia	Dubious dtella		LC	X	X	X
Heteronotia binoei	Bynoe's gecko		LC	X	X	X
Delma plebeia	Common delma		LC		X	
Lialis burtoni	Burton's legless lizard		LC		X	
Pygopus schraderi	Eastern hooded scaly-foot		LC		X	
Anomalopus leuckartii	Two-clawed Worm-skink		LC		X	
Carlia munda	Striped rainbow skink		LC		X	
Carlia pectoralis	Open-litter rainbow skink		LC	X		

GROUP			Status		SGP Region		
	Scientific Name	**Common Name**	**EPBC**	**NCA**	**Sth**	**Cnt**	**Nth**
	Carlia rubigo	Orange-flanked rainbow skink		LC	X	X	X
	Carlia sp.	Rainbow skink		LC	X	X	
	Carlia vivax	Tussock rainbow-skink		LC	X		
	Cryptoblepharus pulcher	Elegant snake-eyed skink		LC	X	X	X
	Cryptoblepharus sp.			LC	X	X	
	Ctenotus allotropis	Brown-blazed wedgesnout ctenotus		LC	X	X	
	Ctenotus spaldingi	Straight-browed ctenotus		LC	X	X	
	Cyclodomorphus gerrardii	Pink-tongue lizard		LC	X		
	Egernia striolata	Tree skink		LC	X		
	Lerista fragilis	Eastern mulch-slider		LC	X	X	X
	Lerista punctatovittata	Eastern robust slider		LC	X	X	
	Lerista timida	Timid slider		LC	X	X	
	Lygisaurus foliorum	Tree-base litter-skink		LC	X	X	
	Menetia greyii	Common dwarf skink		LC	X	X	
	Menetia sp.			LC	X		
	Morethia boulengeri	South-eastern morethia skink		LC	X	X	X
	Pygmaeascincus timlowi	Dwarf litter-skink		LC	X	X	
	Tiliqua rugosa	Shingleback		LC	X		
	Tiliqua scincoides	Eastern blue-tongue lizard		LC	X		
	Amphibolurus burnsi	Burns' dragon		LC	X		
	Amphibolurus sp.			LC	X		
	Diporiphora australis	Tommy round-head dragon		LC		X	
	Intellagama lesueurii	Eastern water dragon		LC	X	X	
	Pogona barbata	Eastern bearded dragon		LC	X	X	
	Varanus gouldii	Sand monitor		LC	X	X	
	Varanus panoptes	Yellow-spotted monitor		LC	X	X	
	Varanus tristis	Black-headed monitor		LC		X	
	Varanus varius	Lace monitor		LC	X	X	
	Morelia spilota	Carpet python		LC			
	Boiga irregularis	Brown tree snake		LC		X	
	Dendrelaphis punctulata	Common tree snake		LC	X		
	Tropidonophis mairii	Keelback		LC		X	
	Brachyurophis australis	Coral snake		LC		X	
	Cryptophis nigrescens	Eastern small-eyed snake		LC		X	
	Demansia psammophis	Yellow-faced whipsnake		LC	X	X	
	Furina diadema	Red-naped snake		LC	X	X	
	Hemiaspis damelii	Grey snake		**End**	X		
	Hoplocephalus bitorquatus	Pale-headed snake		LC	X	X	
	Parasuta dwyeri	Dwyer's snake		LC	X		
	Pseudechis porphyriacus	Red-bellied black snake		LC	X	X	
	Pseudonaja textilis	Eastern brown snake		LC		X	
	Vermicella annulata	Bandy Bandy		LC	X		
Reptile Total		55			44	44	6

GROUP		Status		SGP Region		
Scientific Name	Common Name	EPBC	NCA	Sth	Cnt	Nth
BIRD						
Dromaius novaehollandiae	Emu		LC	X	X	
Cygnus atratus	Black Swan		LC	X		
Chenonetta jubata	Australian wood duck		LC	X		X
Nettapus coromandelianus	Cotton pygmy-goose		LC		X	
Anas gracilis	Grey teal		LC	X	X	
Anas superciliosa	Pacific black duck		LC	X	X	X
Tachybaptus novaehollandiae	Australasian grebe		LC	X	X	
Columba livia	Rock dove		I			
Phaps chalcoptera	Common bronzewing		LC	X	X	
Ocyphaps lophotes	Crested pigeon		LC	X	X	X
Geopelia striata	Peaceful dove		LC	X	X	
Geopelia humeralis	Bar-shouldered dove		LC	X	X	
Podargus strigoides	Tawny frogmouth		LC	X	X	
Eurostopodus mystacalis	White-throated nightjar		LC	X	X	
Eurostopodus argus	Spotted nightjar		LC	X	X	
Aegotheles cristatus	Australian owlet-nightjar		LC	X	X	X
Hirundapus caudacutus	White-throated needletail	**M**	LC	X	X	
Apus pacificus	Fork-tailed swift	**M**	LC		X	
Elanus axillaris	Black shouldered kite		LC	X		
Microcarbo melanoleucos	Little pied cormorant		LC	X	X	
Phalacrocorax sulcirostris	Little black cormorant		LC	X		
Pelecanus conspicillatus	Australian pelican		LC	X		
Ardea pacifica	White-necked heron		LC	X		
Egretta novaehollandiae	White-faced heron		LC	X	X	
Nycticorax caledonicus	Nankeen Night-Heron		LC	X	X	
Threskiornis molucca	Australian white ibis		LC		X	
Threskiornis spinicollis	Straw-necked Ibis		LC	X		
Aviceda subcristata	Pacific baza		LC			
Haliaeetus leucogaster	White-bellied sea-eagle		LC	X		
Haliastur sphenurus	Whistling kite		LC	X		
Accipiter fasciatus	Brown goshawk		LC	X		X
Accipiter cirrocephalus	Collared sparrowhawk		LC		X	
Circus approximans	Swamp harrier		LC	X		
Aquila audax	Wedge-tailed eagle		LC	X		
Falco cenchroides	Nankeen kestrel		LC	X		
Falco berigora	Brown falcon		LC	X	X	X
Falco longipennis	Australian Hobby		LC		X	
Gallirallus philippensis	Buff-banded Rail		LC		X	
Gallinula tenebrosa	Dusky moorhen		LC		X	
Fulica atra	Eurasian coot		LC		X	
Ardeotis australis	Australian bustard		LC			
Burhinus grallarius	Bush stone-curlew		LC		X	
Vanellus miles	Masked lapwing		LC	X		

GROUP			Status		SGP Region		
	Scientific Name	Common Name	EPBC	NCA	Sth	Cnt	Nth
	Dendrocygna arcuata	Wandering whistling duck		LC			
	Turnix varius	Painted button-quail		LC	X	X	
	Calyptorhynchus banksii	Red-tailed Black-cockatoo		LC			
	Calyptorhynchus lathami	Glossy black-cockatoo		**Vul**	X	X	
	Calyptorhynchus funereus	Yellow-tailed Black-cockatoo		LC			
	Eolophus roseicapillus	Galah		LC	X	X	X
	Cacatua sanguinea	Little corella		LC	X		
	Cacatua galerita	Sulphur-crested cockatoo		LC	X	X	X
	Nymphicus hollandicus	Cockatiel		LC	X		
	Trichoglossus haematodus	Rainbow lorikeet		LC	X	X	
	Trichoglossus chlorolepidotus	Scaly-breasted lorikeet		LC	X	X	
	Daphoenositta chrysoptera	Varied sitella		LC	X	X	
	Glossopsitta pusilla	Little lorikeet		LC	X	X	
	Alisterus scapularis	Australian king-parrot		LC	X	X	
	Aprosmictus erythropterus	Red-winged parrot		LC	X	X	X
	Platycercus adscitus	Pale-headed rosella		LC	X	X	X
	Psephotus haematonotus	Red-rumped parrot		LC	X		
	Centropus phasianinus	Pheasant coucal		LC	X	X	
	Eudynamys orientalis	Eastern koel		LC		X	
	Scythrops novaehollandiae	Channel-billed cuckoo		LC		X	
	Chalcites basalis	Horsfield's bronze-cuckoo		LC	X	X	
	Chalcites osculans	Black-eared cuckoo		LC		X	
	Chalcites lucidus	Shining bronze-cuckoo		LC	X	X	
	Chalcites minutillus	Little bronze-cuckoo		LC		X	
	Cacomantis flabelliformis	Fan-tailed cuckoo		LC		X	
	Cacomantis variolosus	Brush cuckoo		LC	X	X	
	Cacomantis pallidus	Pallid cuckoo		LC	X	X	
	Tyto delicatula	Eastern barn owl		LC		X	
	Ninox boobook	Southern boobook		LC	X	X	
	Ceyx azureus	Azure kingfisher		LC		X	
	Dacelo novaeguineae	Laughing kookaburra		LC	X	X	X
	Todiramphus pyrrhopygius	Red-backed Kingfisher		LC	X		
	Todiramphus sanctus	Sacred kingfisher		LC	X	X	
	Merops ornatus	Rainbow bee-eater		LC	X	X	
	Eurystomus orientalis	Dollarbird		LC	X	X	
	Cormobates leucophaea	White-throated treecreeper		LC	X	X	
	Climacteris picumnus	Brown treecreeper		LC	X		
	Malurus cyaneus	Superb fairy-wren		LC	X	X	X
	Malurus melanocephalus	Red-backed fairy-wren		LC		X	X
	Malurus lamberti	Variegated fairy-wren		LC	X	X	X
	Chthonicola sagittata	Speckled warbler		LC	X	X	
	Smicrornis brevirostris	Weebill		LC	X	X	X
	Gerygone fusca	Western gerygone		LC			
	Gerygone olivacea	White-throated gerygone		LC	X	X	X

