Bioscience

Integrating Resource Management

Flora Survey:
Lot 7779 on Deposited Plan 209806
Wannamal Road, Cullalla

Wannamal Road Organics Pty Ltd
Western Australia
August 2021

Flora Survey
Lot 7779 Wannamal Rd, Cullalla

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Contents

List of Figures

List of Appendices

Executive Summary

Vinsan Holdings Pty Ltd, the owners of Lot 7779 on Deposited Plan 209806, Cullalla, is seeking to develop a composting facility which is a Prescribed Activity under the Environmental Protection Act (DWER reference CPS 7612/1). To this end and to conform to regulatory requirements for the development of land, they have commissioned Bioscience Pty Ltd to conduct a Terrestrial Flora and Vegetation Survey to support the clearing of native vegetation from 25 ha of their 1647 ha property.

Several surveys were conducted within the 25 ha area in question and the broader surrounding area (2015 and 2017/2018). The area was defined as a low open Banksia (*Banksia attenuata, B. menziesii*) woodland largely representing a disturbed Cullula Complex (Heddle et al. 1980). Although the defining species *Eucalyptus todtiana* and *B. ilicifolia* were present in low numbers, another key species, *Corymbia calophylla*, was not found during surveys. Given the clearing of the land in 1981 followed by agricultural use, the flora community present does not resemble a threatened ecological community. This finding is supported by cluster analysis of a Bray-Curtis similarity matrix which showed that the vegetation in this area is distinct from floristic community types 21, 22, and 23 (Gibson et al. 1994).

No Declared Rare Flora were found despite a concerted effort using multiple transects and 4 quadrats that were examined in detail five times over 2 years, including searching the 10 m perimeter of each quadrat. In the detailed survey one specimen of the P4 taxon *Verticordia paludosa* was found outside of quadrat 4.

1 Introduction

1.1 Purpose of this Report

Vinsan Holdings Pty Ltd, the owners of Lot 7779 on Deposited Plan 209806, Cullalla, is seeking to develop a composting facility which is a Prescribed Activity under the Environmental Protection Act (DWER reference CPS 7612/1). In order to achieve this development aspiration, and to conform to regulatory requirements for the development of land, they have commissioned Bioscience Pty Ltd to conduct a Terrestrial Flora and Vegetation Survey to support the clearing of native vegetation from 25 ha of their 1647 ha property. This follows a fauna survey conducted by [redacted] in 2015 which found no evidence of rare or endangered fauna.

There are two distinct purposes for this report. The first is to undertake work to meet the general requirements of EPA Guidance 51 and the *Technical Guide – Terrestrial Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA and DPaW 2016) to enable regulatory authorities to gauge the conservation value of the area in consideration of a Permit to Clear Native Vegetation. The second purpose is to assist with development of the land by identifying both flora and vegetation complexes present and the vegetation condition, both with the proposed clearing site and adjacent, to facilitate its preservation and conservation of adjacent land.

1.2 Survey Area

The area proposed for clearing is the northern portion of Lot 7779 Wannamal Rd (31.09.44° S, 115.58.04° E), 25 ha of low open Banksia (*Banksia attenuata, B. menziesii*) woodland largely representing a disturbed Cullula Complex (Heddle et al. 1980). Although *Eucalyptus todtiana* and *B. ilicifolia* are present in low numbers, *Corymbia calophylla* was not found. The site is situated approximately 90 km north of Perth and approximately 55 km east of the coast. (Figure 1). It lies within the Shire of Gingin and is surrounded by Boonanarring Nature Reserve to the west, a mix of mostly uncleared rural properties to the north and east, and an approved landfill site proposed on the lot 7778 at the southern boundary.

1.3 Site History and Previous Land Use

The property has been privately owned by Vinsan Holdings Pty Ltd for the last 10 years. Mapviewer shows that in 1981, the land had been cleared of native vegetation for farming, by chaining, windrowing and burning, with distinct burn lines evident (Figures 2 and 3).

According to the current owners the property had been used for low level grazing for approximately 40 years prior to 1981. This prolonged period of grazing use likely resulted in the understory of the property becoming modified. The combined actions of low level grazing, then clearing have likely led to major changes in the vegetation communities present and/or the vegetation unit structure.

In 1996 part of the northern eastern section of the property near the proposed development site was classified as a Resource Enhancement Wetland under the (then) Department of Environment's Wetland Classification guidelines. This area was already cleared, so was sown to oats by the current owners in 2014.

1.4 Geomorphology, Geology and Hydrogeology

The property is located within the southern end of the Dandaragan Plateau which comprises mostly Tertiary laterites with outcroppings of Pleistocene to Quaternary sands over Cretaceous rock. The soils belonging to the Cullalla Association consist of white sands with low dunes and occasional wetlands. The specific site is exclusively white Bassendean sands, being well drained deep light grey sands with fine to coarse quartz and feldspar with a gentle relief to a central east/west dune ridge. The central dune is 165 m AHD, grading to 160 m at the northern and southern edges.

The proposal development envelope lies within the Gingin Groundwater Area (GGA) which is a gazetted groundwater area under the RIWI Act 1914, subject to a range of management protocols overseen by the Department of Water and Environmental Regulation (DWER). It is within the Red Gully Sub-area associated with the unconfined superficial formations and surficial resources over the confined Leederville and Yarragadee Aquifers. Adjoining the Red Gully Sub-area to the west is the Beermullah Plain Sub-area. Within the superficial formations there is lateral groundwater flow from east to west from the Red Gully Sub-area to the Beermullah Plain Sub-area and to the west and down-gradient there is groundwater flow within the Leederville and Yarragadee aquifer systems.

1.4.1 Local Hydrogeology

The hydrogeology of the proposed development area and surrounding area is characterised by four principle aquifers :

- Mirrabooka Aquifer – perched, surficial formations of the Red Gully Sub-area, beneath the Dandaragan Plateau;
- Superficial Aquifer – superficial formations of sub-areas Red Gully and Beermullah Plain, thus beneath the Gingin Scarp and Beermullah Plain;
- Leederville Aquifer – beneath the surficial formations (Dandaragan Plateau) and superficial formations (Gingin Scarp and Beermullah Plain); and
- Yarragadee Aquifer – unconformably underlies the Leederville Aquifer in this area, and is separated from the Leederville Aquifer by a clay layer.

1.4.2 Wetlands

The original information regarding classification of the wetlands of the sand plain was first published in the *Wetlands of the Swan Coastal Plain Volume 2B Wetland Mapping, Classification and Evaluation: Wetland Atlas* which was captured at a scale of 1:25,000 (Hill et al. 1996). According to this dataset a significant portion of the north eastern part of the

property consists of a Resource Enhancement Sumpland (UFI 11503).The investigation area is 60 m to the west of this Sumpland.

In the central part of the property there are 14 discrete Conservation Category Wetlands and three Resource Enhancement damplands, however, these are not located in the subject area.

1.5 Climate

The south west of Western Australia is characterised by a Mediterranean climate comprising hot dry summers and cool wet winters. According to the Bureau of Meteorology the mean annual rainfall within the vicinity of the property is 651.3 mm (Gingin Aero, 009178). The monthly distribution of rainfall (Figure 4) indicates approximately 85% of the rainfall occurs during the months of May to October. The potential annual evaporation of the area is 1800 mm (BOM, 2019), which is significantly more than annual precipitation, the daily evaporation is closer to 5.2 mm/day. The prevailing wind is from a south-westerly direction, however westerly and easterly winds are common, particularly in the summer months.

2 Botanic Background

The south-west of Western Australia is one of the richest but most threatened reservoirs of plant and animal life on earth. It is one of the most biologically diverse areas on Earth. It contains approximately 13,000 species of plants, of which 3,000 are yet to be formally named, and has a high level of endemism. There are over 700 genera of plants, with more being discovered each year. The major families present are Myrtaceae (over 807 species) Proteaceae (681 species) Papilionaceae (424 species) and Mimosaceae (398 species) (FloraBase). It also has the highest concentration of rare and endangered species in Australia (Hopper and Gioia, 2004). For these reasons, the South West of Australia Floristic Region (SWAFR) is valued socially, culturally, economically and ecologically, making it increasingly important to protect for future generations. The SWAFR has been listed by Conservation International as one of 34 Global Biodiversity Hotspots, by WWF as one of the Global 200 Ecoregions, and by BirdLife International as an Endemic Bird Area. Furthermore, it is one of only five globally significant Mediterranean-climate regions in the world and is considered a global Centre of Plant Diversity.

2.1 Swan Coastal Plain Flora, Floristic Community Types and Vegetation Complexes

The work of Gibson *et al.* (1994) adopts an approach to vegetation complexes which recognises that flora species occur in groups depending on environmental factors. By sampling 509 plots on publicly owned land containing different vegetation types in generally very good condition, this study divided the Swan Coastal Plain into four major groups based on the predominating geomorphological elements present. The four groups are the eastern edge of the Swan Coastal Plain (The Pinjarra Plain and Ridge Hill Shelf), the seasonal wetlands (which include a range of soil types and geomorphologies), the Bassendean Dunes, and the Spearwood and Quindalup Dunes mostly adjacent to the coast. Within these four groups, thirty major floristic community types were described, with some further refined by subdivision to give 43 total groups.

The approach of Gibson et al. (1994) has some shortcomings relative to modern ecological metrics, in that it only considers the presence or absence of species in a vegetation unit, rather than their relative abundance. As such the method requires a complete list of all species at a site, irrespective of abundance or dominance. Given the seasonal nature of some ephemeral species, the approach requires detailed work over a number of seasons. However, it is very useful in assessing the conservation value of a particular site's flora because it enables comparisons with other areas and to determine how well represented such community types are in the conservation estate.

Vegetation complexes can be considered as broad ecosystems that contain a range of habitats depending on relief, aspect and local geomorphology. According to Gibson et al. (1994) the swan coastal plan has 30 defined floristic communities, of which only four are located within the Bassendean dune system. These four groups (i.e. 20 to 23) can be subdivided into nine different subgroups (i.e. 20a, 20b, 20c, 21a, 21b, 21c, 22, 23a, and 23b).

Notwithstanding that the Dandaragan Plateau is not part of the Swan Coastal Plain, the study by Gibson *et. al.* (1994) remains salient for understanding the nature of the flora and vegetation units at the site.

2.2 Previous Area Studies

Heddle et al. (1980) described the vegetation in the survey area as being Cullala Complex which occurs in the Dandaragan Plateau and consists of Low Open Forest of *Banksia attenuata, B. menziesii, B. ilicifolia* and *Eucalyptus todtiana* with open woodland of *Corymbia calophylla*.

Within the immediate area, flora and vegetation studies have been undertaken in the adjoining Boonanarring Nature Reserve to the west (Burbridge et al. 1996) as have fauna surveys (DPAW 2015), and to the immediate south (Lot 7778 Wannamal Rd) by Coffey Environments 2007, and to the south east by GHD (2014).

3 Methodology and Limitations of the Survey

3.1 Methods

3.1.1 Initial Survey

Environmental appraisal of Lot 7779 by reconnaissance surveys began in 2015 and were conducted by Bioscience's [redacted] assisted by graduate staff including [redacted] and [redacted] who collectively have over 100 years experience with the flora and fauna of South Western Australia. This work showed that the northern quarter of the property had poorer environmental values due to development history, stocking, cropping and construction of houses, sheds, dams and roadways. The original intention of the property owners had been to develop an olive business, but after initial preparation and planting, this plan was put aside. The southern 75% of the property had less disturbance, and due to greater diversity of geomorphology, contains a wider range of floristic community structures.

This Bioscience team concluded the least environmental impact of the proposed development would be by locating composting operations within the north east area of the property that was essentially cleared, and under Vinsan Holdings ownership, had been sown to oats. However, the team was aware this area was mapped as a Resource Enhancement Wetland. An application to change the wetland management category to Multiple Use was prepared and submitted (Appendix 1), but was refused.

In 2017, the current north central site was investigated in more detail by walking east/west and north/south transects. The area was found to have no Declared Rara Flora and had a generally very uniform vegetation structure, with minor changes associated with aspect. In the autumn and summer of 2017/18, equipped with lists of Priority and Rare flora, further transects were examined in detail, and no DRF or priority species were found, thus in early winter of 2018, 4 quadrats of 10 x 10 m were laid out and detailed work began.

3.1.2 Detailed Survey

The detailed survey followed EPA (Dec 2016) *Technical Guidance, Flora and Vegetation Surveys for Environmental Impact Assessment.*

As the vegetation community was ascertained to be essentially similar across 25 ha, four quadrats of 10 x 10 m were selected based on slight differences in the condition of vegetation, trees present, in aspect and/or surface soil colour. Boundary corners were marked out by stakes and recorded by GPS. A complete inventory of flora species was recorded five times between late winter (July) of 2018 to late Spring (November) of 2019 in each quadrat. Size and percentage cover of each species were also recorded.

Quadrat surveys were conducted by [redacted], who both have tertiary qualifications and over 25 years' experience each with the flora of Western Australia. A fresh survey sheet was completed for each site visit, which looked within the quadrat in fine detail, and in the surrounding 10 m area for additional taxa in lesser detail.

Specimens were collected from quadrats and from transects to represent all species present (except for trees and larger species well known to the authors). Samples were pressed and dried for preservation and vouchering if required in the WA Herbarium. Photographs were also taken as an aid to identification.

