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ECOLOGICAL MANAGEMENT

FIELD VALIDATED REGIONAL ECOSYSTEM MAPPING OF RW3A

Report prepared for

Santos GLNG Pty Ltd

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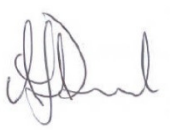

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Date: 1 February 2017

FIELD VALIDATED REGIONAL ECOSYSTEM MAPPING OF RW3A

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Abbreviations

CSIRO	Commonwealth Scientific and Industrial Research Organisation
DEHP	Queensland Department of Environment and Heritage Protection
DoE	Commonwealth Department of the Environment
DSITIA	Queensland Department of Science, Information Technology, Innovation and the Arts
E	Endangered
EPBC Act	Commonwealth Environment Protection and Biodiversity Conservation Act 1999
GLNG	Gladstone Liquid Natural Gas project
ha	Hectare
LC	Least Concern
LZ	Land Zone
MNES	Matter of National Environmental Significance
NC	No Concern at Present
OC	Of Concern
PLA	Petroleum Lease Area
RE	Regional Ecosystem
REDD	Regional Ecosystem Description Database
TEC	Threatened Ecological Community
VM Act	Queensland's Vegetation Management Act 1999

1.0 INTRODUCTION

1.1. BACKGROUND AND PURPOSE

Santos GLNG require large scale accurate mapping of ecological constraints within its project tenements to facilitate infrastructure design and construction and development of their gas fields of Southern Queensland. The production of accurate regional ecosystem and fauna habitat values mapping will allow Santos GLNG to meet ecological obligations under their EA and EPBC act conditions. To-this-end Terrestria Pty Ltd have been engaged to produce field validated high resolution mapping of regional ecosystems of the Roma West 3a study area.

1.2. LOCATION OF STUDY AREA

The study area approximately 19,500 ha in size, located approximately 20 km due east of Roma immediately north of the Warrego highway, in southern Queensland (**Figure 1.1**). The study is associated with the Roma West 3a project development.

2.0 METHODOLOGY

2.1. REGIONAL ECOSYSTEM ASSESSMENT

The remnant/non-remnant status of native vegetation was determined using the methods set out in *Guideline for Conducting Vegetation Assessments: A Guide to using the 'Procedure for Conducting Vegetation Assessments' Document Number: 0007-650-GDE-0002* and Neldner et. al., (2012). The relative dominance of species in each strata were assigned as per the definitions in the August 2012 version of the Regional Ecosystem Map Assessment Kit (Queensland Herbarium, 2012) where:

- d (dominant species) – A species that contributes most to the overall above-ground biomass of a particular stratum
- c (co-dominant species) – Where two or more species contribute more or less equally to form the dominant above-ground biomass of a particular stratum
- s (subdominant species) – A species is considered to be subdominant when it contributes less biomass than the dominant species, but occurs as more than an isolated individual. As a general rule, the species must individually contribute more than 10% of the total biomass of the stratum in which it occurs.
- a (associated species) – Any species is present in a stratum but does not contribute more than 10% of the total biomass of the stratum in which it occurs.

2.2. FUNCTIONAL REGIONAL ECOSYSTEM ASSESSMENT

Endangered and Of Concern (Biodiversity status) regional ecosystems that have not developed a Remnant (VMA, 1999) structure are assessed for their potential to provide for ecological functioning within the landscape. The Santos methodology "Functional Thresholds for Assessing Regional Ecosystem Functionality" was employed to assess whether these non-remnant vegetation patches reach a threshold of functionality. This method includes the assessment of the following criteria:

- Patch width
- Patch Size
- Non-native perennial vegetative cover
- Recruitment to the Ecologically Dominant Layer (EDL)
- Minimum median canopy height
- Presence of Large trees that are greater than 50% of the benchmark height of EDL
- Organic Litter cover as a percentage of the mean benchmark
- Coarse woody debris as a percentage of the mean benchmark

2.3. PRE-FIELD DESKTOP ASSESSMENT

Priority patches were identified for field verification based primarily of likely Biodiversity status and uncertainty of desktop attribution. That is, those polygons thought likely to contain remnant Endangered or 'functional[1]' endangered vegetation were prioritised for field survey. Site locations are provided in **Figure 3.4.**

2.4. POST-FIELD REGIONAL ECOSYSTEM MAPPING

Field data was used in combination with aerial photographic interpretation and available spatially explicit information including geology, contours, soils and land systems to produce reliable fine scale mapping of regional ecosystems. Map polygons were attributed confidence ratings to indicate accuracy of both the polygon boundary and RE attribution for each polygon (as per (Neldner, et al., 2012)). Those patches that had been visited were attributed a high confidence rating whilst those patches that were attributed through the desktop assessment were given a medium confidence rating.