GROUP			Status		SGP Region		
	Scientific Name	Common Name	EPBC	NCA	Sth	Cnt	Nth
	Acanthiza nana	Yellow thornbill		LC	X	X	X
	Acanthiza chrysorrhoa	Yellow-rumped thornbill		LC		X	X
	Acanthiza uropygialis	Chestnut-rumped Thornbill		LC			X
	Acanthiza reguloides	Buff-rumped thornbill		LC	X	X	
	Acanthiza apicalis	Inland thornbill		LC	X	X	X
	Acanthiza pusilla	Brown thornbill		LC	X	X	
	Pardalotus punctatus	Spotted pardalote		LC	X	X	
	Pardalotus striatus	Striated pardalote		LC	X	X	X
	Lichenostomus chrysops	Yellow-faced honeyeater		LC	X	X	X
	Gavicalis virescens	Singing honeyeater		LC		X	
	Lichenostomus leucotis	White-eared honeyeater		LC	X	X	
	Lichenostomus melanops	Yellow-tufted honeyeater		LC	X		
	Ptilotula fusca	Fuscous honeyeater		LC	X	X	
	Lichenostomus penicillatus	White-plumed honeyeater		LC	X	X	
	Manorina melanocephala	Noisy miner		LC	X	X	X
	Manorina flavigula	Yellow-throated miner		LC	X	X	
	Acanthagenys rufogularis	Spiny-cheeked honeyeater		LC	X	X	X
	Myzomela sanguinolenta	Scarlet honeyeater		LC	X	X	
	Lichmera indistincta	Brown honeyeater		LC	X	X	X
	Melithreptus gularis	Black-chinned honeyeater		LC	X	X	
	Melithreptus brevirostris	Brown-headed Honeyeater		LC	X	X	
	Melithreptus albogularis	White-throated honeyeater		LC	X		
	Melithreptus lunatus	White-naped Honeyeater		LC		X	
	Entomyzon cyanotis	Blue-faced honeyeater		LC	X	X	
	Philemon corniculatus	Noisy friarbird		LC	X	X	
	Philemon citreogularis	Little friarbird		LC	X	X	
	Plectorhyncha lanceolata	Striped honeyeater		LC	X	X	X
	Pomatostomus temporalis	Grey-crowned babbler		LC	X	X	X
	Coracina novaehollandiae	Black-faced cuckoo-shrike		LC	X	X	
	Coracina papuensis	White-bellied cuckoo-shrike		LC	X	X	
	Coracina tenuirostris	Cicadabird		LC	X	X	
	Lalage tricolor	White-winged triller		LC	X	X	
	Pachycephala pectoralis	Golden whistler		LC	X	X	
	Pachycephala rufiventris	Rufous whistler		LC	X	X	X
	Colluricincla harmonica	Grey shrike-thrush		LC	X	X	
	Oriolus sagittatus	Olive-backed oriole		LC	X	X	X
	Artamus leucorynchus	White-breasted woodswallow		LC	X	X	
	Artamus superciliosus	White-browed woodswallow		LC	X	X	
	Artamus cyanopterus	Dusky woodswallow		LC	X	X	
	Artamus minor	Little woodswallow		LC	X		
	Cracticus torquatus	Grey butcherbird		LC	X	X	X
	Cracticus nigrogularis	Pied butcherbird		LC	X	X	
	Cracticus tibicen	Australian magpie		LC	X	X	X
	Strepera graculina	Pied currawong		LC	X	X	

GROUP			Status		SGP Region		
	Scientific Name	Common Name	EPBC	NCA	Sth	Cnt	Nth
	Dicrurus bracteatus	Spangled Drongo		LC	X		
	Rhipidura rufifrons	Rufous fantail	**M**	LC	X		
	Rhipidura albiscapa	Grey fantail		LC	X	X	
	Rhipidura leucophrys	Willie wagtail		LC	X	X	X
	Corvus coronoides	Australian raven		LC	X	X	X
	Corvus orru	Torresian crow		LC	X	X	
	Myiagra rubecula	Leaden flycatcher		LC	X	X	
	Myiagra inquieta	Restless flycatcher		LC	X	X	
	Grallina cyanoleuca	Magpie-lark		LC	X	X	X
	Corcorax melanorhamphos	White-winged chough		LC	X	X	
	Struthidea cinerea	Apostlebird		LC	X	X	X
	Microeca fascinans	Jacky winter		LC	X	X	
	Petroica goodenovii	Red-capped robin		LC	X	X	
	Eopsaltria australis	Eastern yellow robin		LC	X	X	
	Zosterops lateralis	Silvereye		LC	X		
	Hirundo neoxena	Welcome Swallow		LC	X		
	Petrochelidon nigricans	Tree martin		LC	X	X	
	Dicaeum hirundinaceum	Mistletoebird		LC	X	X	X
	Taeniopygia bichenovii	Double-barred finch		LC	X	X	X
	Anthus novaeseelandiae	Australian pipit		LC			X
	Sturnus tristis	Common myna		I	X		
Bird Total		151			122	116	38
MAMMAL							
	Tachyglossus aculeatus	Short-beaked echidna		LC	X	X	X
	Antechinus flavipes	Yellow-footed Antechinus		LC	X		
	Planigale maculata	Common planigale		LC	X	X	
	Sminthopsis murina	Common dunnart		LC	X	X	
	Phascolarctos cinereus	Koala	**Vul**	**Vul**	X	X	
	Trichosurus vulpecula	Common brushtail possum		LC	X	X	
	Petaurus breviceps	Sugar glider		LC	X	X	
	Petaurus norfolcensis	Squirrel glider		LC	X	X	
	Petauroides volans	Greater glider	**Vul**	**Vul**	X	X	
	Acrobates frontalis	Broad-toed Feathertail glider		LC		X	
	Aepyprymnus rufescens	Rufous bettong		LC		X	
	Macropus dorsalis	Black-striped wallaby		LC	X	X	
	Macropus giganteus	Eastern grey kangaroo		LC	X	X	
	Macropus robustus	Wallaroo		LC	X		
	Macropus rufogriseus	Red-necked wallaby		LC	X	X	X
	Wallabia bicolor	Swamp wallaby		LC	X	X	
	Saccolaimus flaviventris	Yellow-bellied sheathtail bat		LC	X	X	
	Austronomus australis	White-striped freetail bat		LC	X	X	
	Mormopterus lumsdenae	Northern free-tailed bat		LC	X	X	
	Mormopterus ridei	Ride's free-tailed bat		LC	X	X	

GROUP			Status		SGP Region		
	Scientific Name	**Common Name**	**EPBC**	**NCA**	**Sth**	**Cnt**	**Nth**
	Mormopterus petersi	Inland free-tailed bat		LC	X	X	
	Mormopterus sp.			LC	X		
	Chalinolobus gouldii	Gould's wattled bat		LC	X	X	
	Chalinolobus picatus	Little pied bat		LC	X	X	
	Nyctophilus geoffroyi	Lesser long-eared bat		LC	X		
	Nyctophilus gouldi	Gould's long-eared bat		LC	X	X	
	Nyctophilus corbeni	South-eastern long-eared bat	**Vul**	**Vul**	X	X	
	Nyctophilus sp.				X	X	
	Scotorepens balstoni	Inland broad-nosed bat		LC	X	X	
	Scotorepens greyii	Little Broad-nosed bat		LC	X	X	
	Vespadelus baverstocki			LC	X	X	
	Vespadelus troughtoni	Eastern cave bat		LC		X	
	Vespadelus vulturnus	Little forest bat		LC	X	X	
	Pseudomys delicatulus	Delicate Mouse		LC		X	
	Rattus tunneyi	Pale field rat		LC	X		
	Mus musculus	House mouse		I		X	
	Canis lupus	Dingo/dog		I	X	X	
	Felis catus	Feral cat		I	X	X	
	Lepus capensis	Brown hare		I	X	X	
	Oryctolagus cuniculus	European rabbit		I	X	X	
	Sus scrofa	Feral pig		I	X	X	
	Vulpes vulpes	Red fox		I	X		
		Unidentified deer species		I	X		
Mammal Total		40			38	35	2
Grand Total		**266**			**220**	**215**	**46**

Appendix G. Present, Likely or Possible Threatened Fauna Species Profiles and Mapping Criteria Mapping Criteria

BUTTERFLIES

Pale Imperial Hairstreak (*Jalmenus eubulus*)

Status

Vulnerable (NC Act)

Distribution and Habitat

Jalmenus eubulus is restricted to the eastern Brigalow Belt Bioregion. The northern limit of its distribution appears to be around the latitude of Mackay and ranges south to around Boggabilla in northern NSW. The eastern limit of its distribution is roughly designated by the Great Dividing Range, being found near Kroombit Tops, Binjour Plateau, Bunya Mountains and Jondaryan (Eastwood et al. 2008). It may be found as far west as Carnarvon (Sands and New 2002).