Identification relied on the use of several taxonomic keys, principally Blackall and Grieve (1988), Marchant et al. (1998), and Meney and Pate (1999) and then by further reference and nomenclature updated using the WA Herbarium FloraBase.

3.2 Limitations of the Flora Survey

The survey was restricted to the angiosperms in the survey areas, even though a number of fungi, mosses and lichens were observed.

Although a significant time was spent in the field recording flora, the probability is that some species of very restricted distribution or very small population size may have been missed. A number of native species only germinate and become abundant after fire, whereas no substantial fires had been experienced in the site for at least the last ten years, thus such species may be present but were not recorded.

The main survey year, 2018 was somewhat drier than average with the nearest BOM weather station recording 501 mm compared to the average 644 mm. Although August was wetter than average, spring was much drier. The site was revisited in October and November 2019 and again in July 2021 which was a very wet month.

Dieback caused by *Phytophthora cinnamomi* is prevalent in many areas throughout the state, particularly in Banksia and Jarrah woodlands. Because this pathogen has a wide and diffuse host range amongst the flora of the Swan Coastal Plain, it may represent another selective pressure changing species presence, and thus obscuring the original community type present prior to disturbance. Dr Keating is an executive committee member of the Dieback Working Group and experienced in dieback assessments. He concluded that based on the predominance of species within the site that are known to be susceptible to die-back (https://www.cpsm-phytophthora.org/resources_supRes.php) there was no evidence of dieback being present, but it could not be completely excluded.

3.3 Details of Quadrats

Each quadrat was marked with permanent stakes at each corner and the precise location recorded by GPS and marked on the map (Figure 5).

3.4 Details of Transects

Transects were conducted in 2017, 2018, and 2019 (Figures 6 and 7) Transect walks involved four or two scientists, walking about 5 m apart.

4 Conservation Value

The conservation value of flora and vegetation in any area can be assessed according to parameters including:

- The scarcity of vegetation within the area.
- The diversity of vegetation communities and floristic types present.
- Whether the area falls within the accepted geographic range of the species of vegetation present, or is an extension of that range.
- The condition of the vegetation in the area.
- The presence of rare species (particularly Declared Rare Flora) or priority taxa, poorly known species, poorly protected species or geographically restricted species.

4.1 DBCA Declared Rare and Priority Flora

Prior to the surveys, a desktop survey was carried out through NatureMap (DBCA, 2015) to build a list of species categorised as Declared Rare Flora or Priority Flora possibly present at the site (Appendix 3). This record was updated each year of the work. In initial transects to select areas for detailed study, none of the species on the list were found within the site.

During the detailed survey, no declared rare flora were found within quadrats. A single individual of another species was found outside Quadrat 3, *Verticordia paludosa* A.S.George which is classified as P4 (Appendix 3). A specimen originally identified as *Grevillea althoferorum*. threatened species with two subspecies was found in Quadrat 4. Subsequently, the pressed specimen was re-examined and dissected. This dissection revealed the fruit was not consistent with Grevillea, and the name was reassigned to *Petrophile macrostacya*

Because of the limitations of the survey, and despite the intensity of the work undertaken, the presence of DRF and further Priority Flora cannot be completely excluded.

4.2 Regional and Local Significance

The ecological criteria for classifying regional and local significance have been summarised by EPA (June 2015) as part of the South West Biodiversity Projects (SWBP). Five headings are considered within Table 1 of this publication:

1. regional representation;
2. diversity;
3. rarity;
4. maintenance of ecological processes or natural systems - connectivity; and/or
5. protection of wetland, streamline, estuarine or coastal natural areas.

The first heading refers to “regional representation” whereby, if the area is not already recognised as being of international, national or local value, it is considered in the context of Swan Coastal Plain Vegetation Systems as described by Heddle et al. (1980) and the extent to which such systems remain (as at 2015).

The criteria of diversity and rarity both score poorly. Based on the species richness for the floristic community types described by Gibson et al. (1994), the floristic communities present have lost between 50% and 60% of the species which may have been originally present.

The species found are predominantly common, as they are robust, resilient and pioneers of natural revegetation after clearing.

5 Flora Survey Results

5.1 Description of Quadrats

Quadrat W01

Descriptor	Details
Peg Locations (UTM)	[redacted]
Landform	West facing slope approximately 1:35
Soil Type	White medium to coarse sand under 75% leaf litter cover.
Vegetation	Low open woodland of *Banksia menziesii*, *Banksia attenuata and Eucalyptus todtiana*.
Condition	Very good to excellent
Fire Age	+ 20 years
Search Intensity	+95% of flora recorded
Quadrat size/shape	10 x 10m square

Species	Family	Height (cm)	Ground cover (%)
Adenanthos cygnorum Diels	Proteaceae Juss.	200.0	2
Banksia attenuata R.Br.	Proteaceae Juss.	300.0	1
Banksia ilicifolia R.Br.	Proteaceae Juss.	400.0	1
Banksia menziesii R.Br..	Proteaceae Juss.	500.0	6
Banksia sphaerocarpa R.Br. var. *sphaerocarpa*	Proteaceae Juss.	25.0	10
Boronia ramosa subsp. *anethifolia*	Rutaceae Juss.	30.0	1
Burchardia congesta Lindl.	Colchicaceae DC.	60.0	1
Conospermum boreale E.M.Benn.	Proteaceae Juss.	120.0	1
Conostephium pendulum Benth.	Ericaceae Juss.	60.0	1
Conostylis setigera R.Br.	Haemodoraceae R. Br.	10.0	10
Dampiera alata Lindl.	Goodeniaceae R. Br.	15.0	1
Daviesia triflora Crisp	Fabaceae Lindl.	40.0	2
Desmocladus flexuosus (R.Br.) B.G.Briggs & L.A.S.Johnson	Restionaceae R. Br.	20.0	5
Drosera erythrorhiza Lindl.	Droseraceae Salisb.	<1	1
Drosera spilos N.G.Marchant & Lowrie	Droseraceae Salisb.	0.4	1
Eremaea pauciflora (Endl.) Druce	Myrtaceae Juss.	70.0	30
Gastrolobium linearifolium G.Chandler & Crisp	Fabaceae Lindl.	25.0	1
Hakea lissocarpha R.Br.	Proteaceae Juss.	300.0	1
Hemiandra pungens R.Br.	Lamiaceae Martinov	15.0	1
Hibbertia hypericoides (DC.) Benth.	Dilleniaceae Salisb.	50.0	1
Hibbertia racemosa (Endl.) Gilg	Dilleniaceae Salisb.	30.0	1
Jacksonia floribunda Endl.	Fabaceae Lindl.	20.0	5
Melaleuca seriata Lindl.	Myrtaceae Juss.	100.0	7
Patersonia occidentalis R.Br.	Iridaceae Juss.	40.0	2
Petrophile linearis R.Br.	Proteaceae Juss.	50.0	1
Philotheca spicata (A.Rich.) Paul G.Wilson	Rutaceae Juss.	30.0	1
Stirlingia latifolia (R.Br.) Steud	Proteaceae Juss.	50.0	10
Stylidium adpressum Benth.	Stylidiaceae R. Br.	10.0	1
Tetraria octandra (Nees) Kük.	Cyperaceae Juss.	50.0	1
Verticordia nitens (Lindl.) Endl.	Myrtaceae Juss.	150.0	10
Xanthorrea preisii	Xanthorrhoeaceae Dumort.	90.0	1
Total number of species 31			

Quadrat W02

Descriptor	Details
Peg Locations (UTM)	[redacted]
Landform	Flat with a sight depression from hilltop to the East.
Soil Type	White medium to coarse sand under 75% leaf litter cover.
Vegetation	Semi closed woodland of *Banksia menziesii*, *Banksia attenuata and Eucalyptus todtiana*.
Condition	Very good to excellent
Fire Age	+ 20 years
Search Intensity	+ 95% of flora recorded
Quadrat size/shape	10 x 10m square

Species	Family	Height (cm)	Ground cover (%)
Acacia pulchella R.Br.	Fabaceae Lindl.	150.0	1
Adenanthos cygnorum Diels	Proteaceae Juss.	100.0	1
Anarthria humilis Nees	Anarthriaceae D.F.Cutler & Airy Shaw	35.0	1
Banksia attenuata R.Br.	Proteaceae Juss.	1200.0	40
Banksia ilicifolia R.Br.	Proteaceae Juss.	350.0	20
Banksia menziesii R.Br..	Proteaceae Juss.	30.0	1
Calytrix flavescens A.Cunn.	Myrtaceae Juss.	20.0	1
Chamaescilla corymbosa (R.Br.) Benth.	Xanthorrhoeaceae Dumort.	15.0	1
Conostephium pendulum Benth.	Ericaceae Juss.	20.0	2
Conostylis aculeata R.Br.	Haemodoraceae R. Br.	10.0	1
Dampiera alata Lindl.	Goodeniaceae R. Br.	15.0	1
Dampiera trigona R. Br.	Goodeniaceae R. Br.	40.0	1
Desmocladus flexuosus (R.Br.) B.G.Briggs & L.A.S.Johnson	Restionaceae R. Br.	25.0	1
Drosera spilos N.G.Marchant & Lowrie	Droseraceae Salisb.	0.4	1
Eremaea pauciflora (Endl.) Druce	Myrtaceae Juss.	150.0	5
Eucalyptus todtiana F.Muell.	Myrtaceae Juss.	500.0	30
Lechenaultia biloba Lindl.	Goodeniaceae R. Br.	20.0	1
Leucopogon conostephioides DC.	Ericaceae Juss.	70.0	5
Leucopogon sprengelioides Sond.	Proteaceae Juss.	40.0	2
Lysinema pentapetalum R.Br.	Ericaceae Juss.	30.0	1
Patersonia occidentalis R.Br.	Iridaceae Juss.	40.0	1
Petrophile linearis R.Br.	Proteaceae Juss.	40.0	3
Philotheca spicata (A.Rich.) Paul G.Wilson	Rutaceae Juss.	30.0	1
Pterostylis vittata Lindl. Banded Greenhood	Orchidaceae Juss.	10.0	0
Stirlingia latifolia (R.Br.) Steud	Proteaceae Juss.	100.0	1
Stylidium adpressum Benth. Trigger-on-stilts	Stylidiaceae R. Br.	10.0	1
Stylidium araeophyllum Wege Stilt Walker	Stylidiaceae R. Br.	40.0	1
Thysanotus sparteus R.Br.	Asparagaceae Juss.	20.0	1
Verticordia nitens (Lindl.) Endl.	Myrtaceae Juss.	120.0	3
Total number of species: 29			

Quadrat W03

Descriptor	Details
Peg Locations	[redacted]
(UTM)	[redacted]
Landform	Gentle west facing slope approximately 1:45
Soil Type	White medium to coarse sand under 75% leaf litter cover.
Vegetation	Low open woodland of *Banksia menziesii*, *Banksia attenuata* over Myrtaceous shrubland
Condition	Very good to excellent
Fire Age	+ 20 years
Search Intensity	+95% of flora recorded
Quadrat size/shape	10 x 10m square

Species	Family	Height (cm)	Ground cover (%)
Adenanthos cygnorum Diels	Proteaceae Juss.	150.0	1
Anarthria humilis Nees	Anarthriaceae D.F.Cutler & Airy Shaw	60.0	1
Banksia attenuata R.Br.	Proteaceae Juss.	500.0	10
Banksia menziesii R.Br.	Proteaceae Juss.	550.0	10
Conostephium pendulum Benth.	Ericaceae Juss.	70.0	2
Daviesia triflora Crisp	Fabaceae Lindl.	100.0	5
Desmocladus flexuosus (R.Br.) B.G.Briggs & L.A.S.Johnson	Restionaceae R. Br.	10.0	1
Eremaea pauciflora (Endl.) Druce	Myrtaceae Juss.	70.0	20
Eucalyptus todtiana F.Muell.	Myrtaceae Juss.	500.0	5
Hibbertia huegelii (Endl.) F.Muell.	Dilleniaceae Salisb.	20.0	1
Hibbertia hypericoides (DC.) Benth.	Dilleniaceae Salisb.	40.0	1
Hibbertia racemosa (Endl.) Gilg	Dilleniaceae Salisb.	20.0	1
Lechenaultia expansa R.Br.	Goodeniaceae R. Br.	40.0	1
Lepidosperma pubisquameum Steud.	Cyperaceae Juss.	70.0	2
Lyginia imberbis R.Br.	Anarthriaceae D.F.Cutler & Airy Shaw	80.0	2
Petrophile linearis R.Br.	Proteaceae Juss.	40.0	1
Philotheca spicata (A.Rich.) Paul G.Wilson	Rutaceae Juss.	40.0	1
Stirlingia latifolia (R.Br.) Steud	Proteaceae Juss.	70.0	10
Stylidium adpressum Benth.	Stylidiaceae R. Br.	10.0	1
Trigger-on-stilts			
Stylidium schoenoides DC.	Stylidiaceae R. Br.	50.0	1
Synaphea spinulosa subsp. *spinulosa*	Proteaceae Juss.	100.0	1
Verticordia nitens (Lindl.) Endl.	Myrtaceae Juss.	150.0	10
Total number of species 22			

Quadrat W04

Descriptor	Details
Peg Locations	[redacted]
(UTM)	[redacted]
Landform	Gently facing slope SW ->NE approximately 1:45
Soil Type	White medium to coarse sand under 75% leaf litter cover.
Vegetation	Open woodland of *Banksia menziesii*, *Banksia attenuata and Eucalyptus todtiana*. *Allocasuarina campestris*
Condition	Very good to excellent
Fire Age	+ 20 years
Search Intensity	+95% of flora recorded
Quadrat size/shape	10 x 10m