2.5. FIELD SURVEY

Due to the small amount of native vegetation occurring across the survey area most patches large enough (> 0.5ha) to be mapped were visited. A Regional ecosystem code assessment form F from the Queensland Herbarium Queensland Herbarium's Regional Ecosystem map modification kit was completed at all sites deemed remnant. Santos' Vegetation Assessment proformas were utilised where vegetation communities were not remnant but were thought to be borderline 'functional' under the definition within *Guideline for Conducting Vegetation Assessments: A Guide to using the 'Procedure for Conducting Vegetation Assessments' Document Number: 0007-650-GDE-0002.* At each location, the HMAT from the *Santos GLNG Procedure for conducting Regulated Fauna Habitat Assessments* was also completed.

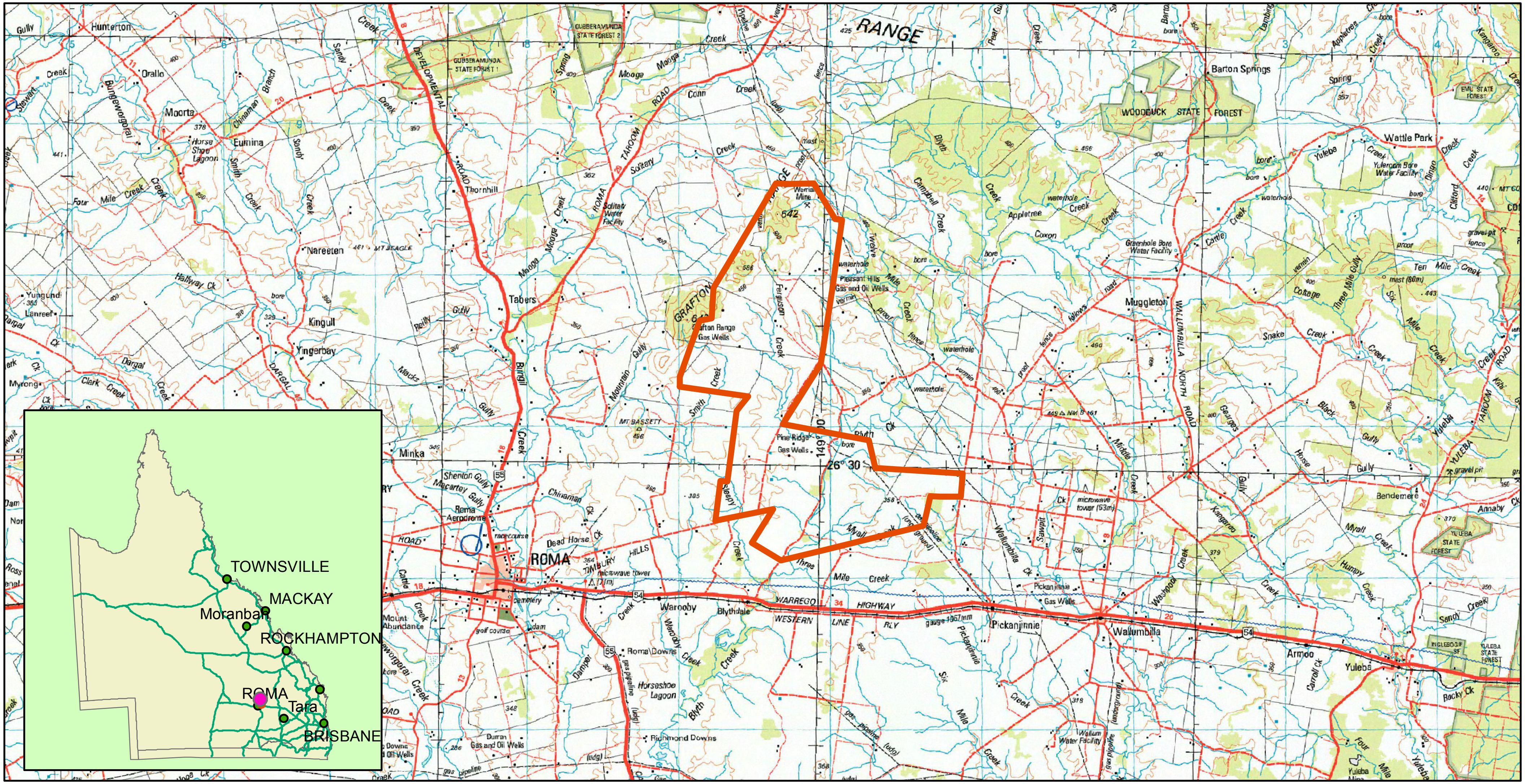
[1] 'Functional' communities refers to those communities that are deemed to be ecologically functional according to Santos' methodology (see Guideline for Conducting Vegetation Assessments: A Guide to using the 'Procedure for Conducting Vegetation Assessments' Document Number: 0007-650-GDE-0002

2.6. REGIONAL ECOSYSTEM AND HABITAT MAPPING

Orthorectified 25 cm high resolution aerial imagery supplied by Santos Pty Ltd was used to delineate native vegetation communities and areas of potential habitat across the study area. The imagery was captured during June 2014. Digital spatial data including; Herbarium RE mapping (version 8.0), 10 m contours, waterways, Biodiversity Planning Assessment (BPA) mapping, specimen backed records and 250K geology were used to aid in the attribution of regional ecosystems to all mapped vegetation polygons and fauna habitat classification to areas of potential habitat. The amended RE mapping line work was produced at a nominal scale of 1:10,000, which has a minimum polygon size of approximately 0.1 ha, a minimum width for linear features of approximately 10 m, and polygon boundaries with spatial precision of ±10 m.