The species is restricted to Brigalow (*Acacia harpophylla*)-dominated woodlands and open-forests. Its core habitat is old-growth Brigalow, particularly those areas with Belah (*Casuarina cristata*), emergent eucalypts such as *Eucalyptus populnea* and understorey shrubs and adults are always observed in association with old-growth (remnant) *A. harpophylla* communities (Breitfuss and Hill 2003; Eastwood et al. 2008). Being highly mobile, isolated patches may also provide suitable habitat.

Ecology

Jalmenus eubulus feeds exclusively on Brigalow (*A. harpophylla*) shrubs ranging in height from 0.5 to 5m and (Braby 2000; Breitfuss and Hill 2003; Eastwood et al. 2008). The species has also been documented as feeding on other *Acacia* species (Sands and New 2002), but this has been discarded as erroneous in recent reviews (Eastwood et al. 2008).

It is likely that eggs enter diapause shortly after being laid. Emergence is triggered by summer rainfall, which may fall irregularly throughout the species' range, resulting in apparent different activity patterns between populations and years. Adults have been recorded between October and April, with peak activity in February and March. Peak activity appears to occur approximately two months after the wettest months of the year (December and January) (Eastwood et al. 2008).

Larvae feed singly, or occasionally in small groups of up to three individuals (Braby 2000). As in many lycaenid butterflies, the larvae are always attended by ants of the *Iridomyrmex* group, on which they are likely to be reliant for survival (Braby 2000; Sands and New 2002; Eastwood et al. 2008).

Known Threats to the Species

This species is threatened by clearing of suitably sized stands of old-growth Brigalow woodland (Sands and New 2000).

Records Relevant to the SGP

Three records are located within the SGP, the most recent is nearly 20 years old. An additional five records are within 10km of the SGP boundary. The species requires targeted

surveys by experts experienced in butterfly identification. The lack of records is likely to reflect low survey effort as the species is expected to be more widespread and abundant than indicated in databases.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire SGP area.
2. Within the SGP, all areas of remnant Brigalow (11.3.1, 11.3.17, 11.4.3 11.4.3a, 11.9.5) are classed as "Core Habitat Possible".
3. All "Core Habitat Possible" within 2km of a recent (1980+), accurate (± 500m) record is reclassified as "Core Habitat Known".
4. The remaining Regional Ecosystems and non-remnant areas are classed as "Absence Suspected".

Specific Map Modifications

None.

Mapping Confidence

The life-cycle and habitat requirements for the Pale Imperial Hairstreak is well documented and understood. Correlation between important habitat characteristics and Regional Ecosystem descriptions is high. The habitat mapping for this species is expected to be highly accurate.

REPTILES

Golden-tailed Gecko (*Strophurus taenicauda*)

Status

Near Threatened (NC Act)

Distribution and Habitat

Golden-tailed geckoes are distributed from the western slopes of the Great Dividing Range to Carnarvon, and from Emerald in the north to Inglewood/Millmerran in the south. Areas within and surrounding Barakula State Forest may represent a stronghold for this species (Richardson 2006).

This species is a Brigalow Belt endemic. They are found in a wide variety of woodland and forest habitats, mainly in association with brigalow (*Acacia harpophylla*), cypress (*Callitris* spp.) and ironbark (*Eucalyptus* spp.). They can also be common in areas with a shrubby understorey (particularly *Acacia* spp. and *Callitris* spp, including regrowth). Ground cover, tree hollows and loose or peeling bark on standing trees and tree stumps may be important shelter sites for this species (Richardson 2006).

Ecology

During the daytime, golden-tailed geckos shelter under loose bark and in tree hollows (Wilson 2015). They may also bask during the daytime. In Spring/Summer, females lay a clutch of two eggs. Females may lay more than one clutch in a season.

Movement patterns of the species have not been documented. However, individuals have been recorded crossing dual lane roads during warm summer nights.

Known Threats to the Species

Habitat loss and degradation including inappropriate roadside management, inappropriate fire regimes, clearing and thinning of vegetation for agriculture appear to be the species main threats (Richardson 2006). Deaths on roads and predation from introduced carnivores (e.g., foxes and cats) may also affect populations.

Records Relevant to the SGP

The Golden-tailed Gecko have been frequently recorded during these surveys as well during previous ecological works. It is currently known from 82 observations within the SGP, but is likely to be much more widely distributed than indicated by these records. It has been recorded in both the central and southern regions of the SGP, but not the northern region where possible habitat is fragmented and minor in extent. The species has also been regularly recorded in the surrounding area.

General Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire SGP area.
2. Within the SGP, RE's 11.3.1, 11.3.14, 11.3.17, 11.3.18, 11.4.3 11.4.3a, 11.5.1, 11.5.1a, 11.5.4, 11.5.4a, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.6, 11.7.7, 11.9.2, 11.9.5 are mapped as "Core Habitat Possible".

3. Within the SGP, RE's 11.3.2, 11.3.4, 11.3.26, 11.7.5, 11.7.5b, and 11.7.5x are mapped as "General Habitat".
4. All areas of advanced regrowth (10+) should be treated as remnant vegetation and classed according to the above rules.
5. Core Habitat Possible and General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
6. Habitat patches <5ha and not adjacent or near other remnant vegetation (i.e., isolated) are reclassed as "Absence Suspected".
7. "Core Habitat Possible" or "General Habitat" between 5ha and 10ha in size and not adjacent or near other remnant vegetation (i.e., isolated) are reclassed as "General Habitat" and "Absence Suspected" respectively.
8. Remaining regrowth and RE's are classed as "Absence Suspected".
9. Cleared agricultural, grazing land and palustrine and lacustrine wetlands (RE 11.3.3c, 11.3.27c) is classed as "Absence Likely".

Specific Map Modifications

Habitats in the northern section of the SGP (Wondoan) are open and heavily impacted by grazing activities. They generally lack a shrubby understory preferred by this species. All habitats classed as "Core Habitat Possible" or "General Habitat" using the above rules in the northern (Wondoan) section have been reclassified as "Absence Suspected".

Inspections along Wilkie Creek and the Condamine River suggest the bulk of vegetation in this alluvial system lack a suitable shrubby understorey and have been classed as "Absence Suspected".

A small number of small fragments which are unlikely to be valuable for the species based on their landscape position have been manually removed from the mapping product or dropped to a lower mapping category (i.e., Core Habitat Possible to General Habitat).

Mapping Confidence

Golden-tailed Geckos appear to be unevenly distributed throughout suitable habitat. However, they can also inhabit regrowth or cleared habitats with abundant shrubs. As such, the mapped habitat area is likely to have a moderate accuracy.

Common Death Adder (*Acanthophis antarcticus*)

Status

Vulnerable (NC Act)

Distribution and Habitat

This species is widespread throughout Queensland, with the exception of Cape York Peninsula and the Mulga Lands in the south-west (Wilson 2015). Once abundant in the Brigalow Belt, it is now rarely observed and in the southern Brigalow belt the species seems

to be particularly aligned with large contiguous tracts of vegetation (e.g. state forests around Inglewood and Southwood National Park may represent strongholds) which maintains a healthy ground strata (and in particular ground debris) (EPA 2008).

It is found in a wide variety of habitats, including rainforest, open woodland, shrubland and heath (Ehmann 1992; Wilson and Swan 2013).

Ecology

The Common Death Adder is a slow-moving, sedentary snake that lies motionless while partially buried in leaf litter, vegetation or soil. Breeding takes place in spring and autumn (Ehmann 1992).

Diet consists of lizards and small mammals, and to a lesser extent, birds and frogs. However, diet changes with age, young animals consuming more reptiles and frogs, whilst adults feed predominantly on small mammals and birds (Shine 1980).

Known Threats to the Species

Threats to this species are poorly known. Land clearing and fragmentation are likely to have extensively affected the occurrence of this species in the Brigalow Belt. Alteration to microhabitats is also likely to detrimentally affected ambush snakes such as death adders, as they require ground cover to ambush their prey. Grazing, agriculture, urbanisation and inappropriate fire regimes modify ground cover considerably, reducing potential ambush sites (Ehmann 1992; Reed and Shine 2002, EPA 2008). Similar patterns of decline have been seen in other ambush snake species (Shine 1994). The species is also at risk from Cane Toad ingestion in areas where toad abundance is high.

Records Relevant to the SGP

Two records of the species are located within 5km of the SGP boundary, including one from 2015. It is possible the species is present within the SGP although this species is very cryptic and difficult to detect, even during suitable conditions.

General Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. Vegetation with a combined extent >5,000ha should be classed as "Core Habitat Possible".
3. Core Habitat Possible within 1km of a recent (1980+), accurate (±500m) record is classed as "Core Habitat Known".
4. Vegetation not connected to larger patches, but within close proximity (<500m) can be classed as "General Habitat".
5. Regrowth and cleared areas are mapped as "Absence Suspected".
6. Cleared farmland or tilled crops are classed "Absence Likely".

Specific Map Modifications

Areas along the Kogan-Condamine Rd (in the north-west corner of the southern region) include suitable habitat types (e.g., brigalow communities) but are limited in extent reducing

their value for the species. However, this vegetation connects larger remnant patches in the west (just outside the SGP) and has been mapped as "General Habitat".