Species	Family	Height (cm)	Ground cover (%)
Allocasuarina campestris (Diels) L.A.S.Johnson	Casuarinaceae R. Br.	400.0	2
Banksia attenuata R.Br.	Proteaceae Juss.	600.0	20
Banksia menziesii R.Br.	Proteaceae Juss.	500.0	10
Calytrix fraseri A.Cunn.	Myrtaceae Juss.	25.0	1
Conospermum boreale E.M.Benn.	Proteaceae Juss.	140.0	1
Conospermum filifolium Meisn. subsp. *filifolium*	Proteaceae Juss.	30.0	1
Daviesia triflora Crisp	Fabaceae Lindl.	40.0	1
Eremaea pauciflora (Endl.) Druce	Myrtaceae Juss.	180.0	30
Eucalyptus todtiana F.Muell.	Myrtaceae Juss.	100.0	1
Petrophile macrostachya R.Br.	Proteaceae Juss.	60.0	1
Hibbertia huegelii (Endl.) F.Muell.	Dilleniaceae Salisb.	10.0	1
Hibbertia hypericoides (DC.) Benth.	Dilleniaceae Salisb.	10.0	1
Hibbertia racemosa (Endl.) Gilg	Dilleniaceae Salisb.	20.0	1
Mesomelaena tetragona (R.Br.) Benth.	Cyperaceae Juss.	50.0	5
Patersonia occidentalis R.Br.	Iridaceae Juss.	20.0	1
Petrophile linearis R.Br.	Proteaceae Juss.	20.0	1
Stirlingia latifolia (R.Br.) Steud	Proteaceae Juss.	50.0	10
Synaphea spinulosa subsp. *spinulosa*	Proteaceae Juss.	80.0	2
Total Species 18			

Species found to 10 m outside quadrats:

Species	Family
Verticordia paludosa A.S.George	Myrtaceae Juss.
Beaufortia aestiva K.J.Brooks	Myrtaceae Juss.
Leucopogon propinquus R.Br.	Ericaceae Juss.
Bossiaea eriocarpa Benth.	Fabaceae Lindl.
Hemiphora bartlingii (Lehm.) B.J.Conn & Henwood	Lamiaceae Martinov
Gompholobium scabrum Sm.	Fabaceae Lindl.
Anigozanthos humilis Lindl.	Haemodoraceae R. Br.
Thelymitra campanulata Lindl.	Orchidaceae Juss.
Total Species 8	

5.2 Vegetation Survey Results

The concept of vegetation complexes for the Swan Coastal Plain was developed in the recognition that different vegetation types grow in soils with different geomorphic characteristics (Heddle et al. 1980). Vegetation complexes can be considered as broad ecosystems that contain a range of habitats depending on relief, aspect and local geomorphology. Gibson et al. (1994) extended the previous work by Heddle et al. (1980) by identifying 43 vegetation subtypes.

Of the 43 subtypes, 11 occur within the Bassendean system, and of these only two could be possibly ascribed to the survey area:

- Type 23a - Central *Banksia attenuata / Banksia menziesii* woodland
- Type 23b – Northern *Banksia attenuata / Banksia menziesii* woodland.

The entire site is low open Banksia-Eucalyptus woodland with *Banksia attenuata*, *Banksia menziesii* and, to a lesser extent, *Eucalyptus todtiana* and *Banksia ilicifolia* the defining species throughout. There was no discernible difference across the 25 ha site for soil, geology hydrology, fire period or past history.

A total of 65 species were found in quadrats (Appendix 4), and a further eight species were identified in transects or outside but not withiin quadrats. There were 23 families, of which Proteaceae has the greatest number of species (13), followed by Myrtaceae (9 species), Fabaceae (5 species) and Ericaceae and Goodeniaceae (4 species each).

The number of species found in each quadrat was: 31 for quadrat 1, 30 for quadrat 2, 22 for quadrat 3 and 18 for quadrat 4. Gibson et al. (1994) describes species richness in 23a (mean of 19 quadrats) as 62.8, and species richness in 23b as 53.2 (mean of 21 quadrats). This compares to a mean of 25 species per quadrat in this study, suggesting 50% to 60% of species originally present have been lost.

Multivariate analysis of quadrats was undertaken using Bray-Curtis analysis in PRIMER-e (Clarke and Gorley, 2015), producing dendrograms comparing the vegetation to that described in Gibson et.al. (1994).

The community composition of the four quadrats were similar and thus clustered closely together in dendrograms. However, quadrats did not cluster within the 23a and 23b floristic community types as would be expected given the restricted species diversity (Figure 8). This result did not change when the species lists of all quadrats were combined to represent the overall floristic diversity at the site (Figure 9).

The study area is clearly a low open banksia woodland. Whether it belongs to the vegetation types described by Gibson et al (1994) as 23a, 23b or the more recently described 23c (EPBC *Approved Conservation Advice for Banksia Woodlands of the Swan Coastal Plain Ecological Community* (Sept 2016)) cannot be determined based on the flora species present, given significant diversity has been lost and only species common to all three vegetation types remain. However, based on the geographic location within the Dandaragan Plateau, the site was most likely Floristic Community Type 23c.

6 Vegetation Condition

6.1 Condition Scoring System Used

In Western Australia, particularly on the Swan Coastal Plain, vegetation condition reporting has become an important tool for judging the relative conservation value of bushland, particularly for areas being considered for either conservation or clearing. The rationale is that biodiversity conservation is much harder in severely degraded bushland, but more easily and cost effectively implemented for bushland in good condition.

The first published condition rating method was by Trudgen in the early 1990's, who broke condition into 6 groupings, ranging from excellent to completely degraded, with intermediate grading of very good, good, poor and very poor.

Later Keighery, acknowledging Trudgen, modified the names and descriptions of the various divisions. This was adopted in the Bush Forever publications, and since 2000 has been widely cited. Accordingly we have sought to rate vegetation condition objectively, using the same criteria adopted by Trudgen and by Keighery (Table below).

	VEGETATION CONDITION RATING SCALE
PRISTINE	Pristine or nearly so, no obvious signs or disturbances.
EXCELLENT	Vegetation structure intact, disturbance affecting individual species and weeds are non- aggressive species.
VERY GOOD	Vegetation structure altered, obvious signs of disturbance, for example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
GOOD	Vegetation structure significantly altered by very obvious signs of multiple disturbance. Retains basic vegetation structure of ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing. .
DEGRADED	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management, For example disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
COMPLETELY DEGRADED	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees of shrubs.

The factors they mention which impact on condition are physical disturbance, and disease and weed invasion. Collectively these reduce "naturalness", reduce native biodiversity and promote the "unnatural selection" of hardy and robust taxa over more delicate and sensitive species. The physical disturbance of grazing and past land clearing likely has significantly and/or severely reduced species richness at the site to less than 50%. Large burnt trunks of former *Corymbia calophylla* remain from past windrow burning, but no living specimens have

regenerated. However, there was no evidence of pests such as rabbits. No weeds were found, and this was believed to be due to no application of fertilisers to the study area. Also there was no evidence of disease. We thus conclude the areas vegetation condition is very good to good to degraded (based on physical disturbance and reduced species diversity) to excellent (based on absence of pests, weeds and disease).

6.2 Conservation Significance of Flora and Vegetation

The December 2016 EPA Technical Guide for terrestrial Flora and Vegetation surveys describes features of significance.

Flora species, subspecies, varieties, hybrids and ecotypes may be significant for a range of reasons, including the following:

- a keystone role in a particular habitat for threatened or Priority flora or fauna species, or large populations representing a considerable proportion of the local or regional total population of a species;
- relictual status, being representative of taxonomic or physiognomic groups that no longer occur widely in the broader landscape;
- anomalous features that indicate a potential new discovery;
- being representative of the range of a species (particularly at the extremes of range, recently discovered range extensions, or isolated outliers of the main range);
- the presence of restricted subspecies, varieties or naturally occurring hybrids;
- local endemism (a restricted distribution) or association with a restricted habitat type (e.g. surface water or groundwater dependent ecosystems); and
- being poorly reserved.

Vegetation may be significant for a range of reasons, including the following:

- restricted distribution;
- degree of historical impact from threatening processes;
- local endemism in restricted habitats;
- novel combinations of taxa;
- a role as a refuge;
- being representative of a vegetation unit in 'pristine' condition in a highly cleared landscape, recently discovered range extensions, or isolated outliers of the main range; and
- being poorly reserved.

In this study, one individual outside the quadrats *(Verticordia paludosa*) is classified as P4, the vast majority of flora species described do not fit the criteria of significance, but rather are common and hardy survivors of disturbance by grazing and clearing.

Further, it is noted in the Conservation Advice for Banksia Woodlands related to the EPBC (26 August 2016), the Banksia woodland type 23c is not a Threatened Ecological Community in WA.

6.3 Threatened Ecological Communities

Many Banksia woodlands of the Swan Coastal Plain are classified as Threatened Ecological Communities. The Approved Conservation Advice (26 August 2016) at Table 1 classifies TEC's according to Floristic Community Type that are mostly derived from Gibson *et al* (1994).

Despite using multivariate analysis of the data collected, due to the loss of the original species that may have been present, it is no longer possible to precisely define the Floristic Community Type now present. Based on the geographic location within the Dandaragan Plateau, and the elevation at 160 – 165 mAHD, it was most likely to have been FCT 23 c, North-eastern *Banksia attenuate Banksia Menziesii* woodlands. An average of 25 species was found in 4 very similar quadrats (based on Bray Curtis similarlty). According to table 1 of the Approved Conservation Advice, 53% of the species have been lost. If it originally was FCT 23a, then 58% of the species have been lost. If it originally was FCT 23b , then 47% of the species have been lost. Of the three possible FCT's, Table 1 has only 23b listed as a P3 TEC, whereas 23 a and 23 c are not listed as TEC's.

The Approved Conservation Advice (26 August 2016) at Section 2 details guidance for determining whether a TEC is present, in particular Section 2.2.1, at p20 under *Contra-indicators,* states:

- FCT 20c – Eastern shrublands and woodlands, corresponds with a separated EPBC ecological community listing, Shrublands and Woodlands of the Swan Coastal Plain.
-

However, the description contained within this reference refers strictly to the Forrestfield Unit of the Hill Ridge system, which has clayey soil. with only 2 occurrences known. One area of 39 ha is vested in the Commonwealth of Australia (Army) 36 ha is vested with the Shire of Swan and 5 ha is unvested.

The Approved Conservation Advice at 2.2.2 precisely describes how the intensity of the flora survey undertaken is appropriate.

Step 4 goes to "significant impacts". Interestingly, although the preceding sections (Table 1) Records only 23b is a P3 TEC, at Table 4 in Section 2, FCT 23 a,b,and c are grouped together as P3 TEC', however Table 5 says Banksia Woodands in the Dandaragan Plateau subregion SWA1 are 30.43% Protected.

In summary, it becomes objectively unclear whether the area proposed to be cleared is a TEC. Some of the guidance says it is, some is contradictory. However the overriding consideration is how much native species diversity has declined. There is no metric provided to gauge whether more that 50% species loss is "Moderate", or Low". On balance, and considering the generally much greater species diversity and variation in vegetation units in the environmental offset area offered, the clearing of this land is judged to be inconsequential to Banksia Woodland TECs, whereas approval for clearing would, through environmental offsets, put a more biodiverse area 24 time the size into the conservation estate by way of a conservation covenant.

6.4 Context of conservation significance within the area and the proposed development

The 25 ha site is proposed to be cleared for the construction and operation of a composting facility. It is located on a property of 1647 ha which is adjacent to the Boonanarring Nature Reserve which covers 9250 ha.

The nature reserve has at least 573 different flora species in 10 different vegetation types.

The landowners recognise their obligation to provide an environmental offset in order to clear part of their land for a commercial purpose, even though that purpose, being the recycling and beneficiation of organic waste, has considerable strategic environmental benefits. They are accordingly prepared to place a significant part of their land (600 ha) into the conservation estate at no cost to the state through the implementation of a conservation covenant.

The proposed covenanted land contains a very large tract of Banksia woodland of the same type as is proposed to be cleared. However, as described by Burbridge et al. (1996) in the Flora and Vegetation survey of the Nature Reserve, the land to the south of the site, due to the absence of any grazing, exhibits a much higher biodiversity in excellent condition, and displays a mosaic of interwoven vegetation types, including low banksia healthland, wetlands and eucalyptus woodlands.

Detail of this area which is to be protected with a Conservation Covenant is contained in Appendix 5.

Earlier versions of this report believed two priory species were present, being *Eucalyptus absita, and Grevillia althofereum.* A subsequent visit to the site and inspection of preserved samples by [redacted], one of the state's most experienced and respected botanists, pointed out that these identifications were in error. The Eucalypt originally identified as *absita* was more likely a hydrid between *Eucalyptus marginata* and *Eucalyptus todtiana,* This opinion was confirmed by Genetic studies by Bioscience, comparing extracted DNA from the Wannamal Road samples with DNA from authentic Jarrah and Blackbut.

[redacted] Could immediately identify that, despite a very similar leaf shape, what had been identified as *Grevillea althoferorum,* was in fact *Petrophile macrostachya.*

[redacted] report is contained as Appendix 6.

The report on DNA identification of Eucalyptus hybris as contained as Appendix 7.