2.7. NOMENCLATURE

Scientific names for terrestrial flora are consistent with those used in the Census of the Queensland Flora (Bostock & Holland, 2010) and botanical binomials presently accepted by the Queensland Herbarium, (DSITIA). The description of regional ecosystems follows that of the Regional Ecosystem Description Database (REDD, Version 7.1 (Queensland Herbarium, 2013)).



Kilometers

0 1.75 3.5 7 10.5 14

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Study Area

FIGURE 1.1: Study Area Location RW3a

Field Validated Regional Ecosystem Mapping of RW3a

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Data Source: XXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXXX

3.0 RESULTS AND DISCUSSION

The study area is dominated by low rolling hills of clay soils derived from cretaceous sandstone. These soils have largely been cleared for cropping and cattle grazing with native vegetation communities confined to small stands and shade lines. The prominent exceptions are the sandstone and basalt hills that form part of the Grafton ranges within the north-west which have retained some larger patches of brigalow and SEVT and the riparian areas associated with Blythdale Creek in the central southern area where extensive woodlands dominated by poplar box occur.

The most common vegetation communities are dominated by; poplar box *Eucalyptus populnea*, brigalow *Acacia harpophylla* or belah *Casuarina cristata* canopies. It is the land zone which drives the regional ecosystem to which these communities are assigned. The derivation of mapped land zones across the Study area are primarily driven by the 250k geology (DNRM, 2012). Where a range of soil types may be derived from the underlying geology the expression of land zone type is determined in the field.

3.1. GEOLOGY

The Department of Natural Resources and Mines (DNRM) geology dataset for the Roma 1:250,000 geology map sheet (Department of Natural Resources and Mines, 2012) (**Figure 3.1**) identifies the study area as being dominated by Cretaceous aged sedimentary deposits (land Zone 9 and 10) with minor occurrences of Tertiary aged basalt and olivine basalt confined to the north-west of the study area (Land zone 8)(**Table 3.1**).

Table 3.1: Major geology units mapped from the study area (source: Roma 1:250,000 geology map)

Map Symbol	Age	Lithology Description	Land Zone
Klm	Quaternary	Alluvium	3
Tb	Tertiary	Basalt and Olivine basalt	8
Kli	Cretaceous and/or Tertiary	Glauconitic lithic to quartoze sandstone, siltstone, mudstone, bioturbidites. Shelly fossils	9
Kln	Cretaceous and/or Tertiary	Quartoze to labile sandstone, siltstone, mudstone	9
Klk	Cretaceous and/or Tertiary	Clayey sandstone, carbonaceous mudstone	9
Klm	Cretaceous and/or Tertiary	Quartoze to labile sandstone, some clayey; some sandstone, conglomerate	9/10

