

Ecological Assessment Report

NEBP - Residential West RoL

7903-59/017

Prepared for
North East Business Park

12 June 2014



Contact Information

Cardno (QLD) Pty Ltd
ABN 57 051 074 992

Level 11 Green Square North Tower
515 St Paul's Terrace
Fortitude Valley QLD 4006
Locked Bag 4006 Fortitude Valley



Telephone: 07 3369 9822
Facsimile: 07 3369 9722
International: +61 7 3369 9822

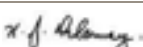
cardno@cardno.com.au
www.cardno.com.au

Document Information

Prepared for	North East Business Park
Project Name	NEBP - Residential West RoL
File Reference	I:\7903-59 Northeast Business Park\Phase 17-RWA ecological\wp\Reports\Ecological Assessment Report_V2.docx
Job Reference	7903-59/017
Date	12 June 2014

Document Control

Version	Date	Description of Revision	Prepared By	Prepared (Signature)	Reviewed By	Reviewed (Signature)
A	23 January 2014	Draft	DKW		KJD	
B	13 February 2014	Draft	DKW		KJD	
C	23 May 2014	Draft	DKW		KJD	
1	4 June 2014	Final for issue	DKW	D Wassman	KJD	J Delaney
2	12 June 2014	Final for issue	DKW		KJD	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
A	For Client Review	KJD		23 January 2014
B	For Client Review	KJD		13 February 2014
C	For Client Review	KJD		23 May 2014
1	To support DA	KJD	J Delaney	4 June 2014
2	To support DA	KJD		12 June 2014

© Cardno 2014. Copyright in the whole and every part of this document belongs to Cardno and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person other than by agreement with Cardno.

This document is produced by Cardno solely for the benefit and use by the client in accordance with the terms of the engagement. Cardno does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by any third party on the content of this document.

Table of Contents

1	Introduction	1
2	Assessment Methods	3
2.1	Desktop Investigations	3
2.2	Field Surveys	3
2.3	Mapping	6
2.4	Classification of Wetland Communities	6
2.4.1	Community Class	6
2.4.2	Community Value and Condition	8
2.4.3	Threatened Species Habitat Value	9
3	RWA Development Plan	14
4	Assessment Results	16
4.1	Overview of the RWA Development Site	16
4.2	Wetland Values, Impacts and Offsets	17
4.3	Marine Plant Values, Impacts and Offsets	22
4.4	Threatened Species Habitat Values, Impacts and Offsets	23
4.5	Borrow Area	28
5	Development Compliance Assessment	29
5.1	MCU Condition Compliance	29
5.2	SPP Compliance	35
5.3	SDAP Compliance	36
5.3.1	Module 5 – Fisheries resources	36
5.3.2	Module 10 – Coastal protection (in part).	41
6	References	43

Tables

Table 2-1	Methodologies employed during the field surveys over the Residential West area	4
Table 2-2	Wetland communities recorded within the RWA and characteristics of these communities (adapted from the QWP guideline)	6
Table 2-3	Non-Wetland communities recorded on the Site and characteristics of these communities	8
Table 2-4	Community Value classes (adapted from the QWP guideline)	8
Table 2-5	Community Condition classes (adapted from the QWP guideline)	9
Table 2-6	Threatened flora which may be supported by habitat within the RWA	9
Table 2-7	Threatened fauna which may be supported by habitat within the RWA	10
Table 2-8	Threatened Species Habitat Value classes	12
Table 4-1	Extent of Wetland Class within the RWA belonging to each Value Class	18
Table 4-2	Extent of Wetland Class Impacts	19
Table 4-3	Extent of Wetland Class Impacts and Restoration Offsets	21
Table 4-4	Threatened Species Habitat Value classes	23
Table 4-5	Extent of Impact to different Threatened Species Habitat Value classes	24
Table 4-6	Threatened flora which may be supported by habitat within the RWA	25
Table 4-7	Threatened fauna which may be supported by habitat within the RWA	25
Table 5-1	Compliance Assessment – Council Condition 11 (a) – (f)	29
Table 5-2	Compliance Assessment – State Agency Conditions	32
Table 5-3	Compliance Assessment – SPP	35
Table 5-4	State Development Assessment Provisions – Module 5	37
Table 5-5	State Development Assessment Provisions – Module 10	41

Figures

- Figure 1 Site Location
- Figure 2 Pre-clearing Vegetation Types
- Figure 3 RWA Plan of Development
- Figure 4 RWA Open Space Zones
- Figure 5 RWA Wetland Mapping
- Figure 6 Threatened Species Habitat Mapping
- Figure 7 Habitat Protection and Restoration Units

Appendices

- Appendix A Curriculum Vitae
- Appendix B Statutory Mapping
- Appendix C RWA Civil Engineering Plans
- Appendix D FRC Environmental and Austecology Mapping
- Appendix E Open Space Restoration Concept Plan

1 Introduction

The Northeast Business Park (NEBP) is a multi-use business park that will integrate industry, commercial, marine development, residential, heritage and recreational greenspace precincts. The locations and extents of the NEBP site and the Residential West Area (RWA) are illustrated in Figure 1.

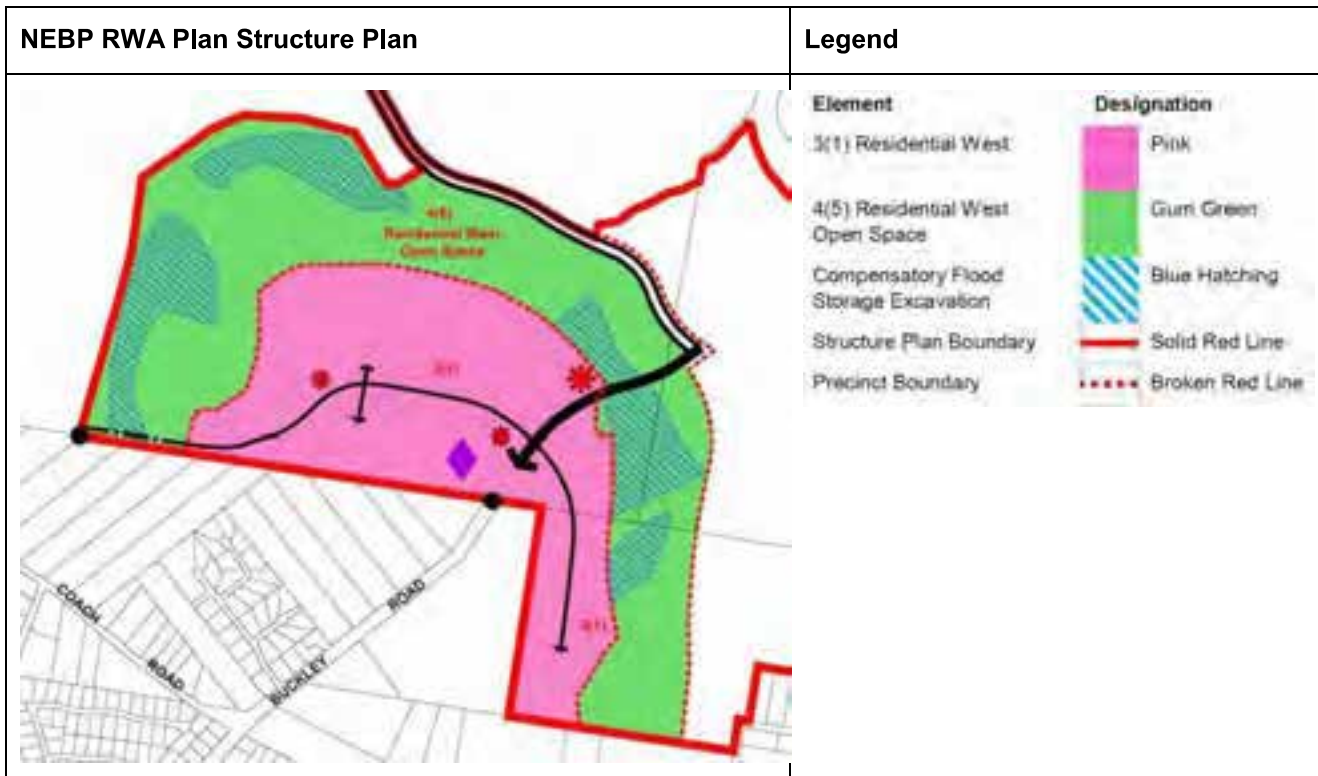
The RWA of the NEBP is the subject of:

- > a Commonwealth approval (Ref: EPBC 2006/2912) under the provisions of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act); and
- > a Queensland Planning and Environment Court Appeal (Ref: 254 of 2010) judgement, dated 28 June 2013, approving a Material Change of Use (MCU) development in accordance with:
 - a set of Conditions specified in by the Moreton Bay Regional Council (MBRC), dated 26 June 2013; and
 - a set of State Agency Conditions dated 27 June 2013.

In securing the above approvals relevant consideration was given to the environmental values of the subject land and the impacts of development upon same. Based on these assessments the location and extents of the following precincts within the RWA were determined:

- > the Residential West Precinct (the Residential Precinct); and
- > the Residential West Open Space Precinct (the Open Space Precinct).

The general locations and extents of these Precincts are defined on the NEBP Residential West Area Plan Structure Plan (the Structure Plan), extracts of which are presented below.



A notable feature of the approved Structure Plan is the recognition that establishment of the Residential West precinct will involve the partial filling of the Raff Creek flood plain and that to offset the effects of that

filling it will be necessary to re-profile parts of the Open Space Precinct, and potentially some additional areas of land to the east, to provide the necessary compensatory flood storage.

The focus of this report is on MBRC Condition 11 Environmental Requirements which states that:

With respect to achieving the intent of the Residential West Open Space Precinct, creation of Compensatory Flood Offset Areas and satisfaction of Stormwater and Flood Management conditions 15 – 20 inclusive, the following actions are required:

- a) *Submit a revised plan identifying the distribution of wetlands on the site by a suitably qualified expert in accordance with the Queensland wetland program definitions which also includes disturbed wetlands.*
- b) *Submit a revised plan determined by a suitably qualified expert and in accordance with the definitions under the Fisheries Act 1994 and Fish Habitat Management Operational Policies, identifying the distribution of marine plants on the site.*
- c) *Submit a revised plan which identifies the distribution of habitats for terrestrial fauna of conservation significance in accordance with the fauna preliminary joint expert report dated 1 May 2013.*
- d) *Stormwater management of the site is to ensure that there are no impacts unacceptable to the Council to wetland ecology, flora and fauna.*
- e) *With reference to (a) – (c) above, design and management of the development is to ensure:*
 1. *marine plants (as defined by the Fisheries Act 1994 and Fish Habitat Management Operational Policies) are not disturbed in any manner unacceptable to the Council*
 2. *habitat for terrestrial fauna of conservation significance is not affected in any manner unacceptable to the Council*
 3. *disturbance to waterways is minimised*
 4. *the natural hydrological regime of the remaining wetlands and particularly the significant wetlands, are maintained to a level acceptable to the Council.*
 5. *preservation and where appropriate, rehabilitation of all wetlands within the site.*
 6. *Preservation and where appropriate, rehabilitation of the ecological corridors on the site.*
- f) *Constructed flood storage excavation areas are to be planted (where appropriate) with native wetland species of appropriate densities, without impacting on the flood levels.*

An assessment of the degree of compliance that proposed plan of development for the Residential West precincts achieves with the requirements of MBRC Condition 11 and other relevant State Agency Conditions are also provided.

2 Assessment Methods

This ecological assessment is based on a combination of:

1. background and desktop investigations;
2. field investigations and mapping;
3. assessment of scale and magnitude of ecological impacts associated with the plan of development; and
4. compliance assessment.

The surveys and assessments that are documented herein have been carried out by appropriately qualified and experienced ecologists, with copies of the Curriculum Vitae provided in Appendix A.

2.1 Desktop Investigations

The purpose of the desktop investigations were to collate and review information of relevance to an assessment of the ecological, including wetland, values of the RWA. Relevant information sources considered as part of the desktop investigations included:

- > the NEBP EIS and associated technical assessments;
- > historical aerial photography of the RWA dating from 1955 to the present;
- > high resolution aerial photography sourced from Nearmap (circa November 2013);
- > the State Referrable Wetland Mapping (refer Appendix B);
- > the State Regulated Vegetation Map (refer Appendix B);
- > the (now repealed) Koala State Planning Policy (2/10) Koala Conservation in South East Queensland - SEQ Koala Protection Area - Koala Habitat Values Mapping (refer Appendix B);
- > the State Assessment and Referral Agency (SARA) Mapping Online System (refer Appendix B);
- > the North East Business Park Residential West Stormwater Management Plan and Flooding Assessment (Ref: 7903/59/R2V1A) prepared by Cardno (2014);
- > the Queensland Wetland Program (<http://www.environment.gov.au/topics/water/water-our-environment/wetlands/wetlands-programs/queensland-wetlands-program>);
- > various publications and online information sources providing details concerning the ecology and preferred habitat requirements of threatened wildlife species known or potentially occurring within the RWA site, including:
 - the National Recovery Plan for the wallum sedgefrog and other wallum-dependent frog species (QEPA, 2006); and
 - the Commonwealth Species Profile and Threat Database (<http://www.environment.gov.au/cgi-bin/sprat/public/sprat.pl>).

As part of this assessment consideration was also given to review comments and associated materials provided by Council in respect of a working draft that was provided for Council's consideration in March 2014.

2.2 Field Surveys

A number of field surveys of the NEBP site, including the RWA, have been carried out since 2004 to collate information relevant to assessing the ecological values of the NEBP site and the acceptability or otherwise of the impacts that the NEBP development would have on those values. This previous survey work informed the NEBP EIS and ultimately the Queensland Planning and Environment Court Appeal (Ref: 254 of 2010) judgement, dated 28 June 2013, to approve the RWA development.

In addition to that previous work and in general accordance with the requirements of Condition 11 it was necessary to:

- a. determine an appropriate method for the classification of wetland types;
- b. determine the appropriate scale at which to map and assess wetland types; and
- c. determine a suitable number of survey sites.

Table 2-1 describes the methodology employed and provides a reference for the document that describes the method in greater detail.

Table 2-1 Methodologies employed during the field surveys over the Residential West area

Field outcome or requirement	Description	Reference
Classification of wetland type	<p>As required by Condition 11, the QWP Guideline methodology was used.</p> <p>This involves collection of data associated with:</p> <ul style="list-style-type: none"> > hydrology; > vegetation present; > habitat value; > wetland value; and > wetland condition. 	<p>Department of Environment and Resource Management (2011) Queensland Wetland Definition and Delineation Guideline, Queensland Government, Brisbane.</p>
Scale of mapping and assessment	<p>Based on the need to make property scale decisions with respect to wetland type, value and condition and the relatively small assessment area (i.e. <200ha) a smaller scale than recommended within the QWP guidelines was deemed necessary.</p> <p>Guidance is provided within the Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland for property planning type uses. It is recommended that a scale of 1:10,000 is appropriate.</p> <p>At this scale the recommended minimum feature size to be surveyed and mapped is approximately 0.20ha.</p>	<p>Neldner, V.J., Wilson, B.A., Thompson, E.J. and Dillewaard, H.A. (2012) Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland. Version 3.2. Updated August 2012. Queensland Herbarium, Queensland Department of Science, Information Technology, Innovation and the Arts, Brisbane. 124 pp.</p>
Number of survey sites	<p>Determining the survey site numbers depends on the uniformity or disparity of condition within a given assessment unit, the scale of the desired mapping and assessment program and the desired outcome of the assessment.</p> <p>Desktop investigations determined that uniformity within assessment units was likely to be high.</p> <p>The scale of the mapping and assessment was determined to be 1:10,000.</p> <p>The desired outcome was both classification and boundary delineation.</p> <p>The Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland provides guidance with respect site selection and density.</p> <p>At a scale of 1:10,000 it is recommended to use 25 sites per 100ha. However, given our need to delineate boundaries a greater density was deemed necessary. At a scale of 1:5,000 the recommended density is 100 sites per hectare. As such the decision was made to halve the recommended site density for the 1:5,000 scale and aim for approximately 50 survey sites across the site.</p>	<p>Neldner, V.J., Wilson, B.A., Thompson, E.J. and Dillewaard, H.A. (2012) Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland. Version 3.2. Updated August 2012. Queensland Herbarium, Queensland Department of Science, Information Technology, Innovation and the Arts, Brisbane. 124 pp.</p>

The identification and mapping of wetlands within the RWA was carried out generally in accordance with the Queensland wetland definition and delineation guideline Part A - A guide to existing wetland definitions and the application of the Queensland Wetlands Program (QWP) definition, and Part B - Delineation and mapping guidelines. In this respect a "multiple lines of evidence" approach was applied in the identification and mapping of wetland areas, taking into account:

- > the pre-clearance regional ecosystem mapping for the NEBP locality showing the approximate location and extent of wetland regional ecosystems prior to the commencement of broad scale vegetation clearance within the locality;
- > field based observations of ponded water and saturation of the soil surfaces;
- > other hydrological indicators of wetland presence based on consideration of micro-relief, aerial photography and detailed topographic mapping;
- > the presence and relative dominance of hydrophytes (a plant that grows in water or needs a water-logged environment);
- > the presence of wetland dependent fauna (e.g. amphibians); and
- > the known extents of areas that are subject to inundation during flood events within the Raff Creek and/or Caboolture River catchments.

Soil surveys were not carried out as part of the wetland identification and mapping process because of the costs involved and the fact that in most instances the presence/absence of wetland conditions could be reliably determined from other lines of evidence.

The QWP methodology recognises that in some instances it is difficult to identify and determine wetland boundaries particularly when the wetlands have been modified, are predominantly ephemeral or where there is a broad ecotone (transition zone) between the wetland and adjacent landscape, or where the scale of assessment makes it difficult to determine if an area is identified as a wetland or not. In such instances the conservative approach has been taken as part of this assessment to classify such areas as "wetland".

Based on the above methodology, a targeted field survey was completed by two ecologists on the 27th of November 2013 to refine the wetland mapping for the RWA. The purpose of the surveys was to identify and map wetland communities across the RWA and to assess the threatened species habitat values of the different communities. Field surveys involved visiting the pre-determined survey site locations across the RWA and conducting an assessment at each location in accordance with the requirements of the QWP. At each survey site data pertaining to the following aspects was collected.

- > The presence or absence of hydrological features characteristic of wetlands, such as swamp hummocks, drains, mud cracks, surface staining, aerial roots and iron staining.
- > The presence of Wetland Indicator Species (WIS), as defined by the QWP, and the proportion of the overall community that was comprised of WIS. Other data collected for each strata (layer) of the community included: the dominant species, height and crown cover.
- > The relative value and condition of the wetland community at each of the survey sites was assessed on a site scale based on consideration of the following criteria provided within the QWP:
 - wetland processes (e.g. habitat, nutrient cycling);
 - conservation significance (e.g. diversity, representativeness, and naturalness);
 - wetland benefits (e.g. control of pests, mitigation of erosion and water supply);
 - the presence of pressures such as:
 - input of contaminants;
 - grazing;
 - weed invasion;
 - hydrological changes; and
 - mechanical changes to the soil and surface level.

- > Signs of the presence (i.e. direct observation, audible calls, scats, nests, tracks) or potential presence based on habitat structure and condition, of threatened fauna or flora.

In addition to the November 2013 survey:

- Inspections of the RWA site were completed by an experienced ecologist on the 23rd of November 2013 and the 7th of March 2014, at which time general observations and assessments were made concerning the ecological values of the RWA site including incidental observations of the presence of threatened species; and
- an additional survey of the RWA and the site of a proposed Borrow Area (for flood storage offset purposes) was carried out on the 15th of April 2014 to specifically review the findings of the initial wetland and threatened species surveys in the light of review comments received from Council and to inspect the proposed Borrow Area site located to the east of the RWA which was not inspected as part of the initial survey work.

2.3 Mapping

Mapping of the wetland units across the RWA was undertaken on MapInfo V11.5 and involved both analysis of ground-truthed data (i.e. site mapped boundaries and survey site data), aerial photography and contour interpretation.

The aerial photography was sourced from Near Map with an imagery date of 9 November 2013. The RWA contour information is 2006 Airborne Laser Survey data.

The final boundaries of the wetlands were derived from the field surveys, existing vegetation community mapping completed as part of the EIS and aerial imagery interpretation.

The final classification of wetland value and condition and habitat value for threatened species was achieved by reviewing the data collected during the field surveys and a final review of the local context for each wetland area (i.e. patch size and connectivity). The wetland value, condition and habitat value assessments were made on a relative scale at the local site level and not on a broader scale (e.g. local or regional). In this respect it is noted that the extensive history of vegetation clearance, grazing, plantation forestry and subsequent grazing have left the majority of the RWA in a highly degraded condition from an ecological perspective at the local and regional scales.

2.4 Classification of Wetland Communities

2.4.1 Community Class

The Queensland wetland habitat typology, within the QWP guideline was used to classify the wetland communities within the RWA. A brief description of the observed communities has been provided in Table 2-2.

Table 2-2 Wetland communities recorded within the RWA and characteristics of these communities (adapted from the QWP guideline)

Wetland Community Class	Characteristics of Community
Mangrove wetlands	<p>Dominated by mangrove species with characteristic aerial roots. Invariably located below HAT and often in most frequently tidally inundated areas. Occur on soils that are classically estuarine – fine dark silty clay which is highly saline and anaerobic.</p> <p>Within the RWA this community is confined to the tidally influenced reaches of Raff Creek and is generally dominated by Grey mangrove (<i>Avicennia marina</i>) and River mangrove (<i>Aegiceras corniculatum</i>) with a fringing band of Saltwater couch (<i>Sporobolus virginicus</i>), Swamp oak (<i>Casuarina glauca</i>) and other species such as Suaeda sp., Ruby saltbush (<i>Enchylaena tomentosa</i>).</p> <p>This community is recognised as being a marine wetland community.</p>

Wetland Community Class	Characteristics of Community
<p>Coastal and sub-coastal <u>saline swamps</u></p>	<p>The most conspicuous feature of coastal grass-sedge wetlands is dominance by grasses (family Poaceae) and/or sedges (principally, family Cyperaceae). Inundation is usually temporary, ranging from a few weeks each year during periods of heavy rain and flash flooding, to many months.</p> <p>The geomorphologic setting for coastal grass-sedge wetlands is minor basins, small depressions and poorly drained flats on marine or alluvial plains with gentle or minimal slope.</p> <p>Soil of coastal grass-sedge wetlands typically is heavy, dark clay that was originally deposited by streams or the ocean. On marine plains the underlying substrate may have a high salt content but may be overlaid with more recent alluvial deposits that are not saline.</p> <p>Within the RWA this community occurs adjacent to the tidally influenced downstream reaches of Raff Creek and occupies an area that has been cleared in the past and is actively maintained in an open condition and subject to livestock grazing. The vegetation in this community is dominated by Saltwater couch (<i>Sporobolus virginicus</i>) and other saltmarsh species.</p> <p>This community is recognised as being a marine wetland community.</p>
<p>Coastal and sub-coastal floodplain tree swamps - melaleuca and eucalypt</p>	<p>Tree swamps are non-tidal, wooded wetlands generally occupying depressions and drainage lines. These communities are seasonally inundated with the period of inundation being highly variable but extending in some instances to 3–6 months of the year.</p> <p>They occur on a broad range of soil types, from the predominantly silty to loamy clays on the edges of water bodies to sandy alluvia soils on a floodplain and poorly oxygenated marine clays or the black soil plains.</p> <p>Within the RWA this community is represented by areas of non-remnant paperbark (<i>Melaleuca quinquenervia</i>) open forest derived from RE12.3.5 which would have occupied the majority of the Raff Creek flood plain prior to the commencement of broad scale vegetation clearance and subsequent use of the land for agricultural, forestry and grazing purposes.</p> <p>The vegetation is generally dominated by Broad-leaved paperbark (<i>Melaleuca quinquenervia</i>) to a height of approximately 20m with scattered Queensland blue gum (<i>Eucalyptus tereticornis</i>), Grey ironbark (<i>Eucalyptus siderophloia</i>) and Swamp box (<i>Lophostemon suaveolens</i>). The understorey is dominated by a combination of native species, exotic grasses and other introduced plants. Species that occur within this community include Poison peach (<i>Trema tomentosa</i>), Monkey rope vine, <i>Melaleuca linariifolia</i>, White passion flower (<i>Passiflora subpeltata</i>), Groundsel bush, Pink euodia (<i>Melicope elleryana</i>), <i>Glochidium sumatranum</i>, <i>Stephania japonica</i>, Red ash, <i>Pittosporum revolutum</i>, <i>Kennedia rubicunda</i>, Frogsmouth (<i>Philydrum lanuginosum</i>), Smartweed (<i>Persicaria sp.</i>), Water hyacinth (<i>Eichhornia crassipes</i>), Wild tobacco, Soft bracken (<i>Calochlaena dubia</i>), <i>Lomandra longifolia</i>, <i>Ludwigia peploides</i>, Camphor laurel (<i>Cinnamomum camphora</i>), Mile-a-minute, Fleabane (<i>Conzya sp.</i>) and <i>Passiflora sp.</i> However, <i>Phragmites australis</i> and <i>Blechnum indicum</i> become locally predominant in some areas of the communities associated with the drainage lines.</p> <p>This community is recognised as being a palustrine wetland community.</p>
<p>Coastal and sub-coastal floodplain, grass, sedge herb swamps</p>	<p>The most conspicuous feature of coastal grass-sedge wetlands is dominance by grasses (family Poaceae) and/or sedges (principally, family Cyperaceae). Inundation is usually temporary, ranging from a few weeks each year during periods of heavy rain and flash flooding, to many months.</p> <p>The geomorphologic setting for coastal grass-sedge wetlands is minor basins, small depressions and poorly drained flats on marine or alluvial plains with gentle or minimal slope.</p> <p>Soil of coastal grass-sedge wetlands typically is heavy, dark clay that was originally deposited by streams or the ocean. On marine plains the underlying substrate may have a high salt content but may be overlaid with more recent alluvial deposits that are not saline.</p> <p>Within this RWA this community is primarily represented by areas that would originally have supported RE12.3.5 and which have been actively managed to suppress regrowth of an overstorey of paperbarks and allied species. Removal of disturbance pressures would see most of these areas transition over time to the community described as Coastal and sub-coastal floodplain tree swamps - Melaleuca and Eucalypt.</p> <p>This community is recognised as being a palustrine wetland community.</p>

Wetland Community Class	Characteristics of Community
Disturbed Wet-Terrestrial Grassland Mosaic	<p>Whilst this is not a wetland community class recognised in the QWP Guideline, this class applies to the balance of the RWA that is located below the Q100 flood contour. These areas:</p> <ul style="list-style-type: none"> > have been subjected to substantial disturbance in the past associated with broad-scale clearing, agricultural, forestry and grazing activities; > would have originally supported wetland ecosystems prior to the broad scale clearance and development of the NEBP (refer Figure 2); and > currently supports a disturbed mosaic of terrestrial and ephemeral wetland (floodplain, grass, sedge herb swamps) areas that difficult to map accurately. <p>The costs of field based surveys and investigations that would be required to separate wet grassland areas from terrestrial grassland areas would be prohibitive and as such the conservative assumption has been made to treat this mosaic as a wetland class.</p>

The remainder of the RWA was comprised of the disturbed non-wetland communities described in Table 2-3.

Table 2-3 Non-Wetland communities recorded on the Site and characteristics of these communities

Non-Wetland Community	Characteristics of Community
Disturbed Terrestrial Grassland	This community is characterised by species that are common to disturbed rural landscapes such as Pigeon grass (<i>Setaria spp.</i>), Rhodes grass (<i>Chloris gayana</i>), <i>Paspalum sp.</i> , Guinea grass (<i>Panicum maximum</i>), Wild tobacco, Balloon cotton bush (<i>Gomphocarpus physocarpus</i>), Phasey bean (<i>Macroptilium lathyroides</i>), Siratro (<i>Macroptilium atropurpureum</i>), Blady grass (<i>Imperata cylindrica</i>), Cobblers peg (<i>Bidens pilosa</i>), Blue billygoat weed (<i>Ageratum houstonianum</i>), Scotch thistle (<i>Cirsium vulgare</i>), Groundsel (<i>Baccharis halimifolia</i>), Devils fig (<i>Solanum torvum</i>), Lantana (<i>Lantana camara</i>), and some scattered areas of Slash pine (<i>Pinus elliotii</i>) and Acacia regrowth.
Disturbed Terrestrial Woodland	The disturbed woodland community was recorded from a narrow strip alongside the riparian zone and atop the isolated knoll on the eastern portion of the site. The overstorey consists of scattered canopy species such as Queensland blue gum (<i>Eucalyptus tereticornis</i>), Pink bloodwood (<i>Corymbia intermedia</i>), Moreton Bay ash (<i>Corymbia tessellaris</i>), Slash pine, Acacia sp. and Broad-leaved paperbark (<i>Melaleuca quinquenervia</i>). Owing to a history of disturbance and edges effects this community is currently subject to high levels of invasion by many of the exotic plant species described for the disturbed grassland community. These areas would in pre-disturbance condition have supported RE 12.5.3 which is characterised by a dominance of Scribbly gum (<i>Eucalyptus racemosa</i>) however this species was found to be conspicuously absent from the disturbed woodland community within the Site.