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Bioscience

REQUEST FOR MODIFICATION

OF

RESOURCE ENHANCEMENT

DAMPLAND

UFI 11428

7779 Wannamal Rd.

Cullala

Request for Modification of Resource Enhancement Sumpland UFI11428
Wetland Reclassification
7779 Wannamal Rd. Cullala
Wannamal Rd. Organics Pty Ltd

Prepared by: [redacted]
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Document Control

Issue	Date	Author	Reviewer	Approved
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Contents

1. Introduction

Lots 7779 Wannamal Rd. Gingin is located approximately 90km north of Perth and 55 km east of the coast (Fig.1). The properties cover an area of approximately 1674Ha, the site is mostly native vegetation in varying condition. There are some areas which have been cleared for farming, which have rehabilitated which is found in the North east corner (Fig.2). This area has been used for low intensity grazing and the land is a mixture of native regrowth and pasture composed mostly of annual/perennial grasses and dicot weeds. There is a single residential house, sheds and parking in the north west frontage against Wannamal Rd. Bioscience was engaged by [redacted] to review the current Resource Enhancement Wetland classification on this lot, in order to submit a request to modify the Swan Coastal Plain Geomorphic Wetlands dataset.

2. Site Description and Investigations

2.1 Land use

According to the current owners the property has been used as agricultural land for approximately 40 years. This prolonged period of low level grazing use has resulted in the understory of the property becoming modified. The general appearance of the land and the overall structure of most of the bushland is largely unchanged. In addition, the land on site and in the surrounding area has been drained in the past, which appears to have altered the hydrology. The area of concern in this survey is an REW, that has been modified considerably compared with the remainder of the property, including harrowing and clearing of native vegetation.

2.2. Climate

The south west of Western Australia is characterised by a Mediterranean climate comprising hot dry summers and cool wet winters. According to the Bureau of Meteorology the mean annual rainfall within the vicinity of the property is 651.3mm (Gingin Aero, 009178). The monthly distribution of rainfall (Fig. 3) indicates approximately 85% of the rainfall occurs during the months of May to October. The potential annual *evaporation* of the area is 1800/200mm (BoM, 2016), which is significantly more than annual precipitation (Davidson and Yu, 2006), the daily evaporation is closer to 5.2mm/day (BOM). The prevailing wind is from a south-westerly direction, however westerly and easterly winds are common, particularly in the summer months.

2.3. Geomorphology and Topography

The area has a undulating relief with numerous variations in topography (Fig.4), the south western end of the Lot has sand and lateritic hills of 220m Australian Height Datum (AHD), the western portion of the lot has undulating lateritic hills with heights of 210m the north eastern corner (the site in question) has a low relief, but is surrounded by low sand hills spot heights of up to 170m (Fig. 5).

2.4. Regional Geology

The property is located on the Northern Swan Coastal Plain within the Quaternary colluvial dune systems, a gently undulating sand plain with discrete sand rises. It comprises of a mixture of well to moderately well drained deep light grey sands with fine to coarse quartz and feldspar and poorly drained deep siliceous or bleached sands. This is underlain by poorly drained clay or less frequently a pale yellow B-horizon or iron-inorganic hardpan 1-2m below the surface The south and west of the property have large hills of massive, cemented and vesicular laterite, overlain by ferruginous gravels in a clay-sand matrix (Fig. 6).

The subject site is characterised by poor drainage due to the low permeability of Bassendean formation sub-soil clays, which prevent the downward infiltration of rainfall, consequently during the winter month's waterlogging and surface inundation can occur, this results in acidic soils (Fig. 7). In addition, the clay fraction of the soil is known to have highly variable Plasticity Indices (Hillman et al., 2003). Soil Organic content varies between 1-3% of volume in the surface layers, dropping to between 0.2-1% in subsoils *(ASRIS).*

2.5. Acid Sulfate Soils

Acid Sulfate soils are soils that contain reduced forms of sulfur, which typically originate from the reducing conditions associated with anaerobic soils in wetlands. In Western Australia, Acid Sulfate Soils occur in low-lying coastal lands such as Holocene swamps and Lakes. If such soils are exposed to oxygen, for example by excavation or dewatering, reduced sulfides convert to sulfuric acid and significantly lower pH, causing a range of undesirable environmental consequences. If they remain undisturbed and inundated, they are stable.

According to the Planning bulletin 64 on Acid Sulfate Soils (WAPC 2003), the majority of the site has been classified as having a low-risk of Acid Sulfate Soils (ASS) occurring within 3 m of the natural soil surface and activities disturbing soils at depths greater than 3m carry a high to moderate risk of disturbing ASS. However there is an area of high-risk soil, in the north east of the properties (Fig. 7).

2.6. Vegetation

A full vegetation survey usually means a level 2 Survey as per EPA Guidance 51, in this instance this was not warranted. Guidance 51 surveys are appropriate for native vegetation in much better condition, and where vegetation units and structure are clearly discernible and comparable to the state's flora database. Accordingly, Bioscience undertook a modified vegetation survey of the subject land involving a careful assessment of all the wetland and surrounding areas to document all native species present at two points in time. These site visits indicated that a large amount of native vegetation has been cleared in parts of the site and using the condition rating system of "Bush forever", is degraded. However, there is regrowth in areas and there the condition could be described as good.

The local vegetation complexes are Predominantly Cullala Complex with areas of Wannamal complex to the north-eastern corner and across the southern part of the property.

The dominant species should be: a mixture of low open forest of banksia species, eucalyptus todtiana and open woodlands of *Corymbia calophylla with Eucalyptus todtiana, Banksia illicifolia, Banksia menziesii* and *Banksia attenuata*. In the lower lying areas it becomes a mixture of low shrublands of *Melaleuca species, Eucalyptus wandoo* and *eucalyptus loxophleba*. (Heddle et al. 1980)

The Site can be subdivided into five vegetation zones or areas (Fig. 8):

- Melaleuca zone – Several low-lying areas across the property are populated by *Melaleuca sp.* of varying size. These include *Melaleuca preissiana, Melaleuca raphiophylla and Melaleuca urceolaris.* Understorey includes *Regelia ciliata, Conostephium pendulum* and *Verticordia lindleyi*

- Cleared zone - Clearing has been carried out historically around the Melaleuca zone and these areas, although showing signs of regeneration are mainly populated by invasive grasses and weeds.
- Banksia zone – Raised dune areas surrounding the melaleuca zone are populated by Banksia woodlands mainly *Banksia illicifolia, Banksia attenuata* and *Banksia menziesii.* The understorey consisting of*, Hibbertia sp., Calothamnus sp., Drosera sp., Grevillea sp.* and *Stylidium sp.*
- Eucalyptus zone – Lateritic hills in the West and South of the property
- Mixed Eucalyptus/Banksia woodlands – Found between the Banksia and eucalyptus woodlands

2.7. Hydrogeology

2.7.1. Regional Hydrogeology

The proposal development envelope lies within the Gingin Groundwater Area (GGA) which is a gazetted groundwater area under the RIWI Act 1914, subject to a range of management protocols overseen by the Department of Water (DoW). It is within the Red Gully Sub-area associated with the unconfined superficial formations and surficial resources for the confined Leederville and Yarragadee Aquifers. Adjoining the Red Gully Sub-area to the west is the Beermullah Plain Sub-area. Within the superficial formations there is lateral groundwater flow from east to west from the Red Gully Sub-area to the Beermullah Plain Sub-area and to the west and down-gradient there is groundwater flow within the Leederville and Yarragadee aquifer systems.

2.7.2. Local Hydrogeology

The hydrogeology of the proposal development envelope and surrounding area is characterised by four principle aquifers :

- Mirrabooka Aquifer – perched, surficial formations of the Red Gully Sub-area, beneath Dandaragan Plateau;
- Superficial Aquifer – superficial formations of sub-areas Red Gully and Beermullah Plain, thus beneath the Gingin Scarp and Beermullah Plain;
- Leederville Aquifer – beneath the surficial formations (Dandaragan Plateau) and superficial formations (Gingin Scarp and Beermullah Plain); and

- Yarragadee Aquifer – unconformably underlies the Leederville Aquifer in this area, and separated from the Leederville Aquifer by a clay layer.

Mirrabooka Aquifer – Surficial Formations

The Mirrabooka Aquifer is a perched aquifer on the Gingin Scarp and Dandaragan Plateau, comprising sandstones with interbedded siltstone and shale. This aquifer is located to the east of the proposal development envelope, occurring at relatively higher elevations than the proposal development envelope. Recharge to the Mirrabooka Aquifer is provided by rainfall percolating through the Dandaragan Plateau.

Both the Mirrabooka Aquifer and Kardinya Shale Member pinch-out towards the west and the Gingin Scarp. Intersections of the Kardinya Shale Member with the Gingin Scarp and incised watercourses provide potential for local discharge from the Mirrabooka Aquifer in the form of natural springs and seeps. Natural springs within and or adjoining the Bartlett's Well Nature Reserve and incised watercourses on the escarpment are attributed to the Mirrabooka Aquifer.

The water table elevations of this aquifer range from about 120m AHD to 175m AHD, reflecting depths to the water table of 75m to 130m, expressing at the surface on occasion as natural springs.

Groundwater flow in the Mirrabooka Aquifer broadly conforms to the ground surface topography.

Superficial Aquifer – Superficial Formations

The Superficial Aquifer is an unconfined, uppermost aquifer occurring within the superficial formations beneath the Swan Coastal Plain, comprising of Bassendean Sands, Guildford Clay, Yoganup Formation and Ascot Formation. The Superficial Aquifer has an eastern limit beneath the Gingin Scarp.

There is potential for the Mirrabooka Aquifer, beneath the Gingin Scarp, to recharge the eastern limits of the Superficial Aquifer. On the escarpment and Swan Coastal Plain, recharge to the Superficial Aquifer occurs from rainfall infiltration and in selected settings upward leakage from the Leederville Formation. Net recharge to the proposal area from rainfall infiltration is estimated at less than five percent of annual average rainfall (DoW, September 2008).

Water table elevations in the Superficial Aquifer beneath the proposal development envelope range from 65m AHD to 90m AHD, at depths approximately 20m to 30m below ground level. The water table broadly follows the ground surface topography. Groundwater flow is to the west-southwest and the Swan Coastal Plain.

The highest water table elevations occur opposite the topographical ridges on the Gingin Scarp crest. The depth to the water table progressively decreases beneath the foot-slopes of the Gingin Scarp. A shallow water table occurs at the toe of the escarpment. In settings where Guildford Clay occurs at the toe of the escarpment, the water table may be locally expressed on the ground surface. To the west, beneath the Beermullah Plain, the water table occurs at shallow depths.

The depth to the water table progressively decreases beneath the foot-slopes of the Gingin Scarp. A shallow water table occurs at the toe of the escarpment. In settings where Guildford Clay occurs at the toe of the escarpment, the water table may be locally expressed on the ground surface. To the west, beneath the Beermullah Plain, the water table occurs at shallow depths.

Leederville Aquifer

The Leederville Aquifer, a significant regional multi-layered groundwater flow system comprised of interbedded sandstones, siltstones and shale ranging in thickness up to 20m.

Under the Dandaragan Plateau, the Leederville Aquifer is interpreted to be confined by Kardinya Shale and Osborne Formation. Further west, beneath the Gingin Scarp and the proposal area, the confining beds may include the Otorowiri Member, Parmelia Formation and/or upper shale beds of the Pinjar Member. Beneath the local Swan Coastal Plain and locally, the Leederville Aquifer is semi-confined, supporting the groundwater levels within the superficial formations with some upward leakage.

Recharge to the Leederville Aquifer beneath the Dandaragan Plateau occurs when the sediments are exposed to watercourses and stream flow. Beneath the Swan Coastal Plain, recharge occurs via the overlying Superficial Aquifer.

Local discharge from the Leederville Aquifer occurs where the superficial formations are fully incised by the Gingin Brook (DoW, January 2011 in Supporting Study 4.1). The

reaches of the Gingin Brook that host these discharge zones occur where the Guildford Clay is absent and the Ascot Formation is overlain by Bassendean Sands.

The transition of the Leederville Aquifer transition from confined to semi-confined conditions beneath the Swan Coastal Plain occurs to the west of the eastern-most Guildford Clay settings, approximately along the alignment of Whitfield Brook and Beermullah Lake (to the west of the proposal development envelope). The perennial nature of Beermullah Lake may reflect accentuated local recharge by upward leakage from the Leederville Aquifer.

If the Leederville aquifer is assumed to be unconfined, the natural water level is likely to range from 120m AHD (potentiometric surface beneath the northeast Dandaragan Plateau) to 35m AHD associated with discharge zones on reaches of Gingin Brook near its confluence with the Moore River. Groundwater flow is from the northeast to the southwest, under steeper hydraulic gradients beneath the Dandaragan Plateau compared to the Beermullah Plain.

Yarragadee Aquifer

The Yarragadee Aquifer is a regional confined multi-layered groundwater flow system. Studies show that the local Yarragadee Aquifer successions have a thickness greater than 2,800m comprised of interbedded sandstones, siltstones and shales. The top of the Yarragadee Formation was estimated at minus 177m AHD.

The potentiometric surface elevations of the Yarragadee Aquifer in the area of the proposal development envelope range from 40m AHD to 66m AHD in the vicinity of the Moore River to approximately 20km southwest of the proposal area, with flow being from a north to south direction from Moore River to Gingin Brook.