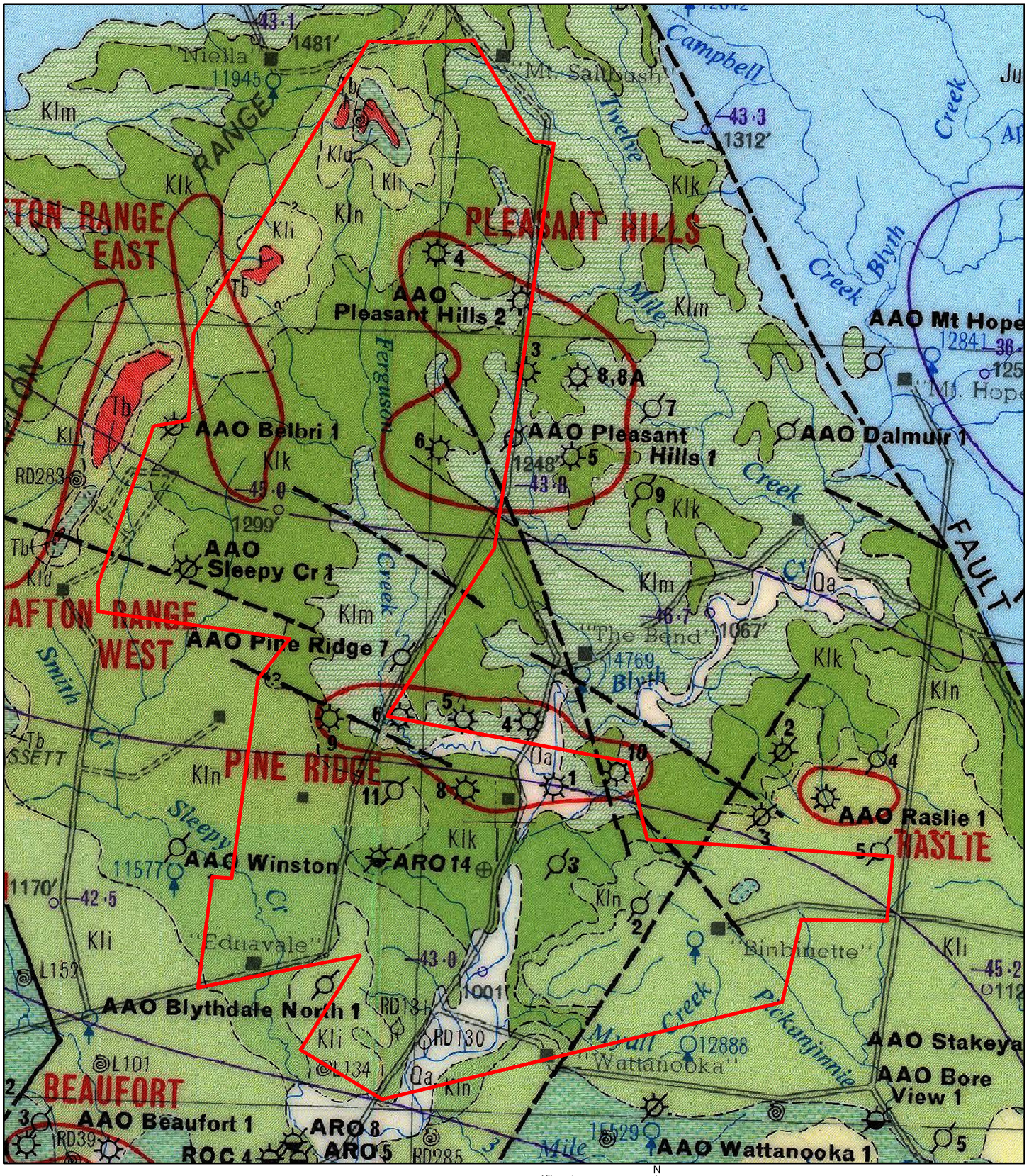

FIGURE 3.1

1:250,000 Geological Mapping

Field Validated Regional Ecosystem Mapping of RW3a

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3.2. REGIONAL ECOSYSTEMS MAPPING

47 Tertiary level sites were recorded on the Queensland Herbarium's Map modification request, Sheet D (**Table 3.2; Figure 3.4**); **Appendix A**). This field validation resulted in the mapping of an extra 324ha of vegetation as remnant and functional regional ecosystems (Figures 3.2 & 3.3). This mapping includes; 309 ha of remnant ecosystems, 15ha of confirmed non-remnant functional endangered vegetation.

One of the major drivers for the increase in mapped regional ecosystem area is the higher map resolution that allows for the mapping of patches of structurally mature native vegetation communities previously too small to map (< 5.0ha) at the 1:100,000 scale. The production of this appropriately field validated high resolution mapping has led to the mapping of a further 46ha of remnant and functional regional ecosystem considered endangered and 281ha of regional ecosystem considered Of Concern under DEHP's biodiversity status. Although large amounts of endangered regional ecosystem patches were mapped across the study area the increase in total area of endangered RE was tempered by the remapping of large areas of endangered vegetation as the Of Concern Regional ecosystem RE 11.9.7 mostly around the Blythdale Creek area. No regional ecosystems not previously mapped by the Queensland Herbarium were mapped within the Study area.

Approximately 49ha of SEVT was mapped as occurring on land zone 8. This regional ecosystem (RE11.8.3) has an Of Concern biodiversity status but is still considered as a TEC under the EPBC Act. The mapping of this regional ecosystem was driven by the mapped presence of Tertiary Basalt and Olivine basalt (Td) in the north-western extremity of the Study area and has not been confirmed in the field due to the rugged nature of the landscape preventing timely access.

In addition to the increase in mapped regional ecosystem area the use of better aerial imagery coupled with more intense on-ground surveys has also led to better community type attribution and the elimination of heterogeneous polygons.