A number of small linear patches, which are mapped as "Core Habitat Possible" or "General Habitat" using the above guidelines were removed.

Mapping Confidence

Habitat use by Death Adders is difficult to predict; they may occur in any remnant habitat, yet are absent from seemingly good habitats within their range. This may reflect historic land use or events that have affected ground structure. Historical fires, for example, may have reduced ground cover and resulted in local extinctions. Following fire, recolonisation may only occur if remaining patches are large or well connected to nearby populations. Due to these difficulties, the habitat map for this species is considered to have a low accuracy.

Dunmall's Snake (*Furina dunmalli*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act Act)

Distribution and Habitat

Dunmall's snake (*Furina dunmalli*) is confined to the Brigalow Belt bioregion of south-eastern Queensland and north-eastern New South Wales, occurring north to Clermont and near Rockhampton. Most records are from the Dalby-Tara area of the Darling Downs (Hobson 2012a).

The species has been found in a wide range of habitats, including forests and woodlands dominated by brigalow (*Acacia harpophylla*) and other acacias (*A. burowii*, *A. deanii*, *A. leiocalyx*), cypress (*Callitris* spp.) or bulloak (*Allocasuarina luehmannii*) on black alluvial cracking clay and clay loams (Covacevich *et al*. 1988; Stephenson and Schmida 2008; Brigalow Belt Reptiles Workshop 2010; Hobson 2012a). It also occurs in spotted gum (*Corymbia citriodora*) and ironbark (*Eucalyptus crebra* and *E. melanophloia*) on sandstone-derived soils and there is a record from the edge of dry vine scrub (Stephenson and Schmida 2008; Brigalow Belt Reptiles Workshop 2010). However, preferred habitat appears to be brigalow growing on cracking black clay and clay loams (Cogger et al. 1993), with the majority of records from between 200 to 500 m elevation (Hobson 2012a). The species can, on rare occasions, inexplicably appear in in sub-optimal vegetation. Advanced regrowth habitat should not be excluded, particularly when adjacent or linking areas of suitable habitat. It is unlikely to occur in highly fragmented vegetation, particularly narrow linear strips.

Ecology

Dunmall's snake is a nocturnal, cryptic, secretive species that is possibly genuinely scarce and very rarely encountered (Wilson 2015; Hobson 2012a). The species has been found sheltering under fallen timber and ground litter (Cogger et al. 1993; Brigalow Belt Reptiles Workshop 2010) and may use cracks in alluvial clay soils (Ehmann 1992). Little is known of its ecology, but it reportedly preys on lizards and geckoes (Gow and Swanson 1977; Shine

1981). Nothing is known of its breeding biology other than that it lays eggs (Wilson and Swan 2013).

Known Threats to the Species

Due to the paucity of records and secretive nature of Dunmall's snake, it is not known if the species has declined, although records suggest a decline in eastern parts of its range. Its distribution, however, is confined to the Brigalow Belt bioregion, an area that has been highly modified for agriculture, the timber industry, natural gas and coal extraction, and urban development. Much of its habitat has been cleared or fragmented, particularly in its core area on the Darling Downs (Hobson 2012a). The main threats to the local populations of Dunmall's snake are thought to be:

- Predation by feral animals,
- Pasture improvement practices,
- Livestock grazing,
- Inappropriate roadside management, because much of its core habitat now only exists as linear fragments along roads and in stock routes (Richardson 2006; Hobson 2012a), and
- Increased mortality from vehicle strike.

Other possible threats include loss of fallen timber and ground litter (e.g., fuel reduction burns, firewood collection), weed invasion and drainage of swamps (DoE 2017a).

Records Relevant to the SGP

Two old records (i.e. >20 years) exist in the southern portion of the SGP. An additional two records are located within 8km of the SGP, most recent from 2000. The species is cryptic and difficult to detect, even during suitable conditions.

Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. All remnant vegetation >50ha in extent and within 500m of a larger vegetation patch of RE 11.3.1, 11.3.14, 11.3.17, 11.3.18, 11.4.3, 11.4.3a, 11.5.1, 11.5.1a, 11.5.4, 11.5.20, 11.5.21, 11.7.2, 11.7.4, 11.7.6, and 11.7.7 should be classed as "Core Habitat Possible".
3. Smaller vegetation patches of the above RE's may be mapped as "General Habitat" if they are in close proximity to large areas of "Core Habitat Possible".
4. Core Habitat Possible within 1km of a recent (1980+), accurate (±500m) record is classed as "Core Habitat Known".
5. Advanced regrowth of all the above RE's are mapped as "General Habitat" if they are adjacent to or connect large areas of "Core Habitat Possible" or "General Habitat".
6. Remaining regrowth is mapped as "Absence Suspected".

Specific Map Modifications

A number of narrow linear fragments (particularly Brigalow communities) were removed based on their limited extent and surrounding land use (high intensity farming practices).

Mapping Confidence

This species is very poorly understood and records are scarce. Predicting its occurrence is extremely difficult and the mapping is likely to have low accuracy.

Grey Snake (*Hemiaspis damelii*)

Status

Endangered (NC Act)

Distribution and Habitat

Grey snakes occur throughout the Brigalow Belt, from coastal districts near Rockhampton, south-east to the Lockyer Valley in South East Queensland (Wilson 2015).

Grey snakes inhabit dry eucalypt forest and pasture (Covacevich and Wilson 1995), favouring cracking, flood-prone soils along floodplains and near watercourses within the Brigalow Belt (Hobson 2002; Wilson 2015).

Ecology

Grey Snakes are nocturnal frog specialists (Wilson and Swan 2013), sheltering during the day under fallen logs, within soil cracks and down in animal burrows. They are known to give birth to up to 10 live young (Covacevich and Wilson 1995), but little else is known of their breeding biology.

Known Threats to the Species

This species is threatened by habitat loss, habitat degradation and fragmentation. Existing habitats and populations are under threat from agriculture and urban development (Eyre et al. 1997), as well as mining activities and the loss of waterways or wetlands. In addition, ingestion of cane toads and subsequent death from poisoning pose a threat to the species.

Records Relevant to the SGP

The Grey Snake was recorded during these surveys as well during previous ecological works. It is currently known from 16 observations within the SGP and has been recorded in both the central and southern regions of the SGP, but not the northern region where the habitat is fragmented and minor in extent.

Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. All remnant vegetation where surface water could collect provides potential habitat for these species. In particular, vegetation on Landzones 3, and 4 should be classed as "Core Habitat Possible". In addition, the following RE's have clay soils, gilgai's or are likely to be subject to temporal ponding and should also be "Core Habitat Possible"; 11.9.5.
3. Derived Grasslands, which occur in alluvial floodplains in the SGP, are mapped as "Core Habitat Possible".

4. Larger contiguous areas of RE's 11.5.1, 11.5.1a, 11.5.20, and 11.5.21, or where these are immediately adjacent Core Habitat Possible, are included as "General Habitat".
5. Artificial waterbodies are mapped as "General Habitat".
6. All remnant vegetation, non-remnant vegetation, regrowth or cleared land within 1km of a recent (1980+), accurate (±500m) record is classed as "Core Habitat Known".
7. Regrowth be classed according to its parent regional ecosystem.
8. Cleared farmland or tilled crops are mapped as "Absence Suspected".

Specific Map Modifications

Field investigations in the northern area (Wondoan) showed riparian habitats in this area were highly fragmented and heavily impacted from cattle grazing leading to loss of soil structure (ie., reduced soil cracks etc). Habitats in this area have been reduced to "General Habitat" in recognition of their reduced value.

Some unsuitable farm dams were removed.

Mapping Confidence

This species may occur in a number of habitats, including artificial grazing land. Predicting its occurrence is therefore difficult based on RE mapping. The habitat map for this species is moderately accurate.

BIRDS

Glossy Black-Cockatoo (*Calyptorhynchus lathami*)

Status

Vulnerable (NC Act)

Distribution and Habitat

Glossy Black-Cockatoos (*Calyptorhynchus lathami*) have a patchy distribution along the east coast and ranges south from near the Paluma Range to Gippsland in Victoria. An isolated population is located on Kangaroo Island in South Australia. They are uncommon and declining, especially in the south-western parts of its range, and are now extinct in mainland South Australia (Garnett *et al.* 2011). There has been concern for the status of Glossy Black-Cockatoos in the Southern Downs due to the loss of feeding and nesting resources (EPA 2003).

Birds inhabit woodlands and forests that contain abundant *Allocasuarina* spp. and abundant large hollows suitable for nesting. Many populations are restricted to remnant vegetation within hills and gullies surrounded by agricultural land (Higgins 1999); however, some populations move through artificial landscapes such as semi-urban parks, gardens and golf courses to access favoured food resources (Higgins 1999, M. Sanders pers. obs.). Groups are never far from waterbodies, which are visited daily. Being highly mobile, birds may travel considerable distances to isolated fragments in search of food. Advanced regrowth may also provide some foraging opportunity.