2.7.3. Wetlands

The original information regarding classification of the wetlands of the sand plain was first published in the *Wetlands of the Swan Coastal Plain Volume 2B Wetland Mapping, Classification and Evaluation: Wetland Atlas* (Fig. 9), which was captured at a scale of 1:25,000 (Hill et al. 1996b). According to this dataset a large portion of the site consists of Resource Enhancement Wetlands, with some Conservation Category Wetlands to the south of the site. The new digitised version (Fig. 10) has re-numbered these wetlands, but none have been re-assigned (Summary Table 1)

Summary Table 1

Old Wetland ID	Category	New Wetland ID	New Category
40087654993	C	11519	C
40103654966	C	11434	C
40180654968	C	11436	C
40180654987	C	11426	C
40210655186	M	11430	M
40230655048	R	11432	R
40277655240	R	11503	R
40301654983	C	11513	C
40320655002	R	11518	R
40272654896	R	11443	R
40288655018	C	11515	C
40295655043	C	11510	C
402965497	C	11437	C
40285655197	R	11428	R
40122654998	C	11516	C
40204655030	C	11512	C
40231655021	C	11514	C
40234655007	C	11517	C

However, some of the REW's have been cleared for farmland for a number of years, suggesting an error in the mapping. Field investigation and NearMap reveals that these areas are cleared farmland, which had been heavily degraded by grazing pressure, although some regeneration is evident most of these areas are weed strewn.

2.8. Swan Coastal Plain Wetland Evaluation

As part of the site investigation, a series of photographs were taken (Appendix 1). As per DEC requirements a SCP wetland evaluation was conducted on site to determine the conservation status of the wetland (Appendix 2 - 4). From the results of this survey parts of the wetland is best described by the multiple use category.

3. Justification for Wetland Re-classification

Wetlands are defined as areas where the soil can become inundated or waterlogged, either permanently or seasonally, with fresh or saline water. Where natural soils become waterlogged, their chemistry changes, due mainly to soil microbes and plant roots removing oxygen at a rate greater than it can be replenished from the atmosphere. The altered chemistry is manifested as decreasing redox potential, the gradual accumulation of organic carbon, and depending on soil mineralogy, the potential accumulation of reduced iron and sulphur. Such soils are not conducive to the growth of many plants, so a selection occurs for those plant species, which have special adaptive mechanisms to cope with anaerobic soil. As such, wetlands develop a characteristic vegetation community.

Driven by the recognition of the importance of wetlands in the Swan Coastal Plain ecosystem, and the fact that European settlement had caused a rapid loss of wetlands, studies were initiated in the 1990's to map wetlands in the Perth area, and to assign management categories in order for them to be protected from future decline.

Initially five management categories were assigned, but later this became three categories:

- **Conservation Category Wetlands** have high conservation significance where the wetland functions, values and attributes are to be protected by preventing activities, which may cause their decline. The surrounding land is likewise protected in order to provide a buffer against threats to the wetland function and attributes. The management objective should be to preserve and protect all the ecological, hydrological and social functions.
- **Resource Enhancement Wetlands** are those which retain functions, values and attributes which, although somewhat compromised and degraded, are still worthy of preservation. The management objective is to restore the values and attributes of such areas towards those of Conservation category Wetlands.
- **Multiple Use Wetlands** are areas where wetland functions, values and attributes have been seriously degraded such that they no longer serve any substantial ecological role. They are typically cleared of native vegetation and most wetland fauna. The management objective is to preserved hydrological functions, but otherwise they can be developed for more beneficial use.

The location and management category of wetlands was originally determined and published in 1996 in Hill et al, Wetlands of the Swan Coastal Plain Volumes 2a and 2b (1996). Since that time, maps have been converted to digital format as the Wetlands geomorphic dataset, which is administered by the Wetland Program Office of the Department of Environment Regulation.

The location and classification of wetlands are determined by the presence or absence of these three features:

- The presence of water at or above the soil surface either permanently or intermittently.
- Changes in soil chemistry characterised as becoming hydritic.
- Vegetation which includes plants adapted to inundated soils.

From a comparison of the original and digitised datasets with a satellite image of the properties (Fig.11a &11b), it can be inferred that there is some discrepancy between the two and the satellite image. The satellite image shows large cleared areas with adjacent Melaleuca woodlands, but with a degraded understorey.

Whilst Bioscience accepts that parts of this area will become waterlogged in the winter months and thus still retain some wetland function, we believe that its boundaries have become altered by normal farming practices.

The nearest bush forever site is Wilbinga (BF406) which is 41 km from the site. This does not give a good representation of what the vegetation communities on site may have been pre-clearing a it is a different vegetation type.

The closest accessible area for reference is a Sumpland Conservation area (13482) to the east of the site.
This is relatively intact and has a similar composition to the site. However, the *Melaleucas* and wetland are far more established with less disturbance.

It is on this basis that Bioscience maintains that areas of the wetland, which have vbeen cleared historically are more appropriately classified as a multiple use wetland, as the values and attributes that constitute a wetland have been so seriously degraded, that they no longer serve any substantial ecological role.

4. Conclusion

Bioscience would like you to consider the re-classification of the cleared areas of Sumpland Resource Enhancement area 11428 to a more appropriate Multiple use category (Fig 11b). This part of the wetland is more appropriately classified as a multiple use wetland, as the values and attributes have been seriously degraded via clearing and grazing over the last 40 years, so that they no longer serve any substantial ecological role.

In summary, the cleared areas of the wetland;

- Have lost wetland function, values and attributes.
- The vegetation is dominated by weeds, introduced species and is largely cleared and grazed.
- The Swan coastal plain survey results indicate that is better described as a multiple use wetland using Bulletin 686.

5. References

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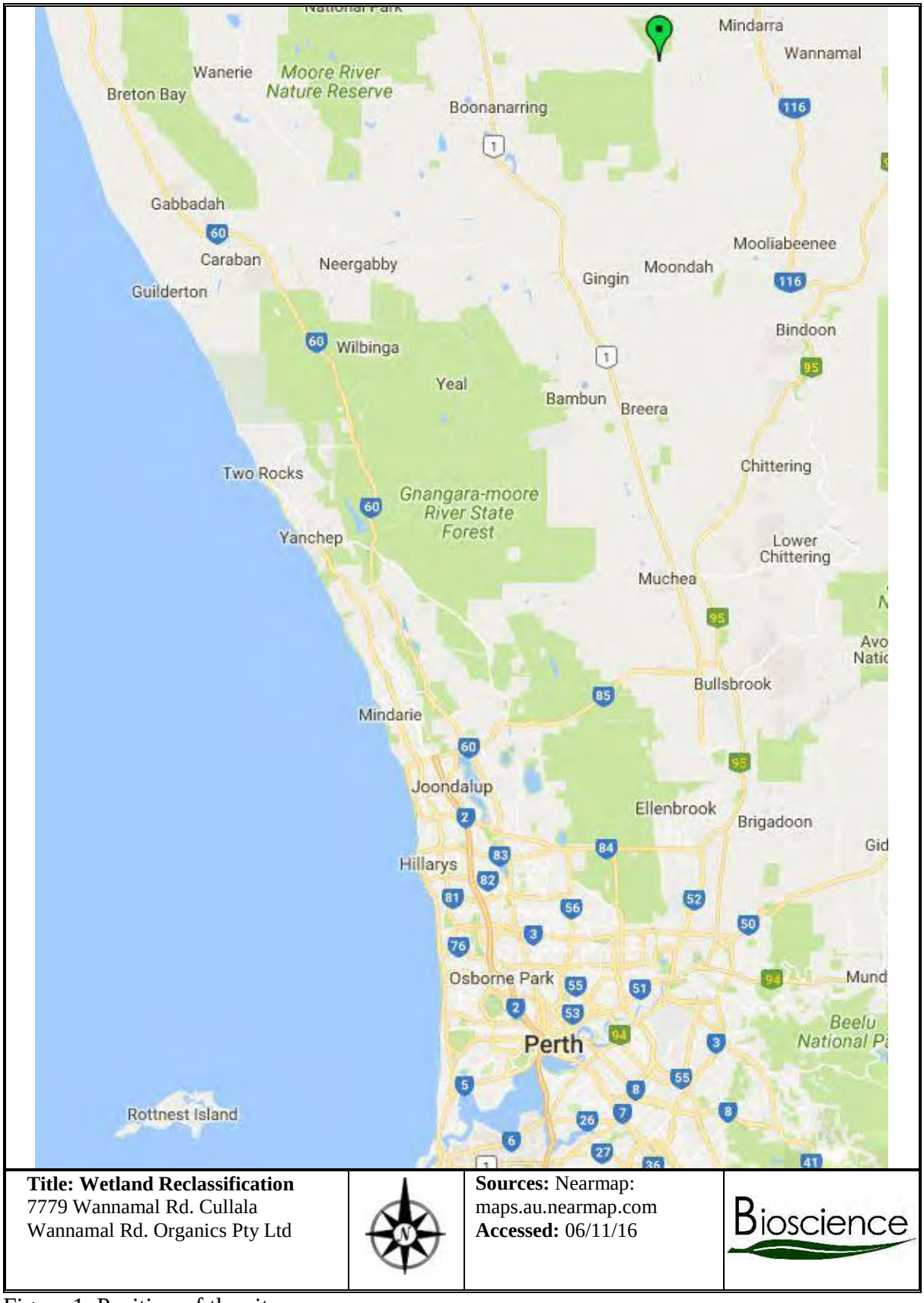
6. Figures



Title: Wetland Reclassification 7779 Wannamal Rd. Cullala Wannamal Rd. Organics Pty Ltd		**Sources:** Nearmap: maps.au.nearmap.com **Accessed:** 06/11/16	Bioscience