2.4.2 Community Value and Condition

The qualitative and relative Community Value classes used in this assessment, and a brief description of the characteristics of same, are provided in Table 2-4.

Table 2-4 Community Value classes (adapted from the QWP guideline)

Value Class	Characteristics of Class
High	<p>High value areas typically contain a substantial proportion of the ecological features and functions that would be expected to be present within a remnant example of that wetland class.</p> <p>High value wetlands are areas support a broad range (>7 examples) of wetland ecological processes (e.g. species interactions, dispersal, breeding, connectivity) and ecosystem benefits and services (e.g. erosion protection, control of pests, sediment retention, nutrient cycling) with most of these considered to be of high or moderate value within a local context.</p>
Moderate	<p>Moderate value areas have been substantially modified but still provide some of the key the ecological features and functions that would be expected to be present within a remnant example of that wetland class.</p> <p>Moderate value wetlands support a moderate range (4 to 7 examples) of wetland ecological processes and ecosystem benefits and services with most of these considered to be of moderate value within a local context.</p>

Value Class	Characteristics of Class
Low	<p>Low value areas have been substantially modified and are fundamentally different from the original wetland community that would have occurred in the area.</p> <p>Low value wetlands support a narrow range (<4 examples) of wetland ecological processes and ecosystem benefits and services with most of these considered to be of low value within a local context.</p>

The wetlands within the RWA have been subject to wide-ranging and longstanding pressures both directly and across the adjoining catchment. The nature and magnitude of the pressures within the surrounding catchment are mostly uniform with respect to type (e.g. grazing or clearing) and magnitude (i.e. the grazing or clearing pressure has been assumed to have occurred at a relatively consistent level). As such condition class was assigned based on the degree of impact at a local scale rather than the number of pressures or impacts. This was deemed to reflect how a particular wetland or area of wetland has responded to the external pressures or impacts.

The qualitative and relative wetland Condition classes used in this assessment, and a brief description of the characteristics of same, are provided in Table 2-5.

Table 2-5 Community Condition classes (adapted from the QWP guideline)

Condition Class	Characteristics of Class
High	<p>High condition wetland areas have typically be subjected to a relatively low level of disturbance in comparison to other wetland areas within the RWA and still resemble a remnant example of that wetland class.</p> <p>Any number of pressures considered to have impacted the wetland at low levels. These areas are characterised by lower levels of clearing or thinning, fewer signs of grazing, pest animal and weed impacts and limited visible changes to the hydrology.</p>
Moderate	<p>Moderate condition wetland areas have typically be subjected to a relatively high level of disturbance in comparison to High condition wetland areas within the RWA. Moderate condition areas exhibit a relatively high potential for regeneration if existing pressures were removed.</p> <p>One or more pressures considered to have impacted the wetland at moderate levels. Areas characterised as Moderate Condition showed clear signs of weed infestation, grazing impacts and disturbance to the hydrology and/or soil within and surrounding the wetland.</p>
Low	<p>Low condition wetland areas have typically be subjected to a very high level of disturbance in comparison to other wetland areas within the RWA. Low condition areas exhibit a relatively low potential for regeneration if existing pressures were removed.</p> <p>Multiple pressures considered to have impacted the wetland at high levels. Low Condition areas have been subject to clearing and thinning and show fewer signs of regeneration, are characterised by high levels of weed infestation and grazing levels which have clearly impacted the soil and sediment within the wetland.</p>

2.4.3 Threatened Species Habitat Value

The threatened flora and fauna species specifically considered during the habitat surveys and assessments are identified in Table 2-6 and Table 2-7 below.

Table 2-6 Threatened flora which may be supported by habitat within the RWA

Flora	Status	Profile and Essential Habitat Features
<i>Acacia attenuata</i>	QV, CV	<p>This slender shrub grows to a height of 3-4 m and tends not to occur further than 40 km inland from the coast. The species is restricted to heath ecotones or layered eucalypt open-forest and woodland. <i>Acacia attenuata</i> has been recorded growing in shrublands with <i>Leptospermum whitei</i> and <i>Baekea frutescens</i>, in wallum with <i>Banksia aemula</i> and <i>Eucalyptus robusta</i>, in woodlands with <i>Corymbia trachyphloia</i>, <i>E. umbra</i> and <i>Banksia oblongifolia</i>, and in open forests of <i>E. umbra</i>, <i>E. racemosa</i> and <i>Melaluca quinquenervia</i>. It prefers areas with high rainfall and can survive seasonal waterlogging in sandy soils. It usually occurs in areas less than 1m AHD.</p>

Flora	Status	Profile and Essential Habitat Features
Hairy Joint Grass (<i>Arthraxon hispidus</i>)	QV, CV	Hairy joint grass is a slender, creeping grass with branching, erect to semi-erect purplish stems that form roots at the node. Leaf-blades are ovate to ovate-lanceolate, 2 – 6 cm long, broad at the base and tapering abruptly to a short point with long white hairs fringing the margins. Hairy joint grass is typically described as moisture and shade-loving grass often associated with the edges of rainforest, wet sclerophyll forest, creeks and swamps.
Leafless Tongue Orchid (<i>Cryptostylis hunteriana</i>)	CV	This leafless orchid has stems 50-450 mm tall with 1 to 10 flowers. The flowers are 20-30 x 6-8 mm. It occurs from Rainbow Beach to Tin Can Bay and inland to Gibraltar Range. It is a highly localised species occurring singly or in colonies in moist sandy soil in sparse to dense heath and sedgeland. They can also occur in coastal forest in moist to dry clay loam. This species has not been observed above 1000m AHD.
Lesser Swamp Orchid (<i>Phaius australis</i>)	QE, CE	This orchid occurs along the coastlines of Queensland and New South Wales at altitudes up to 1100 m. It can grow to be 2 m tall and have up to 16 flowers. Flowers are usually a deep brownish red. It is most common in swamps and islands in the Moreton District. It grows in swamps and low lying depressions within forests of the coastal lowlands. It requires full shade and is often found in association with <i>Melaleuca quinquenervia</i> wetlands.

Table 2-7 Threatened fauna which may be supported by habitat within the RWA

Fauna	Status	Essential Habitat Features
Koala (<i>Phascolarctos cinereus</i>)	QV, CV	The Koala's range stretches from the temperate south of the country to the tropical north. Koala habitat consists of open eucalypt forest and woodland at lower altitude in undulating country on relatively deep and usually high nutrient soil. Primary food species include Eucalyptus, Corymbia, Lophostemon, Angophora and Melaleuca species. The species does not use nests or dens and is considered nomadic within a home range which is usually approximately 100ha in size.
Water Mouse (<i>Xeromys myoides</i>)	QV, CV	The Water Mouse is a small native rodent recorded from coastal saltmarsh including samphire shrublands, saline reed-beds and saline grasslands, mangroves and coastal freshwater wetlands. The Water Mouse is probably entirely nocturnal, sheltering during the day and between tidal cycles in constructed nesting mounds and natural or artificial hollows. The species feeds on a variety of molluscs, crustaceans and polyclads located within the tidal areas of mangrove communities.
Wallum Rocketfrog (<i>Litoria freycineti</i>)	QV	The Wallum Rocketfrog occurs in lowland coastal areas extending from Fraser Island in Qld to Jervis bay in NSW. Within its range it is associated with coastal wet heath, sedge swamps, drainage lines and perched lakes in areas of sandstone and sandy soil. May also be found some distance from water in eucalypt forest near areas of wet heath. <i>L. freycineti</i> breeds in spring and summer, after rain, usually breeds in ephemeral swamps and pools.
Wallum Froglet (<i>Crinia tinnula</i>)	QV	<i>Crinia tinnula</i> is a tiny terrestrial frog that inhabits lowland, coastal areas of south east Queensland and northern NSW, including the sand islands off the Queensland coast (Fraser, Bribie, Moreton and North Stradbroke Island). Originally ranging from Bundaberg, QLD to Sydney, NSW, the distribution of the wallum froglet has been severely decreased and fragmented. The Wallum Froglet is found along drainage lines in sub-coastal wet heath, in acid paperbark (<i>Melaleuca</i>) swamps, and sedge swamps in areas of sandy soil and sandstone; rarely encountered around coastal lakes. It is frequently recorded from disturbed wallum habitat, including recently burnt heath, 4WD-impacted sites, an old quarry site, and sugar cane farms and exotic pine plantations. Animals have also been recorded in eucalypt woodland/forest and dry heath, some distance from water. <i>Crinia tinnula</i> is broadly sympatric with other <i>Crinia</i> species and is rarely found together with <i>C. parinsignifera</i> , except in disturbed habitat. Breeding has been recorded in all seasons following rain in shallow (< 1m) ephemeral waters that are typically tannin-stained and acidic (pH < 6.0). Males call from the base of sedges near water or atop matted sedges. Eggs are laid singly or in clumps attached to submerged vegetation.

Fauna	Status	Essential Habitat Features
Green-thighed Frog (<i>Litoria brevipalmata</i>)	QV	<p>Green-thighed Frogs occur in a range of habitats from rainforest and moist eucalypt forest to dry eucalypt forest and heath, typically in areas where surface water gathers after rain. It prefers wetter forests in the south of its range, but extends into drier forests in northern NSW and southern Queensland. The frogs are thought to forage in leaf-litter.</p> <p>Breeding occurs following heavy rainfall from spring to autumn, with larger temporary pools and flooded areas preferred. Frogs may aggregate around breeding sites and eggs are laid in loose clumps among waterplants, including water weeds. The larvae are free swimming. The call is a continuous series of 'quack' or 'wok' sounds.</p>
Tusked Frog (<i>Adelotus brevis</i>)	QV	<p>The Tusked Frog is distributed across the coastal plain and adjacent Great Dividing Range from central Queensland to southern NSW.</p> <p>Tusked frogs are found through a broad range of habitats covering open grasslands, large swamps, low woodlands, dry and wet sclerophyll forests and rainforest and appear none too concerned about whether the site is natural or artificial or whether it is pristine or highly disturbed. They rarely occur more than 400m above sea level and will breed in quite a broad range of sites for an Australian frog, being found wherever there is relatively still water. They have been observed calling (rarely) in temporary pools on the sides of roads, in larger flooded depressions, in permanent fire dams and ponds and on the banks of small to quite large streams. In the faster flowing streams the tadpoles probably stick to specific microhabitats to avoid being washed around too much.</p>
Cotton Pygmy Goose (<i>Nettaus coromandelianus</i>)	QNT, CM	<p>The Cotton Pygmy Goose is a surface feeder generally found in freshwater lakes, swamps, dams and lagoons that are vegetated. This species utilizes hollows within standing, dead trees, that are close to water, as roosting sites. Although its distribution was once along the eastern coastline of Australia from Cape York to southern New South Wales, it is now believed uncommon in Queensland.</p>
Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>)	QNT	<p>The Black-necked Stork is the only stork species in Australia. The distribution of this species extends across northern and eastern Australia, with sightings decreasing into NSW and rarely seen south of Sydney. Throughout its range it is most frequently encountered alone or in pairs foraging on frog, fish, eels, turtles, crabs and snakes. The foraging and breeding habitats include freshwater (permanent or ephemeral) wetlands, adjacent grasslands and woodlands and are occasionally seen on intertidal areas of the coast.</p>
Eastern Curlew (<i>Numenius madagascariensis</i>)	QNT, CM	<p>The Eastern Curlew is a non-breeding summer resident of the Australian coastline, where it is usually encountered around estuaries, salt-marshes, mudflats and sandy beaches. The majority of birds leave Australia over the period of April to May and return to their northern hemisphere breeding grounds.</p>
Beach Stone-curlew (<i>Esacus neglectus</i>)	QV	<p>In Australia, the Beach Stone-curlew occupies coastlines from about Point Cloates in Western Australia, across northern and north-eastern Australia south to north-eastern NSW, with occasional vagrants to south-eastern NSW and Victoria. Within this range Beach Stone-curlews are found exclusively along the coast, on a wide range of beaches, islands, reefs and in estuaries, and may often be seen at the edges of or near mangroves. They forage in the intertidal zone of beaches and estuaries, on islands, flats, banks and spits of sand, mud, gravel or rock, and among mangroves. Beach Stone-curlews breed above the littoral zone, at the backs of beaches, or on sandbanks and islands, among low vegetation of grass, scattered shrubs or low trees; also among open mangroves. The diet consists of crabs and other marine invertebrates.</p>
Lewin's Rail (<i>Rallus pectoralis</i>)	QNT	<p>The distribution of Lewin's Rail extends from Townsville, QLD to Kangaroo Island, SA. Breeding sites are not well known due to the cryptic nature of the species and their nests. Lewin's rail is found to occupy fresh to saline water bodies that are permanent or ephemeral and have emergent or fringing vegetation. The bird forages in this vegetation eating small invertebrates, birds eggs and frogs. Habitat can be degraded by livestock grazing, regular burning and increased salinity due to excessive vegetation clearance within catchments and the species is likely to abandon wetlands where fringing vegetation has been degraded by grazing, inappropriate burning, or trampling and rooting by stock and feral pigs.</p>

Fauna	Status	Essential Habitat Features
Australian Painted Snipe (<i>Rostratula australis</i>)	QV, CEM	The Australian Painted Snipe is restricted to Australia with most records being from the south east, particularly the Murray Darling Basin, with scattered records across northern Australia and historical records from around the Perth region in Western Australia. Throughout its range the species prefers fringes of swamps, dams and nearby marshy areas where there is a cover of grasses, lignum, low scrub or open timber. Within its habitat it forages nocturnally on mud-flats and in shallow water, feeding on worms, molluscs, insects and some plant-matter.

The relative value of different areas as habitat for threatened species was classified, on a qualitative and relative basis, taking into account:

- > the status of the area pursuant to statutory mapping which reflects the recorded presence of the species within the RWA, or adjacent sectors of the NEBP, and the quality of the habitat from a bioregional perspective;
- > the presence of known and generally accepted habitat resources required to support the threatened species; and
- > the presence and magnitude of known threats to the species that was evident in areas of potential habitat within the RWA, including habitat clearance, grazing and predation.

Brief descriptions of the characteristics of the Threatened Species Habitat Value classes used in this assessment are provided in Table 2-8.

Table 2-8 Threatened Species Habitat Value classes

Habitat Value Class	Characteristics
Very High	<p>Very High Habitat Value Areas exhibit all of the following characteristics:</p> <ul style="list-style-type: none"> ▪ the area is classified as threatened species “habitat” on any of the following: <ul style="list-style-type: none"> ○ the Regulated Vegetation Management Map – Essential Habitat Map; ○ the (now repealed) Koala State Planning Policy (2/10) Koala Conservation in South East Queensland - SEQ Koala Protection Area - Koala Habitat Values; or ○ State Planning Policy (SPP) Matters of State Environmental Significance Mapping; <p>and</p> <ul style="list-style-type: none"> ▪ one or more threatened species has been recorded in the area; and ▪ the area exhibits the habitat values or features that are likely to sustain the permanent, rather than the ephemeral or transitory, presence of the threatened species; and ▪ the area is in a relatively intact ecological condition with reference to the regional ecosystem from which the habitat is derived; and ▪ the area maintains a relatively high level of connectivity to other areas of potential habitat within or external to the RWA site.
High	<p>High Habitat Value Areas exhibit the following characteristics:</p> <ul style="list-style-type: none"> ▪ more than one threatened species has been recorded in the area; and ▪ the area exhibits the habitat values or features that are likely to sustain the permanent, rather than the ephemeral or transitory, presence of the threatened species; and ▪ the area is in a relatively intact ecological condition with reference to the regional ecosystem from which the habitat is derived; and ▪ the area maintains a relatively high level of connectivity to other areas of potential habitat within or external to the RWA site.

Habitat Value Class	Characteristics
Moderate	<p>Moderate Habitat Value Areas exhibit the following characteristics:</p> <ul style="list-style-type: none">▪ one or more threatened species have been either recorded or are considered likely to occur in the area; and▪ the area exhibits the habitat values or features that are likely to sustain an ephemeral or transitory, rather than permanent, presence of the threatened species; and▪ the area is in a highly modified ecological condition with reference to the regional ecosystem from which the habitat is derived, but does exhibit signs that regeneration could occur if existing pressures were removed; and▪ the area maintains a moderate level of connectivity to other areas of habitat within or external to the RWA site.
Low	<p>Low Habitat Value Areas exhibit the following characteristics:</p> <ul style="list-style-type: none">▪ one or more threatened species have been either recorded or are considered likely to occur in the area;▪ the area is only capable of sustaining an ephemeral or transitory presence of the threatened species; and▪ the area is in a highly modified ecological condition with reference to the regional ecosystem from which the habitat is derived and is not likely to regenerate to a natural condition if existing pressures are removed.

3 RWA Development Plan

The general nature of the plan of development for the RWA is illustrated in Figure 3 and the engineering drawings presented in Appendix C. Overall the RWA is approximately 175 ha in extent and will be comprised of:

- > an Urban Residential Precinct, approximately 88 ha in extent, which will accommodate residential allotments and associated roadways; and
- > an Open Space Precinct, approximately 87 ha in extent, which will accommodate active parklands, stormwater wetlands, areas of retained vegetation and wildlife habitat associated with Raff Creek and areas of land that have been re-profiled to achieve flood offset requirements and within which ecological restoration works will be carried out.

The RWA development will involve an extensive program of bulk earthworks. The key features of this bulk-earthworks program include the following.

- 1) The bulk earthworks would be carried out in stages.
- 2) Filling of the area within the central northern portion of the RWA adjacent to Raff Creek to above the 100 year ARI peak flood levels. Lot levels are to be above the higher of the 100 year ARI peak flood level including the impacts of climate change and the January 2011 flood event levels.
- 3) Filling within the south east corner of the site adjacent to the unnamed waterway.
- 4) Filling along the development footprint extents adjacent to Raff Creek and the unnamed waterway to provide suitable park areas. The majority of park areas have been designed to have immunity for the designated 100 year ARI design flood event. The proposed park area on the northern side of Raff Creek is only just inundated for the 100 year ARI event and will readily be above the 20 year ARI peak flood levels in this area. This park also includes provision for a 10m wide channel to convey overflows between the Caboolture River and Raff Creek which currently flows across the future MIBA land.
- 5) Constructed wetlands between the proposed parks, development footprint and the main Raff Creek and unnamed waterway banks. The constructed wetlands have been included assuming a standing water level at HAT (1.36mAHD) and perimeter bunds at 2.16mAHD following advice from Council regarding acceptable levels of immunity.
- 6) Compensatory cut is located adjacent to the banks of the main Raff Creek waterway. The existing ground surface levels will be lowered by up to 3.0 m in a manner that will generally enable the re-profiled areas to free draining into Raff Creek.
- 7) Compensatory cut within a 9.4 ha Borrow Area located on the land opposite the eastern extents of the RWA development. The Borrow Area will be lowered to as low as 0.0mAHD, however flood storage volumes only account for volumes above the MHWS level of 0.82mAHD.
- 8) A 955 metre long bund 300mm high along the southern bank of the small drain to the north of the Borrow Area to limit additional flows being conveyed through the area of the Borrow Area.

The Raff Creek Open Space Precinct will be a total of 87 hectares in extent and comprised of approximately:

- 1) 8 hectares of land to be developed as formal parklands, generally located above the Q100 flood level (the Parkland Zone);
- 2) 5 hectares of land that is to be maintained in its current condition to accommodate a potential regional road corridor;
- 3) 12 hectares of land that will accommodate a total of six constructed wetlands that are proposed as part of the NEBP RWA development's stormwater treatment train (the Constructed Wetland Zone);
- 4) 31 hectares of existing native vegetation and fauna habitats associated with Raff Creek that are to be retained and managed primarily for environmental purposes (the Habitat Protection Zone); and

- 5) 31 hectares of land that is to be re-profiled to provide the required flood storage offsets and then subsequently rehabilitated to a natural condition and managed for environmental purposes (the Habitat Restoration Zone).

The locations and extents of the above described zones within the Raff Creek Open Space Precinct are illustrated in Figure 4.

The re-profiled areas of land within the Open Space precinct are to be the subject of a program of rehabilitation works. In this respect the Raff Creek Open Space Precinct Restoration Concept Plan (RCP), presented in Appendix E, provides general specifications for the rehabilitation and management of the Raff Creek Open Space corridor. The RCP identifies and describes the particular types of ecosystems that are to be established within the Open Space corridor based on consideration of:

- a) the regional ecosystems to be retained within the Open Space corridor;
- b) proposed location and extents of earthworks and resultant finished ground surface levels;
- c) levels of tidal inundation that may be experienced within the re-profiled Raff Creek flood plain;
- d) the habitat requirements of rare and threatened flora and fauna that currently (or which potentially) occur within the Raff Creek catchment and a desire to preserve these species within the RWA;
- e) a desire to have the rehabilitation works make a positive contribution towards an overall improvement in the quality of water discharging from the Raff Creek catchment into the Caboolture River, potentially reducing the need to dedicate resources towards water quality improvement works within upstream reaches of the Raff Creek catchment;
- f) the provision of "off-sets" for the loss of native vegetation and fauna habitats elsewhere within the RWA, including the southern Raff Creek anabranch;
- g) the maintenance of acceptable levels of bushfire hazard within adjacent residential areas;
- h) the minimisation of mosquito breeding habitats;
- i) the management of public access to and enjoyment of sensitive areas; and
- j) the staging of the development and associated earthworks program.

The Raff Creek Open Space Precinct RCP provides guidelines concerning the manner in which the objectives of the RCP will be achieved, including consideration of:

- a) the role of different approaches to rehabilitation of native ecosystems as specified in the *South East Queensland Ecological Restoration Framework: Guideline (2012)*, prepared by Cardno Chenoweth and Bushland Restoration Services on behalf of SEQ Catchments and South East Queensland Local Governments;
- b) the staging and monitoring of rehabilitation works;
- c) the requirement for preparation of detailed rehabilitation plans to support subsequent applications for Operational Works approvals; and
- d) the relevant qualifications required for the preparation and implementation of rehabilitation works.

Detailed restoration plans will need to be prepared for each relevant phase of the RWA development.

4 Assessment Results

4.1 Overview of the RWA Development Site

The RWA comprises approximately 175ha of the larger NEBP and is centrally located along the southern boundary of the NEBP development area and is largely bound by areas of disturbed grassland and patchy vegetation associated with the remainder of the NEBP. The southern extent of the RWA is bound by rural residential properties and the northern extent of the RWA adjoins an estuarine wetland complex associated with Raff Creek. Figure 1 illustrates the location of the RWA.

The RWA is predominantly flat, ranging in elevation from Mean Sea Level (MSL) to 14m Australian Height Datum (AHD) at the crest of a small isolated hummock situated in the central eastern sector of the Site. The Mean High Water Springs (MHWS) level for the RWA is 0.82m AHD and the Highest Astronomical Tide (HAT) is 1.36m AHD.

The majority of the RWA is highly disturbed and has been the subject of previous land clearing, farming, livestock grazing and plantation forestry activities. The site is characterised by expanses of disturbed grassland, scattered trees, paperbark (*Melaleuca quinquenervia*) communities, Eucalypt open forest and areas of marine vegetation within and adjacent to tidally influenced reaches of Raff Creek.

A key purpose of this assessment is to provide a value and condition assessment of the wetlands and threatened species habitats at a property scale resolution such that it may inform planning decisions relating to the development of the RWA, with a particular focus on the Open Space precinct.

However it must be recognised that the current condition of the wetlands and threatened species habitats within the RWA reflects the history of land management practices that have altered both the vegetation communities and hydrology of the NEBP site. When considered from a pre-disturbance perspective much of the RWA is in poor condition and consists of highly modified vegetation communities that are a product of approximately 150 years of active use for agricultural, grazing and plantation forestry purposes.

In reference to the pre-clearance mapping produced by the Department of Environment and Heritage Protection (DEHP), reproduced in Figure 2, the RWA is likely to have been dominated by Regional Ecosystem (RE) 12.3.5 and to a lesser extent RE12.5.3 prior to the commencement of broad-scale vegetation clearance works. Short descriptions of these communities have been provided below.

- > RE12.3.5 – *Melaleuca quinquenervia* open forest to woodland. Understorey depends upon duration of water logging; sedges and ferns, especially *Blechnum indicum*, in wetter microhabitats and grasses and shrubs in drier microhabitats. Ground layer species include the grasses *Leersia hexandra* and *Imperata cylindrica*, the sedges/rushes, *Baumea rubiginosa*, *Gahnia sieberiana*, *Lepironia articulata*, *Schoenus brevifolius* and *Schoenus scabripes* and the fern *Lygodium microphyllum*. Other tree species that may be present as scattered individuals or clumps include *Lophostemon suaveolens*, *Eucalyptus robusta*, *E. tereticornis*, *E. bancroftii*, *E. latisinensis*, *Corymbia intermedia*, *Melaleuca salicina*, *Livistona australis*, *Casuarina glauca*, *Endiandra sieberi*. *Melastoma malabathricum* subsp. *malabathricum*, *Glochidion sumatranum* and *Melicope elleryana* are often in understorey. Occurs on Quaternary alluvium in coastal areas.
- > RE12.5.3 – *Eucalyptus racemosa* subsp. *racemosa* woodland with *Corymbia intermedia*, *E. siderophloia* +/- *E. tindaliae*, *E. resinifera*, *E. pilularis*, *E. microcorys*, *Angophora leiocarpa*. *Melaleuca quinquenervia* is often a prominent feature of lower slopes. Minor patches (<1ha) dominated by *Corymbia citriodora* subsp. *variegata* sometimes occur. Occurs on complex of remnant Tertiary surfaces +/- Cainozoic and Mesozoic sediments.

No part of the RWA currently supports any areas of remnant vegetation, a vegetation community that is a derivative of RE12.5.3 and the RWA is largely devoid of vegetation analogous to RE12.3.5 with the exception of the southern and western patches of paperbark community.

Hydrological alterations may have also led to an increase in the area of the RWA which supports plant communities that are tolerant of (or dependent on) periodic tidal inundation. Previously the tidally influenced communities within the RWA were likely to have been restricted to a small area on the central northern

boundary. However, within Raff Creek evidence of tidal influences on vegetation composition and structure now extend up to 800m upstream of the confluence of Raff Creek and the Caboolture River. This is likely to be attributable to a combination of drainage works that may have allowed tidal inflows further upstream and the fact that over recent years there has been a measurable increase in sea levels (i.e. recorded HAT levels for Beachmere (Caboolture River) have increased by 0.02m over the 15 year period from 1998 to 2013).

4.2 Wetland Values, Impacts and Offsets

Pursuant to QWP, wetlands are “*areas of permanent or periodic/intermittent inundation, with water that is static or flowing fresh, brackish or salt, including areas of marine water the depth of which at low tide does not exceed 6 metres. To be a wetland the area must have one or more of the following attributes:*

- > *at least periodically the land supports plants or animals that are adapted to and dependent on living in wet conditions for at least part of their life cycle; or*
- > *the substratum is predominantly undrained soils that are saturated, flooded or ponded long enough to develop anaerobic conditions in the upper layers; or*
- > *the substratum is not soil and is saturated with water, or covered by water at some time.”*

Based on this broad definition and with reference to the preclearance regional ecosystem mapping for the RWA presented in Figure 2, a substantial proportion of the RWA (i.e. ~ 65%) and almost the entire Open Space Precinct would have originally supported wetland areas comprised of the following ecosystem types:

- > RE12.1.1 - *Casuarina glauca* woodland on margins of marine clay plains;
- > RE12.1.2 - Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains;
- > RE12.1.3 - Mangrove shrubland to low closed forest on marine clay plains and estuaries; and
- > RE12.3.5 - *Melaleuca quinquenervia* open forest on coastal alluvium.

The locations, extents and relative condition of different types of wetland communities identified within the RWA based on the most recent surveys and assessments are illustrated in Figure 5. It is noted that this wetland mapping is generally consistent with the wetland mapping of broader NEBP site that was undertaken by FRC Environmental on behalf of Council (refer Appendix D).

The impact of past and current land uses of the NEBP and RWA are such that these wetlands have been substantially modified and are currently in a degraded ecological condition compared to undisturbed examples of the regional ecosystems from which they are derived. This assessment is consistent with the fact that none of the existing wetland areas within the RWA are classified as:

- > wetlands of High Ecological Significance pursuant to the Map of Referable Wetlands for the Environmental Protection Act 1994 (refer Appendix B), except for some of the tidally influenced wetlands located in the lower reaches of Raff Creek;
- > as remnant vegetation pursuant to the Regulated Vegetation Management Map (refer Appendix B); and
- > MSES wetlands pursuant the State Planning Policy (SPP) Matters of State Environmental Significance Mapping (refer Appendix B).

Notwithstanding the above, the wetland areas contained within the RWA do possess some values and functions and as required by Condition 11 of the MCU approval, updated plans have been completed to illustrate:

- a. the location and extent of wetland communities across the RWA (refer Figure 5);
- b. the location and suitability of habitat for threatened species (refer Figure 6).