Ecology

Typically encountered in small family parties, Glossy Black-Cockatoos are dietary specialists, feeding exclusively on the seeds of *Allocasuarina* and *Casuarina* spp. Favoured species include *A. torulosa*, *A. littoralis*, *A. luehmannii*, *A. distyla*, *A. diminuta*, *A. gymnanthera* and *A. verticillata* (Chapman 2007). It is poorly documented, but Glossy Black-Cockatoos also feed on *A. inophloia* in and around the Kumbarilla to Inglewood area (M. Sanders pers. obs.).

Observations of the species feeding on other resources (e.g., *Callitris* and *Banksia* spp.) are likely to represent food switching during periods of poor *Allocasuarina* cone production (Chapman 2007). It is unclear if the use of *A. inophloia* by local populations reflect food switching, or if local populations rely on stands of *A. inophloia*. However, given the abundance of orts (feeding signs) in some locations, and their repeated observation over consecutive years, the latter seems plausible.

Birds show a preference for productive trees (e.g., higher seed/cone weight ratio), notwithstanding the influence of other factors such as distance from water or breeding hollows (Clout 1989; Pepper et al. 2000; Crowley and Garnett 2001; Cameron and Cunningham 2006; Chapman and Paton 2006; Chapman 2007). Stands of *Allocasuarina* spp. are therefore not of uniform value, and the loss of individual stands or trees may have disproportionate impacts.

The production of cones by *Allocasuarina* spp. closely tracks rainfall (Cameron 2006a), and hence the availability of resources for resident Glossy Black-Cockatoos fluctuate between

years. While resources may be sufficient to support existing birds, drought is likely to reduce breeding success (Cameron 2009).

Pairs breed during winter, mainly from April to July, although breeding has been recorded as late as August or as early as March (Beruldsen 2003). Nests are located in a large vertical hollow extending one or two meters deep. Hollows may be reused over many years (Beruldsen 2003). Females incubate and care for the young alone, but are regularly attended and fed by the male. Only one egg is produced, which hatches in about 30 days. Once hatched the chick fledges in around 60 days, but remains with its parents and is fed for another three months (Garnett et al. 1999).

Known Threats to the Species

Threats to Glossy Black-Cockatoo populations include:

- Clearing of habitat remains a serious threat. Previous clearing has reduced the species' range in the south and west of the Great Dividing Range (Garnett and Crowley 2000),
- Fire can reduce or remove suitable feed trees from large areas for several years and, if followed by grazing, prevent regeneration of previous habitats.,
- Fragmentation of habitats may also result in an increase in predation of nestlings and eggs or alternatively result in higher competition for hollows (Downes et al. 1997). This threat may be particularly severe where species adapted to altered or open habitats are abundant. These 'edge' species may include Common Brushtail Possum (*Trichosurus vulpecula*), Little Corella (*Cacatua sanguinea*), Galah (*Eolophus roseicapilla*) and Sulphur-crested Cockatoo (*Cacatua galerita*). By out-competing cockatoos for nest hollows, these predators and/or competitors can significantly reduce recruitment of Glossy Black-Cockatoos (Garnett et al. 1999),
- Prolonged and severe drought can significantly reduce *Allocasuarina* cone production, reducing feeding resources and therefore breeding success. Global climate change may therefore negatively impact the species on a broad scale, particularly on the western slopes of the Great Divide (Cameron 2009), and
- The loss of suitable hollow-bearing trees through processes such as fire or logging (Cameron 2006).

Records Relevant to the SGP

The Glossy Black-cockatoo has been frequently recorded during these surveys as well as previous ecological works. It is currently known from 29 observations within the SGP. It has been recorded in both the central and southern regions of the SGP, although it has been more commonly recorded in the southern portion where there is possibly more suitable foraging habitat available.

Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. Regional Ecosystems containing *Casuarina cristata* (11.3.1. 11.3.17, 11.4.3, 11.4.3a, 11.9.5) and *Allocasuarina inophloia* (11.5.4) are classed as "Core Habitat Possible". South

of the Warrego Highway areas of RE 11.7.4 may also have *Allocasuarina littoralis* and have been mapped as "Core Habitat Possible".

3. Regrowth of the above RE's, which could contain larger trees with suitable foraging resources, are mapped as "Core Habitat Possible".
4. Core Habitat Possible and General Habitat within 2km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
5. All remaining Regional Ecosystems are classed "Absence Suspected".

Specific Map Modifications

None

Mapping Confidence

Within the SGP Core Habitat Possible accurately predicts the presence of *Allocasuarina* foraging resources, though it is acknowledged that individual trees can be scattered throughout remnant vegetation or modified landscapes. While Core Habitat Possible is abundant in the southern region (Dalby region) of the SGP, it is more scattered in the central region, reducing the likelihood that Glossy Black-cockatoos will occur.

A hot wildfire severely damaged large areas of Glossy Black-cockatoo habitat in Kumbarilla State forest in late 2016. It may take several decades for foraging resources to recover in this area.

General Habitat will be an overestimate as areas of suitable regrowth vegetation (mapped as "General Habitat") will not contain trees of sufficient size to attract foraging birds.

Nests are located in large tree hollows, usually in proximity to foraging resources. Predicting where suitable nest trees might occur is difficult and no attempt has been made to capture possible nest areas in the mapping product.

A supply of water is also important for Glossy Black-cockatoo populations, and suitable locations which may attract birds are likely to be scattered throughout areas of vegetation not mapped.

Painted Honeyeater (*Grantiella picta*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

Endemic to Australia, the Painted Honeyeater (*Grantiella picta*) may be found from the eastern section of the Northern Territory to Victoria and southern regions of South Australia (Pizzey and Knight 2007). Rare in the Northern Territory, they are widespread throughout Queensland, absent only from Cape York and high rainfall areas.

Painted Honeyeaters occur mainly in dry open woodlands and forests, particularly box-ironbark woodlands. They may also be located in riparian forest, on plains with scattered

eucalypts, and in remnant trees on farmland. Their occurrence is strongly associated with mistletoe, on which they feed (Higgins et al. 2001) and fragmented or disturbed *Acacia* communities often have the highest density of Mistletoe. More advanced stands of *Acacia* regrowth may also have abundant mistletoe.

Ecology

Painted Honeyeaters feed almost exclusively on mistletoe fruit, but may also collect nectar and invertebrates (Oliver *et al*. 2003). Most foraging is undertaken within the canopy of trees (Higgins *et al.* 2001).

Nesting occurs during spring-summer (Sept.-Feb.), predominantly in the south-east of its range north to and around Brisbane. The breeding season is determined by photoperiod to coincide with warmer summer months, but actual breeding is cued in relation to the progression of mistletoe fruiting. This ensures that breeding is matched by peak resource availability, avoiding temporal variation inherent in unpredictable environments (Barea and Watson 2007).

Small, frail cup-shape nests with narrow sides are constructed in the outer foliage and branchlets of eucalypts, casuarinas and acacias. However, a disproportionately large number of nests are placed in mistletoe clumps in taller trees (Whitemore and Eller 1983; Beruldsen 2003; Barea 2008).

While not well understood, movement patterns are generally described as a north-south migration (Keast 1968). Populations move north during winter and return south of approximately 26° during spring-summer to breed (Higgins *et al.* 2001).

Known Threats to the Species

Large areas of suitable woodland habitat have been extensively cleared throughout this species' range. However, increased mistletoe abundance in degraded woodlands and roadside reserves may have benefited the species and alleviated somewhat the impacts of broad-scale habitat loss (Higgins *et al.* 2001; Bowen et al. 2009).

Records Relevant to the SGP

Three records are located within the SGP in the southern portion near Lake Broadwater where mistletoe is abundant in tall *Eucalyptus* spp., and several records exist within 10km of the SGP boundary, including records from the past few years. Likely to occur within the SGP infrequently, depending on availability and density of mistletoe fruit.

Rule(s) for Habitat Mapping:

1. The species could occur throughout the entire EIS area.
2. RE's 11.3.1, 11.3.17, 11.4.3, 11.4.3a and 11.9.5 (including 'disturbed' communities) are mapped as "Core Habitat Possible".
3. The above RE's and RE's 11.5.20 and 11.5.27 are mapped as "Core Habitat Known" around Lake Broadwater.
4. Regrowth RE 11.3.1, 11.3.17, 11.4.3, 11.4.3a, 11.9.5, and 'Regrowth Brigalow (>15yrs)' are mapped as "General Habitat".

5. All "Core Habitat Possible" within 2km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
6. All remaining regional ecosystems and non-remnant areas are "Absence Suspected"

Specific Map Modifications

A small non-remnant (below patch threshold size) of Weeping Myall (Acacia pendula woodland) was added as "Core Habitat Possible".

Mapping Confidence

The presence of abundant mistletoe can only be accurately determined through field assessment, though it can be predicted to occur with moderate accuracy in areas of Core Habitat Possible. The mapped General habitat, to capture more advanced Acacia regrowth, is likely to over evaluate habitat extent and will have a low accuracy.

Australian Painted Snipe (*Rostratula australis*)

Status

Australian Painted Snipe - Vulnerable (NC Act); Endangered (EPBC Act)

Distribution and Habitat

Most records of the species occur east of a line between Eyre Peninsula and the Gulf of Carpentaria, excluding Cape York Peninsula where they appear to be absent (Marchant and Higgins 1993). However, scattered individuals occur west as far as Western Australia, where they may have once been common in the Kimberley and Swan Coastal Plain (Johnstone and Storr 1998). Recent records mostly centre on the Murray-Darling basin of eastern Queensland and New South Wales (Marchant and Higgins 1993; Rogers et al. 2005). Lake Broadwater is considered to be important habitat for this species within Brigalow Belt South, although there is no known breeding record from this location (EPA 2003).