Figure 1. Position of the site

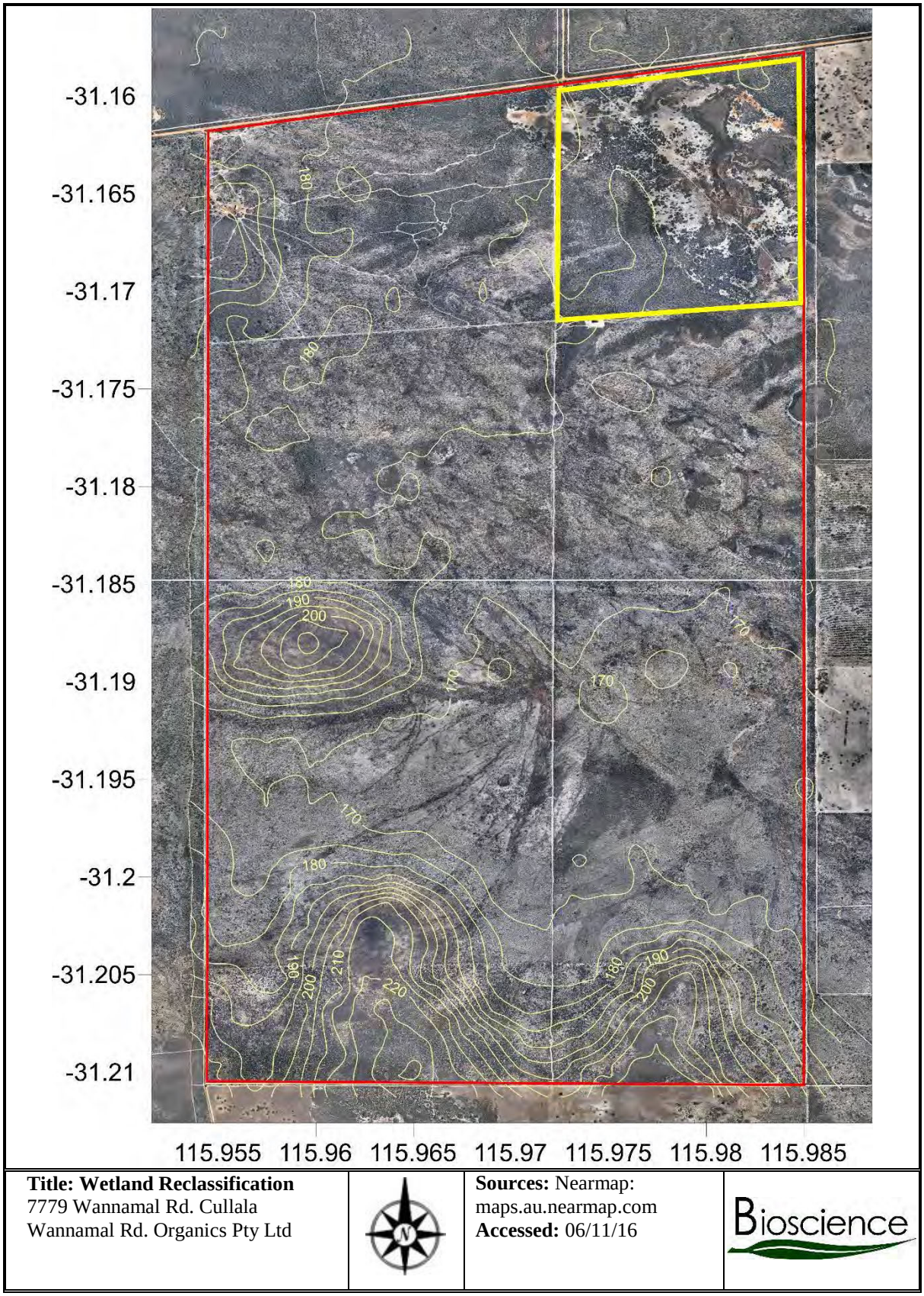
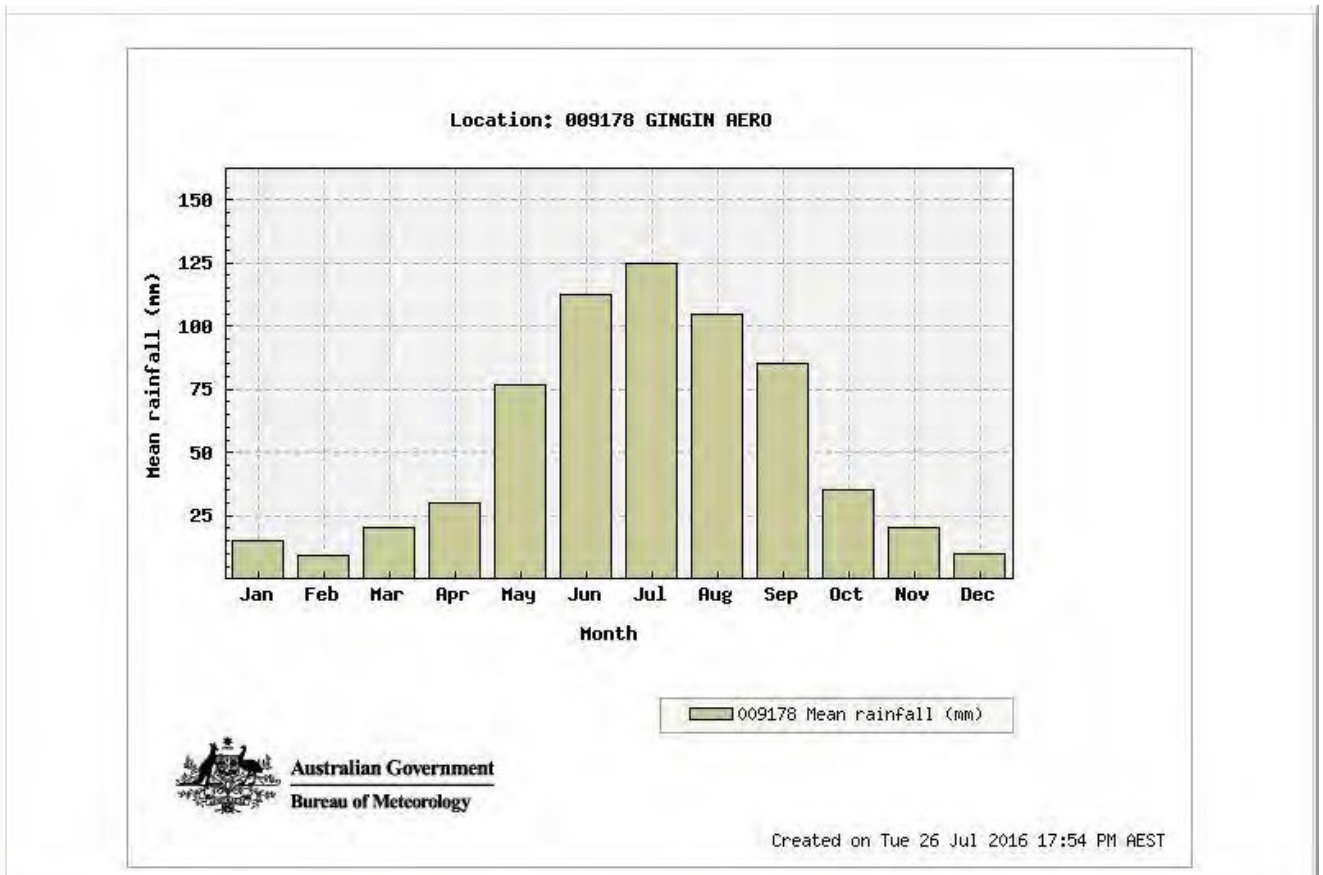


Figure 2. Aerial photo of Property boundary (Red) and Site boundary (Yellow)



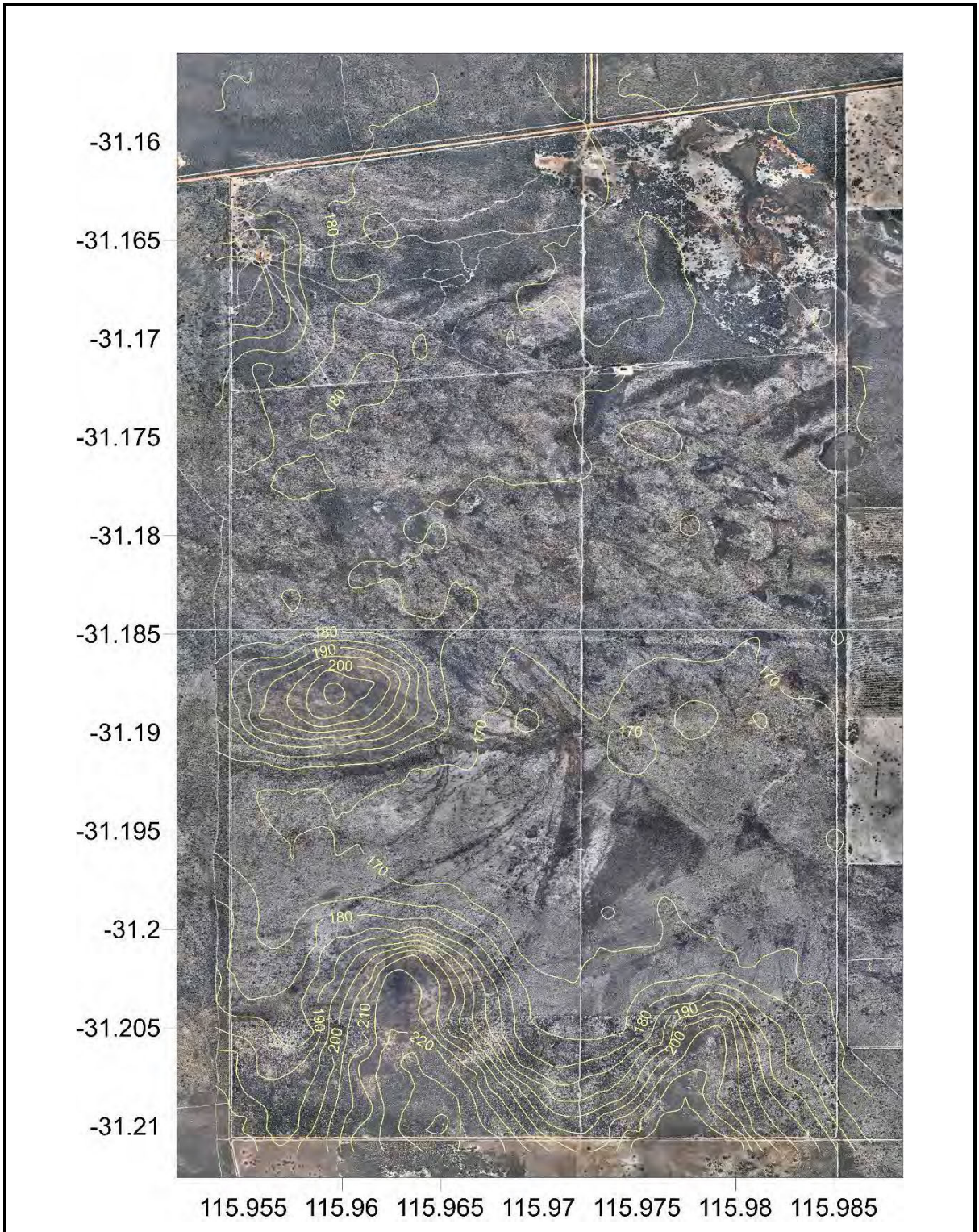
Statistics	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual	Years
Mean rainfall (mm) for years 1996 to 2016	15.1	9.5	20.6	29.9	76.7	112.6	124.9	105.0	85.0	35.0	20.3	9.8	651.3	20

Figure 3. Average rainfall for 2016 (Gingin Aero)

Title: Wetland Reclassification
7779 Wannamal Rd. Cullala
Wannamal Rd. Organics Pty Ltd

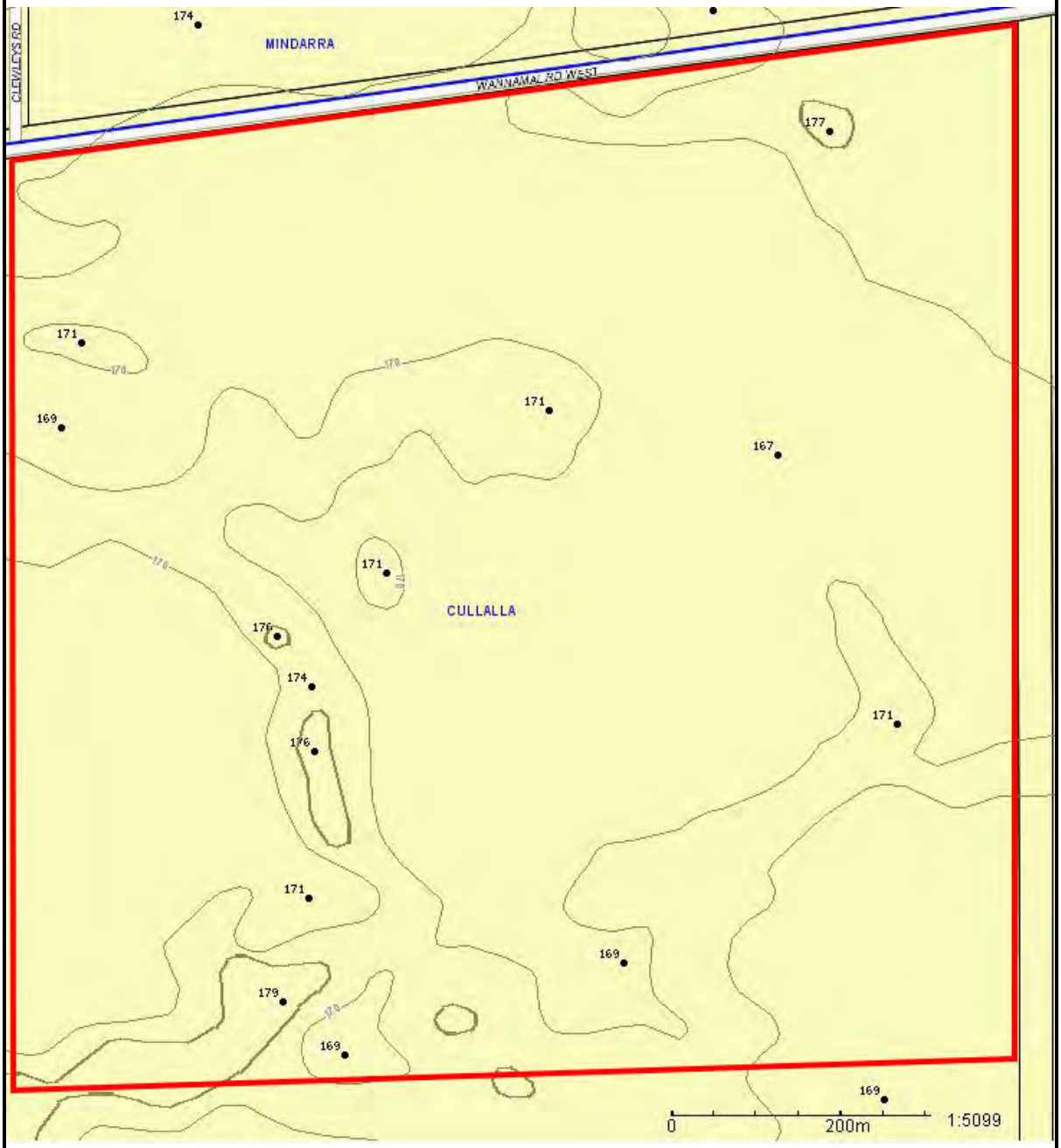
Sources: Nearmap:
maps.au.nearmap.com
Accessed: 06/11/15

Bioscience



Title: Wetland Reclassification 7779 Wannamal Rd. Cullala Wannamal Rd. Organics Pty Ltd	N	**Sources:** Nearmap: maps.au.nearmap.com **Accessed:** 06/11/16	Bioscience

Figure 4. Topography of Property



Title: Wetland Reclassification 7779 Wannamal Rd. Cullala Wannamal Rd. Organics Pty Ltd		**Sources:** Nearmap: maps.au.nearmap.com **Accessed:** 06/11/16	Bioscience

Figure 5. Topography of the site bordered in red.