A summary of the extents and relative condition of different wetland types identified within the RWA is provided in Table 4-1 below.

Table 4-1 Extent of Wetland Class within the RWA belonging to each Value Class

Wetland Class	Total Area (ha)	Value Class (ha)		
		High	Mod	Low
(1) Coastal and sub-coastal floodplain grass, sedge, herb swamp	17.3	0.0	11.9	5.4
(2) Coastal and sub-coastal floodplain tree swamp	21.2	16.1	3.9	1.2
(3) Coastal and sub-coastal saline swamps	1.4	0.0	0.0	1.4
(4) Mangrove wetlands	8.9	3.7	4.3	0.9
(5) Disturbed Wet-Terrestrial Grassland Mosaic	64.6	0.0	0.0	64.6
Total Extent of Wetland Areas	113.4			
Non-Wetland Community - Disturbed Terrestrial Woodland	9.0			
Non-Wetland Community - Disturbed Terrestrial Grassland	52.6			
Total RWA Assessment Area	175.00			

Approximately 113 ha (or 65%) of the RWA support areas that satisfy the QWP definition of wetland. The dominant wetland community is the Disturbed Wet-Terrestrial Grassland Mosaic which represents ~ 57% of the total extent of the mapped wetlands within the RWA.

Wetland communities that support marine plants cover an area of ~ 10.3 ha and represent ~ 9.1% of the total extent of the mapped wetlands within the RWA.

The Value of wetland communities, which is a reflection of their disturbance histories, was variable with:

1. Disturbed Wet-Terrestrial Grassland Mosaic community generally being of Low value (100%);
2. Coastal and sub-coastal saline swamps being of Low value (100%), primarily due to the impact of livestock; and
3. the following communities generally being of Moderate - High Value:
 - > Coastal and sub-coastal floodplain grass, sedge, herb swamp (69%);
 - > Coastal sub-coastal floodplain tree swamp (94%); and
 - > Mangrove wetlands (97%).

Non-wetland communities, which all have a Low ecological condition due to the impact of past and existing land uses, occupy 61.6 ha (or 35%) of the RWA assessment area.

The RWA development will result in direct impacts to existing wetland and terrestrial communities, including the permanent loss of some areas that will ultimately be developed for urban purposes. Table 4-2 provides a summary of the existing extent of the different communities that occur within the RWA and:

- > the proportion of the total wetland impact that will occur within each wetland community; and
- > the proportion of each wetland community that will be impacted.

Table 4-2 Extent of Wetland Class Impacts

Wetland Class	Existing Extent (ha)	Extent of Impact #	Proportion of Total Impact	Proportion of Community Impacted
		(ha)	(%)	(%)
(1) Coastal and sub-coastal floodplain grass, sedge, herb swamp	17.3	17.1	21	99
(2) Coastal and sub-coastal floodplain tree swamp	21.2	3.8	5	11
(3) Coastal and sub-coastal saline swamps	1.4	1.3	2	95
(4) Mangrove wetlands	8.9	1.2	1	13
(5) Disturbed Wet-Terrestrial Grassland Mosaic	64.6	59.4	73	92
Total Extent of Wetland Areas	113.4	81.2	100	
(6) Non-wetland Community	61.6	61.2		99
Total Extent	175.0	142.4		

#: estimates of impacts presented herein do not account for any impacts that may be associated with the possible future construction of the regional roadway through the eastern sector of the RWA.

The design of the bulk earthworks program, particularly in terms of the selection of parts of the Raff Creek flood plain to be re-profiled to achieve the compensatory flood storage requirements, gave consideration to the relative quality of different wetland areas. As indicated in Table 4-2, approximately ~96% of the impact on wetlands will occur within the following communities:

- > Disturbed Wet-Terrestrial Grassland Mosaic which constitutes ~73% of all wetland disturbance with ~92% of this community being either permanently filled or re-profiled and then subsequently rehabilitated;
- > Coastal and sub-coastal floodplain grass, sedge, herb swamp communities which are a derived community that constitutes ~21% of all wetland disturbance with 99% of this community being either permanently filled or re-profiled and then subsequently rehabilitated; and
- > Coastal and sub-coastal saline swamps which constitutes ~2% of all wetland disturbance with ~95% of this community being either permanently filled or re-profiled and then subsequently rehabilitated.

All of the above communities are highly modified and generally have low wetland value and condition scores. In comparison the extent of impacts within the following wetland communities, which typically have higher values in terms of wetland condition and functional values, were considerably lower:

- > Coastal and sub-coastal floodplain tree swamp, which constitutes ~5% of all wetland disturbance with ~11% of this community being either permanently filled or re-profiled and then subsequently rehabilitated; and
- > Mangrove wetlands, which constitutes ~1% of all wetland disturbance with ~13% of this community being either permanently filled or re-profiled and then subsequently rehabilitated.

As detailed in Section 3, the areas of the Raff Creek flood plain that are re-profiled for flood storage purposes and which are not subsequently utilised for residential, parkland or stormwater quality improvement purposes will be subjected to a program of works designed to enhance and restore wetland habitats. In total:

- > ~ 31 hectares of the existing wetland habitats associated with Raff Creek are to be retained and managed primarily for environmental purposes (the Habitat Retention Zone); and
- > ~ 31 hectares of land is to be re-profiled to provide the required flood storage offsets and then subsequently rehabilitated to a natural condition and managed for environmental purposes (the Habitat Restoration Zone).

The locations and extents of the Habitat Protection Units and Habitat Restoration Units, along with an indication of the types of habitats to be protected or restored, are illustrated in Figure 7.

Table 4-3 provides a summary of:

- > the existing extent of each community within the RWA;
- > the extent of each community to be impacted by the RWA development, including areas that will be permanently lost and areas that will be re-profiled and subsequently rehabilitated;
- > the extent of each community that will be retained within the Raff Creek Open Space Precinct and not subjected to any direct impacts;
- > the total extents of the areas currently occupied by each community that will be either:
 - retained and restored to a particular wetland class by natural regeneration; or
 - re-profiled and subsequently restored to a particular wetland class, including constructed stormwater wetlands; and
- > the ultimate extent of each wetland community class that is expected to be present within the Raff Creek Open Space Precinct following the completion of the RWA development.

As demonstrated in Table 4-3 and previously in Table 4-2, the majority of the RWA development will occur within highly disturbed areas that support:

- > Terrestrial (non-wetland) ecosystems which occupy 61.2 ha (or 43%) of the area to be impacted; or
- > Disturbed Wet-Terrestrial Grassland Mosaic ecosystems which occupy 59.4 ha (or 41%) of the area to be impacted.

In contrast the majority of wetland areas of relatively high quality will be retained within the Open Space Precinct, including over 80% of the existing extent of the *Coastal and sub-coastal floodplain tree swamp* and *Mangrove wetland communities* and 87% of the *Mangrove wetlands*.

As detailed in Table 4-3, the RWA development will result in:

- > a 27.6 ha (230%) increase in the extent of Coastal and sub-coastal floodplain tree swamp within the RWA, which community is analogous to RE12.3.5 which would have originally occupied the majority of the Raff Creek flood plain prior to development of the NEBP site for agricultural, and plantation forestry and grazing; and
- > a 0.5 ha (5%) increase in the total extent of marine plant dominated communities within the RWA.



Table 4-3 Extent of Wetland Class Impacts and Restoration Offsets

Wetland Community Class	Existing Extent		Total Impact Extent		Permanent Loss Extent		Retained Extent		Re-profiled Extent		Total Retained & Re-profiled Extents		Retained & Restoration Extent for individual Wetland Community Type		Ultimate Extent		% of Original Extent		
	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	Ha	%	
(1) Coastal and sub-coastal floodplain grass, sedge, herb swamp	17.3	40	17.1	6.9	0.2	1	10.2	59	10.4	19.0	18.2 / (2)	9.4 / (2)	0.0	0	0.0	0	0.0	0	
																			2.2
(2) Coastal and sub-coastal floodplain tree swamp	21.2	11	3.8	2.2	17.4	82	1.6	7	19.0	19.0	18.2 / (2)	9.4 / (2)	48.8	230	48.8	230	48.8	230	
																			0.3
(3) Coastal and sub-coastal saline swamps	1.4	23	1.3	0.3	0.1	7	0.8	54	1.1	1.1	0.1 / (3)	0.1 / (3)	2.7	193	2.7	193	2.7	193	
																			1.1
(4) Mangrove wetlands	8.9	12	1.2	1.1	7.7	87	0.1	2	7.9	7.9	7.8 / (4)	7.8 / (4)	8.1	91	8.1	91	8.1	91	
																			1.2
(5) Disturbed Wet-Terrestrial Grassland Mosaic	64.6	56	59.4	36.1	5.2	8	23.3	36	28.5	28.5	16.0 / (2)	1.4 / (3)	2.0	3	2.0	3	2.0	3	
																			0.0
(x) Constructed Stormwater Wetland	0.0	na	0.0	0.0	0.0	na	0.0	na	0.0	0.0	na	na	12.0	na	12.0	na	12.0	na	
																			113.4
(6) Terrestrial	61.6	11	61.2	54.4	0.4	1	6.8	11	7.2	7.2	5.2 / (2)	0.6 / (3)	0.4	1	0.4	1	0.4	1	
																			175.0
Total Extent All Areas	175.0	58	144.0	101.0	31.0	18	42.8	24	74.0	74.0	na	na	74.0	65	74.0	65	74.0	65	

4.3 Marine Plant Values, Impacts and Offsets

Pursuant to sec 8 of the *Fisheries Act 1994*, a marine plant includes the following:

- a) a plant (a tidal plant) that usually grows on, or adjacent to, tidal land, whether it is living, dead, standing or fallen;
- b) material of a tidal plant, or other plant material on tidal land; and
- c) a plant, or material of a plant, prescribed under a regulation or management plan to be a marine plant.

The definition of a marine plant does not include a plant that is a declared pest under the *Land Protection (Pest and Stock Route Management) Act 2002*.

As noted in Section 5.4 of the DPI&F Fish Habitat Management Operational Policy FHMOP 001 (2007):

“The definition of marine plants is broad, and includes macro and micro marine plants as well as the material of tidal or other plants on tidal land. Marine plants include mangroves, seagrass, samphires, saltcouch and saltmarsh plants, algae and other tidal plants growing adjacent to the tidal zone, landward and seaward (see Appendix 1).

Material of a tidal plant relates to all parts of mangroves or other marine plants, such as bark, leaves, stems, roots, flowers or seeds.

Dead marine wood, including flotsam, falls within the marine plant definition as it provides material to the food chain as it breaks down, shoreline protection from wave action and habitat for marine animals, such as shipworms and gastropods.”

Section 10.1 of the FHMOP 001 (2007) provides the following further advice regarding the interpretation of the Fisheries Act definition of a Marine Plant.

The question of what constitutes ‘adjacent’ has become a key issue in investigating whether certain plants are captured in the definition of marine plants and to what extent their loss might affect fisheries production. The Fisheries Act does not define ‘adjacent’ as it relates to marine plants. In the absence of a definition, this policy describes the application of ‘adjacent’ in terms of when a marine plant development permit application would be required for disturbance of plants in or adjacent to the tidal zone.

High fisheries significance plants are plants that usually grow on or adjacent to tidal land (that have a capacity for connectivity, for example, via seasonal flows during the wet season) and are known to contribute to fisheries productivity. Plants that usually grow on tidal lands include all true mangroves, seagrasses, marine algae, saltcouch and samphires. These types of plants would normally occur where there is some tidal influence. These are protected marine plants regardless of their location and whether or not they are on tidal lands.

*Plants that usually grow adjacent to tidal lands include *Melaleuca* and *Casuarina* species. These plants are of value to fisheries productivity. In particular, where *Melaleuca* swamps adjacent to tidal areas are either permanently or periodically tidally connected and where *Casuarina* stands on the landward edge of tidal flats have saltcouch or samphire communities growing underneath them.*

A fisheries development approval application is required for any disturbance of high fisheries significance plants.

Low fisheries significance plants: for practical purposes, the term marine plant does not include other plants that grow geographically adjacent to tidal land and which are not considered or not known (on current knowledge) to contribute to fisheries productivity. Low fisheries significance plants generally include non-tidal, terrestrial plants, whole or part, such as river gums, terrestrial grasses and palm trees.

A fisheries development approval application is not required for any disturbance of low fisheries significance plants.

*Note that each tidal vegetation community varies in species composition. In certain circumstances, a particular species may dominate (e.g. *Hibiscus*) and may therefore play a greater role in fisheries production. This may lead to that species being considered as a plant of higher fisheries significance.*

Marine plants, such as saltcouch, that grow above HAT and are isolated from tidal inundation do fall within the 'marine plant' definition. They need to form part of a fisheries development approval, despite having a low fisheries significance.

Consistent with the above definitions and guidance the location and extent of marine plants within the RWA corresponds to the locations and extents of the following wetland community classes:

- > Mangrove wetlands; and
- > Coastal and sub-coastal saline swamps.

As detailed previously, the RWA development will result in some direct loss of marine plants as a consequence of:

- > the bulk earthworks program; and
- > the construction of a road crossing of Raff Creek.

As detailed in section 4.2, approximately ~2.5 ha (or ~25%) of the existing extent of marine plant dominated communities will be directly affected by the RWA development.

As detailed in the Raff Creek Open Space RCP presented in Appendix E, approximately 3.4 hectares of the re-profiled Raff Creek flood plain is currently designed to be re-profiled with finished surface levels that would support marine plant dominated communities. This will result in a net increase in the extent of marine plant dominated communities of approximately 0.5 ha or 5%.

It is noted that as part of the detailed design phase of each relevant phase of development it would be possible to adjust the finished surface levels of some areas located adjacent to the tidally influenced reaches of Raff Creek to promote the establishment of additional areas of saltmarsh or mangroves if it was determined that this was a desirable outcome.

From a fisheries perspective it is also noted that the eventual construction of a road linkage between the RWA development and the NEBP Mixed Industry Business Area (MIBA) to the north of Raff Creek, will allow an existing low-level culvert crossing of Raff Creek to be replaced. The new crossing would be designed to a much higher standard and would result in an improved capacity for fish movement within Raff Creek once the constricting effect of the existing culverts was removed.

4.4 Threatened Species Habitat Values, Impacts and Offsets

As detailed previously in the NEBP EIS, the NEBP and RWA provides confirmed and potential habitat resources for a threatened flora and fauna species notwithstanding the impact that historic and current uses of the NEBP site have had, and continue to have, on the quality of habitat for those species.

The locations and extents of the different Threatened Species Habitat Value classes described in Section 2.4.3 are illustrated in Figure 6 and summarised in Table 4-4. Figure 6 also shows the locations where threatened species have actually been recorded within, or adjacent to, the RWA.

Table 4-4 Threatened Species Habitat Value classes

Habitat Value Class	Extent (Ha)	Extent (%)
Very High	0.0	0.0
High	25.8	14.7
Moderate	18.9	10.8
Low	130.3	74.3

Based on the above, the majority of the RWA has Low habitat values for threatened flora and fauna species and no part of the RWA is classified as having Very High habitat value for threatened species. The balance 44.7 ha (or 25.5%) of the RWA is classified as having Moderate to High habitat values for one or more threatened species.

The RWA development will have an impact on areas classified as having, on a qualitative and relative scale, Moderate to High habitat value for one or more threatened species. The extent of impacts upon different threatened species habitat value classes is summarised in Table 4-5.

Table 4-5 Extent of Impact to different Threatened Species Habitat Value classes

Habitat Value Class	Mapped Extent (Ha)	Impacted Extent # (Ha)	Retained Extent (Ha)	Proportion Retained (%)
Very High	0.0	0.0	0.0	-
High	25.8	3.4	22.4	87
Moderate	18.9	15.6	3.3	17
Low	130.3	125.0	5.3	4
Total	175.0	144.0	31.0	17

#: estimates of impacts presented herein do not account for any impacts that may be associated with the possible future construction of the regional roadway through the eastern sector of the RWA.

Consistent with the design intent to preferentially locate required flood storage offset areas within areas of relatively Low ecological value, approximately 87% of the extent of areas classified as being of relatively High threatened species habitat value will be protected from direct physical disturbance.

In addition to the retention of ~ 31 ha of existing habitat, including 8.6 ha of Low to Moderate habitat value that will be enhanced, approximately 31 ha of land within the Raff Creek floodplain will be the subject of a program of restoration works that will be designed to create habitat for native wildlife including threatened species.

Overtime the combined effect of the protection, enhancement and restoration of habitat within the Open Space Precinct will be to increase the extent of High quality habitat from 25.8 ha to approximately 60 ha, an overall increase of approximately 230%.

Further details concerning the confirmed (or likely) presence of specific threatened flora or fauna species, their habitat within the RWA and the likely significance of the RWA development impacts on each species are provided in Table 4-6 (flora) and Table 4-7 (fauna).

Table 4-6 Threatened flora which may be supported by habitat within the RWA

Flora	Presence, Habitat and Impact Assessment
<i>Acacia attenuata</i>	<p>Unlikely</p> <p><i>Acacia attenuata</i> has not been recorded within the RWA or adjacent sectors of the NEBP site. The RWA development is unlikely to have a significant adverse impact on this species. Consideration could be given to the use of this species as part of the Raff Creek restoration works program.</p>
Hairy Joint Grass (<i>Arthraxon hispidus</i>)	<p>Unlikely</p> <p>Hairy Joint Grass has not been recorded within the RWA or adjacent sectors of the NEBP site. The RWA development is unlikely to have a significant adverse impact on this species. Consideration could be given to the use of this species as part of the Raff Creek restoration works program.</p>
Leafless Tongue Orchid (<i>Cryptostylis hunteriana</i>)	<p>Unlikely</p> <p>Leafless Tongue Orchid has not been recorded within the RWA or adjacent sectors of the NEBP site. The RWA development is unlikely to have a significant adverse impact on this species. Consideration could be given to the use of this species as part of the Raff Creek restoration works program.</p>
Lesser Swamp Orchid (<i>Phaius australis</i>)	<p>Unlikely</p> <p>Lesser Swamp Orchid has not been recorded within the RWA or adjacent sectors of the NEBP site. The RWA development is unlikely to have a significant adverse impact on this species. Consideration could be given to the use of this species as part of the Raff Creek restoration works program, however it is noted that this species is particularly prone to illegal collection.</p>

Table 4-7 Threatened fauna which may be supported by habitat within the RWA

Fauna	Presence, Habitat and Impact Assessment
<i>Koala (Phascolarctos cinereus)</i>	<p>Confirmed.</p> <p>Koalas occur within the RWA and make use of the remnant eucalypts that occur throughout the RWA. That part of the RWA that is of greatest habitat value to Koala is the Raff Creek corridor which provides suitable forage and shelter species (e.g. <i>E. tereticornis</i>) and a relatively intact band of vegetation through which Koala can move to access resources located to the south and north of the RWA.</p> <p>Both the overall quality and quantity of Koala habitat within the RWA are limited, which is reflected by the Koala State Planning Policy (2/10): Koala Conservation in South East Queensland - SEQ Koala Protection Area Koala Habitat Values mapping.</p> <p>The RWA development will result in the loss of some existing habitat resources for Koala but will preserve core habitat and a movement corridor centred on Raff Creek. The program of restoration works proposed within the re-profiled sections of the Raff Creek Open Space Precinct will be designed to create additional habitat for Koala.</p>

Fauna	Presence, Habitat and Impact Assessment
<p>Water Mouse (<i>Xeromys myoides</i>)</p>	<p>Unlikely</p> <p>A search of the following sources indicates that there are no records within the published literature or held by relevant State agencies of the occurrence of the Water Mouse occurring within the Caboolture River system</p> <ul style="list-style-type: none"> ▪ Atlas of Living Australia; ▪ Wildnet GIS; ▪ Google scholar for recent publication on discovery; ▪ SPRAT profile including the recovery plan; ▪ general news/local newspaper/etc archive; ▪ community groups website that were involved with the discovery of the Maroochy river ones (Wetland care, etc...); ▪ the QLD Museum (Heather Janetzki/Steve Van Dyke); and ▪ the Department of Environment and Heritage Protection (Dr Ian Gynther) <p>A targeted survey for the Water Mouse carried out by Yurrah Pty Ltd in 2004, using Elliott Type A traps set along the Caboolture River banks and baited with pilchards, did not capture any Water Mouse and nor did Yurrah detect any of the distinctive nests or feeding signs for this species.</p> <p>Potential habitat for this species within the RWA is limited to the relative small areas Mangrove and Coastal and sub-coastal saline swamps wetlands situated associated with tidally influenced sectors of Raff Creek. The extent of areas of potential habitat within the RWA is limited as is the quality of that habitat due to the impact of livestock and feral pigs. If this species is present within the Caboolture River system it is most likely to occur in the more expansive mangrove-saltmarsh complexes located downstream.</p> <p>The RWA development is not likely to have any substantive impacts on this species.</p>
<p>Wallum Froglet (<i>Crinia tinnula</i>)</p>	<p>Confirmed</p> <p>The Wallum Froglet is endemic to the NEBP site and the adjacent sectors of the Caboolture River floodplain and their presence within the NEBP site was noted in the NEBP EIS. This species was recorded throughout the RWA and adjacent sections of the NEBP site during site surveys (refer Figure 6) and areas of Essential Habitat for this species are mapped on the RV Map (refer Appendix B) as occurring on land adjacent to the RWA.</p> <p>The wide distribution and abundance of Wallum froglet throughout the RWA's disturbed wetland mosaic is consistent with the established ecology of this species which is tolerant of, and in many instances favoured by, habitat disturbance. The past and current patterns of disturbance involving vegetation clearance, landform modification and alterations to drainage patterns have clearly not eliminated this species from the site and are in fact likely to have created conditions within which this species has flourished.</p> <p>The RWA development will result in:</p> <ul style="list-style-type: none"> ▪ the mortality of Wallum Froglet during the conduct of bulk earthworks; ▪ a reduction in the extent of existing Wallum Froglet habitat within the boundaries of the RWA; and ▪ the preservation of approximately 17 ha of core Wallum Froglet habitat (i.e. Coastal and sub-coastal floodplain tree swamp) of sufficient extent and quality to ensure the persistence of this species within the RWA; and ▪ the restoration of approximately 31 ha of Wallum Froglet habitat within the Open Space Precinct. <p>Whilst the total extent of existing Wallum Froglet habitat will be reduced as a consequence of the RWA development, the successful implementation of the proposed habitat restoration works would result in a net improvement in the quality of habitat.</p>

Fauna	Presence, Habitat and Impact Assessment
<p>Tusked Frog (<i>Adelotus brevis</i>)</p>	<p>Confirmed (Yarruh 2004)</p> <p>The Tusked Frog is found through a broad range of habitats covering open grasslands, large swamps, low woodlands, dry and wet sclerophyl forests and rainforest and appear none too concerned about whether the site is natural or artificial or whether it is pristine or highly disturbed. They rarely occur more than 400m above sea level and will breed in quite a broad range of sites for an Australian frog, being found wherever there is relatively still water. They have been observed calling (rarely) in temporary pools on the sides of roads, in larger flooded depressions, in permanent fire dams and ponds and on the banks of small to quite large streams. In the faster flowing streams the tadpoles probably stick to specific microhabitats to avoid being washed around too much.</p> <p>The Tusked Frog was recorded within the broader NEBP site by Yurrah Pty Ltd in 2004 but the species has not been recorded during more recent surveys.</p> <p>The majority of freshwater habitats present within the RWA provide potential habitat for the Tusked Frog.</p> <p>The RWA development will result in a reduction in the total extent of potential habitat for this species, however habitat protection and restoration works within the Open Space Precinct will preserve the potential for this species to occur within the RWA and may effect an overall increase in the quality of available habitat.</p>
<p>Wallum Rocketfrog (<i>Litoria freyciniti</i>)</p>	<p>Potential</p> <p>The Wallum Rocketfrog has not been recorded within the RWA or broader NEBP.</p> <p>The preferred habitat for this species (coastal wet heath, sedge swamps and drainage lines) in areas of sandy soils is present within the RWA but has been subjected to substantial disturbance. Mapped areas of essential habitat for this species occur to the north of the NEBP site.</p> <p>The RWA development will result in a reduction in the total extent of potential habitat for this species, however habitat protection and restoration works within the Open Space Precinct will preserve the potential for this species to occur within the RWA and may effect an overall increase in the quality of available habitat.</p>
<p>Green-thighed Frog (<i>Litoria brevipalmata</i>)</p>	<p>Unlikely</p> <p>The Green-thighed Frog has not been recorded within the RWA or broader NEBP and areas of suitable habitat for this species within the RWA are limited.</p> <p>The RWA development is not likely to have a significant impact on this species.</p>
<p>Cotton Pygmy Goose (<i>Nettaus coromandelianus</i>)</p>	<p>Potential</p> <p>The sections of Raff Creek that traverse the RWA and which support standing water vegetated with waterlilies and other floating and submerged aquatic vegetation provide potential habitat for the Cotton Pygmy Goose. The Cotton Pygmy Goose also uses standing dead trees with hollows close to water for roosting and breeding, but this resources is limited within the RWA due to the impact of past land clearance activities.</p> <p>Most areas of suitable habitat for this species will be retained within the RWA Open Space Precinct and the RWA development is not likely to have a significant impact on this species.</p>
<p>Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>)</p>	<p>Confirmed</p> <p>The Black-necked Stork has been observed within the NEBP site and is likely to exploit habitat resources available within the RWA. This species inhabits wetlands, such as floodplains of rivers with large shallow swamps and pools, and deeper permanent bodies of water. Occasionally individuals will stray into open grass, woodland areas or flooded paddocks in search of food.</p> <p>Whilst the RWA development will result in a net loss of suitable foraging habitat for the Black-necked Stork that loss is not likely to have a significant impact on this species due to its high levels of mobility, non-resident use of the RWA and the extent of suitable habitat that would remain within the Caboolture River flood plain. The habitat restoration works that are proposed within the Open Space Precinct will generally not create suitable habitat for not Black-necked Stork.</p>
<p>Eastern Curlew (<i>Numenius madagascariensis</i>)</p>	<p>Not Likely</p> <p>The RWA does not contain any extensive areas of suitable habitat for this migratory species, which forages within the intertidal sand/mud flats associated with the Caboolture River and broader Moreton Bay complex.</p> <p>The RWA development is not likely to have any direct impacts on this species.</p>

Fauna	Presence, Habitat and Impact Assessment
Beach Stone-curlew (<i>Esacus neglectus</i>)	<p>Not Likely</p> <p>The RWA does not contain any extensive areas of suitable habitat for this resident shorebird, which may forage within downstream estuarine sections of the Caboolture River and broader Moreton Bay complex.</p> <p>The RWA development is not likely to have any direct impacts on this species.</p>
Lewin's Rails (<i>Rallus pectoralis</i>)	<p>Potential</p> <p>The Lewin's Rail has not been recorded during site surveys and past and current land management practices within the RWA have substantially reduced the extent of dense vegetation that is preferred by this cryptic species. Nevertheless some areas of potentially suitable habitat are still present along the Raff Creek corridor.</p> <p>The RWA development is not likely to have a significant adverse impact on this species. The removal of livestock and program of habitat restoration works that are proposed within re-profiled sections of the Open Space Precinct would improve the quality of habitat for this species.</p>
Australian Painted Snipe (<i>Rostratula australis</i>)	<p>Potential</p> <p>The Australian Painted Snipe has not been recorded during site surveys and past and current land management practices within the RWA.</p> <p>Past clearance of forested wetlands has potentially increased the extent of suitable habitat for this species, however the frequent grazing and slashing of wet grassland areas within the RWA also limits their suitability as potential habitat for the Australian Painted Snipe.</p> <p>The RWA development is not likely to have a significant adverse impact on this species. The removal of livestock and program of habitat restoration works that are proposed within re-profiled sections of the Open Space Precinct may effect some improvement in the quality of habitat for this species.</p>

4.5 Borrow Area

As detailed in Section 3 and Appendix C, the RWA development will involve the establishment of a compensatory cut within a 9.4 ha Borrow Area located on the land opposite the eastern extents of the RWA development. The Borrow Area will be lowered to as low as 0.0m AHD, however flood storage volumes only account for volumes above the MHWS level of 0.82m AHD.

The purpose of establishing this Borrow Area is to provide required flood storage offsets without any further disturbance to the ecological values of Raff Creek.

The location for the Borrow Area was informed by the findings of a field based survey, carried out on the 7th of March 2014, which determined that the subject area:

- > was not a wetland area; and
- > did not support Wallum Froglet or Koala habitat.

5 Development Compliance Assessment

Assessments of the degrees of compliance that the RWA development achieves with the following regulatory requirements are provided in Section 5.1 to 5.3.

- > Council and State Agency Conditions of approval contained within Queensland Planning and Environment Court Appeal (Ref: 254 of 2010) judgement, dated 28 June 2013, approving a Material Change of Use (MCU) development for the RWA development.
- > Part E: Interim development assessment requirements of the single State Planning Policy (SPP) concerned with Biodiversity; and
- > State Development Assessment Provisions (SDAP) Module 5 – Fisheries resources and SDAP Module 10 – Coastal protection (in part).