Birds may be recorded singly or in small groups in freshwater marshes. They are extremely nomadic, coming and going in response to local rainfall and flooding. Although its occurrence in a location is often erratic, with the bird absent some years and common in others (Marchant and Higgins 1993) there is indication of some regular seasonal migration, e.g., to central and north coastal Queensland in autumn and winter (Black et al. 2010). Breeding only occurs in swamps with temporary water regimes and complex shorelines forming islands, shallow water, exposed wet mud and dense low fringing vegetation (Rogers et al. 2005; Geering et al. 2007). During non-breeding periods, they may be found in a wider range of habitats including dams, rice paddocks, waterlogged grasslands, roadside drains and even brackish waterways (Marchant and Higgins 1993).

Ecology

The Australian painted snipe appears to be crepuscular and nocturnal, feeding on mudflats or in shallow water during the morning and evening and throughout the night (Geering et al. 2007). A variety of foods are eaten, including vegetation, seeds, insects, worms, molluscs,

crustaceans and other invertebrates including beetles (Marchant and Higgins 1993; Johnstone and Storr 1998).

Nesting occurs in spring and summer in southern Australia and during the wet season in northern Australia (Geering et al. 2007). Nests consist of a simple scrap in the ground lined by dry grasses, fine twigs and other vegetation. These nests are located in specific positions such as on a small island surrounded by shallow water, or occasionally on small mounds of purpose-built vegetation surrounded by water (Beruldsen 2003; Rogers et al. 2005). Breeding occurs only in suitable temporary wetlands with low relief and complex shorelines after an influx of water (Rogers et al. 2005).

Migration patterns are poorly known for the species (Pringle 1987). They are possibly dispersive or migratory. It is possible that such movements are due to local conditions, moving to flooded areas from drying wetlands (Marchant and Higgins 1993).

Known Threats to the Species

Threats to Australian Painted Snipe populations include:

- Loss or alteration of wetland habitats and their water regimes, particularly areas of breeding habitat (Rogers et al. 2005; Garnett et al. 2011).
- Degradation of existing wetlands through weed invasion.
- Trampling of habitat by cattle and feral pigs (*Sus scrofa*) (Rogers et al. 2005; Tzaros et al. 2012).
- Reduced water quality due to a lack of flushing, increased nutrient runoff, pesticide and herbicide runoff, saline discharge and increased erosion and turbidity due to vegetation removal (Tzaros et al. 2012).

Records Relevant to the SGP

Six records for Australian Painted Snipe are known from the southern section of the SGP, all in the vicinity of Lake Broadwater. The species is likely to be a vagrant and rare visitor to the SGP, though there is a low possibility the species might occur at Lake Broadwater and breed in the surrounding habitat during the SGP life of operation..

Rule(s) for Habitat Mapping:

1. Lake Broadwater (RE 11.3.27c and 11.3.27f) is mapped as 'Core Habitat Known'.
2. Long Swamp (RE 11.3.27d and 11.3.27f) is mapped as "Core Habitat Possible'.c
3. All remaining regional ecosystems are "Absence Suspected"

Specific Map Modifications

None

Mapping Confidence

While the Australian Painted Snipe can occur on a variety of wetlands (including minor waterbodies), it is only known to occur within the immediate area of Lake Broadwater. Habitats outside these are likely to be marginal.

MAMMALS

South-eastern long-eared Bat (*Nyctophilus corbeni*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

The south-eastern long-eared bat (*Nyctophilus corbeni*) is largely restricted to the Murray-Darling Basin (Churchill 2008; Turbill et al. 2008), with its stronghold in the Pilliga forests of central New South Wales (Turbill and Ellis 2006). In Queensland, the species is mainly recorded in the southern areas of the Brigalow Belt (Reardon 2012). The distributional limits in Queensland are uncertain. McFarland et al. (1999) states that the species is found north to near Duaringa and Venz et al. (2002) consider that the Dawson River area is at, or close to, its northern range limit. However, Parnaby (2009), in a taxonomic review of Australian greater long-eared bats previously known as *N. timoriensis*, states that the most northerly record of the species is from 80 km west of Taroom. It is unknown if possible misidentifications of the species have resulted in the uncertainty attached to its distribution.

The species is most common in box/ironbark/cypress pine woodland on sandy soils (Turbill and Ellis 2006; Churchill 2008; Turbill et al. 2008), though it also occurs in bulloak (*Allocasuarina luehmannii*), brigalow (*Acacia harpophylla*) and belah (*Casuarina cristata*) communities (Turbill et al. 2008), dry sclerophyll forests with *Corymbia citriodora*, and semi-evergreen vine thickets. The species prefers areas with a distinct canopy and a dense understorey (Churchill 2008). Most records are from large tracts of vegetation, approximately 5000+ ha in size (e.g., Southwood National Park) (EPA 2008), although the species can be occasionally recorded from smaller vegetation tracts of 600 ha (e.g., Erringibba National Park). Field observations and published literature also suggests it may use riparian habitats, though these habitats may be more important for providing roosting sites (hollow-bearing trees) and water.

Ecology

Little is known about the ecology of this species and most of what is known comes from research outside of Queensland (Reardon 2012). Roosting has been recorded in hollows of live trees, cracks in tree limbs, occasionally under exfoliating bark and even within foliage (Churchill 2008; Turbill et al. 2008; Reardon 2012).

With broad, short wings, the south-eastern long-eared bat is highly manoeuvrable and well-adapted to its cluttered habitat. They fly close to vegetation, often through the canopy and can drop suddenly to almost ground level after prey (Churchill 2008). Individuals are known to fly more than seven kilometres between roosts and foraging areas. Roosts may be changed frequently, each used for an average of 1.3 days in one study (Reardon 2012).

Mating occurs in autumn and winter. Females are able to store spermatozoa until ovulation and conception in early spring. Two young are usually born in late October to November and lactation continues until January (Turbill et al. 2008).

Known Threats to the Species

The main threats the south-eastern long-eared bat are:

- Major habitat loss over a large part of its distribution, mostly clearing of brigalow (Reardon 2012),
- Degradation of habitat from grazing,
- Loss of hollows and larger trees from logging and fires (Turbill et al. 2008),
- Increased competition for hollows from other species, and
- Increased exposure to predators (Reardon 2012).

Survey data suggest that large, intact remnants of suitable habitat are required to support populations (Turbill and Ellis 2006; Turbill et al. 2008). With more than 75% of habitat cleared in some parts of its range, land clearing and fragmentation continue to threaten this species (Duncan et al. 1999). Increased competition for hollows is an example of a flow-on impact from fragmentation (Reardon 2012).

Records Relevant to the SGP

The South-eastern Long-eared Bat has been recorded during these surveys as well as during previous ecological works. It is currently known from eight observations within the SGP and has been recorded in both the central and southern regions, although it was captured more frequently in the central region.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area.
2. Only remnant vegetation which contributes to significantly large contiguous vegetation patches (>500ha) is considered suitable. Within these larger continuous vegetation patches:
   a. RE's 11.3.14, 11.3.25, 11.3.27d, 11.3.27f, 11.5.1, 11.5.1a, 11.5.4, and 11.5.21 are mapped as "Core Habitat Possible", and
   b. RE's 11.3.1, 11.3.14, 11.3.17, 11.3.18, 11.3.2, 11.3.26, 11.4.3, 11.4.3a, 11.5.20, 11.7.2, 11.7.4, 11.7.6, 11.7.7, 11.9.7, and 11.9.5 are mapped as "General Habitat"
3. All "Core Habitat Possible" or "General Habitat" within 2km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
4. All remaining remnant and non-remnant vegetation is mapped as "Absence Suspected".

Specific Map Modifications

None

Mapping Confidence

Identifying suitably large tracts of remnant vegetation within the SGP is relatively easy. Predicting where the species might occur within this vegetation is more complex. While those RE's listed as "Core Habitat Possible" accurately reflect the best areas of habitat, large tracts of "General Habitat" may have suitable structure and provide good habitat for the

species. A precautionary approach would be to consider all areas of Core Habitat Possible or General Habitat as suitable.

While several RE's have been excluded as not suitable ("Absence Suspected") in the mapping product, their landscape position often contributes to patch integrity and they may therefore provide an important role in ensure a populations persistence.

Greater Glider (*Petauroides volans*)

Status

Vulnerable (EPBC Act)

Distribution and Habitat

The Greater Glider (*Petauroides volans*) is the largest gliding possum in Australia. Its distribution extends from the Windsor Tableland in north Queensland, south to Wombat State Forest in central Victoria (Woinarski et al. 2014). Inland isolated subpopulations are also known from the Gregory Range (west of Townsville) (Winter et al. 2004), and another in the Einasleigh Uplands bioregion of Queensland (Vanderduys et al. 2012).