Table 3.2: Flora and Fauna Survey sites for RW3a Study Area

Site No.	Easting	Northing	Regional Ecosystem	Structure	General Habitat significant fauna species
1	696993	7061722	11.9.7	Remnant	2,3,4,5,6,7
2	698115	7062957	No data		2,3,4,5,6,7
3	697926	7063323	non-remnant 11.9.7	Regrowth	
4	697559	7063693	non-remnant 11.9.5	Regrowth	7
5	697121	7063676	11.9.7	Regrowth	2,3,4,5,6,7
6	697332	7064906	11.9.5	Remnant	2,3,4,7
7	699342	7063420	11.3.27	Remnant	1,2,3,4,5,6,7
8	699281	7063414	11.3.2 Quaternary	Remnant	2,3,4,5,6,7
9	699824	7064431	11.9.10	Remnant	2,3,4,6,7
10	701037	7064493	11.9.5	Remnant	
11	700691	7063693	11.9.10	Remnant	
12	700777	7062789	non-rem LZ 3 Quaternary	Regrowth	
13	697920	7072263	11.9.5	Remnant	
14	697842	7072182	non-remnant Quaternary		
15	698450	7063508	boundary LZ 3/9 Quaternary	Remnant	2,3,4,5,6,7
16	699333	7065501	11.9.7 Quaternary	Remnant	2,3,4,5,6,7
17	699084	7074573	11.9.5	Remnant	2,3,4,6,7
18	697733	7075513	11.9.5	Remnant	2,3,4,6,7
19	696991	7076563	11.9.5	Remnant	2,3,4,6,7
20	696495	7076111	11.9.5	Remnant	2,3,4,6,7

Site No.	Easting	Northing	Regional Ecosystem	Structure	General Habitat significant fauna species
21	695598	7081167	non-rem 11.9.5		2,3,4,6,7
22	696603	7082415	11.9.4a	Remnant	2
23	698408	7083991	11.9.5	Regrowth	2,3,4,6,7
24	696978	7084905	non-rem 11.9.4a		2
25	697310	7084920	11.9.5a	Remnant	2
26	700104	7078889	11.9.10	Remnant	2,3,4,6,7
27	699658	7068770	11.9.7	Remnant	2,3,4,6,7
28	699832	7068844	non-rem 11.3.2		2,3,4,5,6,7
29	699007	7069235	11.9.7	Remnant	2,3,4,5,6,7
30	699021	7069280	11.3.25	Remnant	2,3,4,5,6,7
31	700015	7069173	11.3.2	Remnant	2,3,4,5,6,7
32	695950	7065387	11.9.5	Remnant	2,3,4,7
33	695664	7065997	No data		2,3,4,7
34	696851	7065365	non-rem	Regrowth	2,3,4,6,7
35	696118	7066503	11.9.5	Remnant	2,3,4,6,7
36	697022	7066639	11.9.7 Quaternary	Remnant	2,3,4,6,7
37	698630	7067702	non-rem 11.9.7 Quaternary	Regrowth	2,3,4,6,7
38	698721	7068025	11.9.7	Remnant	2,3,4,6,7
39	699734	7066973	11.3.25	Remnant	1,2,3,4,5,6,7
40	701354	7069040	11.9.7	Remnant	2,3,4,6,7
41	701636	7069026	11.9.5	Remnant	2,3,4,6,7
42	701918	7068662	11.9.5	Remnant	2,3,4,6,7
43	701913	7068486	11.9.5	Remnant	2,3,4,6,7
44	702128	7068146	11.9.5 Quaternary		2,3,4,6,7
45	701220	7066762	11.9.5	Remnant	2,3,4,6,7
46	700380	7067064	11.9.7	Remnant	2,3,4,7
47	699886	7066779	11.3.2	Remnant	2,3,4,5,6,7
48	690519	7072948	11.9.5a	Remnant	2,3,4,7
49	692916	7075303	11.9.5a	Remnant	2,3,4,5,7
50	690225	7073306	11.9.5a	Remnant	2,3,4,7
51	694202	7075196	11.9.5	Remnant	2,3,4,7
52	694482	7078171	No data		2,3,4,6,7
53	694911	7080798	11.9.5a	Remnant	2,3,4,7
54	694911	7080799	11.9.4a	Remnant	2
55	693585	7079053	11.9.5a	Remnant	
56	706433	7066150	11.9.10	Remnant	2,3,4,6,7
57	703763	7065986	11.9.5	Remnant	2,3,4,6,7
58	705214	7064705			2,3,4,5,6,7
59	703972	7064428	11.9.10	Remnant	2,3,4,5,7
60	707872	7063069	11.9.10	Remnant	2,3,4,5,7