5.1 MCU Condition Compliance

An assessment of the degree of compliance that the RWA plan of development achieves with Condition 11 (a)-(f) of the MCU Approval that was imposed by Council and is concerned with ecological and biodiversity issues is provided in Table 5-1.

Table 5-1 Compliance Assessment – Council Condition 11 (a) – (f)

Condition of Approval	Compliance Statement
<p>MBRC Condition 11 (a) – Submit a revised plan identifying the distribution of wetlands on the site by a suitably qualified expert in accordance with the Queensland wetland program definitions which also includes disturbed wetlands.</p>	<p>Compliance achieved. Figure 5 presents a map of the RWA showing the distribution of wetland areas identified in general accordance with the Queensland wetland program definitions as detailed in Section 2. The identification and mapping was completed by appropriately qualified ecologists with expertise and experience in wetland identification and mapping (refer Appendix A).</p>
<p>MBRC Condition 11 (b) – Submit a revised plan determined by a suitably qualified expert and in accordance with the definitions under the Fisheries Act 1994 and Fish Habitat Management Operational Policies, identifying the distribution of marine plants on the site.</p>	<p>Compliance achieved. The nature and extent of Marine Plants, as defined by the Fisheries Act 1994, is presented in Figure 5 and discussed in Section 4.3.</p>
<p>MBRC Condition 11 (c) – Submit a revised plan which identifies the distribution of habitats for terrestrial fauna of conservation significance in accordance with the fauna preliminary joint expert report dated 1 May 2013.</p>	<p>Compliance achieved. The location and extents of areas of habitat value to terrestrial fauna species of conservation significance are illustrated in Figure 6 and discussed in Section 4.4. This information has been collated and presented in a format that is consistent with the fauna preliminary joint expert report dated 1 May 2013.</p>

Condition of Approval	Compliance Statement
<p>MBRC Condition 11 (d) – Stormwater management of the site is to ensure that there are no impacts unacceptable to the Council to wetland ecology, flora and fauna.</p>	<p>Compliance achieved. The North East Business Park Residential West Stormwater Management Plan and Flooding Assessment (Ref: 7903/59/R2V1A) details the manner in which urban stormwater run-off from the RWA development will be managed to achieve relevant water quality objectives and thereby minimise the potential for adverse ecological impacts to the receiving environment. The report concludes that “ <i>that the proposed development incorporating suitable mitigation measures and constructed wetlands, does not result in adverse flood impacts external to the site and that appropriate management of both the quality and quantity of stormwater discharging from the site complies with the intent of the approval conditions and State Planning Policy criteria. The development design has used standard engineering procedures and incorporates current Best Management Practices and Water Sensitive Urban Design principles.</i>”</p>
<p>MBRC Condition 11 (e) - With reference to (a) – (c) above, design and management of the development is to ensure:</p>	
<p>1) marine plants (as defined by the Fisheries Act 1994 and Fish Habitat Management Operational Policies) are not disturbed in any manner unacceptable to the Council</p>	<p>Compliance assessment. As detailed in Section 4.3, the RWA development will involve approximately 2.5 ha of disturbance to marine plant dominated communities. As such an application for approval for marine plant disturbance will need to be submitted to the State Assessment and Referral Agency (SARA). As detailed in Section 4.3 and the Raff Creek Open Space RCP presented in Appendix E, at least 3.4ha of marine plant dominated vegetation will be re-established within re-profiled sections of the Raff Creek, resulting in a net increase in the extent of marine plants. If it is determined that additional areas of marine plant dominated vegetation needs to be established to offset the proposed clearance of 2.5 ha, then adjustments to the design of the re-profiling works can be made to create additional areas suitable for the establishment of marine plants. . The cessation of livestock grazing within the RWA will also result in an improvement in the general condition of marine plant communities that are retained or restored.</p>
<p>2) habitat for terrestrial fauna of conservation significance is not affected in any manner unacceptable to the Council</p>	<p>Compliance assessment. The RWA development will have direct impacts to terrestrial fauna of conservation significance and this fact was known at the time that the MCU Approval was issued. As detailed in Section 4.4, the extent of impact to those areas of the RWA that are considered to have the greatest habitat value for threatened fauna species has been minimised to the extent possible whilst maximising the extent of land available for residential purposes generally in accordance with the approved Structure Plan and meeting flood storage offset, public open space and stormwater quantity and quality management requirements. As detailed in Section 4.2 and the Raff Creek Open Space RCP presented in Appendix E, approximately 31 ha of land will be re-profiled and subsequently rehabilitated to provide habitat for native wildlife, including threatened fauna that would be impacted by the RWA development. The RWA plan of development makes provision for the majority (~87%) of the identified High Value habitat areas to be retained within the Raff Creek Open Space corridor. The retention of these areas in combination with the presence of habitat for threatened fauna within adjacent land should enable local populations of threatened fauna to persist within the RWA and broader NEBP site.</p>

Condition of Approval	Compliance Statement
3) disturbance to waterways is minimised	<p>Compliance assessment.</p> <p>Disturbance to Raff Creek has been minimised to the extent possible whilst maximising the extent of land available for residential purposes generally in accordance with the approved Structure Plan and meeting flood storage offset, public open space and stormwater quantity and quality management requirements.</p>
4) the natural hydrological regime of the remaining wetlands and particularly the significant wetlands, are maintained to a level acceptable to the Council.	<p>Compliance assessment.</p> <p>As detailed in Section 4.2, no significant wetlands have been identified within or adjacent to the RWA.</p> <p>Some disturbance to and modification of the hydrological regime of wetlands located within the RWA will occur as a result of the RWA development. In this respect it is relevant to note that:</p> <ul style="list-style-type: none"> ▪ the existing hydrological regime of the majority of these wetland areas is not “natural”, having been modified to an extent by past and current land use practices; and ▪ any development of the RWA in accordance with the approved Structure Plan will cause further alterations to the hydrological regime of retained wetland areas. <p>As detailed in the North East Business Park Residential West Stormwater Management Plan and Flooding Assessment, based on the results of hydrologic modelling and conceptual water quality modelling, the proposed development does not result in adverse flood impacts external to the site and both the quality and quantity of stormwater discharging from the site complies with the intent of the approval conditions and State Planning Policy criteria.</p>
5) preservation and where appropriate, rehabilitation of all wetlands within the site.	<p>Compliance assessment.</p> <p>As detailed in Section 4, the development of the RWA generally in accordance with the approved Structure Plan cannot be achieved whilst preserving all wetland areas within the RWA site and there will be a net reduction in the extent of wetland habitats as a direct result of the RWA development.</p> <p>Notwithstanding the above it is noted that:</p> <ul style="list-style-type: none"> ▪ no wetlands of High Ecological Significance, as defined in relevant State based wetland mapping systems, occur within the RWA; ▪ all of the wetland areas on the site have been subjected to disturbance and modification as a result of past and existing lawful land uses; ▪ the majority of the wetland areas within the RWA are highly modified and possess low conservation values; ▪ the RWA development would retain approximately 87% of the existing extent of wetland areas considered to have relatively high conservation values; and ▪ substantial areas of land would be rehabilitated to restore wetland ecosystems similar to those that would have occurred within the RWA prior to the commencement of broad scale vegetation clearance and subsequent use of the land for agricultural, forestry and grazing purposes.

Condition of Approval	Compliance Statement
<p>6) preservation and where appropriate, rehabilitation of the ecological corridors on the site.</p>	<p>Compliance assessment.</p> <p>The RWA development makes provision for an ecological corridor that is centred on Raff Creek and which extends around the eastern, northern and western boundaries of the RWA. As detailed in Section 3 and in the Raff Creek Open Space RCP presented in Appendix E, substantial habitat restoration and enhancement works will be undertaken within the Raff Creek ecological corridors.</p> <p>The RWA development will eventually involve the establishment of a road crossing of Raff Creek and as such an application for approval for Waterway Barrier Works will be submitted to SARA as part of the process of obtaining requisite approvals for the particular phase of development that requires the establishment of the crossing. At the road crossing, appropriate provision will need to be made for:</p> <ul style="list-style-type: none"> ▪ the passage of fish along Raff Creek; and ▪ the passage of other native terrestrial fauna, including koala, that may move along this corridor.
<p>MBRC Condition 11 (f) – Constructed flood storage excavation areas are to be planted (where appropriate) with native wetland species of appropriate densities, without impacting on the flood levels.</p>	<p>Compliance assessment.</p> <p>Details concerning the general manner in which those section of the RWA that are to be re-profiled to achieve flood storage requirements will be rehabilitated are provided in the Raff Creek Open Space RCP presented in Appendix E.</p> <p>The restoration of self-sustaining natural ecosystems within the Raff Creek Open Space corridor may impact on the flood flow conveyance characteristics of Raff Creek with the potential for changes in flood levels experienced in upstream properties. In this respect it is noted in sec 3.2.2.2 of the North East Business Park Residential West Stormwater Management Plan and Flooding Assessment that in terms of assessing the impact of the RWA development on local flood levels:</p> <ul style="list-style-type: none"> ▪ <i>Roughness coefficients were essentially unchanged from the pre-development scenario, with areas affected by the proposed bulk earthworks within the flood inundation extents assumed to be revegetated to a similar density to that which currently exists.</i> ▪ <i>The only change to the model was within the areas proposed for the constructed wetlands where a Manning's "n" roughness coefficient of 0.06 was adopted.</i> ▪ <i>Should Council enforce increased revegetation densities that result in higher roughness coefficients than those adopted, the impacts are considered to not be applicable as part the development impact assessment.</i>

An assessment of the degree of compliance that the RWA plan of development achieves with State Agency Conditions 6, 7 and 10 that are concerned with ecological and biodiversity issues is provided in Table 5-2.

Table 5-2 Compliance Assessment – State Agency Conditions

Condition of Approval	Compliance Statement
<p>State Agency Condition 6 – Clearing Remnant Vegetation</p>	
<p>(1) Prior to the clearing of any regional ecosystems on the project site, a development permit for operational works that is the clearing of native vegetation must be obtained.</p>	<p>Compliance achieved</p> <p>The RWA development does not involve any clearance of regulated vegetation (i.e remnant regional ecosystems) and as such an application of a permit for clearing native vegetation is not required.</p>

Condition of Approval	Compliance Statement
(2) An offset that is in accordance with the applicable codes and policies for assessment of the development application for operational works for the clearing of native vegetation must be provided for any and all areas of regional ecosystem that are cleared as part of the project. All offsets are to accord with the Queensland Environmental Offsets Policy 2008.	<p>Compliance achieved</p> <p>The RWA development does not involve any clearance of regulated vegetation (i.e remnant regional ecosystems) and as such no offsets are required.</p>
(3) Any vegetation clearing is to accord with procedures of Policy 6: vegetation clearing practices of the Nature Conservation (Koala) Conservation Plan 2006 and Management Program 2006-2016. Clearing of koala habitat trees must be performed sequentially and in the presence of a qualified koala spotter.	<p>Compliance assessment</p> <p>A Construction Environmental Management Plan (CEMP) will be prepared and submitted in support of an application for Operational Works approval (as required by Condition 9). The CEMP will contain appropriate provisions relating to the appropriate conduct of vegetation clearance operations.</p>
(4) The clearing of koala habitat trees must not occur unless an appropriate equivalent habitat area is available on site or in a nearby location to enable the relocation of individual animals.	<p>Compliance assessment</p> <p>A Construction Environmental Management Plan (CEMP) will be prepared and submitted in support of an application for Operational Works approval (as required by Condition 9). The CEMP will contain appropriate provisions relating to the appropriate conduct of vegetation clearance operations.</p>

State Agency Condition 7 – Wildlife Habitat

a) Wildlife habitat and movement corridors must be incorporated in the design, construction and operation of the project. This must include:	
i. the design and management of the open space and stormwater treatment areas to retain and enhance vegetated areas and maximise fauna movement corridors, to the greatest extent practical around the Raff Creek riparian corridor	<p>Compliance assessment</p> <p>The RWA development makes provision for an open space corridor centred on Raff Creek that:</p> <ul style="list-style-type: none"> ▪ retains the majority of High Value habitat located within the RWA; ▪ provides opportunities for the enhancement and restoration of natural ecosystems; ▪ provides opportunities for the movement of fauna movement.
ii. adequate vegetated buffers to protect sensitive environment as from run-off, nutrient leaching and chemical pollutants – a distance of at least 60m is recommended	<p>Compliance assessment</p> <p>The RWA development makes provision for buffers and other stormwater quality management measures that are designed to protect sensitive areas from adverse impacts associated with the discharge of inadequately treated urban stormwater run-off (refer: North East Business Park Residential West Stormwater Management Plan and Flooding Assessment (Ref: 7903/59/R2V1A).</p>

Condition of Approval	Compliance Statement
<p>iii. an environmental management plan for the Wallum Froglet (<i>Crinia tinula</i>) and Tusked Frog (<i>Adelotus brevis</i>) that are recorded in the Raff Creek area associated with wetland vegetation regional ecosystem RE12.3.5. These species are particularly susceptible to changes in nutrient levels and measures should be included to avoid potential impacts associated with construction and operation of the development.</p>	<p>Compliance assessment</p> <p>A specific management plan for the Wallum Froglet (<i>Crinia tinula</i>) and Tusked Frog (<i>Adelotus brevis</i>) has not been prepared.</p> <p>The Raff Creek Open Space RCP presented in Appendix E details the nature of measures that are proposed to be implemented to preserve and restore areas of suitable habitat for these two species, and other native wildlife, within the Raff Creek Open Space corridor.</p> <p>The North East Business Park Residential West Stormwater Management Plan and Flooding Assessment (Ref: 7903/59/R2V1A) provides details concerning the nature of the proposed stormwater quality measures that are to be implemented. These measures are designed to achieve the following minimum reductions in total pollutant load, compared with that in untreated stormwater runoff, from the developed part of the site:</p> <ul style="list-style-type: none"> ▪ 80% reduction in total suspended solids ▪ 60% reduction in total phosphorus ▪ 45% reduction in total nitrogen ▪ 90% reduction in gross pollutants <p>It is also noted that the majority of wetland habitats that will be retained/restored will not receive treated (or untreated) run-off from the RWA urban areas and as such should not experience any changes in nutrient levels as a result of run-off from urban development within the RWA.</p>
<p>iv. Koala sensitive design measures including:</p> <ul style="list-style-type: none"> ▪ the use of koala friendly fencing within areas of open space ▪ Koala exclusion fencing where appropriate particularly along the western boundary of the site adjacent to the Bruce Highway ▪ landscaping with native vegetation, including locally occurring koala habitat trees ▪ retention and rehabilitation of koala habitat in the biodiversity corridor, Raff Creek riparian corridor, road verges, district, local and pocket parks and residential lots ▪ road design, alignment and construction aims to, where appropriate, reduce speed, increase visibility and provide safe road crossings ▪ installation of fauna friendly over or underpasses to ensure connectivity, particularly where Raff Creek riparian corridor is bisected by Nolan Drive ▪ a maintenance and monitoring program. 	<p>Compliance assessment</p> <p>The RWA development does, or will be subject to completion of relevant detailed design, make provision for the following koala sensitive design measures:</p> <ul style="list-style-type: none"> ▪ the use of koala friendly fencing within areas of open space at appropriate locations; ▪ koala exclusion fencing where appropriate particularly along any major roadway crossings of the Raff Creek corridor (e.g. future connection between the RWA and the MIBA precincts of the NEBP); ▪ landscaping with native vegetation, including locally occurring koala habitat trees, in a manner that recognised that it is not always desirable to establish koala habitat trees, particularly large Eucalypts, within residential areas or adjacent to roadways; ▪ retention and rehabilitation of koala habitat in the Raff Creek riparian corridor; ▪ a road design that minimises impediments to the movement of fauna along the Raff Creek riparian corridor; ▪ installation of a fauna friendly underpass as part of any future road connections that cross the Raff Creek corridor.
<p>b) Measures must be included in a Community Management Statement for the regulation of domestic animals in residential precincts to avoid the disturbance of native fauna in open space areas.</p>	<p>Compliance assessment</p> <p>The RWA development is not based on a body corporate model and as such no Community Management Statement will be prepared.</p>
<p>c) All site rehabilitation work is to be undertaken and/or managed by appropriately qualified personnel.</p>	<p>Compliance assessment</p> <p>All site rehabilitation work is to be undertaken and/or managed by appropriately qualified personnel.</p>

Condition of Approval	Compliance Statement
State Agency Condition 10 – Fish Habitat	
a) An application for the material change of use or reconfiguration of a lot for any portion of the project site that includes fish habitats must also apply for the associated operational works for the removal, damage or destruction of marine plants and/or construction of a waterway barrier.	<p>Compliance assessment</p> <p>Relevant applications for approval for disturbance to marine plants and waterway barrier works will be submitted to the State Assessment and Referral Agency (SARA) at the appropriate time.</p>
b) Any residual impacts of the development that may indirectly or directly affect downstream fish habitats must be appropriately mitigated and offset as determined by the Coordinator General and generally in accordance with the Queensland Government Environmental Offsets Policy.	<p>Compliance assessment</p> <p>As detailed in Section 4.3 and in the Raff Creek Open Space RCP presented in Appendix E, the capacity exists to provide offsets for the proposed loss of marine plants and fisheries habitat resources.</p> <p>Further consideration of impact mitigation and offset measures would be provided in support of relevant applications for approval for disturbance to marine plants and waterway barrier works that will be submitted to the State Assessment and Referral Agency (SARA) at the appropriate time.</p>

5.2 SPP Compliance

Assessments of the degrees of compliance that the RWA development achieves with those sections of Part E: Interim development assessment requirements of the SPP are provided in Table 5-3.

Table 5-3 Compliance Assessment – SPP

SPP Requirements	Compliance Statement
State interest—biodiversity	
The development application is to be assessed against the following requirements:	
(1) identifies any potential significant adverse environmental impacts on matters of state environmental significance, and	<p>Compliance assessment</p> <p>The only matters of state environmental significance (MSES) that are present within the RWA and that will be impacted by the RWA development are threatened wildlife under the <i>Nature Conservation Act 1992</i>.</p> <p>As detailed in Section 4.4, the following species that are MSES are either known or have the potential to occur within the RWA and would be directly affected by the RWA development:</p> <ul style="list-style-type: none"> ▪ Koala (<i>Phascolarctos cinereus</i>) ▪ Wallum Froglet (<i>Crinia tinnula</i>) ▪ Tusked Frog (<i>Adelotus brevis</i>) ▪ Wallum Rocketfrog (<i>Litoria freycineti</i>) ▪ Cotton Pygmy Goose (<i>Nettaus coromandelianus</i>) ▪ Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) ▪ Lewin’s Rails (<i>Rallus pectoralis</i>) ▪ Australian Painted Snipe (<i>Rostratula australis</i>)

SPP Requirements	Compliance Statement
<p>(2) manages the significant adverse environmental impacts on matters of state environment significance by, in order of priority:</p> <ol style="list-style-type: none"> a. avoiding significant adverse environmental impacts, and b. mitigating significant adverse environmental impacts where these cannot be avoided, and 	<p>Compliance assessment</p> <p>As detailed in Section 4.1, the RWA development will have significant impacts upon the following species that are MSES:</p> <ul style="list-style-type: none"> ▪ Koala (<i>Phascolarctos cinereus</i>) ▪ Wallum Froglet (<i>Crinia tinnula</i>) ▪ Tusked Frog (<i>Adelotus brevis</i>) ▪ Wallum Rocketfrog (<i>Litoria freycineti</i>) <p>The scale and magnitude of habitat loss for these species is proposed to be mitigated via:</p> <ul style="list-style-type: none"> ▪ the retention and enhancement of the majority of the higher quality habitat for these species that occurs within the RWA; and ▪ the restoration of habitat within parts of the RWA Open Space precinct following the completion of flood-plain re-profiling works.
<p>(3) where applicable, offsetting any residual adverse impacts.</p>	<p>Compliance assessment</p> <p>The impacts of the RWA development on the above MSES species are proposed to be offset by the habitat restoration and enhancement works proposed within the RWA Open Space Precinct. Consistent with the requirements of Queensland Biodiversity Offset Policy January 2014 Version 1.1, these works will protect and restore known habitat for the species being impacted which contains the elements necessary for the survival of the species being offset.</p>
<p>State interest—coastal environment</p>	
<p>Development:</p> <p>(6) does not involve reclamation of tidal land other than for the purposes of:</p> <ol style="list-style-type: none"> (a) coastal-dependent development, public marine development or community infrastructure, where there is no feasible alternative, or (b) strategic ports, boat harbours or strategic airports and aviation facilities in accordance with a statutory land use plan, or (c) coastal protection works or work necessary to protect coastal resources or coastal processes, and 	<p>Compliance assessment</p> <p>The RWA development will involve the reclamation of approximately 2.5 hectares of tidal land for residential purposes generally in accordance with the approved Structure Plan.</p>

5.3 SDAP Compliance

The proposed plan of development will also require assessment against State Development Assessment Provisions (SDAP), some of which are concerned with ecological issues. The following SDAP Modules will need to be addressed once the findings of the hydraulic analysis (flood modelling) have been completed and the RCP has been prepared:

5.3.1 Module 5 – Fisheries resources

The RWA will ultimately involve operational works that involve the loss of and disturbance to marine plants and other fish habitat resources and the establishment of linear infrastructure across Raff Creek to provide road and service connectivity with the adjacent MIBA development to the north.

Specific details concerning the precise locations and design characteristics of these activities are not currently available and will be prepared to support requisite operational works permit applications. In the absence of such detail, Table 5-4 provides a preliminary assessment of the degree of compliance that the

RWA development generally achieves with the Performance Outcomes sought within SDAP Module 5, Table 5.3.1.

Table 5-4 State Development Assessment Provisions – Module 5

- ✓ Achieved
- P/S Performance solution
- N/A Not applicable

Table 5.3.1: Operational work (including operational work as part of a material change of use or reconfiguring a lot)			
Performance outcomes	Acceptable outcomes	Response	Comment
PO1 Development avoids and protects <u>fish habitats</u> and <u>fisheries resources</u> .	AO1.1 A buffer surrounding <u>fish habitats</u> is provided and has a minimum width of: (1) For tidal <u>fish habitats</u> : (a) 100 metres above highest astronomical tide outside an urban area, or (b) 50 metres above highest astronomical tide within an urban area (1) non-tidal <u>fish habitats</u> : (a) 50 metres above bankfull width outside an urban area or (b) 25 metres above bankfull width within an urban area.	P/S	The RWA development involves the removal of approximately 2.5 ha of marine plant dominated habitat and associated fisheries resources. Following the completion of development works, which also involve the restoration of fish habitat area, the retained areas of fisheries habitat will be buffered from residential allotments by a perimeter roadway and/or open space reserves that generally range from: <ul style="list-style-type: none"> ▪ 30-50m in width adjacent to tidally influenced reaches of Raff Creek; and ▪ 10-50m in width adjacent to non-tidally influenced reaches of Raff Creek.
PO2 There is a demonstrated right to propose development within or adjacent to the <u>public fish habitats and fisheries resources</u> .	AO2.1 The development is supported by a statutory instrument (for example, regional plans made under the Act, Shoreline Erosion Management Plan (SEMP), coordinated project approval under the <i>State Development and Public Works Organisation Act 1971</i>), and the impact on <u>fish habitats</u> have been properly considered. OR	✓	The RWA development is generally in accordance with the approved RWA Structure plan which was the subject of an application and approvals process that considered fisheries issues.
	AO2.2 to AO2.4	N/A	
	AO2.5 The following can be demonstrated: (1) tenure is held for the <u>land</u> directly abutting the <u>tidal land</u> and has full riparian access rights, or (2) tenure has been granted over the area of work, or (3) resource entitlement or resource allocation has been granted for the resource being developed, or (4) for private development work that is a jetty, pontoon or boat ramp, no other maritime access structure adjoins the property.	✓	Freehold title is held over the land where disturbance and loss of marine plants and fisheries resources will occur.
PO3 There is an overriding functional requirement for the development or part of	AO3.1 – AO3.3 Development is for maritime infrastructure (for example, jetty, boat ramp, moorings). OR	P/S	The extent of development of tidal lands is required to facilitate urban development generally in

Table 5.3.1: Operational work (including operational work as part of a material change of use or reconfiguring a lot)			
Performance outcomes	Acceptable outcomes	Response	Comment
<p>the development to be located on <u>tidal lands</u>. Editor's note: Development components that have a functional requirement to be located over fish habitats are acceptable. For example car park areas (including for boat ramps), parklands, marina offices, spoil disposal or amenity facilities do not depend on their location to be on or over tidal lands to function, where alternatives of lesser impact exist.</p>	<p>AO3.2 Development is lineal or nodal infrastructure required to cross or be located within a <u>waterway</u> or tidal area (for example, bridge, culvert crossing, stormwater outlet, pipeline). OR</p>	N/A	<p>accordance with the approved RWA Structure Plan.</p>
	<p>AO3.3 The access is required for the construction of the marine or lineal infrastructure.</p>	N/A	
<p>PO4 Development maintains or enhances community access to <u>fisheries resources</u> and <u>fish</u> habitats, such as through <u>fishing</u> access and linkages between the commercial <u>fishery</u> and infrastructure, services and facilities.</p>	<p>AO4.1 The development does not impact on existing infrastructure or access required by <u>fishing</u> sectors.</p>	✓	<p>The RWA development will enhance public access to fisheries resources associated with Raff Creek.</p>
<p>PO5 Development that has the potential to impact on the operations and productivity of Queensland commercial or recreational fisheries mitigates any adverse impacts due to adjustment of fisheries.</p>	<p>AO5.1 Affected fisheries, and the impacts on those fisheries, are identified. AND</p>	✓	<p>Refer Section 4.3.</p>
	<p>AO5.2 Fair and reasonable compensation to commercial fishers is determined. AND</p>	N/A	<p>The location, nature and extent of fisheries resources that will be impacted will not have any significant impact on commercial or recreational fisheries.</p>
	<p>AO5.3 The impact of the development on commercial <u>fisheries</u> and recreational fishers is offset in accordance with the <i>Guideline on fisheries adjustment</i>, Department of Fisheries and Forestry.</p>	N/A	<p>The location, nature and extent of fisheries resources that will be impacted will not have any significant impact on commercial or recreational fisheries.</p>
<p>PO6 The development will not increase the risk of mortality, <u>disease</u> or injury, or compromise the health and productivity of <u>fisheries resources</u>.</p>	<p>AO6.1 <u>Fish</u> will not become trapped or stranded as a result of development. AND</p>	P/S	<p>During works within the tidal zone all appropriate measures will be undertaken to minimise impact to fish. This will be achieved through the implementation of a CEMP as part of the Operational Works program. The CEMP will address matters such as protection of marine flora and fauna, water quality, acid sulfate soils, waste management, storage and use of chemical and fuels.</p>
	<p>AO6.2 Risks of <u>fish</u> stranding occurring have been identified, and are demonstrably manageable. AND</p>		
	<p>AO6.3 Suitable habitat conditions, such as water and sediment quality, will be maintained to sustain the health and condition of <u>fisheries resources</u> within all <u>fish</u> habitats. AND</p>		
	<p>AO6.4 Herbicides are not used on, and will not drift onto, <u>tidal land</u> or wetlands, or within <u>waterways</u>.</p>		

Table 5.3.1: Operational work (including operational work as part of a material change of use or reconfiguring a lot)

Performance outcomes	Acceptable outcomes	Response	Comment
PO7 Development resulting in drainage or disturbance of acid sulfate soil is managed to prevent impacts on <u>fisheries resources</u> and <u>fish habitats</u> .	AO7.1 Run-off and leachate from disturbed or oxidised acid sulfate soils is contained and treated, and not released to a <u>waterway</u> or other <u>fish</u> habitat.	✓	The disturbance of acid sulphate soils is anticipated to occur as part of the revetment construction works. ASS management measures will be required to be undertaken by the construction contractor and will form part of the construction environmental management plan.
PO8 Development of, or adjacent to, <u>fish</u> habitats avoids the unnecessary loss, degradation or fragmentation of <u>fish</u> habitats and their values and the loss of <u>fish</u> movement.	AO8.1 The development does not directly impact <u>fish</u> habitats and is located: (1) above the highest astronomical tide for tidal <u>fish</u> habitat, or (2) above bankfull width for non-tidal <u>fish</u> habitats (freshwater). OR	N/A	AO8.2 addressed.
	AO8.2 Where impacts on <u>fish habitats</u> cannot be avoided, development meets the following criteria: (1) the location, design and work methods will result in the smallest impact possible to <u>fish habitats</u> (2) development does not increase the risk of transfer of, or impacts from, <u>pest fish</u> and other relevant pest species (3) tidal and freshwater inundation and drainage patterns, extent and timing are maintained such that ecological processes continue (4) works or development will not restrict <u>fish</u> access to <u>fish habitats</u> or <u>fisheries resources</u> (5) tidal or freshwater <u>fish</u> habitats will not be substituted for another type of habitat, for example, creation of mangrove communities from other tidal <u>fish</u> habitats (6) works are undertaken to avoid both seagrass flowering periods and <u>fish</u> spawning and migration periods (7) impacts are mitigated where possible.	P/S	The RWA development generally complies with AO8.2 to the extent that is feasible whilst facilitating development generally in accordance with the approved Structure Plan.
Public infrastructure to facilitate fishing (Not Applicable)			
Public infrastructure (linear and nodal) (Not Applicable)			
Public infrastructure – waterway crossings			
PO12 Development maintains existing tidal inundation and drainage patterns and extent.	AO12.1 Bridge crossings are designed with abutments above the <u>highest astronomical tide</u> . AND	P/S	Any bridge crossing of Raff Creek would be designed to maintain existing tidal inundation and drainage patterns and extent.