The species is predominately restricted to eucalypt forests and woodlands. Greater gliders occur in highest abundance in taller, montane, moist eucalypt forests with larger, relatively old trees and abundant hollows (Andrews et al. 1994; Kavanagh 2000; Eyre 2004; van der Ree *et al*. 2004; Vanderduys et al. 2012). In areas west of the Great Dividing Range, they are found in low woodlands (McKay 2008). The species prefers forests with a diverse range of eucalypt species, due to seasonal variation in its favoured tree species (usually one or two species of eucalypt in any particular area) (Kavanagh 1984). Even in suitable habitat, the distribution may be patchy (Kavanagh 2000).

Ecology

The species is an arboreal nocturnal marsupial which is primarily folivorous, foraging on eucalypt leaves and occasionally flowers (Kehl and Borsboom 1984; Kavanagh and Lambert 1990; van der Ree et al., 2004). It shelters during the day in large tree hollows (Henry 1984; Kehl and Borsboom 1984; Lindenmayer et al., 1991; Smith et al., 2007; Goldingay 2012) and its abundance is often link to hollow density (Andrews et al. 1994; Smith et al. 1994, 1995). Research has shown that in southern Queensland, the species require at least 2–4 live den trees for every 2 ha of suitable forest habitat (Eyre 2002).

Home ranges are usually 1-4ha in size (Henry 1984; Kehl and Borsboom 1984; Comport et al. 1996; Gibbons and Lindenmayer 2002; Pope et al. 2005), however in lower productivity forest and more open woodland habitats home ranges can be up to 16 ha (Eyre 2004; Smith et al. 2007). Males have a larger home range size than females and sexes usually share a den when the breeding season commences (Kavanagh and Wheeler 2004; Pope et al. 2005; McKay 2008).

Females give birth to only one young from March to June. Juveniles emerge from the pouch when three to four months old and become independent at around nine months. However,

greater gliders do not reach their sexual maturity and start breeding until their second year (Tyndale-Biscoe and Smith 1969; McKay 2008). It is estimated that the species can live up to 15 years (Harris and Maloney 2010).

Known Threats to the Species

The main threats to the greater glider are:

- Major habitat loss and fragmentation, mostly through clearing, clearfell logging and the loss of senescent trees due to prescribed fire regimes (Eyre 2006; Lindenmayer et al., 2000; Taylor and Goldingay 2009),
- Inappropriate fire regimes (Lindenmayer et al. 2013),
- Effects from climate change such as range contraction (particularly in northern parts of its range) and declines in the health of eucalypt trees (Kearney et al. 2010; Matusick et al. 2013),
- Hyper-predation by owls (McKay 2008; Bilney et al. 2010; Lindenmayer et al. 2011), and
- Increased competition for hollows from other species (e.g. sulphur-crested cockatoos).

Records Relevant to the SGP

The Greater Glider was recorded several times during these surveys and is currently known from 11 observations within the SGP, in both the central and southern regions. Although, it was detected more frequently in the central portion, particularly along riparian areas.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area. "Core Habitat Possible" includes RE's 11.3.4, 11.3.25 and 11.3.26.
2. Patches of RE 11.3.2, 11.3.3, 11.3.14, 11.3.17, 11.3.18 and 11.3.26 immediately adjacent the above RE's are mapped as "General Habitat".
3. All Core Habitat Possible within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
4. All remaining remnant and non-remnant vegetation is mapped as "Absence Suspected".

Specific Map Modifications

Isolated fragments of Core Habitat Possible or General Habitat were removed as Absence Suspected.

Mapping Confidence

Important habitat characteristics for this species are well understood and can be matched to regional ecosystem descriptions. The mapping is considered to be highly accurate.

Koala (*Phascolarctos cinereus*)

Status

Vulnerable (NC Act); Vulnerable (EPBC Act)

Distribution and Habitat

Endemic to eastern Australia, the Koala is a solitary species that is widespread across coastal and inland areas from Cooktown, Queensland to the Mt. Lofty ranges, South Australia (Martin et al. 2008). Restricted to altitudes below 800m elevation (Munks et al. 1996),

Koalas occur in a diversity of habitats including temperate, sub-tropical and tropical forest, woodland and semi-arid communities, and sclerophyll forest, on foothills, plains and in coastal areas (Martin and Handasyde 1999; Martin et al. 2008). Koalas on the western side of the Great Dividing Range at the western edges of their range are often associated with water courses though are not restricted to them (Melzer et al. 2000; Sullivan et al. 2003). Favoured feed tree species in these areas include *E. camaldulensis, E. coolabah* and *Eucalyptus populnea.*

Koalas have been translocated into a range of areas where they did not occur historically, such as Magnetic, Kangaroo and Phillip Island's.

Ecology

Koalas are well known to have a preference for eucalypt trees as a food source, though not all eucalypts species are equal and diet varies between regions. Although an arboreal species, preferences for individual trees and the distances between feed trees forces individuals to the ground, this is when they are most vulnerable to predation and human-induced mortalities (Hindell et al. 1985; Martin 1985).

Koalas are not strongly territorial and home ranges will overlap. Home ranges vary in size from 1-2 hectares in optimum habitat, and up to 135 hectares in semi-arid regions (Ellis et al. 2002; Martin et al. 2008). Movements are often as short as the distance between feed trees, however dispersing individuals will move over larger distances. Established individuals have been known to make exploratory movements over larger distances before returning to home ranges (Dique 2003).

The breeding season occurs between October and May with females producing up to one offspring per year (Martin et al. 2008). Juveniles become independent from one year of age with males living for over 12 years and females living for over 15 years (Martin and Handasyde 1999). Breeding occurs from two years of age, and is often determined by the establishment of a male hierarchy as males become vocal and fiercely fight for females (Martin et al. 2008).

Known Threats to the Species

Significant threats to Koalas include loss and fragmentation of habitat, vehicle strike, and predation by pet dogs (*Canis lupus familiaris*), whilst wildfire, disease, drought and extreme heat can also be damaging to both individual and population health.

Koalas inhabiting the north-western portion of their range are sparse and insufficiently studied. Although threats are similar to those in areas such as South-east Queensland where more research has been undertaken on Koala populations, it is likely that the severity of some threats is different. In particular, threats such as drought, and extreme heat events, may be more frequent and severe (Munks et al. 1996; Sullivan et al. 2003).

Records Relevant to the SGP

The Koala has been detected numerous times during these surveys as well during previous ecological works. It is currently known from a total of 73 observations within the SGP and has been recorded in both the central and southern regions. However, there are far more records in the southern portion where the Condamine and Wilkie Creek catchments appear to be a stronghold for the species in the southern Brigalow Belt.

Rule(s) for Habitat Mapping:

1. The species may occur throughout the entire EIS area.
2. RE's 11.3.2, 11.3.3, 11.3.4, 11.3.14, 11.3.17, 11.3.18, 11.3.25, 11.3.26, 11.3.27d and 11.3.27f are mapped as "Core Habitat Possible".
3. RE's 11.4.3, 11.4.3a, 11.5.1, 11.5.1a, 11.5.4, 11.5.20, 11.7.2, 11.7.4, 11.7.6, 11.7.7, 11.9.2 and 11.9.7 are mapped as "General Habitat".
4. Regrowth and disturbed vegetation should be mapped as per their parent RE.
5. All Core Habitat Possible and General Habitat within 1km of a recent (1980+), accurate (± 500m) record is classed as "Core Habitat Known".
6. All remaining remnant vegetation is mapped as "Absence Suspected".

Mapping Confidence

Important habitat for this species is reasonably well understood and can be matched to regional ecosystem descriptions. Core Habitat Possible is likely to closely reflect the species distribution, particularly in the southern region of the SGP where the species remains relatively abundant. However, field studies from this work frequently found Koala's in habitats not previously considered high value (mapped as General Habitat), and as such these areas may be more important for the local population than previously understood.

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Appendix H.
Metadata and description of fields for floristic survey database

Appendix F. Metadata and description of fields for floristic survey database.