Site No.	Easting	Northing	Regional Ecosystem	Structure	General Habitat significant fauna species
61	701181	7063095	11.9.7	Remnant	
62	699324	7065721	11.9.7	Remnant	
073	699580	7064037	Quaternary		
082	699028	7064646	11.3.2	Remnant	
085	699485	7066403	11.3.2 Qauternary	Remnant	
086	695645	7067066	non-rem 11.9.5	Regrowth	
091	696158	7075981	non-rem Qauternary		
092	695564	7075064	11.9.5 Quaternary	Remnant	
099	700154	7078487	11.9.7 Quaternary	Remnant	
109	697675	7067311	non-rem 11.9.5 Quaternary		
111	698477	7067786	non-rem 11.9.7 Quaternary	Regrowth	
112	698525	7067793	non-rem 11.9.7 Quaternary	Regrowth	
114	699836	7067760	non-rem		
115	699655	7067055	11.3.25 edge quaternary	Remnant	
121	702564	7068839	Quaternary		
124	700802	7066635	11.9.7/11.9.5 Quaternary	Remnant	
125	700746	7066938	11.9.7 Quaternary	Remnant	
126	700606	7067057	11.9.7 Quaternary	Remnant	
132	695244	7075108	11.9.5 Quaternary	Remnant	
133	694252	7075245	11.9.5 Quaternary	Remnant	
135	693038	7077876	11.9.4a Quaternary	Remnant	
141	705975	7063531	11.9.5 Quaternary	Regrowth	
142	705928	7064087	non-rem	Regrowth	
143	703964	7064565	11.9.10 Quaternary	Remnant	

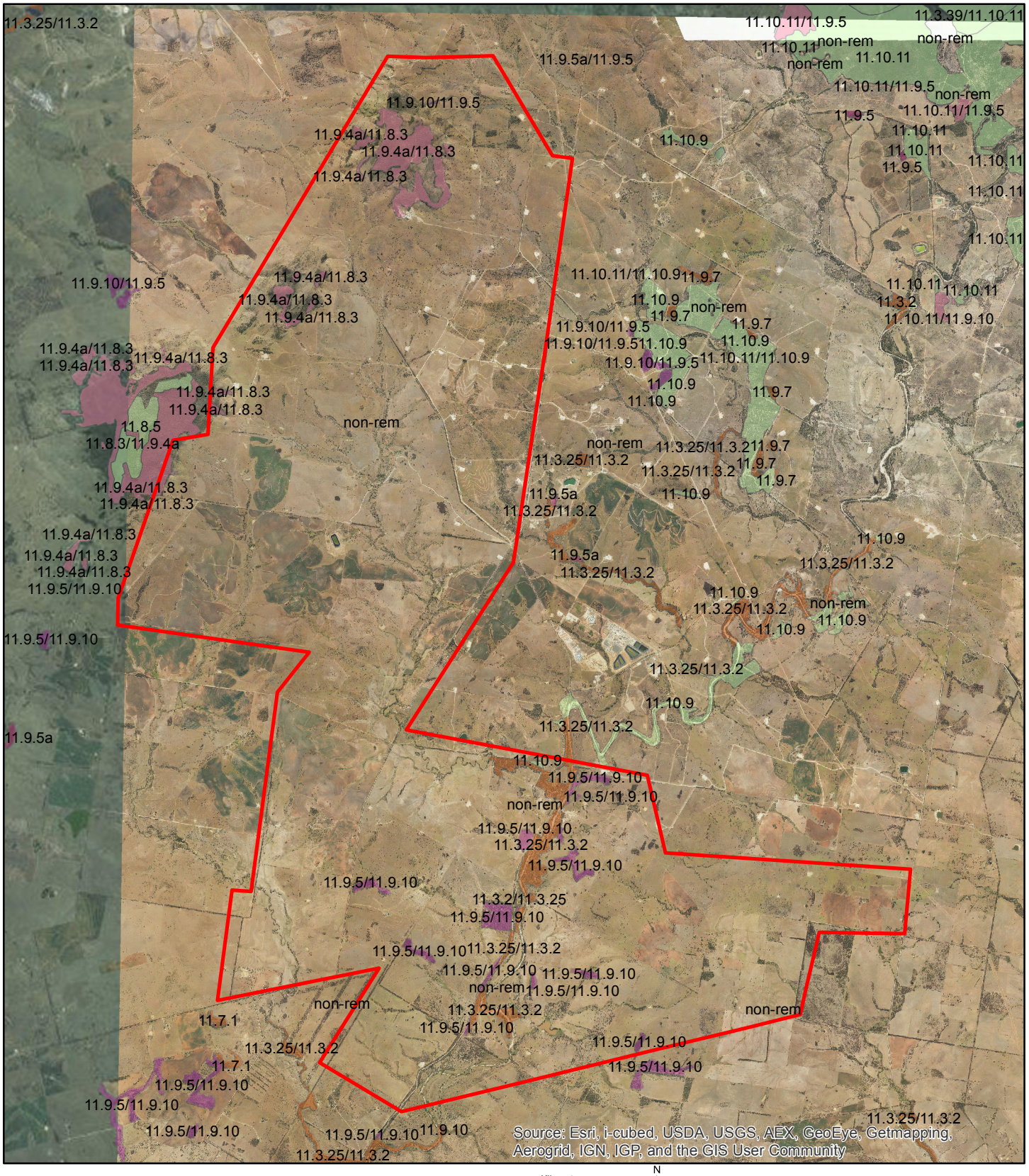
- Regrowth indicated in this table is non-functional
- 1 = Australian painted snipe
- 2 = Brigalow scaly-foot
- 3 = Collared delma
- 4 = Dunmall's snake
- 5 = Koala
- 6 = South-eastern long-eared bat
- 7 = Yakka skink