Table 5.3.1: Operational work (including operational work as part of a material change of use or reconfiguring a lot)

Performance outcomes	Acceptable outcomes	Response	Comment
	AO12.2 Culvert crossing are designed with the size and number of culverts such that it is the entire width of the <u>waterway</u> , the obvert being above the <u>highest astronomical tide</u> and the invert being equal to natural bed level, or a maximum of 300 millimetres below natural bed level. AND	P/S	Any culvert crossing of Raff Creek would be designed to maintain existing tidal inundation and drainage patterns and extent.
	AO12.3 Development is a bed level crossing of 15 metres in width or less.	N/A	
PO13 Development provides for <u>fish</u> passage.	No acceptable outcome is prescribed.	P/S	The planned road crossings of Raff Creek to link the RWA with the MIBA : <ul style="list-style-type: none"> ▪ is located along the alignment of an existing culvert crossing that does not comply with current standards for the provision of fish passage; and ▪ would be designed and constructed to meet current standards for fish passage.
Public infrastructure—pipeline or subterranean infrastructure (Not Applicable)			
Public infrastructure – dredging or extracting sediment (Not applicable)			
Private infrastructure – dredging or extracting sediment (Not Applicable)			
Public infrastructure – erosion control and beach replenishment (Not Applicable)			
Private (maritime) development work (Not Applicable)			
Temporary development (Not Applicable)			
Public health or safety (Not Applicable)			
Restoration works (Not Applicable)			
Works for aesthetic purposes or to provide for views (Not Applicable)			
Offsets			
PO25 Impacts of development on fish habitats or fisheries resources that cannot be avoided are offset in accordance with the <i>Marine fish habitat offset policy (FHMOP 005.2)</i> , Department of Agriculture, Fisheries and Forestry and the <i>Queensland Government environmental offsets policy</i> , Environmental Protection Agency, 2008 unless the development is private infrastructure works impacting less than 17 square metres or public infrastructure works impacting less than 25 square metres of fish habitat.	No acceptable outcome is prescribed.	P/S	As detailed in Section 4.3 and the Raff Creek Open Space RCP presented in Appendix E, the capacity exists to provide offsets for the proposed loss of marine plants and fisheries habitat resources. Further consideration of impact mitigation and offset measures would be provided in support of relevant applications for approval for disturbance to marine plants and waterway barrier works that will be submitted to the State Assessment and Referral Agency (SARA) at the appropriate time.

Table 5.3.1: Operational work (including operational work as part of a material change of use or reconfiguring a lot)			
Performance outcomes	Acceptable outcomes	Response	Comment
Additional requirements for development within a wild river area for specified works, other than within a HPA (Not Applicable)			

5.3.2 Module 10 – Coastal protection (in part).

Future phases of the RWA will involve operational works that involve “tidal works” associated with the bulk earthworks required to establish the RWA Residential Precinct and the establishment of linear infrastructure across Raff Creek to provide road and service connectivity with the adjacent MIBA development to the north.

Specific details concerning the precise locations and design characteristics of these activities are not currently available and will be prepared to support requisite operational works permit applications. In the absence of such detail, Table 5-5 provides a preliminary assessment of the degree of compliance that the RWA development generally achieves with the Performance Outcome PO9 within SDAP Module 10, Table 10.1.1, which is the only PO directly concerned with ecological and biodiversity issues.

Table 5-5 State Development Assessment Provisions – Module 10

- ✓ Achieved
- P/S Performance solution
- N/A Not applicable

Tidal works, or development in a coastal management district state code			
Table 10.1.1: All Development			
Performance outcomes	Acceptable outcomes	Response	Comment
PO9 Development avoids adverse impacts on <u>matters of state environmental significance</u> , or where this is not reasonably possible, impacts are minimised and residual impacts are offset.	AO9.1 Development: <ul style="list-style-type: none"> (1) is set back from matters of state environmental significance (1) avoids interrupting, interfering or otherwise adversely impacting underlying natural ecosystem components or processes and interactions that affect or maintain the matters of state environmental significance, such as water quality, hydrology, geomorphology and biological processes, or (2) incorporates measures as part of its location and design to protect and retain matters of state environmental significance and underlying ecosystem processes within and adjacent to the development site to the greatest extent practicable. Editor’s note: Applications for development should identify any threatened species or their habitats, or threatened ecosystems, that may be affected by the proposal. In particular, applications should identify and describe how the development avoids adverse impacts on any critical life stage ecological processes within or adjacent to the development area. AND	P/S	As detailed in Section 5.5 the RWA development will impact on several wildlife species that are matters of state environmental significance (MSES). The impact of development has been avoided to the extent practicable whilst maximising the extent of land available for residential purposes generally in accordance with the approved Structure Plan and meeting flood storage offset, public open space and stormwater management requirements.
	AO9.2 An <u>environmental offset</u> is provided for any unavoidable significant residual impact on matters		

Tidal works, or development in a coastal management district state code

Table 10.1.1: All Development

Performance outcomes	Acceptable outcomes	Response	Comment
	<p>of state environmental significance caused by the development.</p> <p>Editor's note: Applications for development should identify anticipated losses, and outline what actions are proposed to be undertaken to offset the loss in accordance with the relevant <i>Queensland Government Environmental Offset Policy</i> available from the Department of Environment and Heritage Protection library catalogue.</p>		<p>by the habitat restoration and enhancement works proposed within the RWA Open Space Precinct.</p> <p>Consistent with the requirements of Queensland Biodiversity Offset Policy January 2014 Version 1.1, these works will protect and restore known habitat for the species being impacted which contains the elements necessary for the survival of the species being offset.</p>

6 References

Department of Environment and Resource Management (2011) Queensland Wetland Definition and Delineation Guideline, Queensland Government, Brisbane.

Neldner, V.J., Wilson, B.A., Thompson, E.J. and Dillewaard, H.A. (2012) Methodology for Survey and Mapping of Regional Ecosystems and Vegetation Communities in Queensland. Version 3.2. Updated August 2012. Queensland Herbarium, Queensland Department of Science, Information Technology, Innovation and the Arts, Brisbane. 124 pp.

FIGURES

Figure 1 Site Location

Figure 2 Pre-clearing Vegetation Types

Figure 3 RWA Plan of Development

Figure 4 RWA Open Space Zones

Figure 5 RWA Wetland Mapping

Figure 6 Threatened Species Habitat Mapping

Figure 7 Habitat Protection and Restoration
Units



River

Caboolture

Waterway

Unnamed

Creek

Raff

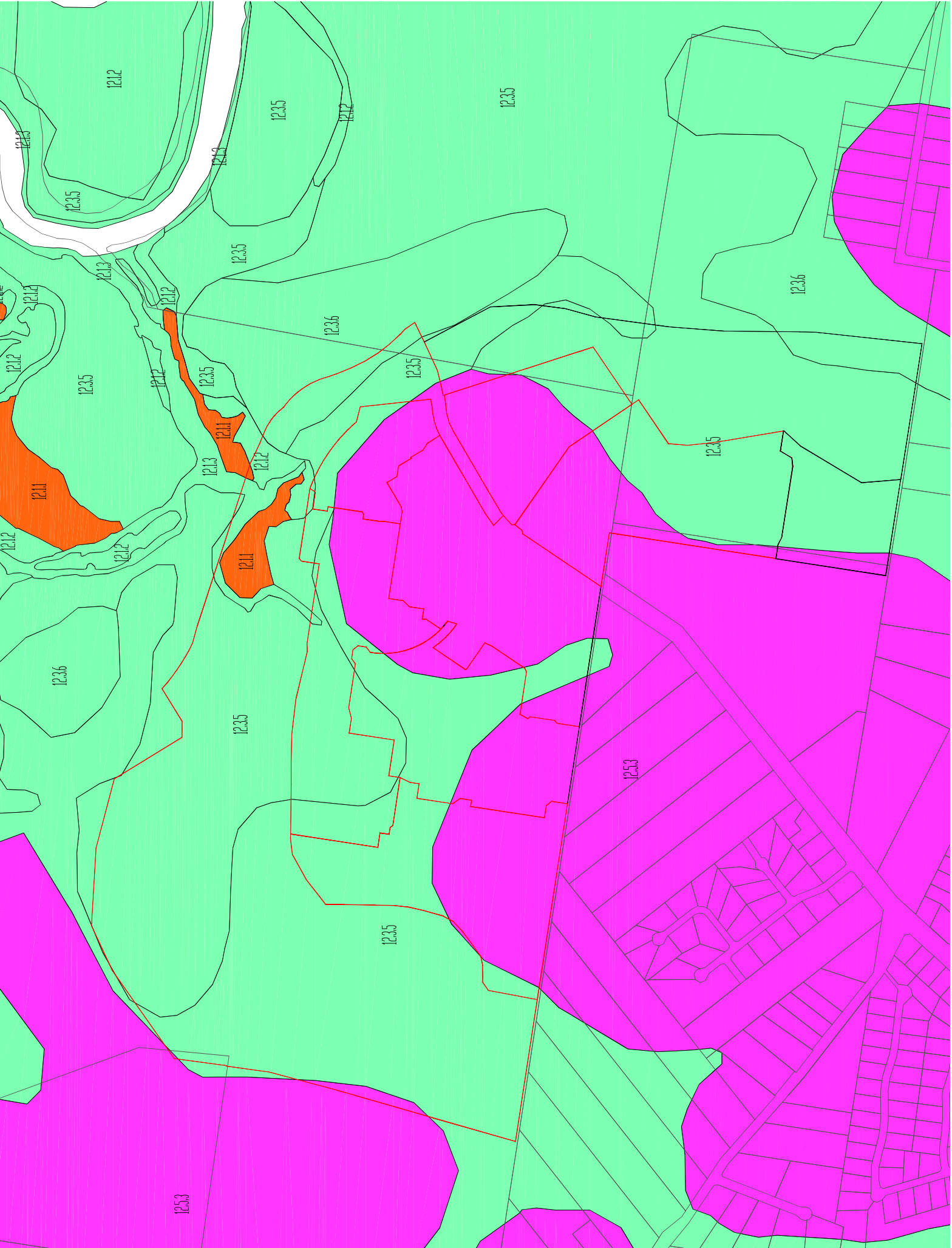
Coach Road East

Buckley Road

Cobb Road

Farry Road

BRUCE HIGHWAY





Leg

7

8

4

6

1

5

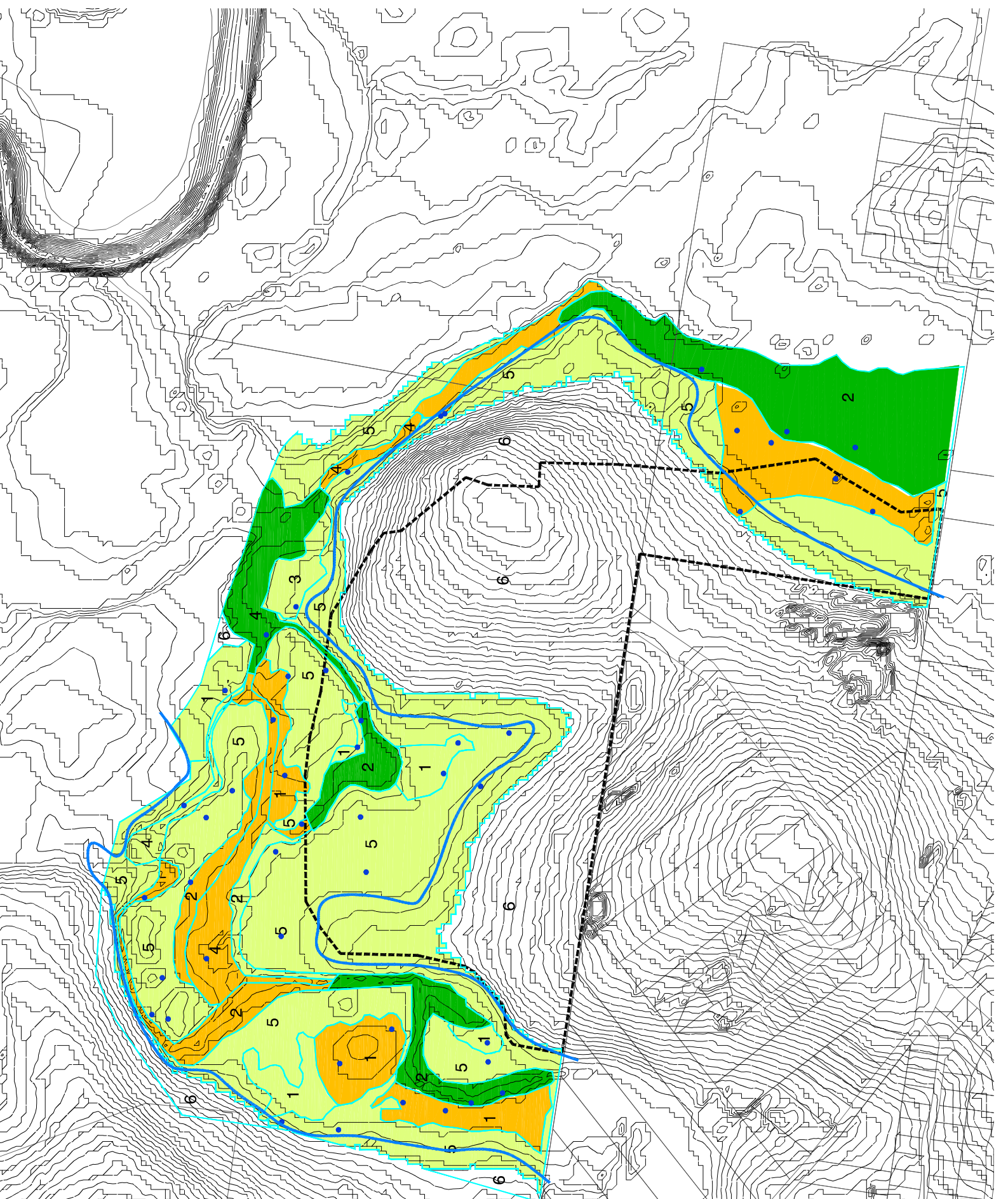
2

3

LEGEND

- NEBP RW Precinct (E)
- Regional F
- Constructe
- Parkland Z
- Habitat Pr
- Habitat Re





LEC

NEBP
Precinct

Wetland

Flood

Wetland C

1 Flood

2 Flood

3 Saline

4 Mang

5 Distur

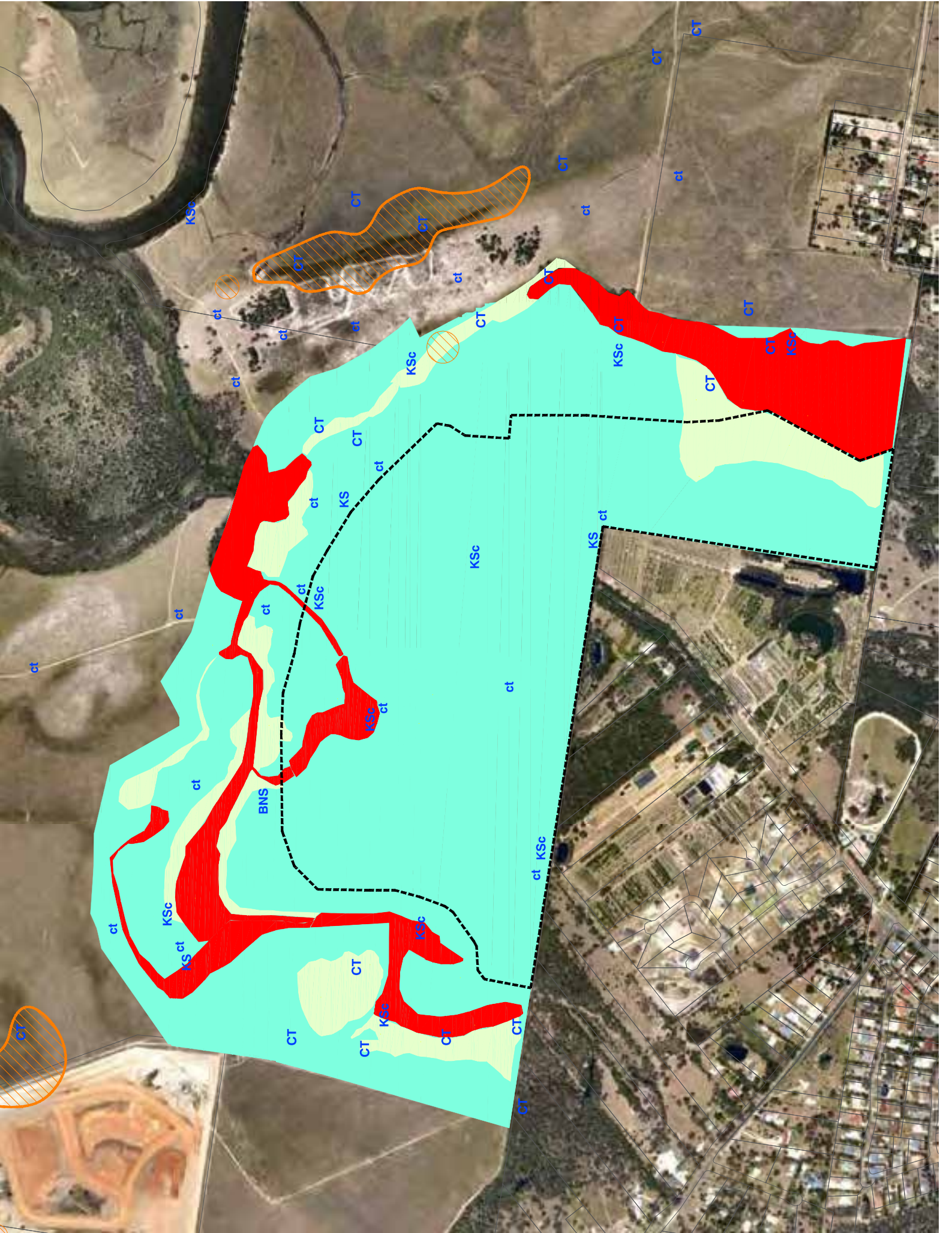
6 Distur

Wetland Valu

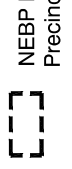
High

Mode

Low



LEC



NEBP
Precinct

THREATENED HABITAT

- Very High
- High
- Moderate
- Low

THREATS

- Wallum
- Wallum
- Wallum
- Koala
- Koala
- Black-tailed



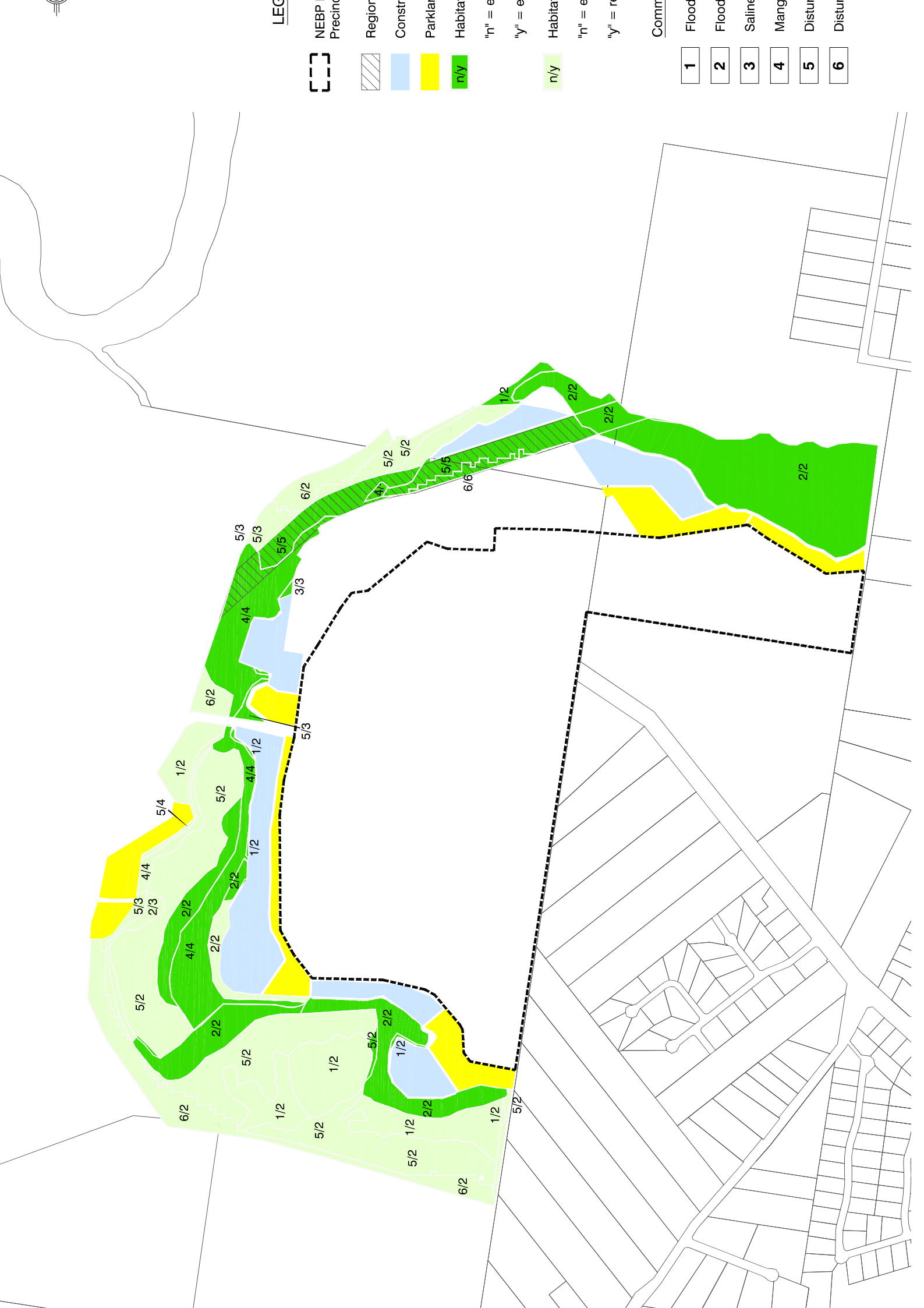
CT

ctn

KS

KSc

BNS



LEG

- NEBP Precinct: Dashed box
- Region: Hatched box
- Const: Light blue box
- Parkland: Yellow box
- Habitat: Green box
- "n" = e: Light green box
- "y" = e: Yellow-green box
- Habitat: Light green box
- "n" = e: Light green box
- "y" = r: Light green box
- Comm: Numbered box
- Flood: Numbered box
- Flood: Numbered box
- Saline: Numbered box
- Mang: Numbered box
- Distur: Numbered box
- Distur: Numbered box

- 1**
- 2**
- 3**
- 4**
- 5**
- 6**

NEBP - Residential West RoL

APPENDIX

A

Curriculum Vitae

John Delaney

Current Position

Senior Principal -
Ecology
Project Director

Profession

Ecologist

Years' Experience

20

Joined Cardno

March 2003

Education

BSc (Ecol Major), Griffith
University, 1984-1987

Affiliations

OELA
UDIA
EIANZ

Summary of Experience

John Delaney is a Senior Principal and Project Director with Cardno and has over 20 years' experience as a research scientist, ecologist and landscape management consultant.

From 1987 to 1993 John held positions as a research scientist at the Centre for Catchment and In-stream Research, at Griffith University, and the Centre for Biological Population Management, at Queensland University of Technology. Since 1994 John has worked as an environmental consultant providing private and public sector clients with service and advice in the areas of ecological surveys and assessments, wildlife management and conservation, environmental offsets, and project management options for ecologically sensitive areas. John has also provided clients with representation during the judicial review of land use planning decisions made by Local and State government authorities.

John's services have been extensively utilised by both the private and public sector on projects ranging from small scale site assessments to regionally significant public infrastructure projects. The demand for ecological assessment, monitoring and management services, such as those provided by John, continues to grow in response to the increasing demands placed on land developers/managers to achieve compliance with the Ecologically Sustainable Development (ESD) principles and the associated requirements of State and Commonwealth legislation having an ESD focus.

Significant Projects

Some significant projects that have benefited from John's expertise and experience include:

- > Qld Coal Seam Gas Management Plans (Independent Third Party Review) – Department of Sustainability, Environment, Water, Population and Communities.
- > PNG LNG Environmental Impact Statement (Independent Review) - PNG Government.
- > Ripley Valley Structure Plan - Ipswich City Council.
- > Northeast Business Park EIS – Northeast Business Park Pty Ltd.
- > Port Hinchinbrook Stage 2 - Cardwell Properties Pty Ltd.
- > Seaspray Residential Development, Emu Park - Seaspray Project Management Pty Ltd.
- > Noosa North Shore Eco Tourism Portal - Petrac Group.
- > Clarence Valley-Coffs Harbour Regional Water Supply Scheme EIS – NSW Department of Public Works and Services.
- > Salt, Seaside City and Casuarina Beach - The Ray Group, Richtech Consolidated Properties.
- > Biodiversity Assessment and Management Plan - Borneo Barracks - Department of Defence.
- > Lauderdale Quay Integrated Impact Assessment, Tasmania - Walker Corporation.



David Wassman

Current Position

Senior Ecologist

Profession

Ecologist

Years' Experience

7

Joined Cardno

July 2010

Education

BSc (Environmental Science)

Affiliations

MEIANZ
Ecological Society of Australia

Summary of Experience

David Wassman has been an Ecologist with Cardno since mid-2010 and has approximately seven years' experience in the environmental field working in both private and State Government sectors.

David provides specialist ecological advice to clients across a range of sectors including linear infrastructure, mining, local government, industrial and commercial development and master planning. David specialises in the areas of ecological assessments including terrestrial and aquatic surveys. David has undertaken a range of aquatic surveys for macroinvertebrates many of which were conducted in accordance with recognised river health methodologies such as SIGNAL 2 and AUSRivAS. David's terrestrial surveys have focussed on the areas of vegetation management, flora and fauna surveys and Regional Ecosystem mapping and classification. David also manages and delivers advice and technical reporting in support of a range of local, state and commonwealth environmental approvals. David is a highly adaptable individual who is capable of liaising with government departments and delivering high quality outputs in short timeframes.

Prior to joining Cardno David was employed as an aquatic ecologist with Australian Wetlands and as a Project Officer in the Water Services sector of the Department of Natural Resources and Water.

David graduated from the University of the Sunshine Coast in 2006 with a Bachelor of Science (Environmental Science), specialising in Environment Management and was awarded with the Deans commendation. David currently resides on the Sunshine Coast.

Significant Aquatic Projects

- > Cudgera Creek Baseline Assessment - Macroinvertebrate and Fish Surveys – Tweed Shire Council.
- > Mudgeeraba Creek Ecosystem Health Assessment - Macroinvertebrate and Fish Surveys – Gold Coast Council.
- > Merrimac West Wastewater Augmentation - Macroinvertebrate and Fish Assessments – Streamline Alliance.
- > Kawana Forest Wetland - Monthly physio-chemical and Macroinvertebrate Surveys - Stockland Development.
- > Woodgrove Wetlands - Monthly physio-chemical and Macroinvertebrate Surveys - Stockland Development.
- > Monitoring the effects of 4wd vehicles on Sandy Beach Macroinvertebrate - Field collection and identification - University of the Sunshine Coast Research Assistant
- > Determining the effects of groynes on sandy beach Macroinvertebrate assemblages - University of the Sunshine Coast Research Assistant
- > Brunswick Area Sewerage Augmentation Scheme - Provision of Review of Environmental Factors reporting and ecological advice for mangrove rehabilitation.

Professional History

July 2010 to Current

Senior Ecologist - Cardno (Qld) Pty Ltd

David's position as an Senior Ecologist involves:

- > provision of environmental advice with respect to environmental constraints and approvals;
- > preparation of applications and supporting technical documentation for Commonwealth, State and Local government approvals;
- > undertaking environmental assessments (including fauna and flora surveys);
- > client liaison;
- > project management
- > preparation of reports (including management plans and written advice);
- > co-ordination of tasks with other industry professionals; and
- > preparation of job proposals and detailed work cost estimates.

July 2008 to July 2010

Ecologist - Australian Wetlands

David's position as an ecologist involved:

- > Water quality monitoring and macroinvertebrate sampling.
- > Undertaking ecological assessments (including flora and fauna surveys).
- > Preparation of reports both scientific and management plan orientated.
- > Client liaison.
- > Preparation of fee proposals and cost estimates.