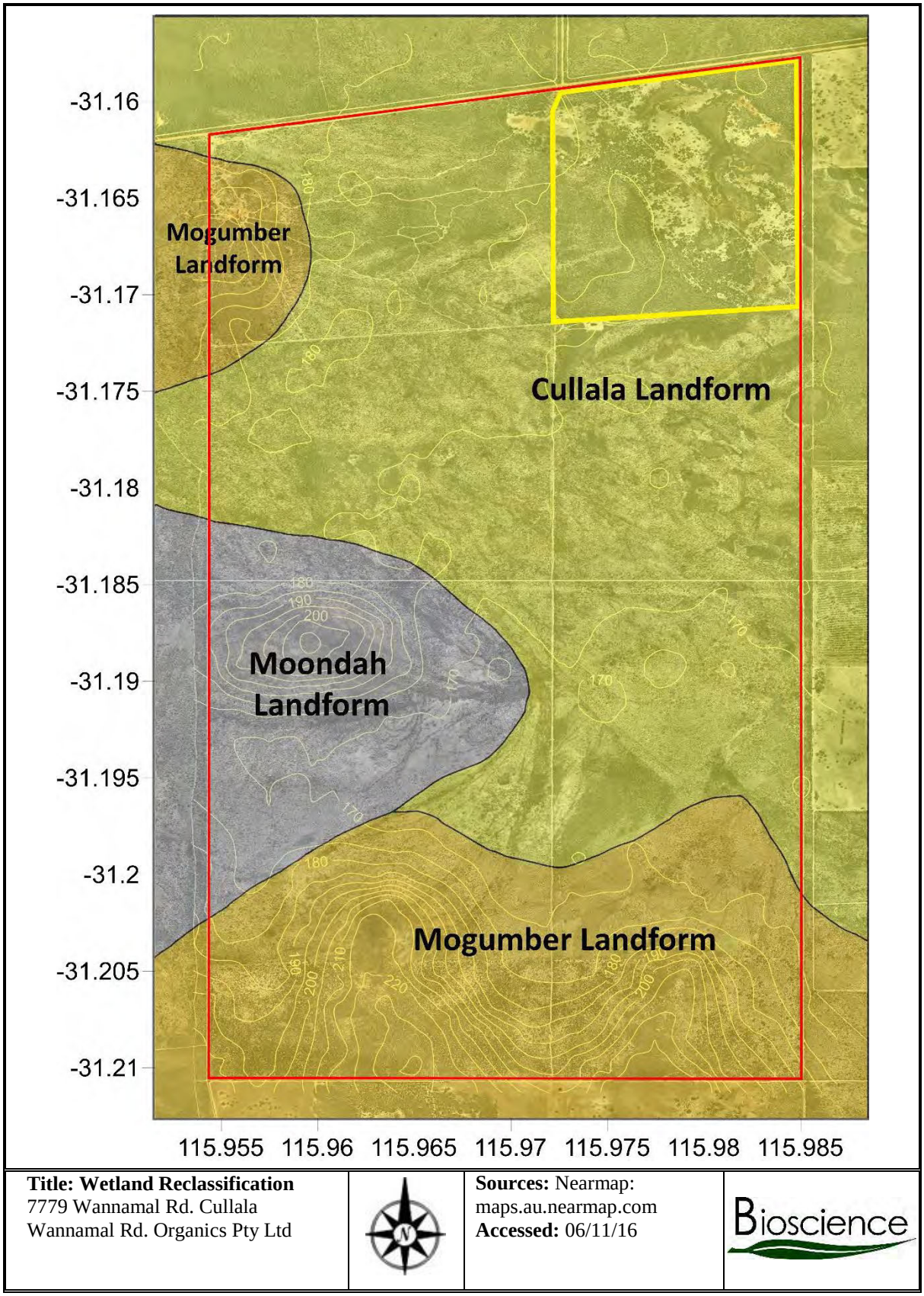
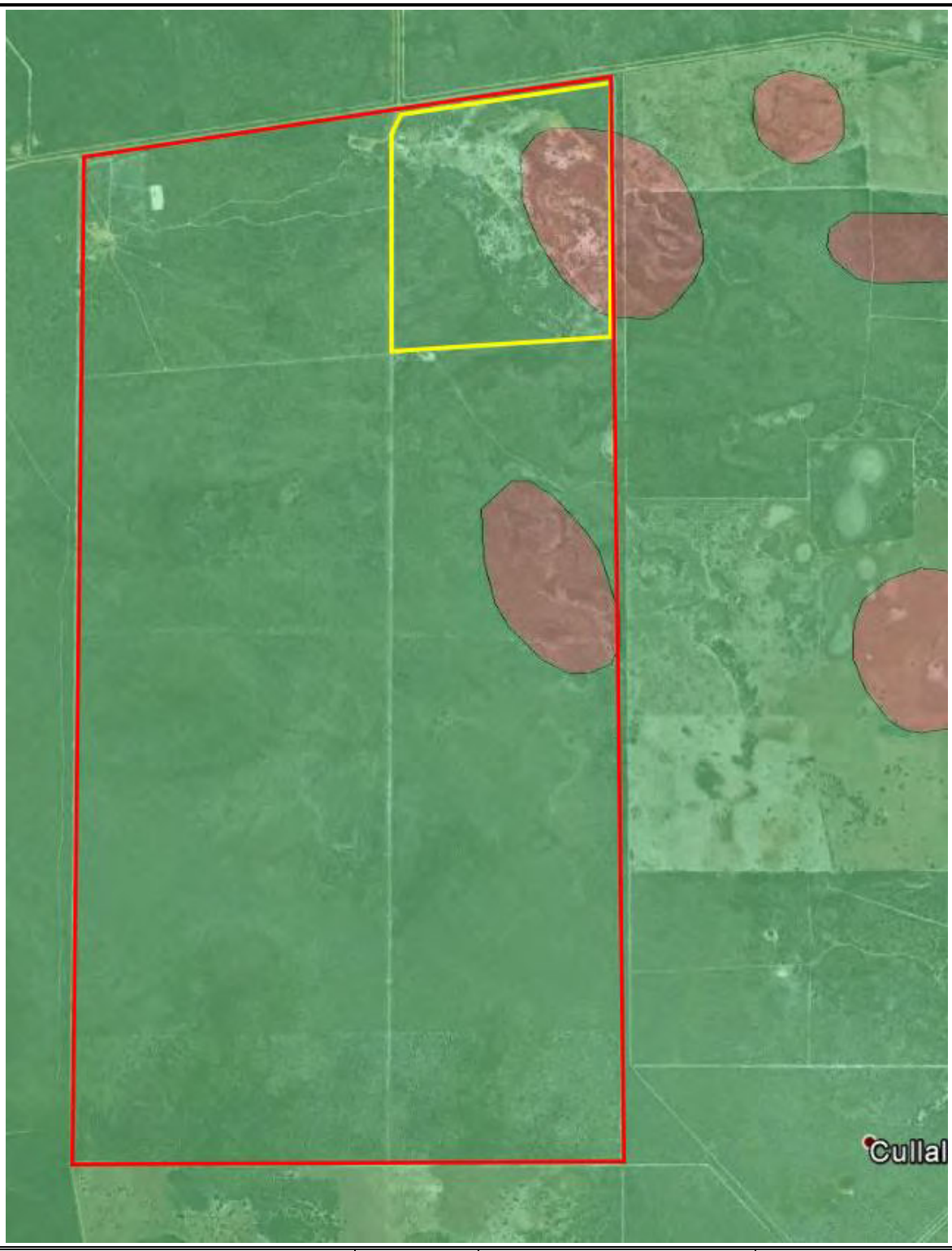


Figure 6. Landforms on the property and site



Title: Wetland Reclassification 7779 Wannamal Rd. Cullala Wannamal Rd. Organics Pty Ltd		**Sources:** Nearmap: maps.au.nearmap.com **Accessed:** 06/11/16	Bioscience

Figure 7. Acid sulfate risk on the property (green - low, red -high)

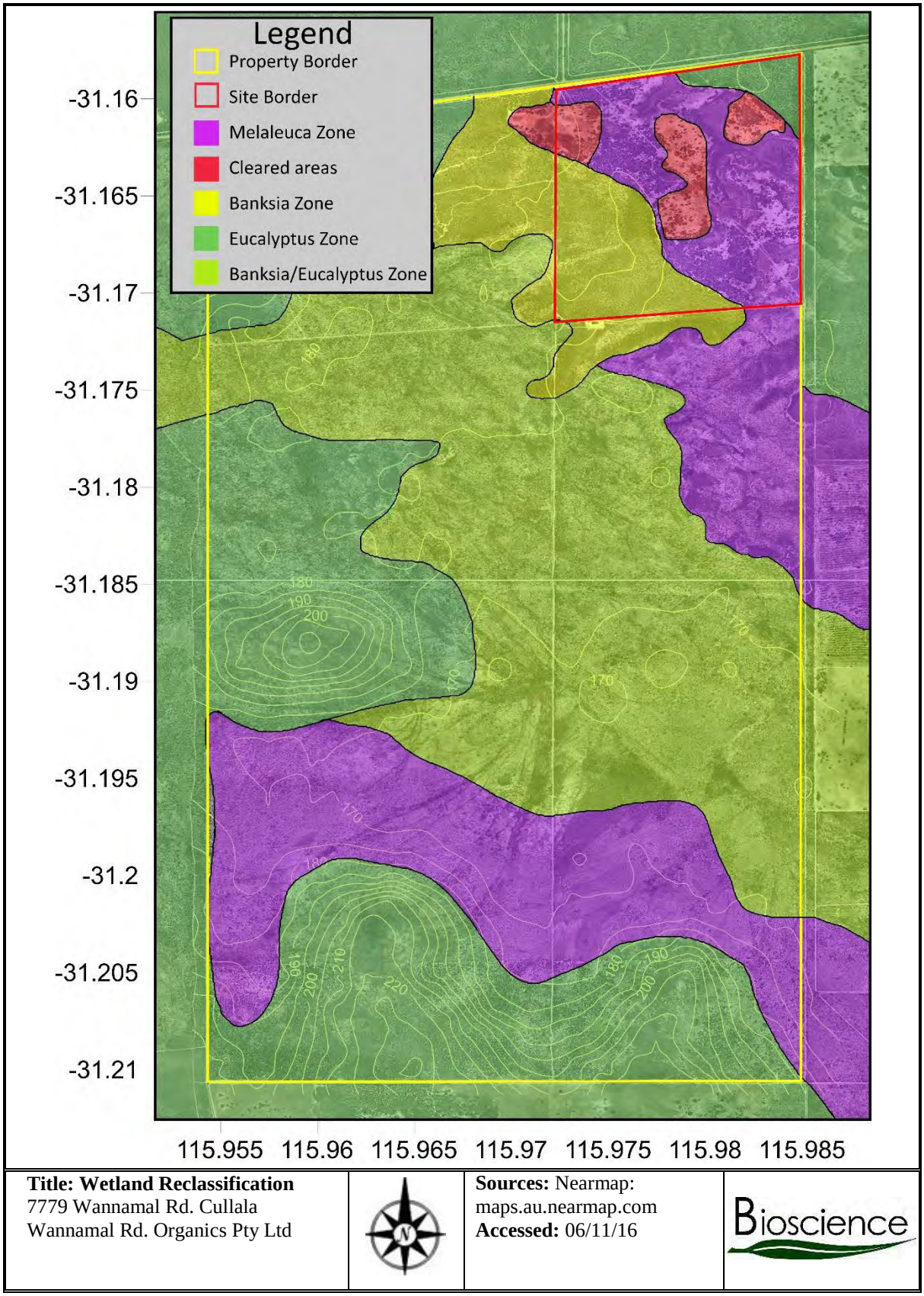
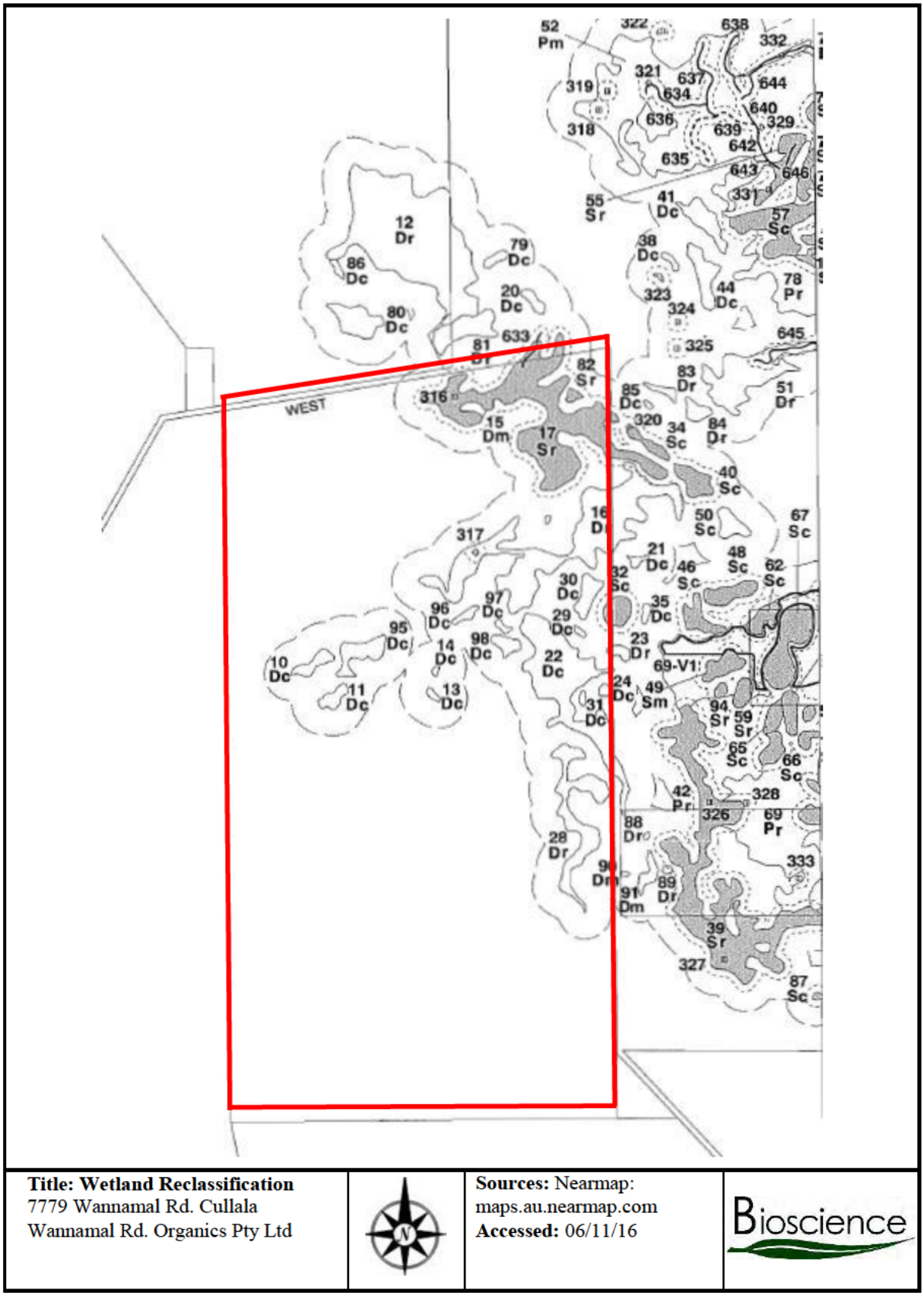
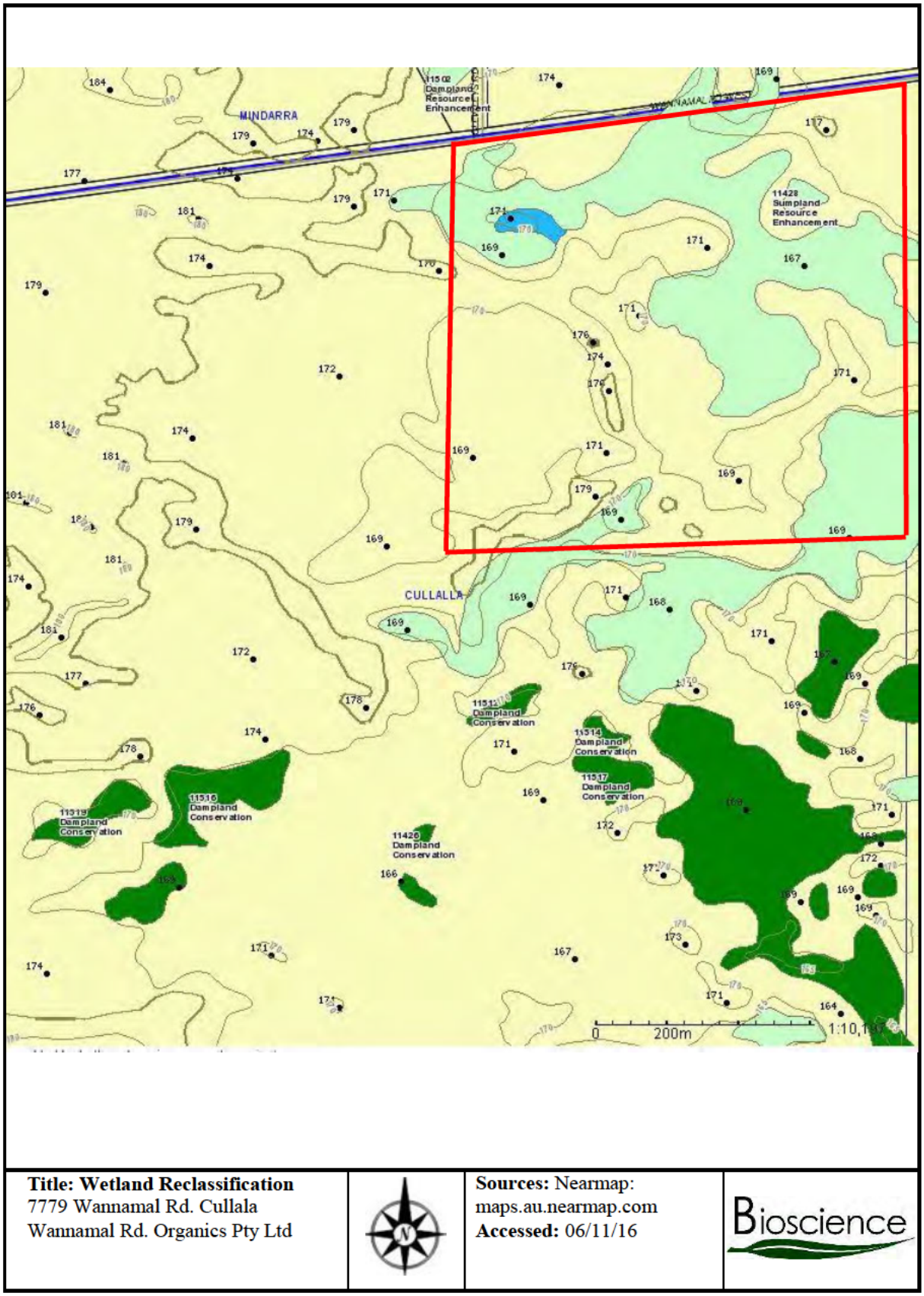