Table 3.2: Comparison of regional ecosystems areas mapped under both the Qld Herbarium's 1:100,000 (v 8.0) and Santos 1:10,000 mapping

Polygon Type	Polygon Number		Area (ha)	
	Herbarium	Field Validated	Herbarium	Field Validated
Non-remnant	8	2	18813	18489
Remnant Endangered	0	95	0	498
Dom Endangered	27	0	436	0
Functional endangered	0	3	0	15
Of Concern	5	48	250	500
Sub-dominant Of Concern				
No Concern at Present	4	0	5.8	0
Total mapped vegetation			689	1013

4.0 CONCLUSION

The use of recent high quality high resolution aerial imagery combined with field verification has led to the production of a large scale regional ecosystem map with a high level of certainty of polygon attribution.



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E	NC/E	OC/E
E/E	NC/NC	OC/E/OC
E/OC	NC/NC/E	OC/NC
E/OC/OC	NC/OC	OC/OC
NC	OC	OC/OC/OC

FIGURE 3.2

Herbarium 1:100,000 Regional Ecosystem Map Version 8.0

Field Validated Regional Ecosystem Mapping of RW3a

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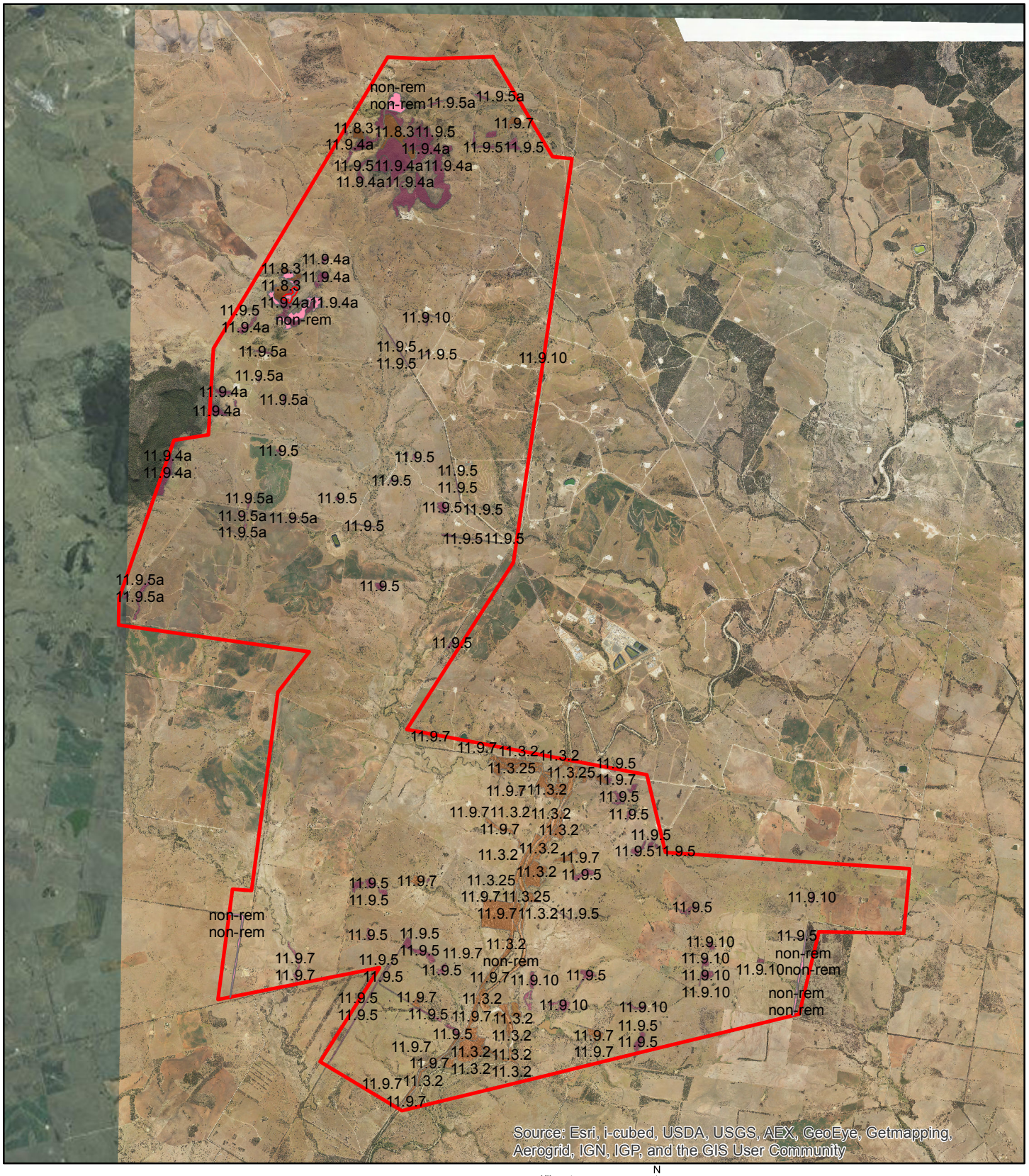