Sept 2006 to July 2008

Project Officer, Water Services - Department of Natural Resources and Water

David's role as Project Officer primarily involved service delivery and resource audits. This involved:

- > Undertaking physio-chemical analysis of surface and groundwater resources within the Lockyer and Mary River Catchments.
- > Undertaking catchment audits of the Lockyer and Mary Catchments to better determine resource demand and usage.
- > Creation of reporting and mapping products resulting from field work.
- > Providing advice to a variety of clients with respect to requirements under legislation. Particularly the Water Act 2000.



Karen Steele

Current Position
Senior Ecologist

Profession
Ecologist

Years' Experience
10

Joined Cardno
May 2007

Education
BSc (Environmental
Science),
Cert. II Conservation &
Land Management

Professional
Registrations
CEnvP

Affiliations
EIANZ Full Member

Summary of Experience

Karen Steele is a Senior Ecologist with Cardno, where she has worked since 2007. Karen has ten years' experience in ecological consulting, vegetation management and weeds research. Karen is also a Certified Environmental Practitioner under the CEnvP scheme which recognises environmental professionals with high standards of professionalism and ethical conduct.

Since joining Cardno, Karen has become familiar with many aspects of Commonwealth, State and local government legislation having a biodiversity conservation focus. As a Senior Ecologist Karen assists in providing clients with service and advice in the areas of ecological assessments, constraints analysis, vegetation and weed management, flora and fauna surveys, Regional Ecosystem mapping and classification, approvals advice and ecosystem restoration strategies.

Prior to joining Cardno Karen was employed in the consultancy team at Greening Australia Queensland and as a weeds researcher by the Department of Natural Resources and Mines' Tropical Weed Research Centre.

Karen graduated from the University of the Sunshine Coast in 2001 with a Bachelor of Science (Environmental Science), specialising in Environment Management and Restoration. She was awarded with the Deans commendation for maintaining a high Grade Point Average of 6.1.

Significant Projects

Some examples of projects that Karen has been involved with:

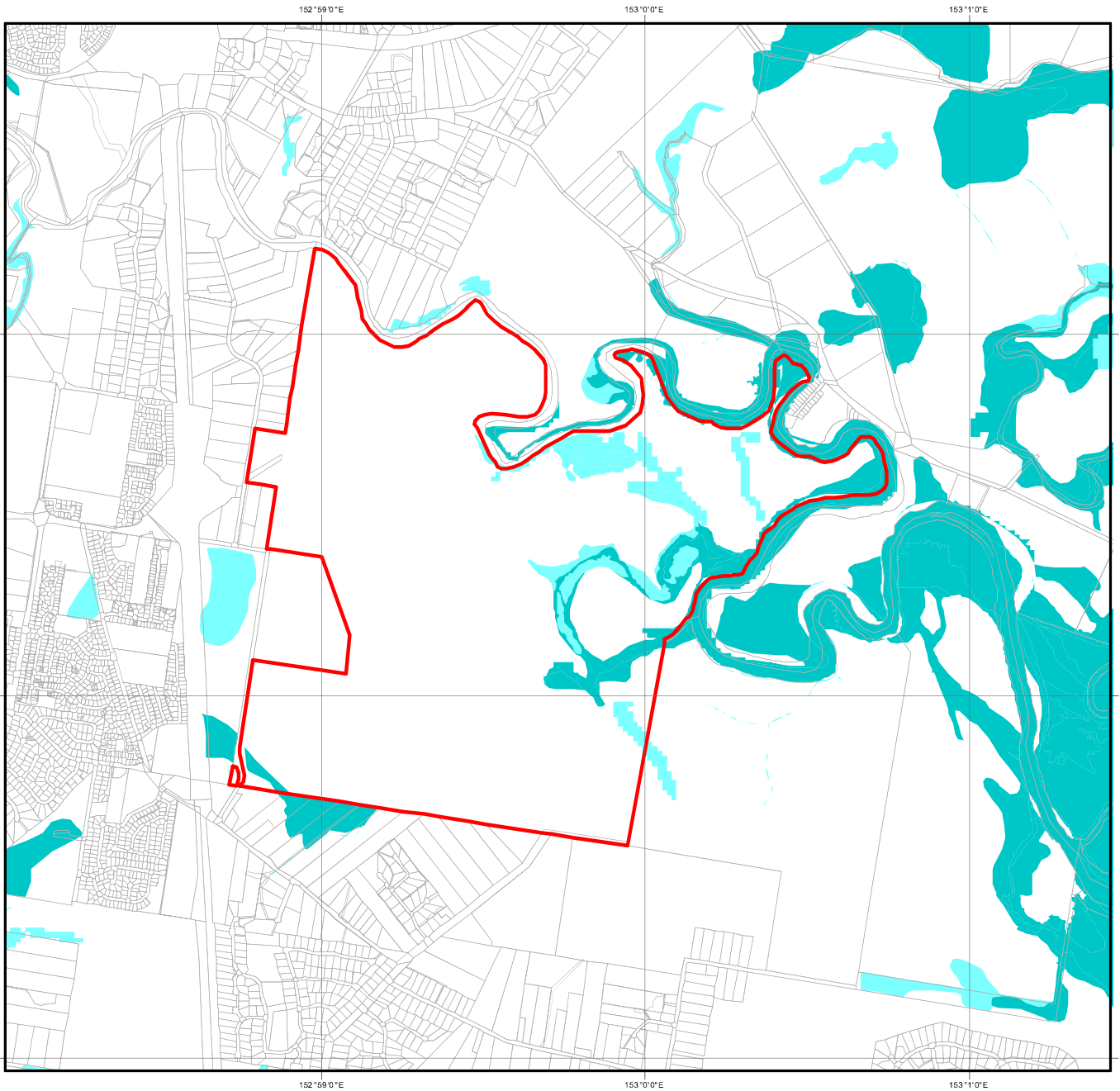
- > Seaside City Development - Richtech Pty Ltd
- > South East Queensland Correctional Precinct Development at Gatton - Queensland Corrective Services
- > Goonyella System Expansion x140 Environmental and Planning Studies - QR National
- > Gatton West Industrial Estate - Lockyer Valley Regional Council
- > Masters Home Improvement - various sites
- > Mackay South trunk main - Mackay Infrastructure Alliance
- > Mackay Dump Rd Prawn Farm rising main - Mackay Infrastructure Alliance
- > Carpenter's Lane Industrial Estate, Cooroy - Sunshine Coast Regional Council
- > Cooroy Bypass - Sunshine Coast Regional Council
- > Tripcony Coastal Pathway - Sunshine Coast Regional Council
- > Moreton Bay Boys College - various stages of the school's expansion
- > Koala Habitat Assessments - Department of Education and Training
- > Fiteni Homes - various residential developments
- > Brassall Bikeway and Goodna Ck Regional Bikeway - Ipswich City Council
- > Coolum Sports Club drainage works - Sunshine Coast Regional Council
- > Mother Teresa Catholic School - Brisbane Catholic Education

NEBP - Residential West RoL

APPENDIX

B

Statutory Mapping



Map of Referable Wetlands for the Environmental Protection Act 1994

Requested By: JOHN.DELANEY@CARDNO.COM.AU

Date: 06 Feb 14 Time: 15.40.37

Centred on Lot on Plan:
10 SP130251

-  Selected Land Parcel
-  Cadastral Boundary
-  HES Wetland GBR Catchments
-  HES Wetland
-  GES Wetland



Note:
This map shows the location of wetlands on the Map of Referable Wetlands which are defined under the Environmental Protection Regulation 2008.

Wetlands are assessed for ecological significance using the environmental values for wetlands in section 81A of the Environmental Protection Regulation 2008. Wetlands are considered either High Ecological Significance (HES) or of General Ecological Significance (GES) for the purposes of the environmental values.

This map is produced at a scale relevant to the size of the lot on plan identified and should be printed at A4 size in portrait orientation. Consideration of the effects of mapped scale is necessary when interpreting data at a large scale.

For further information or assistance with interpretation of this product, please contact the Department of Environment and Heritage Protection at <www.ehp.qld.gov.au> or email <planning.support@ehp.qld.gov.au>



This product is projected into GDA 1994 MGA Zone 56

© The State of Queensland, 2014



Regulated Vegetation Management Map

Legend

- Lot and Plan
- Category A area (Vegetation effects/impacts/losses/Diox)
- Category B area (Semi-rural vegetation)
- Category C area (High value regrowth vegetation)
- Category D area (Rural regrowth/seasonal vegetation)
- Category E area (Vegetation not regulated under the VMA)
- Water
- Area not categorised
- Category line
- Property boundaries shown are provided as a historical only.



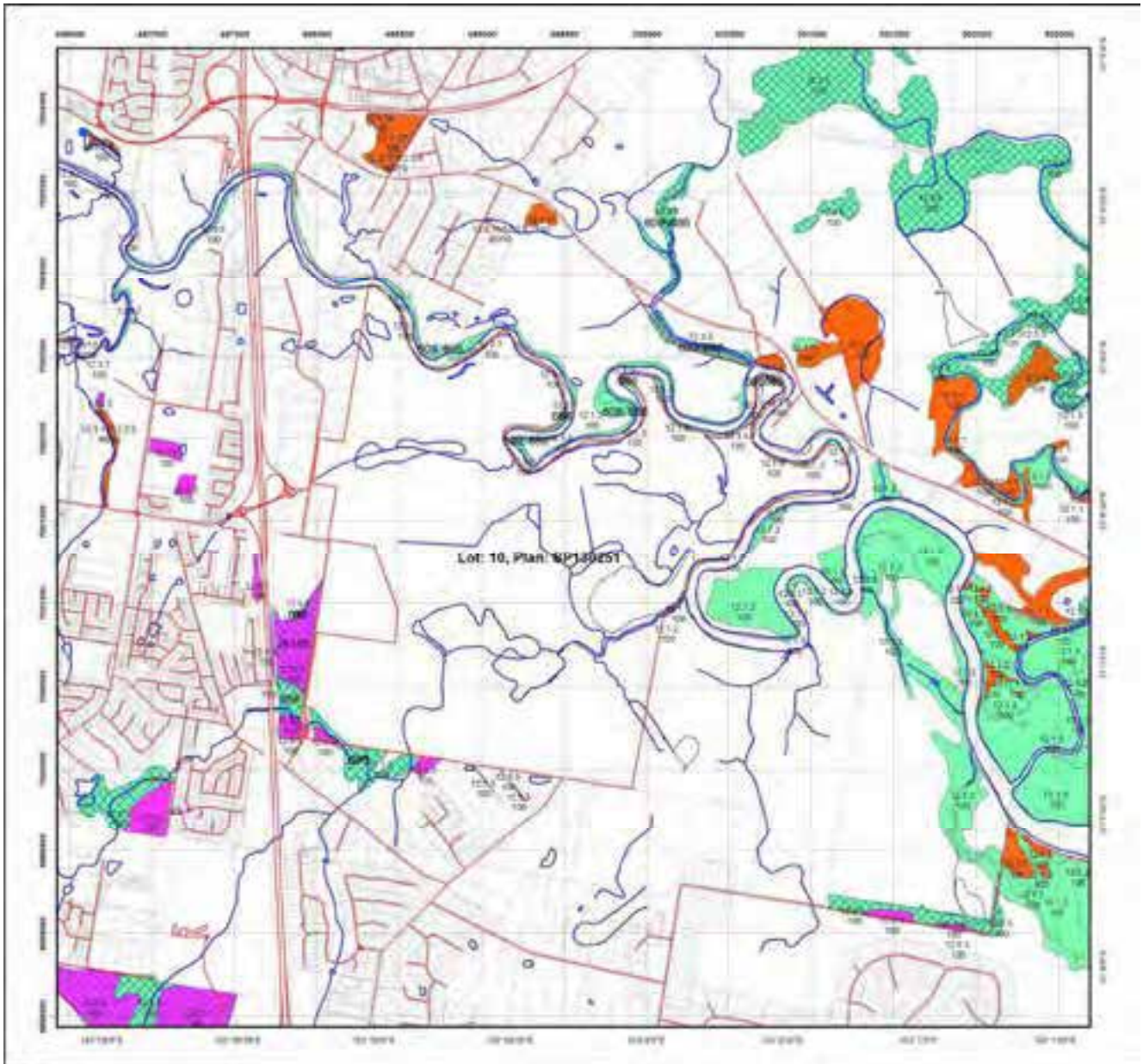
This product is projected into
 GDA 1984 MGA Zone 95

Disclaimer:
 While every care is taken to ensure the accuracy of this product, the Department of Natural Resources and Mines makes no representation or warranty about its accuracy, reliability, completeness or suitability for any particular purpose and accepts all responsibility and all liability (including without limitation liability in negligence) for all expenses, losses, damages (including indirect or consequential damage) and costs which you may incur as a result of the product being inaccurate or incomplete in any way and for any reason.

Additional information required for the assessment of vegetation health is provided in the accompanying "Vegetation Management Supporting map". For further information go to the web site, www.dnrpq.gov.au or contact the Department of Natural Resources and Mines.

Digital data for the regulated vegetation management map is available from the Queensland Spatial Portal at <http://www.spatial.qld.gov.au/>

This map is updated on a monthly basis to provide the PMVA as included as they are approved.



Vegetation Management Supporting Map

Legend

- Lot and Plan
- Category A or B area containing endangered regional ecosystems
- Category A or B area containing of concern regional ecosystems
- Category A or B area that is a least concern regional ecosystem
- Category A or B area containing remnant vegetation
- Category A or B area under Section 204A
These areas are subject to permits and flow with the remnant RL Status
- Category C area containing endangered regional ecosystems
- Category C area containing of concern regional ecosystems
- Category C area that is a least concern regional ecosystem
- Category C area containing high value regrowth vegetation
- Category C area under Section 204
These areas are edged in purple and flow with the remnant RL Status
- Non-Remnant
- Water
- Wetland on the vegetation management separate map
- Essential habitat on the essential habitat map
- Essential habitat species record
- Watercourse on the vegetation management watercourse map
(Streams only shown as black number aligned stream where available)
- Road
- Pittby Rivers (Surface Fly LSI)
- National Parks, State Forests and other reserves
- Cadastral line
- Property boundaries shown are provided as a locational aid only



This product is projected into
 GDA 1984 MGA Zone 56

Labels for Essential habitat are derived on the basis of mapping
 Regional ecosystem Areas have been compiled at a scale of 1:100,000
 except in integrated areas where a resolution scale of 1:50,000 is
 available. Labels should be used as a guide only. The positional
 accuracy of RE data mapped at a scale of 1:100,000 is +/- 100 metres.

Disclaimer
 While every care is taken to ensure the accuracy of this product, the
 Department of Natural Resources and Mines and Pittby Rivers Software, makes no representations or warranties about
 its accuracy, reliability, completeness or suitability for any particular
 purpose and disclaims all responsibility and all liability (including without
 limitation, liability in negligence) for all expenses, losses, damages,
 (including interest or consequential damage) and costs which you might
 incur as a result of the product being inaccurate or incomplete in any
 way and for any reason.

Additional information may be required by the supplier of data relating to
 replacement of a digital elevation map or other applications. For
 further information go to the web site: www.dnr.qld.gov.au or contact
 the Department of Natural Resources and Mines.

Original data for the vegetation management watercourse map, vegetation
 management wetlands map, essential habitat map and the vegetation
 management remnant and regional ecosystems map is available from the
 Queensland Spatial Portal at <http://www.information.qld.gov.au/>

Vegetation Management Act 1999 - Extract from the essential habitat database

Essential habitat is required for assessment under the:

- State Development Assessment Provisions - Module 8: Native vegetation clearing which sets out the matters of interest to the state for development assessment under the *Sustainable Planning Act 2009*; and
- Self-assessable vegetation clearing codes made under the *Vegetation Management Act 1999*

Essential habitat for one or more of the following species is found on and within 1.1 km of the identified subject lot/s or on and within 2.2 km of an identified coordinate on the accompanying essential habitat map.

This report identifies essential habitat in Category A, B and Category C areas.

The numeric labels on the essential habitat map can be cross referenced with the database below to determine which essential habitat factors might exist for a particular species.

Essential habitat is compiled from a combination of species habitat models and buffered species records.

The Department of Natural Resources and Mines website (<http://www.dnrm.qld.gov.au>) has more information on how the layer is applied under the State Development Assessment Provisions - Module 8: Native vegetation clearing and the *Vegetation Management Act 1999*.

Regional ecosystem is a mandatory essential habitat factor, unless otherwise stated.

Essential habitat, for protected wildlife, means a category A area, a category B area or category C area shown on the regulated vegetation management map-

- 1) (a) that has at least 3 essential habitat factors for the protected wildlife that must include any essential habitat factors that are stated as mandatory for the protected wildlife in the essential habitat database; or
- 2) (b) in which the protected wildlife, at any stage of its life cycle, is located.

Essential habitat identifies endangered or vulnerable native wildlife prescribed under the *Nature Conservation Act 1994*.

Essential habitat in Category A and B (Remnant vegetation species record) areas:1100m Species Information - (no results)

Essential habitat in Category A and B (Remnant vegetation species record) areas:1100m Regional Ecosystems Information - (no results)

Essential habitat in Category A and B (Remnant vegetation) areas:1100m Species Information

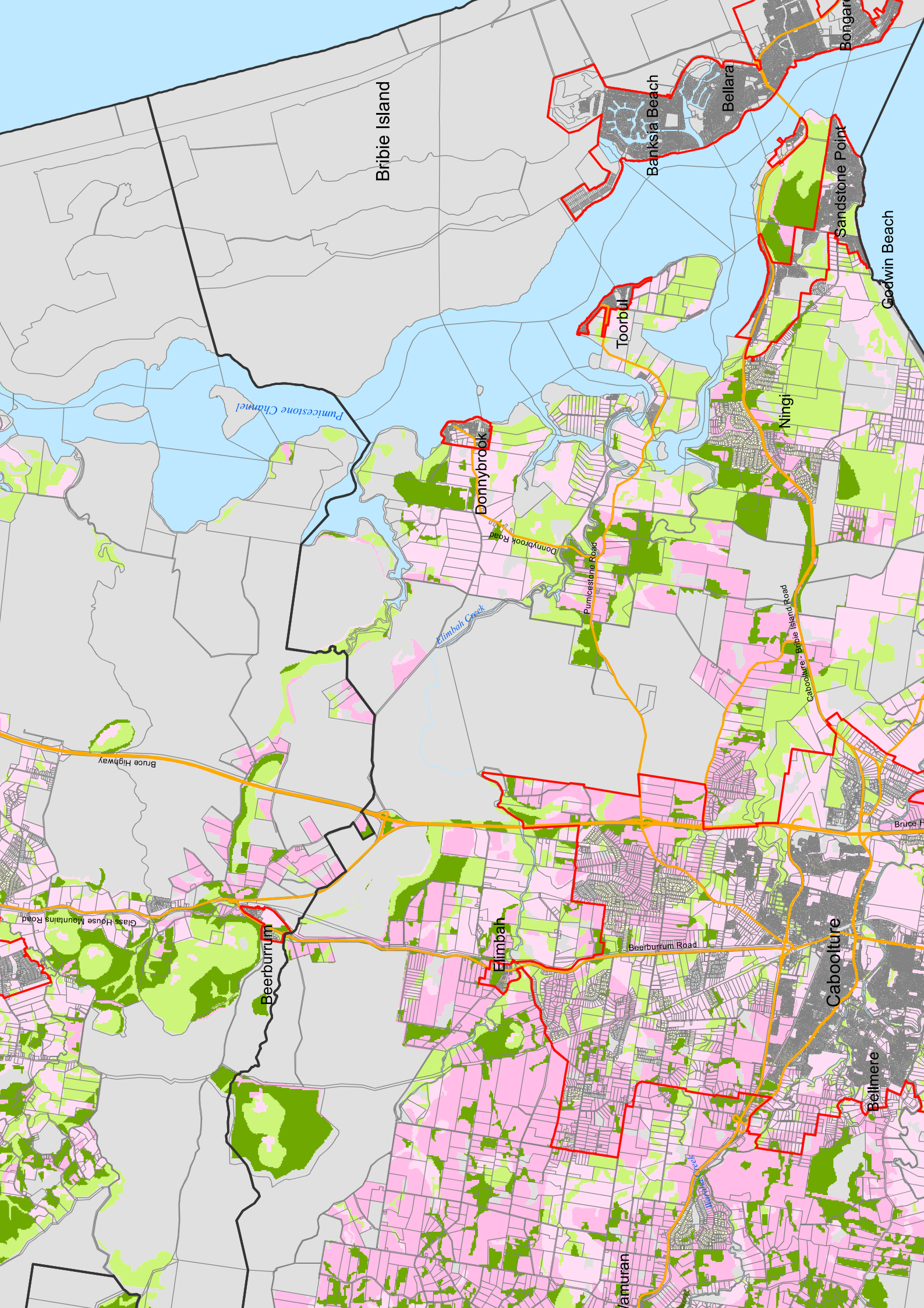
Label	Scientific Name	Common Name	NCA Status	Vegetation Community	Altitude	Soils	Position in Landscape
686	<i>Crinia tinnula</i>	Wallum Froglet	V	Vegetation community is a mandatory essential habitat factor for this species. Permanent to ephemeral acidic (pH 4.3 - 5.2), soft freshwater in Melaleuca (e.g. <i>M. quinquenervia</i>) swamps, sedge/land, wet and dry heathland (e.g. <i>Banksia robur</i> , <i>Xanthorrhoea</i>) and wallum (<i>Banksia aemula</i> shrubland/woodland) areas coastal lowlands on sand or sandstone, occasionally in adjacent open forest/woodland (e.g. <i>Eucalyptus racemosa</i> , <i>Corymbia citriodora</i>) with healthy understorey; known to persist in small remnants (<10ha); may be found well away from water.	Sea level to 200m.	Sandy and sandy-alluvial substrates.	None
29186	<i>Phascolarctos cinereus</i> (southeast Queensland bioregion)	Koala	V	Open eucalypt forest and woodland that has: a) multiple strata layers containing <i>Eucalyptus</i> , <i>Corymbia</i> , <i>Angophora</i> , <i>Lophostemon</i> or <i>Melaleuca</i> trees that—at 1.3 metres above the ground—have a diameter both greater and less than 30 centimetres; and b) at least 1 of the following species: <i>Eucalyptus tereticornis</i> , <i>E. fibrosa</i> , <i>E. propinqua</i> ; <i>E. umbra</i> , <i>E. grandis</i> , <i>E. microcorys</i> , <i>E. tindaliae</i> , <i>E. resinifera</i> , <i>E. populnea</i> , <i>E. robusta</i> , <i>E. nigra</i> , <i>E. racemosa</i> , <i>E. crebra</i> , <i>E. exserta</i> , <i>E. seeana</i> , <i>Lophostemon confertus</i> , <i>L. suaveolens</i> , <i>Melaleuca quinquenervia</i> .	Sea level to 1000m.	no soil information	None
609	<i>Litoria freycineti</i>	Wallum Rocketfrog	V	Vegetation community is a mandatory essential habitat factor for this species. Freshwater acidic swamps/lagoons (permanent or temporary still water) dominated by sedges (e.g. <i>Baumea</i> and <i>Eleocharis</i> spp.) in heathland (e.g. <i>Banksia/Xanthorrhoea</i>), wallum (<i>Banksia aemula</i> shrubland/woodland) or <i>Melaleuca</i> open forest (e.g. <i>M. quinquenervia</i>), and adjacent <i>Eucalyptus racemosa</i> forest, also found around acidic coastal lakes; on sand and sandstone; can be found well away from water during non-breeding season.	Sea level to 200m.	Sandy and alluvial substrates.	None

Essential habitat in Category A and B (Remnant vegetation) areas:1100m Regional Ecosystems Information

Label	Regional Ecosystem (this is a mandatory essential habitat factor, unless otherwise stated)
686	12.2.5, 12.2.7, 12.2.9, 12.2.10, 12.2.12, 12.2.15, 12.3.4, 12.3.5, 12.3.6, 12.3.12, 12.3.14, 12.5.10. These regional ecosystems are not a mandatory essential habitat factor for this species.
29186	12.3.3, 12.3.4, 12.3.6, 12.3.7, 12.3.10, 12.3.11, 12.5.2, 12.5.3, 12.8.14, 12.9-10.4, 12.9-10.7, 12.9-10.17, 12.11.5, 12.11.18, 12.12.12
609	12.2.2, 12.2.5, 12.2.7, 12.2.12, 12.2.13, 12.2.15, 12.3.4, 12.3.5, 12.3.6, 12.3.12, 12.3.13, 12.5.4, 12.5.9, 12.9-10.10, 12.9-10.22. These regional ecosystems are not a mandatory essential habitat factor for this species.

Essential habitat in Category C (High value regrowth vegetation) areas:1100m Species Information - (no results)

Essential habitat in Category C (High value regrowth vegetation) areas:1100m Regional Ecosystems Information - (no results)



Bribie Island

Pumicestone Channel

Eimbah Creek

Bruce Highway

Glass House Mountains Road

Beerburrrum

Jimban

Beerburrrum Road

Caboolture

Bellmere

Jamuran

Donnybrook

Donnybrook Road

Pumicestone Road

Toorbul

Banksia Beach

Bellara

Ningi

Sandstone Point

Godwin Beach

Bongarra

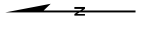
Capoolture - Bribie Island Road



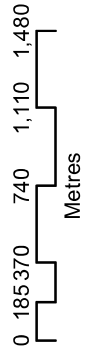
copyright Map Data 2011 MapData Services Pty Ltd (MDS), PSMA

State Planning Policy

Local government development assessment



Date: 16/05/2014



Department of
State Development
Infrastructure and Planning

© The State of Queensland 2013.

Disclaimer:
This map has been prepared with due care based on the best available information at the time of publication. The department holds no responsibility for any errors, inconsistencies or omissions within this document. Any decisions made by other parties based on this document are solely the responsibility of those parties.
Please note whilst Bushfire Hazard Areas have not been triggered they may still apply.

Legend

polygonLayer	
Override 1	
Cadastre (50k)	
Cadastré (50k)	
MSES - Wetlands (riverine)	
MSES - Wetlands (riverine)	
MSES - High ecological value waters (watercourse)	
MSES - High ecological value waters (watercourse)	
MSES - Regulated vegetation (intersecting a watercourse)	
MSES - Regulated vegetation (intersecting a watercourse)	
MSES - Wetlands (palustrine, estuarine and lacustrine)	
MSES - Wetlands (palustrine, estuarine and lacustrine)	
MSES - High ecological value waters (wetland)	
MSES - High ecological value waters (wetland)	
MSES - Wild Rivers (high preservation areas)	
MSES - Wild Rivers (high preservation areas)	
MSES - Wildlife habitat	
MSES - Wildlife habitat	
MSES - Protected area	
MSES - Protected area	
MSES - Marine park	
MSES - Marine park	
MSES - Declared fish habitat area	
MSES - Declared fish habitat area	

MSES - Regulated vegetation	
MSES - Regulated vegetation	
MSES - Legally secured offset area	
MSES - Legally secured offset area	



Disclaimer:

NEBP - Residential West RoL

APPENDIX

C

RWA Civil Engineering Plans



LEGEND

- █ HIGH VALUE WETLANDS - SHAL ONLY
- █ MODERATE VALUE WETLANDS - SWAL ONLY
- █ LOW VALUE WETLANDS - SWAL ONLY

NOTES:

1. ALL CITY AREAS IN RESIDENTIAL WETLAND ZONES SHALL BE TO BE REHABILITATED
2. WATER QUALITY AREAS AND SEWERAGE PUMP STATION LOCATIONS ARE INDICATED ONLY

FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
**NORTH EAST BUSINESS PARK
RESIDENTIAL WEST CONCEPT LAYOUT
EXISTING WETLANDS**

Date: 06/04/2014
Drawing Number: 7903.59.SK008
Revision: 1



LEGEND

- CATCHMENT'S FULL SERVING
- CATCHMENT'S FULL SERVING
- AREAS TO NOTE

NOTES:

1. ALL CITY AREAS RESIDENTIAL WASTE OPEN SPACE ARE TO BE REHABILITATED
2. WATER QUALITY AREAS AND TRENCHES PUMP STATION LOCATIONS ARE INDICATIVE ONLY

© Cardno Limited All Rights Reserved.
This document is produced by Cardno Limited solely for the benefit of and use by the client. It is not to be distributed, copied, reproduced, or otherwise used without the prior written consent of Cardno Limited. All third parties are responsible for their own actions and any third party acting on its own or in reliance on this document.

FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
NORTH EAST BUSINESS PARK
RESIDENTIAL WEST CONCEPT LAYOUT
BULK LAINTWORKS

Drawing Number: **7903.59.SK009**
Date: 29/04/2014
Revision: **2**



FOR INFORMATION ONLY
NOT TO BE USED FOR CONSTRUCTION PURPOSES
**NORTH EAST BUSINESS PARK
RESIDENTIAL WEST CONCEPT LAYOUT
PARKS AND WETLANDS**

Drawing Number: **7903.59.SK010**
Date: 06/04/2014
Revision: **1**

LEGEND

- WETLANDS FOR WATER QUALITY (shaded green)
- RESIDENTIAL AREAS (shaded brown)
- SEWER PUMP STATION LOCATION (shaded grey)

NOTES:

- ALL GUY AREAS IN RESIDENTIAL WEST OPEN SPACES ARE TO BE REGULATED
- WATER QUALITY AREAS ARE TO BEHOLD PUMP STATION LOCATIONS AND REGULATE THEM ONLY

Scale: 1:5000 - A1, 1:10000 - A3

© Cardno Limited. All Rights Reserved.
This document is provided by Cardno Limited solely for the benefit of and use by the client. Cardno Limited and its employees, agents, contractors and subcontractors shall not be liable for any errors or omissions in this document, or for any use or reliance on this document.