Figure 8. Vegetation types on the property



Title: Wetland Reclassification 7779 Wannamal Rd. Cullala Wannamal Rd. Organics Pty Ltd		**Sources:** Nearmap: maps.au.nearmap.com **Accessed:** 06/11/16	Bioscience

Figure 9. Original wetland Classification (Hill et al 1996)



Title: Wetland Reclassification 7779 Wannamal Rd. Cullala Wannamal Rd. Organics Pty Ltd		**Sources:** Nearmap: maps.au.nearmap.com **Accessed:** 06/11/16	Bioscience

Figure 10. Digitised dataset of Swan Coastal Plain wetlands

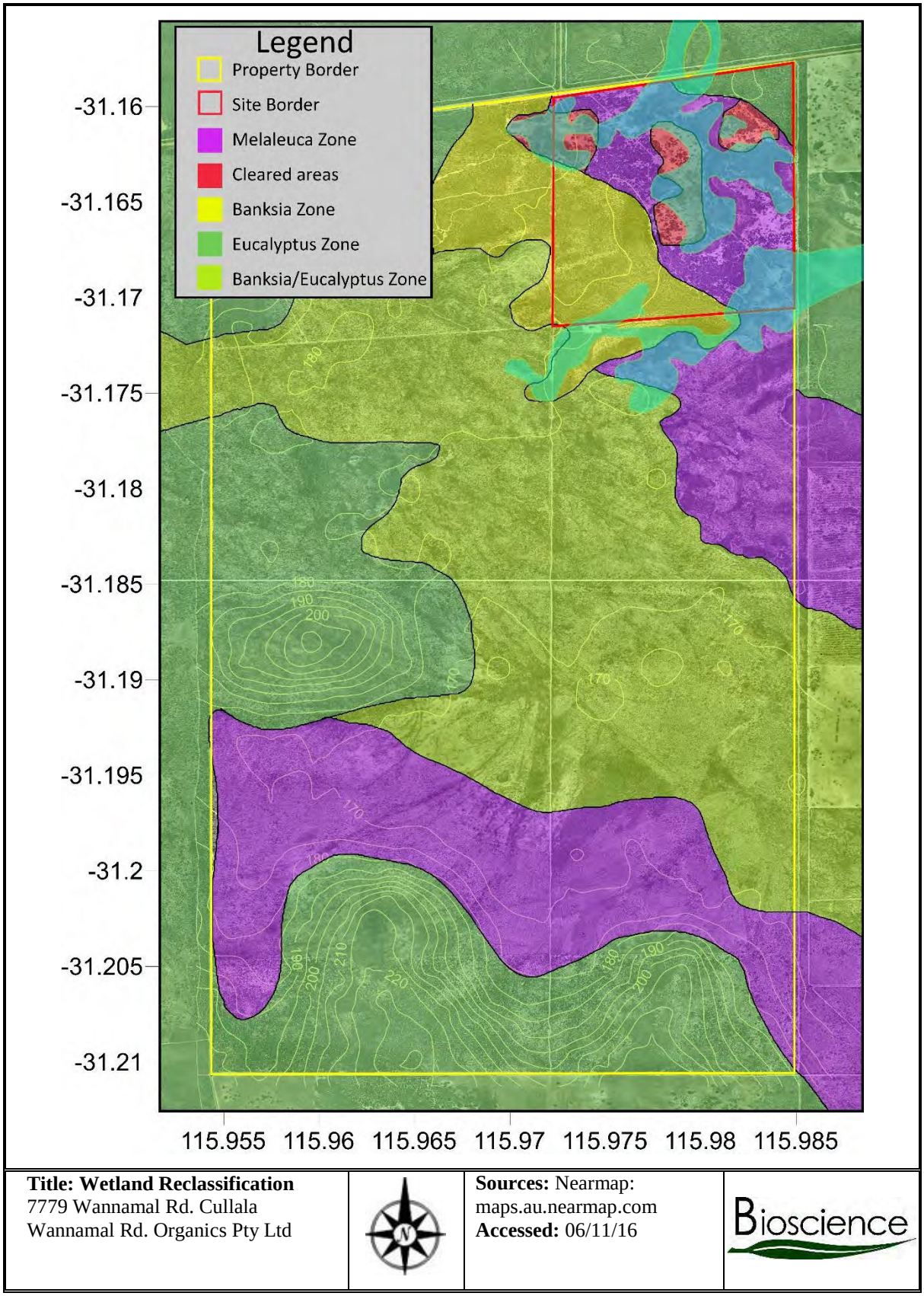


Figure 11a. Comparison of vegetation and Digitised Dataset (Blue)

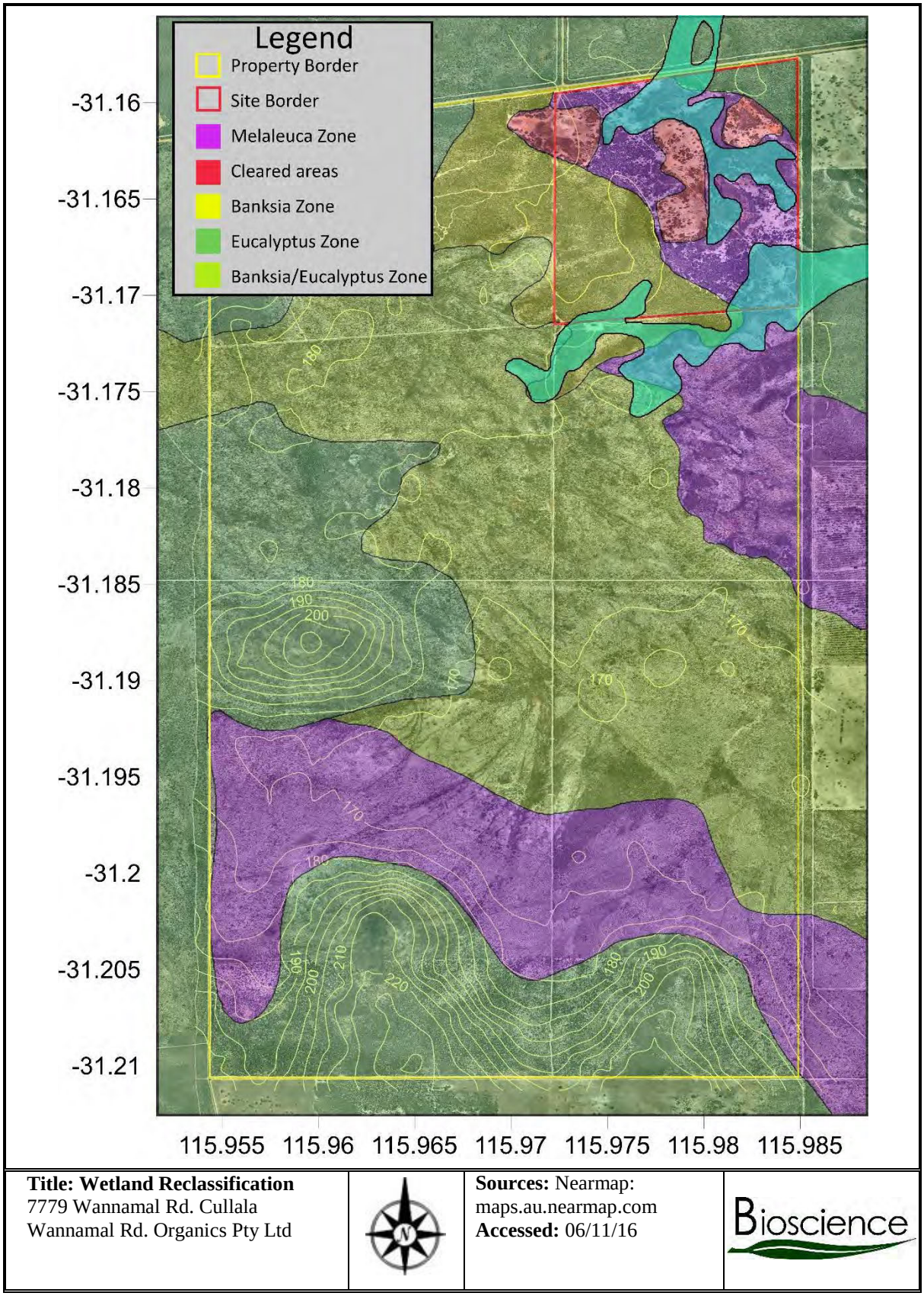


Figure 11b. Wetland modified to match cleared areas on satellite image

Photo Positions