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Functional Regrowth

Remnant Regional Ecosystems

FIGURE 3.3

Field Validated 1:10,000 Regional Ecosystem Map of RW3a

Field Validated Regional Ecosystem Mapping of RW3a

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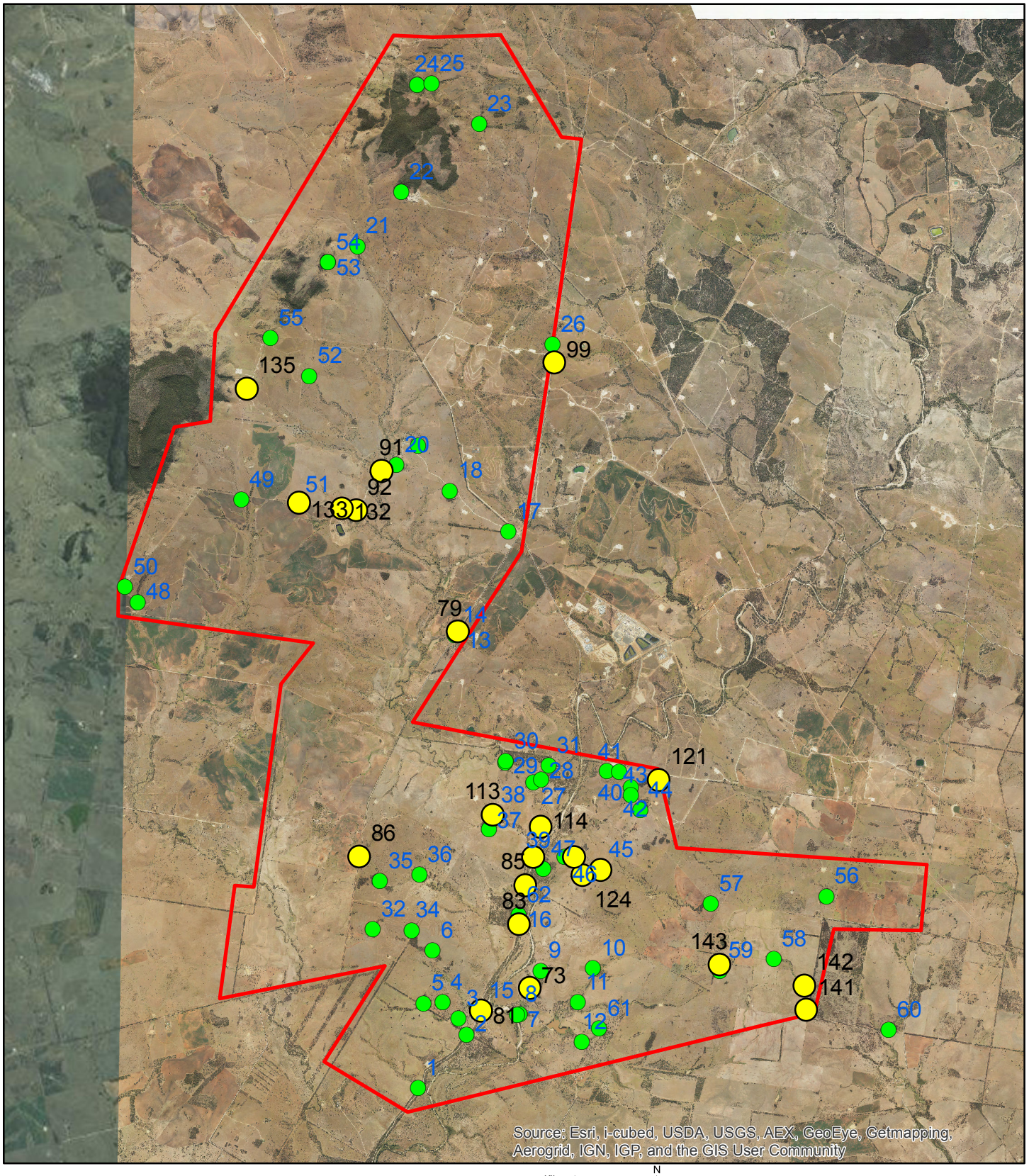

Legend

- RW3a Boundary
- Flora and fauna site locations
- Quaternary site locations

FIGURE 3.4

Survey Site Location

Field Validated Regional Ecosystem Mapping of RW3a

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