NEBP - Residential West RoL

APPENDIX

D

FRC Environmental and Austecology
Mapping



153.02° E
153.01° E
153° E
152.99° E
152.98° E
97° E



LEGEND

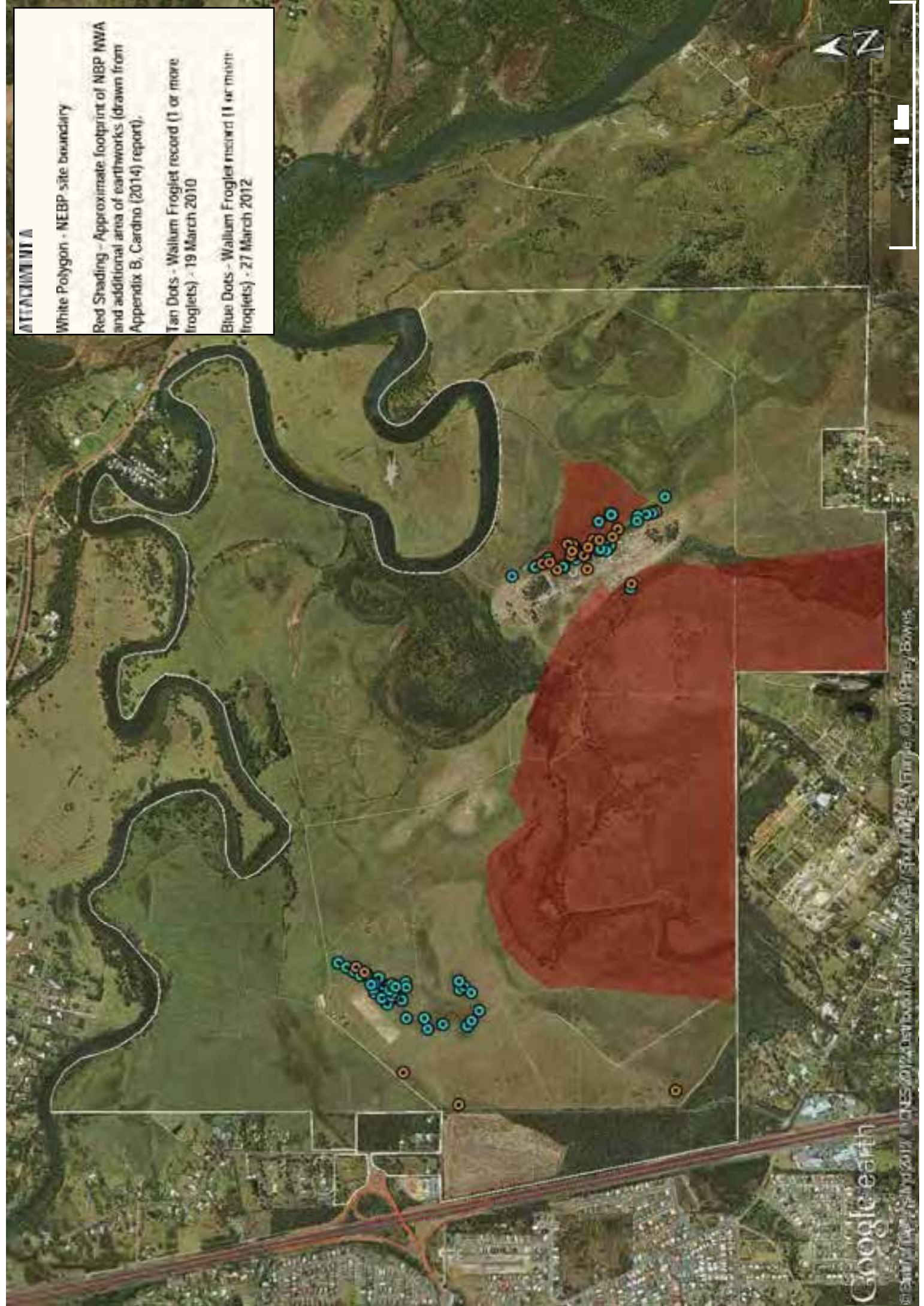
ATTACHMENT A

White Polygon - NEBP site boundary

Red Shading - Approximate footprint of NEP MWA and additional area of earthworks (drawn from Appendix B, Cardno (2014) report).

Tan Dots - Wallum Froglet record (1 or more froglets) - 19 March 2010

Blue Dots - Wallum Froglet record (1 or more froglets) - 27 March 2012



NEBP - Residential West RoL

APPENDIX

E

Open Space Restoration Concept Plan

Raff Creek Restoration Concept Plan

NEBP - Residential West Area

7903-59/020



Prepared for
North East Business Park Pty Ltd

4 June 2014

Contact Information

Cardno (QLD) Pty Ltd
ABN 57 051 074 992

Level 11 Green Square North Tower
515 St Paul's Terrace
Fortitude Valley QLD 4006
Locked Bag 4006 Fortitude Valley



Telephone: 07 3369 9822
Facsimile: 07 3369 9722
International: +61 7 3369 9822


cardno@cardno.com.au
www.cardno.com.au

Document Information

Prepared for	North East Business Park Pty Ltd
Project Name	NEBP - Residential West Area
File Reference	I:\7903-59 Northeast Business Park\020 RCP\wp\Reports\Raff Crk RCP V1.docx
Job Reference	7903-59/020
Date	4 June 2014

Document Control

Version	Date	Description of Revision	Prepared By	Prepared (Signature)	Reviewed By	Reviewed (Signature)
A	26 May 2014	Draft for client review	KJD		DW	
1	4 June 2014	Final	KJD		DW	

Version	Reason for Issue	Approved for Release By	Approved (Signature)	Approved Release Date
A	26 May 2014	KJD		26 May 2014
1	For issue	KJD		4 June 2014

© Cardno 2014. Copyright in the whole and every part of this document belongs to Cardno and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person other than by agreement with Cardno.

This document is produced by Cardno solely for the benefit and use by the client in accordance with the terms of the engagement. Cardno does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by any third party on the content of this document.

Table of Contents

1	Introduction	1
2	The NEBP RWA Open Space Precinct	2
3	Existing Environment	3
3.1	Physical Environment	3
3.2	Ecosystems Characteristics	3
4	Rehabilitation Specifications	6
4.1	Rehabilitation Objectives	6
4.2	Restoration Approaches	6
4.3	Management Units	8
4.3.1	Habitat Protection Units	9
4.3.2	Habitat Restoration Units	14
4.4	Staging of Restoration Works	19
4.4.1	Habitat Protection Units	19
4.4.2	Habitat Restoration Units	19
4.5	Threatened Species Management	22
4.6	Mosquito and Biting Midge Management	22
4.7	Bushfire Management	23
4.8	Access Management	23
4.9	Performance Indicators, Monitoring and Adaptive Management	24
4.10	Restoration Personnel and Contractors	24
4.11	Case Studies	24
5	Restoration Implementation Plans	25
6	References	27

Tables

Table 3-1	Broad habitat types recorded within the RWA Open Space Precinct	3
Table 4-1	Summary of different restoration approaches used in this RCP	7
Table 4-2	Key characteristics of each Management Unit	8
Table 4-3	HPU1/2	10
Table 4-4	HPU2/2	10
Table 4-5	HPU3/3	11
Table 4-6	HPU4/4	11
Table 4-7	HPU5/2	12
Table 4-8	HPU5/3	12
Table 4-9	HPU5/5	13
Table 4-10	HRU1/2	14
Table 4-11	HRU2/2	15
Table 4-12	HRU2/3	15
Table 4-13	HRU4/4	16
Table 4-14	HRU5/2	16

Table 4-15	HRU5/3	17
Table 4-16	HRU5/4	17
Table 4-17	HRU6/2	18
Table 4-18	HRU6/3	18
Table 4-19	General sequencing of restoration tasks - HPUs	19
Table 4-20	Approximate Extents of Topsoil Source Areas and HRUs for different habitat types	20
Table 4-21	General sequencing of restoration tasks - HRUs	21

Figures

Figure 1	Site Location
Figure 2	Raff Creek Open Space Precinct Zones
Figure 3	RWA Ecosystem Mapping
Figure 4	Habitat Protection and Habitat Restoration Units
Figure 5	Habitat Restoration Topsoil Source Areas

Appendices

Appendix A	Restoration Community Profiles
Appendix B	Restoration Case Studies

1 Introduction

This Raff Creek Restoration Concept Plan (RCP) provides general specifications for the rehabilitation of those parts of the Raff Creek floodplain that will be retained in the Open Space Precinct of the approved North East Business Park (NEBP) Residential West Area (RWA) development. The locations and extents of the NEBP site and the RWA are illustrated in Figure 1.

This RCP identifies and describes the particular types of ecosystems that are proposed to be established within the Open Space corridor based on consideration of:

- a) the Regional Ecosystem (RE) character of areas of existing vegetation to be retained within the Open Space corridor;
- b) proposed location and extents of earthworks and resultant finished levels;
- c) projected sea-level rise and associated increased extents of tidal inundation that may be experienced within the re-profiled Raff Creek flood plain;
- d) the system's flood flow conveyance requirements for the purpose of avoiding adverse impacts on upstream flood levels (as informed by the hydraulic modelling that is currently being undertaken by Cardno);
- e) the habitat requirements of rare and threatened flora and fauna that currently (or which potentially) occur within the Raff Creek catchment and a desire to achieve a long-term improvement in those habitat values;
- f) a desire to have the rehabilitation works make a positive contribution towards an overall improvement in the quality of water discharging from the Raff Creek catchment into the Caboolture River, potentially reducing the need to dedicate resources towards water quality improvement works within upstream reaches of the Raff Creek catchment;
- g) the provision of "off-sets" for the loss of native vegetation and fauna habitats elsewhere within the RWA, including the southern Raff Creek anabranch;
- h) the maintenance of acceptable levels of bushfire hazard within adjacent residential areas;
- i) the minimisation of mosquito breeding habitats; and
- j) the management of public access to and enjoyment of sensitive areas.

This RCP provides guidelines concerning the manner in which the objectives of the RCP will be achieved, with reference to:

- a) the role of different approaches to rehabilitation of native ecosystems as specified in Cardno Chenoweth and Bushland Restoration Services (2012) South East Queensland Ecological Restoration Framework: Guideline, prepared on behalf of SEQ Catchments and South East Queensland Local Governments, Brisbane;
- b) the staging and monitoring of rehabilitation works;
- c) the role of performance indicators, monitoring and adaptive management;
- d) the requirement for the preparation of detailed Restoration Implementation Plans as an integral component of requisite Operational Works applications for each relevant phase of the RWA development; and
- e) the relevant qualifications required for the preparation and implementation of rehabilitation works.

The RCP also makes reference to other projects that have involved the restoration and enhancement of highly disturbed waterway corridor and wetland environments, to demonstrate that the rehabilitation and enhancement works proposed within the Raff Creek corridor can realistically be achieved.

2 The NEBP RWA Open Space Precinct

The NEBP RWA Open Space Precinct is centred on Raff Creek and will be a total of 87 hectares in extent and comprised of approximately:

- 1) 8 hectares of land to be developed as formal parklands, generally located above the Q100 flood level (the Parkland Zone);
- 2) 5 hectares of land that is to be maintained in its current condition to accommodate a potential regional road corridor;
- 3) 12 hectares of land that will accommodate a total of six constructed wetlands that are proposed as part of the NEBP RWA development's stormwater treatment train (the Constructed Wetland Zone);
- 4) 31 hectares of existing native vegetation and fauna habitats associated with Raff Creek that are to be retained and managed primarily for environmental purposes (the Habitat Protection Zone); and
- 5) 31 hectares of land that is to be re-profiled to provide the required flood storage offsets and subsequently rehabilitated to a natural condition and managed for environmental purposes (the Habitat Restoration Zone).

The locations and extents of the above described zones within the Raff Creek Open Space Precinct are illustrated in Figure 2.

This RCP is specifically concerned with the Habitat Protection Zone and Habitat Restoration Zone of the RWA Open Space Precinct, which are to be the subject of a comprehensive program of rehabilitation works in general accordance with the specifications presented in Section 4. To be clear this RCP does not apply to:

- > any of the internal or regional road corridors that traverse the Open Space Precinct; or
- > any land this is located within the Constructed Wetland Zone or Parkland Zone.

3 Existing Environment

3.1 Physical Environment

The NEBP RWA Open Space Precinct is predominantly flat, ranging in elevation from Mean Sea Level (MSL) to 6.5m Australian Height Datum (AHD). The Mean High Water Springs (MHWS) level for the RWA is 0.82m AHD and the Highest Astronomical Tide (HAT) is 1.36m AHD.

Raff Creek, a tributary of the Caboolture River, traverses the NEBP RWA Open Space Precinct. The main channel of Raff Creek forms the western and northern boundary of the RWA, whilst an un-named tributary of Raff Creek forms the eastern boundary of the RWA. The existing peak 100 year ARI flood levels range from 3.29m AHD adjacent to Raff Creek in the south west corner down to 3.21m AHD at the confluence of Raff Creek and the unnamed eastern tributary.

The landform and drainage patterns of the RWA have been subjected to some modification as part of the past use of the land for agricultural, forestry and grazing purposes.

3.2 Ecosystems Characteristics

The ecosystems of the NEBP RWA are characterised by expanses of disturbed grassland, scattered trees, paperbark (*Melaleuca quinquenervia*) communities, Eucalypt open forest and areas of marine vegetation within tidally influenced reaches of Raff Creek. When considered from a pre-disturbance perspective much of the RWA is in poor condition and consists of highly modified vegetation communities that are a product of approximately 150 years of active use for agricultural, grazing and plantation forestry purposes.

The RWA the entire Open Space Precinct would have originally supported wetland areas comprised of the following ecosystem types:

- > RE12.1.1 - *Casuarina glauca* woodland on margins of marine clay plains;
- > RE12.1.2 - Saltpan vegetation including grassland, herbland and sedgeland on marine clay plains;
- > RE12.1.3 - Mangrove shrubland to low closed forest on marine clay plains and estuaries; and
- > RE12.3.5 - *Melaleuca quinquenervia* open forest on coastal alluvium.

No part of the RWA Open Space Precinct currently supports any areas of mapped remnant vegetation.

A description of the broad ecosystem types that currently occupy the RWA Open Space Precinct is provided below and their distribution is illustrated in Figure 3.

Table 3-1 Broad habitat types recorded within the RWA Open Space Precinct

Habitat Type	Characteristics
Mangrove wetlands	<p>Dominated by mangrove species with characteristic aerial roots. Invariably located below HAT and often in most frequently tidally inundated areas. Occur on soils that are classically estuarine – fine dark silty clay which is highly saline and anaerobic.</p> <p>Within the RWA this community is confined to the tidally influenced reaches of Raff Creek and is generally dominated by Grey mangrove (<i>Avicennia marina</i>) and River mangrove (<i>Aegiceras corniculatum</i>) with a fringing band of Saltwater couch (<i>Sporobolus virginicus</i>), Swamp oak (<i>Casuarina glauca</i>) and other species such as Suaeda sp., Ruby saltbush (<i>Enchylaena tomentosa</i>).</p> <p>This community is recognised as being a marine wetland community.</p>

Habitat Type	Characteristics
<p>Coastal and sub-coastal <u>saline swamps</u></p>	<p>The most conspicuous feature of coastal grass-sedge wetlands is dominance by grasses (family Poaceae) and/or sedges (principally, family Cyperaceae). Inundation is usually temporary, ranging from a few weeks each year during periods of heavy rain and flash flooding, to many months.</p> <p>The geomorphologic setting for coastal grass-sedge wetlands is minor basins, small depressions and poorly drained flats on marine or alluvial plains with gentle or minimal slope.</p> <p>Soil of coastal grass-sedge wetlands typically is heavy, dark clay that was originally deposited by streams or the ocean. On marine plains the underlying substrate may have a high salt content but may be overlaid with more recent alluvial deposits that are not saline.</p> <p>Within the RWA this community occurs adjacent to the tidally influenced downstream reaches of Raff Creek and occupies an area that has been cleared in the past and is actively maintained in an open condition and subject to livestock grazing. The vegetation in this community is dominated by Saltwater couch (<i>Sporobolus virginicus</i>) and other saltmarsh species.</p> <p>This community is recognised as being a marine wetland community.</p>
<p>Coastal and sub-coastal floodplain tree swamps - melaleuca and eucalypt</p>	<p>Tree swamps are non-tidal, wooded wetlands generally occupying depressions and drainage lines. These communities are seasonally inundated with the period of inundation being highly variable but extending in some instances to 3–6 months of the year.</p> <p>They occur on a broad range of soil types, from the predominantly silty to loamy clays on the edges of water bodies to sandy alluvia soils on a floodplain and poorly oxygenated marine clays or the black soil plains.</p> <p>Within the RWA this community is represented by areas of non-remnant paperbark (<i>Melaleuca quinquenervia</i>) open forest derived from RE12.3.5, which would have occupied the majority of the Raff Creek flood plain prior to the commencement of broad scale vegetation clearance and subsequent use of the land for agricultural, forestry and grazing purposes.</p> <p>The vegetation is generally dominated by Broad-leaved paperbark (<i>Melaleuca quinquenervia</i>) to a height of approximately 20m with scattered Queensland blue gum (<i>Eucalyptus tereticornis</i>), Grey ironbark (<i>Eucalyptus siderophloia</i>) and Swamp box (<i>Lophostemon suaveolens</i>). The understorey is dominated by a combination of native species, exotic grasses and other introduced plants. Species that occur within this community include Poison peach (<i>Trema tomentosa</i>), Monkey rope vine, <i>Melaleuca linariifolia</i>, White passion flower (<i>Passiflora subpeltata</i>), Groundsel bush, Pink euodia (<i>Melicope elleryana</i>), <i>Glochidium sumatranum</i>, <i>Stephania japonica</i>, Red ash, <i>Pittosporum revolutum</i>, <i>Kennedia rubicunda</i>, Frogsmouth (<i>Philydrum lanuginosum</i>), Smartweed (<i>Persicaria sp.</i>), Water hyacinth (<i>Eichhornia crassipes</i>), Wild tobacco, Soft bracken (<i>Calochlaena dubia</i>), <i>Lomandra longifolia</i>, <i>Ludwigia peploides</i>, Camphor laurel (<i>Cinnamomum camphora</i>), Mile-a-minute, Fleabane (<i>Conzya sp.</i>) and <i>Passiflora sp.</i> However, <i>Phragmites australis</i> and <i>Blechnum indicum</i> become locally predominant in some areas of the communities associated with the drainage lines.</p> <p>This community is recognised as being a palustrine wetland community.</p>
<p>Coastal and sub-coastal floodplain, grass, sedge herb swamps</p>	<p>The most conspicuous feature of coastal grass-sedge wetlands is dominance by grasses (family Poaceae) and/or sedges (principally, family Cyperaceae). Inundation is usually temporary, ranging from a few weeks each year during periods of heavy rain and flash flooding, to many months.</p> <p>The geomorphologic setting for coastal grass-sedge wetlands is minor basins, small depressions and poorly drained flats on marine or alluvial plains with gentle or minimal slope.</p> <p>Soil of coastal grass-sedge wetlands typically is heavy, dark clay that was originally deposited by streams or the ocean. On marine plains the underlying substrate may have a high salt content but may be overlaid with more recent alluvial deposits that are not saline.</p> <p>Within this RWA this community is primarily represented by areas that would originally have supported RE12.3.5 and which have been actively managed to suppress regrowth of an overstorey of paperbarks and allied species. Removal of disturbance pressures would see most of these areas transition over time to the community described as Coastal and sub-coastal floodplain tree swamps - melaleuca and eucalypt.</p> <p>This community is recognised as being a palustrine wetland community.</p>

Habitat Type	Characteristics
Disturbed Wet-Terrestrial Grassland Mosaic	<p>Whilst this is not a wetland community class recognised in the QWP Guideline, this class applies to the balance of the RWA that is located below the Q100 flood contour. These areas:</p> <ul style="list-style-type: none"> > have been subjected to substantial disturbance in the past as a consequence of initial broad scale vegetation clearance and subsequent agricultural, forestry and grazing uses; > would have originally supported wetland ecosystems prior to the broad scale clearance and development of the NEBP; and > currently supports a disturbed mosaic of terrestrial and ephemeral wetland (floodplain, grass, sedge herb swamps) areas that are difficult to map accurately. <p>The costs of field based surveys and investigations that would be required to separate wet grassland areas from terrestrial grassland areas would be prohibitive and as such the conservative assumption has been made to treat this mosaic as a wetland class.</p>
Disturbed Terrestrial Grassland	<p>This community is characterised by species that are common to disturbed rural landscapes such as Pigeon grass (<i>Setaria spp.</i>), Rhodes grass (<i>Chloris gayana</i>), Paspalum sp., Guinea grass (<i>Panicum maximum</i>), Wild tobacco, Balloon cotton bush (<i>Gomphocarpus physocarpus</i>), Phasey bean (<i>Macroptilium lathyroides</i>), Siratro (<i>Macroptilium atropurpureum</i>), Blady grass (<i>Imperata cylindrica</i>), Cobblers peg (<i>Bidens pilosa</i>), Blue billygoat weed (<i>Ageratum houstonianum</i>), Scotch thistle (<i>Cirsium vulgare</i>), Groundsel (<i>Baccharis halimifolia</i>), Devils fig (<i>Solanum torvum</i>), Lantana (<i>Lantana camara</i>), and some scattered areas of Slash pine (<i>Pinus elliotii</i>) and Acacia regrowth.</p>
Disturbed Terrestrial Woodland	<p>The disturbed woodland community was recorded from a narrow strip alongside the riparian zone and atop the isolated knoll on the eastern portion of the site. The overstorey consists of scattered canopy species such as Queensland blue gum (<i>Eucalyptus tereticornis</i>), Pink bloodwood (<i>Corymbia intermedia</i>), Moreton Bay ash (<i>Corymbia tessellaris</i>), Slash pine, Acacia sp. and Broad-leaved paperbark (<i>Melaleuca quinquenervia</i>). Owing to a history of disturbance and edges effects this community is currently subject to high levels of invasion by many of the exotic plant species described for the disturbed grassland community. These areas would in pre-disturbance condition have supported RE 12.5.3 which is characterised by a dominance of Scribbly gum (<i>Eucalyptus racemosa</i>) however this species was found to be conspicuously absent from the disturbed woodland community within the Site.</p>

4 Rehabilitation Specifications

4.1 Rehabilitation Objectives

The overall objective of this RCP is to provide general specifications for the staged rehabilitation and management of the Raff Creek Open Space corridor.

The specific outcomes sought through implementation of this RCP are as follows.

- Outcome 1: Protection of the bed and banks of the main Raff Creek channel and associated riparian vegetation and fauna habitats during the construction and occupation of the NEBP RWA development.
- Outcome 2: Restoration of self-sustaining natural ecosystems within those parts of the Raff Creek flood plain, contained within the RWA Open Space Precinct, that are re-profiled as part of the NEBP RWA development.
- Outcome 3: Enhancement of the habitat values of the RWA Open Space Precinct for threatened native wildlife species that are known or likely to occur within the NEBP locality.
- Outcome 4: Provide offsets for the loss of ecological features located within those parts of the RWA that are to be developed for residential purposes.
- Outcome 5: Effect a net improvement in the qualities of waters flowing through the Raff Creek system and discharging into the Caboolture River.
- Outcome 6: Maintain acceptable bushfire hazard levels within urban areas having frontage to the RWA Open Space Precinct.
- Outcome 7: Maintain acceptable levels of mosquito and biting midge breeding within the Raff Creek system such that future residents of and visitors to the RWA are not exposed to unacceptable levels of exposure to mosquito or biting midge.
- Outcome 8: Provide opportunities for public access to and enjoyment of the Raff Creek system that are consistent with the ecological values of the system.

4.2 Restoration Approaches

The South East Queensland Ecological Restoration Framework: Guideline (2012) recognises the following broad approaches to restoration of native wildlife habitat, including:

- a) natural regeneration;
- b) assisted natural regeneration;
- c) reconstruction; and
- d) fabrication (type conversion).

The particular approach to be adopted in a given area will be determined by the existing characteristics of the area and the broader land use context of the locality within which the restored area will exist. Within a given area a combination of approaches may often be required. For example, when remnant native vegetation is surrounded by cleared and degraded lands, an assisted natural regeneration approach would be appropriate for the remnant areas and a reconstruction approach may be required for the surrounding lands that are intended to be restored to extend, or provide linkages between, remnant habitat areas. In areas where fundamental changes have been made to the landform and hydrology of the area to be restored it may be necessary to adopt either an assisted natural regeneration/reconstruction approach or a reconstruction/fabrication approach depending upon whether or not top soil containing native plant seed is available for use and/or seed is able to reach the site from nearby natural areas, through dispersal by birds or other animals, wind or water.

Table 4-1 provides a brief overview of the different restoration approaches upon which this RCP is based.

Table 4-1 Summary of different restoration approaches used in this RCP

Restoration Approach	Attributes	Description
Natural Regeneration	Situation Where Applicable	<p>Relatively large, intact and weed-free areas of native vegetation.</p> <p>Areas where the native plants are healthy and capable of regenerating without human intervention.</p> <p>When native plant seed is stored in the soil or will be able to reach the site from nearby natural areas, through dispersal by birds or other animals, wind or water.</p> <p>Where the plant community has a high potential for recovery after any short lived disturbance, such as a fire or cyclonic winds.</p> <p>When preventative action is all that is required to avert on-going disturbance (e.g. erection of fencing to prevent intrusion by cattle).</p>
	Restoration Objective	In the short-medium term, the re-establishing plant community will attain the same structure, species composition and habitat values as the original vegetation.
	Weed Control	Weed control should have a minor role to play.
	Supplementary Planting	Planting in such sites can work against the aims of restoration by interfering with natural regeneration.
Assisted Natural Regeneration	Situation Where Applicable	<p>To natural areas where the native plant community is largely healthy and functioning.</p> <p>When native plant seed is still stored in the soil or will be able to reach the site from nearby natural areas, through dispersal by birds or other animals, wind or water.</p> <p>Where the natural regeneration processes (seedling germination, root suckering, etc.) are being inhibited by external factors, such as weed invasion, soil compaction, cattle grazing, mechanical slashing, etc.</p> <p>When limited human intervention, such as weed removal, minor amelioration of soil conditions, erection of fencing, cessation of slashing, etc. will be enough to trigger the recovery processes through natural regeneration.</p>
	Restoration Objective	In the medium term, the re-establishing plant community will be similar in structure, composition and diversity to the original vegetation.
	Weed Control	Weed control will be a major component of the restoration program.
	Supplementary Planting	Planting in such sites can work against the aims of restoration by interfering with natural regeneration.
Reconstruction	Situation Where Applicable	<p>Where the site is highly degraded or altered.</p> <p>When the degree of disturbance has been so great and long-standing that the pre-existing native plant community cannot recover by natural means.</p> <p>Areas of fill, sites affected by storm-water flow, and areas that have been drastically cleared, either mechanically or by stock even though there may be a few remaining native trees or shrubs and no viable soil seed bank or pathways for seed recruitment from nearby natural areas.</p> <p>When a greater degree of human intervention is required, such as weed removal, cessation of grazing and/or slashing, amelioration of soil conditions such as importation of soils, drainage works or reshaping of the landscape.</p> <p>When a major component is re-establishment of community structure and composition through active planting programs.</p>
	Restoration Objective	In the medium term natural regeneration processes should be re-established with the long-term objective that the plant community should will be similar in structure, composition and diversity to the original vegetation.
	Weed Control	Weed control will be a major component of the restoration program.
	Supplementary Planting	Planting will be a major component of the restoration (reconstruction) program.
Fabrication	Situation Where	Where site conditions have been irreversibly changed.

Restoration Approach	Attributes	Description
	Applicable	When it is either not possible or appropriate to restore the original native plant community. Where a better-adapted local plant community can be established that will function within the changed conditions. In situations such as the construction of a wetland plant community to mitigate increased urban stormwater run-off.
	Restoration Objective	The establishing planted community should be self-sustaining and similar to a naturally occurring plant community of the same type.
	Weed Control	Important, particularly during the initial stages of plant establishment.
	Supplementary Planting	Planting will be the dominant component of the restoration (fabrication) program.