Metadata Field	Description	Additional Information
Survey Event	The survey program during which the data was collected	Includes data collected during Surat Gas Pipeline Survey, Surat Gas Project EIS and Supplementary EIS, Daandine and Surat Gas Advanced Exploration Surveys.
Survey Event Recorders	Field personnel responsible for recording information	Survey event during which data was collected and personnel responsible for collection of the information.
PP Meander	Timed meander points for Protected Plants within Protected Plant 'High Risk' buffer areas.	Recorded every 5 mins for a 30 minute interval as per the Department of Environment and Heritage Protection (DEHP) (2014). Flora Survey Guidelines – Protected Plants. Department of Environment and Heritage Protection, Queensland Government, Brisbane.
Waypoint Number	Waypoint number from combined survey efforts	Renumbered waypoints based on combined data collected from field personnel.
Ind. Ref. Number	The site number recorded by the individual field personnel. Retained to allow Site Nos to be readily referenced if required by field personnel in the future.	
Survey Type	The intensity of recorded site data as described in Neldner et al (2012)	Secondary: Secondary site data quantifies structural and floristic information for all strata. This includes structural and floristic data for the Emergent (E), Canopy / Sub-canopy (T1, T2), Shrub (S1, S2) and Ground (G) layers. Plot size is a standard 10 x 50 m plot. Ground covers are measured in standard 5 x 1m^2 or 10 x 1m^2 quadrats along a measured centreline. Tertiary: Quantifies structural and floristic information for woody vegetation (T1, T2, S1, S2) in a 10 x 50m plot. Does not record non woody vegetation in ground-covers. Quaternary: Estimates and describes structural and floristic information at a given location. Identifies dominant only and is not plot based. Observation: Provides a description of dominant species and structural formation only. Non-plot based rapid survey effort.
Lat	Latitude in decimal degrees	
Long	Longitude in decimal degrees	
Elevation	Recorded elevation from GPS	
Q Herbarium Mapped RE_2	RE indicated in mapping databases produced by Qld Government agencies (DSITIA).	Most current version is produced by Department of Resources and Mines (Version 8.0, 2014).
RE Ground Truthed	RE recorded at a specific location during field survey.	RE recorded by field ecologists at a specified waypoint. Used to verify RE mapping databases.
VMA Status	Status of RE listed under the VM Act	Categories of Endangered, Of Concern, Least Concern and Non-remnant.
Biodiversity Status	Biodiversity Status of RE	Categories of Endangered, Of Concern, No Concern at Present.
EPBC Status	Status of ecological community listed under the EPBC Act 1999.	Categories of Critically Endangered, Endangered, Vulnerable
Vegetation Structure	Vegetation Structural Formation as defined in Neldner et al 2012.	Categories of Vine forest/ Thicket, Open Forest, Woodland, Open Woodland, Shrubland and Grassland. Further information defined in Neldner et al 2012.
Emergent Height	Height of the Emergent structural layer.	Generally defined as the upper structural layer forming less than 5% total cover (Walker and Hopkins 1990). Neldner et al 2012, define the emergent layer as the upper structural layer that does not form the dominant ecological layer (the layer with the dominant biomass) which typically corresponds with the definition by Walker and Hopkins.
T1 Canopy Height	Measured height of the canopy layer.	Canopy (T1) layer is defined as the upper structural layer that forms the dominant biomass. Often represented as a height interval (e.g. 11 – 13m).

Metadata Field	Description	Additional Information
T1 Canopy Cover	Measured cover of the canopy layer.	Measured by projected canopy cover (PCC) rather than projected foliage cover (PFC). Measured over either a 50 or 100m linear transect.
T1 Count	The number of T1 stems within a standard floristic survey plot.	Standard secondary survey plot is 10 m x 50 m.
T1 Dominant	The dominant species recorded within the T1 structural layer	
T1 Sub-dominant	The sub-dominant species recorded within the T1 structural layer	
T1 Associated	Species associated with the canopy other than dominant and sub-dominant species.	
T2 Canopy Height	Measured height of the sub-canopy layer.	Sub-canopy is the tree layer that lies directly below the canopy (covered by the canopy layer).
T2 Canopy Cover	Measured cover of the canopy layer.	Measured by projected cover of the sub-canopy (PCC).
T2 Count	The number of T2 stems within a standard floristic survey plot.	Standard secondary survey plot is 10 m x 50 m.
T2 Dominant	The dominant species recorded within the T2 structural layer	
T2 Sub-dominant	The sub-dominant species recorded within the T2 structural layer	
T2 Associated	Species associated with the sub-canopy (T2) structural layer other than dominant and sub-dominant species.	
S1 Canopy Height	Measured height of the tallest shrub layer (S1) layer.	Multi-stemmed woody species typically with upper height limits of 8m.
S1 Canopy Cover	Measured cover of the tallest shrub (S1) layer.	
S1 Count	The number of S1 stems within a standard floristic survey plot.	Standard secondary survey plot is 10 m x 50 m.
S1 Dominant	The dominant species recorded within the S1 structural layer	
S1 Sub-dominant	The sub-dominant species recorded within the S1 structural layer	
S1 Associated	Species associated with the tallest shrub layer (S1) other than dominant and sub-dominant species.	
S2 Canopy Height	Measured height of the secondary shrub layer (S2) layer.	Secondary shrub layer falls below the upper (S1) shrub layer. Typical S2 heights range from 0.5 – 2m.
S2 Canopy Cover	Measured cover of the secondary shrub (S2) layer.	
S2 Count	The number of S2 stems within a standard floristic survey plot.	Standard secondary survey plot is 10 m x 50 m.
S2 Dominant	The dominant species recorded within the S2 structural layer	
S2 Sub-dominant	The sub-dominant species recorded within the S2 structural layer	
S2 Associated	Species associated with the secondary (S2) shrub layer other than dominant and sub-dominant species.	

Metadata Field	Description	Additional Information
Ground - % cover live plants.	Total foliage cover of live plants within a standard survey plot. Sometimes represented by an estimate in quaternary plots.	Includes grasses and graminoids, forbs and shrubs <0.5 m, native and exotic species. Excludes leaf litter, timber and bare ground. Measured only in secondary survey plots although estimates can be made in Quaternary survey data. Ground cover measurement is undertaken within 5 or 10 x 1m^2 quadrats (Secondary) and calculated as an average score. Estimates may be made in Quaternary plots.
Ground - % leaf litter	Cover of leaf litter in standard survey plot.	Leaf litter includes dead leaves, bark and other non-specific organic matter.
Ground - % leaf litter	Cover of leaf litter in standard survey plot.	Leaf litter includes dead leaves, twigs, bark and other non-specific organic matter.
Ground - % cover bare ground.	Cover of bare ground in standard survey plot.	Bare ground typically relates to exposed soil and sometimes rock.
Ground - % cover timber.	Cover of timber in standard survey plot.	Timber typical describes woody material (branches) > 5 cm diameter.
Ground - % cover rocks.	Cover of bare rock in standard survey plot.	Exposed rock not covered by soil.
Ground - % Cover Perrenial Native Grass	% cover of perennial native grass measured in a standard secondary plot. Sometimes represented by an estimate in quaternary plots.	% cover of native perennial grasses taken as an average of sampled quadrats (Secondary sites) or an estimate (Quaternary plots). Perennial describes plants that persist throughout seasons although might die back in less favourable growing conditions, resprouting when growth conditions improve (i.e following rain).
Ground - % Cover Native Shrubs < 1m	% cover of shrubs measured within quadrats.	% foliage and branch cover of native shrubs < 1m height taken as an average of sampled quadrats (Secondary sites) or an estimate (Quaternary sites)
Ground - % Cover Native Forbs	% cover of native forbs measured in a standard secondary plot. Sometimes represented by an estimate in quaternary plots.	% cover of native forbs taken as an average of sampled quadrats (secondary sites) or an estimate (quaternary sites). Forbs are herbaceous flowering plants that are not graminoids (grasses and sedges).
Ground - % Cover Exotic Grass	% cover of exotic grass measured in a standard secondary plot. Sometimes represented by an estimate in quaternary plots.	% cover of exotic grasses taken as an average of sampled quadrats (secondary sites) or an estimate (quaternary sites). Perennial describes plants that persist throughout seasons although might die back in less favourable growing conditions, resprouting when growth conditions improve (i.e following rain).
Ground - % Cover Exotic Forbs	% cover of exotic forbs measured in a standard secondary plot. Sometimes represented by an estimate in quaternary plots.	% cover of exotic forbs taken as an average of sampled quadrats (secondary sites) or an estimate (quaternary sites). Exotic forbs are herbaceous flowering plants that are not graminoids (grasses and sedges) and are not native (introduced) to the survey area.
Cryptogams - % Cover	% cover of cryptogams covering soils in the ground layers.	Cryptogams are plants that reproduce by spores without flowers, seeds or leaves. Remnants persist as surface crusts during dry periods.
Grass / Forb dominant	The dominant grass/ forb species measured in ground layers. May be one or several species.	Includes both native and exotic species.
Grass / Forb sub-dominant	The sub-dominant grass / forb species measured in ground layers. May be one or several species.	Includes both native and exotic species.
Total spp. No	Total number of species recorded within a standard secondary survey plot.	Includes all woody and non-woody species although excludes cryptogams.
Harissia cactus % cover	Measured ground cover of Harrisia cactus (Harrisia martini), a declared Class 2 exotic pest.	
Opuntia % cover	Measured ground cover of Opuntia spp., a declared Class 2 exotic pest.	

Metadata Field	Description	Additional Information
Bryophyllum. % cover	Measured ground cover of exotic Sporobolus spp. (Sporobolus fertilis, Sporobolus pyramidalis, Sporobolus jacquemontii).	
Geology/ Soil	Field description of landform, soil and geology at a given survey site.	
Notes	Additional relevant information used to describe site characteristics.	
Philotheca S1 Cover	Measured crown cover of *Cerbera dumicola* in the S1 shrub layer in a standard Secondary site.	Philotheca sporadica is the only threatened species recorded during Arrow Surat Gas Project studies.
Philotheca Stems / ha	Stem counts for *Philotheca sporadica* in standard Secondary site in the shrub layer	
Date of Survey	Time and date of field recording	
Altitude	Altitude of survey location taken as metres above sea level, recorded on GPS.	
Photo number.	Photo number for individual survey locations.	Photo points collected by field recorders according to site location.
Additional Information	Reference to additional structural / floristic data	Reference to structural and floristic information specifically relating to native grassland assessments. Held separately from structural summary table. Includes floristic collection numbers.
Seasonal Effort	Relates to wet or dry season survey	Dry season survey undertaken from June to December and wet season typically from January to May.