4.3 Management Units

For the purposes of this RCP a total of sixteen (16) discrete Restoration Management Units (RMU) have been defined based on the nature of the subject areas and their associated restoration requirements. These RMUs fall into either of the following categories:

- 1) Habitat Protection Units (HPU), which encompass ~ 31 hectares of existing native vegetation and fauna habitats associated with Raff Creek that are to be retained and managed to protect and enhance their habitat values; and
- 2) Habitat Restoration Units (HRU), which encompass ~ 31 hectares of land that is to be re-profiled to provide the required flood storage offsets and then subsequently rehabilitated to a natural condition and managed for environmental purposes.

The locations and extents of the HPUs and HRUs within the Open Space Precinct are illustrated in Figure 4.

The key attributes of each RMU listed in Table 4-2 are provided in Sections 4.3.1 and 4.3.2.

Table 4-2 Key characteristics of each Management Unit

Attribute	Information provided
Extent (ha):	The extent of the subject area.
Existing Surface Elevations (m AHD):	The range of ground surface levels currently existing within the subject area based on LIDAR survey.
Modified Surface Elevations (m AHD):	The range of the modified ground surface levels that will be established within the subject area to achieve flood storage offsets.
Existing Habitat Type:	Brief description of the vegetation and fauna habitat characteristics of the subject area.
Existing Threatened Species Habitat Values:	Details concerning the threatened species known or considered likely to utilise the subject area in its existing condition and the key habitat resources available (e.g. Koala – <i>Eucalyptus tereticornis</i> ; Black-neck Stork - open wetland feeding grounds).
Natural Regeneration:	The strength of natural regeneration observed to be presently occurring within the subject area. This gives an indication of the value of the top-soil as a source of propagules for a particular habitat type that may be used in the restoration of the subject area or one of the other RMUs.
Prescribed Habitat Type (s):	The predominant habitat type that will be restored or enhanced within the subject area through implementation of this RCP. In some instances a secondary habitat type may also be prescribed to reflect the eco-tonal nature of the subject area.
Regional Ecosystem Equivalents:	The RE types that are consistent with the Prescribed Habitat Type(s). (note: Technical descriptions and bio-condition benchmarks for each RE type are provided in Appendix A, where available. If technical descriptions for a particular RE are not currently available then descriptions sourced from the Coastal Wetlands of South-east Queensland (EPA, 1998) are provided. These documents are to be used

Attribute	Information provided
	to guide the development of detailed restoration schedules and/or as benchmarks for the monitoring of restoration works.)
Restoration Approach:	<p>The dominant approach to restoration that will be implemented within the subject area, being:</p> <ul style="list-style-type: none"> > natural regeneration; > assisted natural regeneration; > reconstruction; or > fabrication (type conversion).
Future Threatened Species Habitat Values:	<p>Details concerning:</p> <ul style="list-style-type: none"> > the threatened species that are considered likely to utilise the subject area following implementation of the restoration program; > the key habitat resources that will be available (e.g. Koala – Eucalyptus tereticornis; Black-neck Stork - open wetland feeding grounds); and > any threatened species that currently utilise the subject area that are not likely to occur post restoration
Existing Manning's Roughness:	The Manning's roughness coefficient associated with the vegetation type(s) that currently exist within the subject area and used in the projects flood impact assessments.
Future Manning's Roughness:	The Manning's roughness coefficient associated with the vegetation type(s) that will be established within the subject area through implementation of this RCP.

4.3.1 Habitat Protection Units

A total of seven HPUs have been defined primarily based on the nature of the existing habitats that occupy the subject land and type of habitat that will be preserved or which will establish if the subject area is protected and managed to facilitate natural ecological processes. Details concerning some of the key characteristics of each of the identified HPUs, which are often comprised of a number of discrete areas, are provided in Table 4-3 to Table 4-9.

Table 4-3 HPU1/2

Attribute	Information provided
Extent (ha):	0.4
Existing Surface Elevations (m AHD):	1.3 – 2.4
Modified Surface Elevations (m AHD):	1.3 – 2.4
Existing Habitat Type:	Coastal and sub-coastal floodplain, grass, sedge herb, swamps.
Existing Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) – feeding and breeding habitat. Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) - open wetland feeding grounds.
Natural Regeneration:	Moderate to High natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal floodplain tree swamps - Melaleuca and Eucalypt
Regional Ecosystem Equivalents:	RE12.3.5
Restoration Approach:	Assisted natural regeneration / Natural regeneration.
Future Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Koala (<i>Phascolarctos cinereus</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.15.

Table 4-4 HPU2/2

Attribute	Information provided
Extent (ha):	18.1
Existing Surface Elevations (m AHD):	1.6 – 2.6
Modified Surface Elevations (m AHD):	1.6 – 2.6
Existing Habitat Type:	Coastal and sub-coastal floodplain tree swamps - melaleuca and eucalypt
Existing Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	High natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal floodplain tree swamps - melaleuca and eucalypt
Regional Ecosystem Equivalents:	RE12.3.5
Restoration Approach:	Natural regeneration / Assisted natural regeneration.
Future Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Tusked Frog (<i>Adelotus brevis</i>) Wallum Rocketfrog (<i>Litoria freycineti</i>) Lewin's Rails (<i>Rallus pectoralis</i>) Australian Painted Snipe (<i>Rostratula australis</i>) Koala (<i>Phascolarctos cinereus</i>)
Existing Manning's Roughness:	0.15.
Future Manning's Roughness:	0.15.

Table 4-5 HPU3/3

Attribute	Information provided
Extent (ha):	0.1
Existing Surface Elevations (m AHD):	1.3 - 1.5
Modified Surface Elevations (m AHD):	1.3 - 1.5
Existing Habitat Type:	Coastal and sub-coastal <u>saline swamps</u>
Existing Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>)
Natural Regeneration:	High natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal <u>saline swamps</u>
Regional Ecosystem Equivalent:	RE12.1.2
Restoration Approach:	Natural regeneration/Assisted natural regeneration.
Future Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Water Mouse (<i>Xeromys myoides</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.025.

Table 4-6 HPU4/4

Attribute	Information provided
Extent (ha):	7.3
Existing Surface Elevations (m AHD):	< 1.3
Modified Surface Elevations (m AHD):	< 1.3
Existing Habitat Type:	Mangrove wetlands
Existing Threatened Species Habitat Values:	-
Natural Regeneration:	High natural regeneration potential.
Prescribed Habitat Type (s):	Mangrove wetlands
Regional Ecosystem Equivalent:	RE12.1.3 / RE12.1.1
Restoration Approach:	Natural regeneration
Future Threatened Species Habitat Values:	Water Mouse (<i>Xeromys myoides</i>)
Existing Manning's Roughness:	0.15
Future Manning's Roughness:	0.15

Table 4-7 HPU5/2

Attribute	Information provided
Extent (ha):	0.1
Existing Surface Elevations (m AHD):	1.8 – 2.0
Modified Surface Elevations (m AHD):	1.8 – 2.0
Existing Habitat Type:	Disturbed Wet-Terrestrial Grassland Mosaic
Existing Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Moderate - High natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal floodplain tree swamps - melaleuca and eucalypt
Regional Ecosystem Equivalents:	RE12.3.5
Restoration Approach:	Assisted natural regeneration / Natural regeneration.
Future Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Tusked Frog (<i>Adelotus brevis</i>) Wallum Rocketfrog (<i>Litoria freycinoti</i>) Lewin's Rails (<i>Rallus pectoralis</i>) Australian Painted Snipe (<i>Rostratula australis</i>) Koala (<i>Phascolarctos cinereus</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.15.

Table 4-8 HPU5/3

Attribute	Information provided
Extent (ha):	0.2
Existing Surface Elevations (m AHD):	1.5 - 1.7
Modified Surface Elevations (m AHD):	1.3 - 1.5 (note: some re-profiling of this area may be warranted subject to further investigation at the Operational Works phase of development).
Existing Habitat Type:	Disturbed Wet-Terrestrial Grassland Mosaic
Existing Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Low-Moderate natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal <u>saline swamps</u>
Regional Ecosystem Equivalents:	RE12.1.2
Restoration Approach:	Assisted natural regeneration / Reconstruction
Future Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) - open wetland feeding grounds. Water Mouse (<i>Xeromys myoides</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.025.

Table 4-9 HPU5/5

Attribute	Information provided
Extent (ha):	3.8
Existing Surface Elevations (m AHD):	1.5 – 3.2
Modified Surface Elevations (m AHD):	1.5 – 3.2
Existing Habitat Type:	Disturbed Wet-Terrestrial Grassland Mosaic
Existing Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Low-Moderate natural regeneration potential.
Prescribed Habitat Type (s):	Disturbed Wet-Terrestrial Grassland Mosaic
Regional Ecosystem Equivalents:	N/A
Restoration Approach:	N/A - Area to be maintained in current condition to accommodate future regional roadway.
Future Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.025.

4.3.2 Habitat Restoration Units

A total of nine HRUs have been defined primarily based on the nature of the existing habitats that occupy the subject land and type of habitat that will be restored within the subject area following the completion of Raff Creek flood plain re-profiling works. Details concerning some of the key characteristics of each of the identified HRUs, which are often comprised of a number of discrete areas, are provided in Table 4-10 to Table 4-18.

Table 4-10 HRU1/2

Attribute	Information provided
Extent (ha):	8.8
Existing Surface Elevations (m AHD):	1.9 - 3.5
Modified Surface Elevations (m AHD):	1.6 - 1.9
Existing Habitat Type:	Coastal and sub-coastal floodplain, grass, sedge herb, swamps.
Existing Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>)
Natural Regeneration:	Moderate to High natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal floodplain tree swamps - melaleuca and eucalypt
Regional Ecosystem Equivalents:	RE12.3.5
Restoration Approach:	Fabrication.
Future Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Tusked Frog (<i>Adelotus brevis</i>) Wallum Rocketfrog (<i>Litoria freycineti</i>) Lewin's Rails (<i>Rallus pectoralis</i>) Australian Painted Snipe (<i>Rostratula australis</i>) Koala (<i>Phascolarctos cinereus</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.15.

Table 4-11 HRU2/2

Attribute	Information provided
Extent (ha):	0.8
Existing Surface Elevations (m AHD):	1.6 – 2.3
Modified Surface Elevations (m AHD):	1.4 – 1.6
Existing Habitat Type:	Coastal and sub-coastal floodplain, grass, sedge herb, swamps.
Existing Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Moderate to High natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal floodplain tree swamps - Melaleuca and Eucalypt
Regional Ecosystem Equivalents:	RE12.3.5
Restoration Approach:	Fabrication.
Future Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Tusked Frog (<i>Adelotus brevis</i>) Wallum Rocketfrog (<i>Litoria freycineti</i>) Lewin's Rails (<i>Rallus pectoralis</i>) Australian Painted Snipe (<i>Rostratula australis</i>) Koala (<i>Phascolarctos cinereus</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.15.

Table 4-12 HRU2/3

Attribute	Information provided
Extent (ha):	0.6
Existing Surface Elevations (m AHD):	1.7 – 2.5
Modified Surface Elevations (m AHD):	1.4 – 1.5
Existing Habitat Type:	Coastal and sub-coastal floodplain, grass, sedge herb, swamps.
Existing Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Moderate to High natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal <u>saline swamps</u>
Regional Ecosystem Equivalents:	RE12.1.2
Restoration Approach:	Fabrication.
Future Threatened Species Habitat Values:	Water Mouse (<i>Xeromys myoides</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.15.

Table 4-13 HRU4/4

Attribute	Information provided
Extent (ha):	0.6
Existing Surface Elevations (m AHD):	1.1 – 1.7
Modified Surface Elevations (m AHD):	< 1.3
Existing Habitat Type:	Mangrove wetlands
Existing Threatened Species Habitat Values:	-
Natural Regeneration:	High natural regeneration potential.
Prescribed Habitat Type (s):	Mangrove wetlands
Regional Ecosystem Equivalent:	RE12.1.3 / RE12.1.1
Restoration Approach:	Fabrication / Natural regeneration
Future Threatened Species Habitat Values:	Water Mouse (<i>Xeromys myoides</i>)
Existing Manning's Roughness:	0.15
Future Manning's Roughness:	0.15

Table 4-14 HRU5/2

Attribute	Information provided
Extent (ha):	12.7
Existing Surface Elevations (m AHD):	1.7 – 3.8
Modified Surface Elevations (m AHD):	1.6 – 2.6
Existing Habitat Type:	Disturbed Wet-Terrestrial Grassland Mosaic
Existing Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Moderate - High natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal floodplain tree swamps - melaleuca and eucalypt
Regional Ecosystem Equivalent:	RE12.3.5
Restoration Approach:	Fabrication
Future Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Tusked Frog (<i>Adelotus brevis</i>) Wallum Rocketfrog (<i>Litoria freycineti</i>) Lewin's Rails (<i>Rallus pectoralis</i>) Australian Painted Snipe (<i>Rostratula australis</i>) Koala (<i>Phascolarctos cinereus</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.15.

Table 4-15 HRU5/3

Attribute	Information provided
Extent (ha):	1.1
Existing Surface Elevations (m AHD):	1.7 – 1.8
Modified Surface Elevations (m AHD):	1.4 - 1.5
Existing Habitat Type:	Disturbed Wet-Terrestrial Grassland Mosaic
Existing Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Low-Moderate natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal <u>saline swamps</u>
Regional Ecosystem Equivalents:	RE12.1.2
Restoration Approach:	Fabrication / Natural regeneration
Future Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Water Mouse (<i>Xeromys myoides</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.025.

Table 4-16 HRU5/4

Attribute	Information provided
Extent (ha):	0.3
Existing Surface Elevations (m AHD):	1.5 - 1.7
Modified Surface Elevations (m AHD):	< 1.4
Existing Habitat Type:	Disturbed Wet-Terrestrial Grassland Mosaic
Existing Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Wallum Froglet (<i>Crinia tinula</i>) Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Low-Moderate natural regeneration potential.
Prescribed Habitat Type (s):	Mangrove wetland
Regional Ecosystem Equivalents:	RE12.1.3
Restoration Approach:	Fabrication / Natural regeneration
Future Threatened Species Habitat Values:	Water Mouse (<i>Xeromys myoides</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.15.

Table 4-17 HRU6/2

Attribute	Information provided
Extent (ha):	5.3
Existing Surface Elevations (m AHD):	3.5 – 6.4
Modified Surface Elevations (m AHD):	1.1 – 3.2
Existing Habitat Type:	Disturbed Terrestrial Grassland - Woodland
Existing Threatened Species Habitat Values:	Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Low natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal floodplain tree swamps - Melaleuca and Eucalypt
Regional Ecosystem Equivalent:	RE12.3.5
Restoration Approach:	Fabrication
Future Threatened Species Habitat Values:	Wallum Froglet (<i>Crinia tinula</i>) Tusked Frog (<i>Adelotus brevis</i>) Wallum Rocketfrog (<i>Litoria freycineti</i>) Lewin's Rails (<i>Rallus pectoralis</i>) Australian Painted Snipe (<i>Rostratula australis</i>) Koala (<i>Phascolarctos cinereus</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.15.

Table 4-18 HRU6/3

Attribute	Information provided
Extent (ha):	0.6
Existing Surface Elevations (m AHD):	1.4 – 2.1
Modified Surface Elevations (m AHD):	1.1 – 1.5
Existing Habitat Type:	Disturbed Terrestrial Grassland - Woodland
Existing Threatened Species Habitat Values:	Koala (<i>Phascolarctos cinereus</i>)
Natural Regeneration:	Low natural regeneration potential.
Prescribed Habitat Type (s):	Coastal and sub-coastal <u>saline swamps</u>
Regional Ecosystem Equivalent:	RE12.1.2
Restoration Approach:	Fabrication / Natural regeneration
Future Threatened Species Habitat Values:	Black-necked Stork (<i>Ephippiorhynchus asiaticus</i>) Water Mouse (<i>Xeromys myoides</i>)
Existing Manning's Roughness:	0.025.
Future Manning's Roughness:	0.025.

4.4 Staging of Restoration Works

The general nature and staging of restoration works within the identified HPUs and HRUs are described below.

4.4.1 Habitat Protection Units

Restoration works within the HPUs will primarily be focused on the management of external pressures which may adversely affect natural ecosystem processes within the protected areas, including natural regeneration of native plant communities. Details concerning the general nature and sequencing of restoration tasks within HPUs are provided in Table 4-19.

Table 4-19 General sequencing of restoration tasks - HPUs

Task	Timing
The outer boundary between Habitat Protection Units and the balance of the RWA and adjacent MIBA is to be fenced to exclude livestock and to restrict entry during the physical development of the RWA. The form of fencing to be used needs to provide for the unimpeded movement of native fauna.	Prior to the submission of an Operational Works applications for a phase of the RWA development that involves works within or adjacent to the Open Space Precinct.
The HPU boundary fencing is to be maintained.	Until the adjoining RWA and MIBA development have been completed.
A program of weed and pest monitoring and management is to be implemented and maintained within all HPUs to facilitate the natural regeneration of the various habitat types contained therein.	Concurrent with commencement of Operational Works within the Open Space Precinct and to be maintained.
An ecosystem health monitoring program is to be developed and implemented throughout all HPUs to monitor changes in ecological conditions and any associated requirements for active intervention to assist natural ecological processes that may be under stress due to the nature and scale of the adjacent developments.	Concurrent with commencement of Operational Works and to be maintained until the RWA and adjoining MIBA developments have been completed.

4.4.2 Habitat Restoration Units

The HRU will be the subject of a staged program of bulk-earthworks carried out within the Open Space and Residential Precincts of the RWA, part of which will involve the re-profiling and subsequent restoration of HRUs. The precise sequencing of the bulk earthworks and residential development is still to be determined.

As detailed in Section 4.3.2 the primary approach to restoration of natural ecosystems within the HRUs will be via Fabrication supplemented by Assisted Natural Regeneration. Fabrication will primarily be achieved via:

- > the re-profiling of the HRUs to an Interim Finished Level (IFL) that is 50-100mm lower than the Design Finished Level (DFL);
- > the re-spreading (or translocation) of stripped topsoil sourced from an area that has a high natural regeneration potential for the prescribed habitat type for that HRU;
- > the monitoring and management of weeds; and
- > the design and implementation of a planting program if regeneration from the topsoil is not sufficient to achieve the restoration outcomes.

Stripping and translocating topsoil is a well-accepted means of carrying out post-mining restoration works and is well suited to the Raff Creek restoration works as the topsoil layer contains seeds, rootstock, rhizomes, tubers and soil micro-organisms. The restoration works will be sequenced in a manner that avoids, to the extent practicable, the stockpiling of stripped topsoil that has a high natural regeneration potential to:

- > minimise the potential for the loss of viability of soil organisms and propagules, and the risk of decomposition; and
- > maximise the potential for natural regeneration to occur from the translocated material.

Topsoil should be removed and respread with great care as both the nature of the equipment used and the soil moisture content influence the degree of soil compaction and structural breakdown that can occur during these procedures. The combined use of a front-end loader, truck and bulldozer for the removal, transport and spreading of topsoil is often the best combination to reduce compaction. If the amount of suitable topsoil available is limited, the available material will be spread to a thinner depth or in strips.

For the purposes of the RCP the general locations of areas within the RWA Open Space Precinct and RWA Residential Precinct that are potential sources of topsoil for use in the restoration the HRUs (i.e. Topsoil Source Areas) have been identified and are illustrated in Figure 5. The extents of identified Topsoil Source Areas for particular habitat types and the extent of the HRUs that are to be restored to that same habitat type are detailed in Table 4-20.

Table 4-20 Approximate Extents of Topsoil Source Areas and HRUs for different habitat types

Habitat Type	Extent of Identified Topsoil Source Areas (Ha)	Extent of HRUs (Ha)
Coastal and sub-coastal floodplain tree swamps - Melaleuca and Eucalypt	14.8	27.6
Coastal and sub-coastal saline swamps	1.4	2.6
Mangrove wetland	0.6	0.8

Based on the estimates presented in Table 4-20, there will be a deficit in the volume of topsoil material with a high natural regeneration potential relative to the project requirements for restoring particular vegetation types. This deficit will be managed by a combination of:

- > identification of additional areas within the RWA development footprint that may be suited for use as Topsoil Source Areas and any associated management requirements for such areas (e.g. selective treatment of weed infestations, removal of livestock grazing pressure);
- > application of topsoil in a thinner layer (e.g. < 100mm) or spreading the topsoil in a strip pattern as part of a sequential restoration approach within individual HRUs; and/or
- > the use of tube-stock planting or direct seeding.

Details concerning the general nature and sequencing of restoration tasks within HRUs are provided in Table 4-21.

Table 4-21 General sequencing of restoration tasks - HRUs

Task	General Specification	Timing
Environmental Management	<p>A Construction Environmental Management Plan (CEMP), Land Based Environmental Management Plan (LBEMP) or equivalent is to be prepared and submitted for approval in support of each Operation Works application involving a HRU.</p> <p>The submitted plan is to make appropriate provisions for:</p> <ul style="list-style-type: none"> ▪ vegetation clearance, stockpiling, reuse or disposal with the aim of retrieving suitable material for reuse in revegetation areas, including hollow logs for habitat enhancement in the restored areas; ▪ protection of native fauna, including the use of a fauna spotter catcher to supervise clearing works; ▪ erosion and sedimentation control; and ▪ acid sulphate soils management, taking into account the naturally acidic nature of the Raff Creek environments. 	<p>Plan to be submitted in support of Operational Works applications.</p> <p>Approved plan to be implemented.</p>
Identification of Topsoil Source Areas	<p>Each program of approved Operational Works will include Topsoil Source Areas located within either the RWA Open Space Precinct or the RWA Residential Precinct that can be used in the restoration of the HRUs that are also the subject of the approved Operational Works program</p>	<p>Details to be submitted in support of Operational Works applications.</p>
Identification of Topsoil Receive Area	<p>Each program of approved Operational Works will include Topsoil Receive Areas located within the RWA Open Space Precinct that will receive material sourced from Topsoil Source Areas.</p> <p>(note: In some instances the Topsoil Source Areas and Topsoil Receive Areas may coincide).</p>	<p>Details to be submitted in support of Operational Works applications.</p>
Re-profiling of HRU.	<p>The surface of the HRU (or part thereof) is to be re-profiled to the IFL in accordance with detailed engineering specifications in preparation for receipt of topsoil from the Topsoil Source Areas.</p> <p>(note: HRU re-profiling is to commence in areas that are not identified as a Topsoil Source Area and the associated topsoil with a low regeneration potential is to be stockpiled for potential use elsewhere within the RWA development.)</p>	<p>Details to be submitted in support of Operational Works applications.</p>
Topsoil re-spreading / translocation.	<p>Material from Topsoil Source Areas, sourced from within or external to the HRU, is to be transferred and spread across the surface of the re-profiled HRU to a depth no greater than 100 mm.</p>	<p>Details to be submitted in support of Operational Works applications.</p>
Access management	<p>Upon completion of re-profiling and topsoil restoration works, the boundary of the HRU is to be fenced to exclude livestock and vehicular access. Fencing is not to impede the movement of native fauna.</p>	<p>Prior to completion of Operational Works.</p>
	<p>The HRU boundary fencing is to be maintained.</p>	<p>Until the adjoining RWA and MIBA developments have been completed.</p>
Weed Management	<p>A program of weed monitoring and management is to be implemented and maintained within restored HRUs to facilitate the natural regeneration of the various habitat types contained therein.</p>	<p>Concurrent with commencement of Operational Works in a particular area and to be maintained for a period of at least 24 months following completion of works.</p>
Ecosystem Health Monitoring	<p>An ecosystem health monitoring program is to be developed and implemented within HRUs to monitor changes in ecological conditions and any associated requirements for active intervention to assist natural ecological processes that may be under stress due to the nature and scale of the adjacent developments.</p>	<p>Concurrent with commencement of Operational Works in a particular area and to be maintained for a period of at least 24 months following completion of works.</p>

Task	General Specification	Timing
Active Planting	If ecosystem health monitoring indicates that the outcomes of the RCP are not being achieved within a HRU or part thereof, via the translocation of high natural regeneration potential topsoil, then an active planting program must be developed and implemented for the subject area	As required.

4.5 Threatened Species Management

As detailed in Section 4.3 the RWA provides habitat resources for a number of resident and vagrant threatened fauna species. The HPUs will provide a refuge for threatened fauna species within the RWA whilst the RWA development, including the re-profiling and restoration of HRUs, is occurring. It is anticipated that following the completion of the restoration works within each of the HRUs threatened species will recolonise these restored areas from:

- > the adjacent HPUs;
- > as yet undisturbed HRUs; and/or
- > adjacent habitat areas located outside of the RWA boundaries.

As part of the conduct of the restoration works within each HRU, pre-clearance fauna surveys will be carried out and to the extent that is practicable resident threatened fauna will be captured and translocated to secure areas prior to the commencement of earthworks.

Further consideration of threatened species management during the conduct of development activities will be given in the CEMP (or equivalent) and the Restoration Implementation Plan (see Section 5) that are to be prepared in support of requisite applications for Operational Works approval for each stage of the RWA development.

4.6 Mosquito and Biting Midge Management

The RWA and broader locality support extensive habitat resources for a mosquito and biting midge species that have the potential to impact on existing and future residents of locality. Existing habitat types present within the RWA and broader locality and the mosquito and biting midge species associated with those habitats are as follows.

The freshwater and saline wetlands and waterbodies within the locality presently provide a range of different habitat types for a variety of mosquito species known to be serious pests and vectors of communicable human viruses within the Moreton Bay Region. These habitats include the following:

1. Slightly brackish and freshwater pools in Paperbark wetlands and mangroves provide habitat for *Verrallina funerea* and *Ochlerotatus vigilax*, which are known vectors of Ross River Virus and Barmah Forest fever. Both species are most frequently experienced at pest levels in areas situated within 5 km of breeding grounds.
2. Freshwater pools, provide habitat for *Culex annulirostris*, *Ochlerotatus notoscriptus*, *Coquillettidia linealis* and *Culex quinquefasciatus*, which are known vectors of viruses such as Ross River Virus, Barmah Forest Virus, Australian Encephalitis, Japanese Encephalitis, Murray Valley Encephalitis and Kunjin.
3. Intertidal and brackish pools provide habitat for *Culex sitiens* and *Aedes alterans*, both known to be vectors of Ross River Virus.

Biting midges, which are small mosquito like insects that breed in a range of environments, ranging from rainforests to coastal foreshores and estuarine systems, are not known to transmit disease amongst humans and as such do not possess the same public health management significance as mosquitoes. Nevertheless biting midge may during periods of high abundance cause discomfort to people residing in close proximity to midge breeding/larval habitats. It is likely that the NEBP site provides habitat for the several pestiferous species of biting midge, namely *Culicoides subimmaculatus*, *C. molestus* and *C. longior*. In addition to these species, *C. ornatus*, which appears to be undergoing a range expansion south of the Hervey bay

region, is also likely to be encountered. The main areas of potential breeding habitat for these species are the tidally influenced flats and banks of the Caboolture River and Raff Creek.

The NEBP RWA development will remove substantial areas of existing breeding habitat for mosquitos and to a lesser extent biting midge and as such there is likely to be a net reduction in the extent of mosquito and biting midge breeding habitats as a consequence of the NEBP RWA development.

Notwithstanding the above, consideration will need to be given during the detailed design and construction phases of each stage of the NEBP RWA development to ensuring that the extent and productivity of potential mosquito and biting midge habitats is minimised whilst still providing the conditions required to maintain viable natural ecosystems within the Raff Creek open space corridor. Of particular importance in this respect is the maintenance of a barrier zone between potential mosquito breeding habitats within the Open Space precinct and adjacent residential dwellings. The barrier zone should be at least 40m in width and be a sparsely vegetated area that will interrupt the dispersal route of the biting insects from their breeding sites to residential area and reduce harbourage areas by removing the protection of vegetation for shelter. Esplanade roadways, daytime recreation areas, parking areas, parklands with small shrubs and flower beds, woodlands of tall trees with light foliage, or broad scale agricultural land can be used to create the barrier zone.

4.7 Bushfire Management

The layout of the RWA development and design of the restoration works within the Raff Creek Open Space Precinct seek to achieve the following outcomes with respect to bushfire management.

- 1) The health, safety or property of future residents is not placed at an unacceptable risk in the event of a bushfire occurring within the Open Space Precinct.
- 2) The role that bushfire plays in the functioning of natural ecosystems is recognised and catered for in the management of the Open Space precinct.

To ensure that these outcomes are achieved relevant consideration of bushfire management requirements for public health and safety and ecological purposes are incorporated into the overarching Open Space Management Plan for the RWA development and the Restoration Implementation Plans (RIPs) prepared for each stage of development in support of requisite applications for Operational Works approvals.

Public health and safety issues can primarily be met by providing an appropriate buffer between areas of potentially hazardous vegetation and adjacent residential areas, typically 30-40m in width.

To cater for ecological requirements it would be generally desirable to exclude fire from areas that are being actively regenerated. To facilitate future controlled burns within areas of established vegetation a network of pedestrian and cycle ways that also function as fire trails will be established throughout the Raff Creek Open Space Precinct.

4.8 Access Management

During the conduct of restoration works associated with each phase of the RWA development, access to HPU's and HRU's will be prohibited except for approved construction related activities including:

- > bulk earthworks;
- > the establishment of approved infrastructure, including perimeter fencing;
- > bushfire, vegetation and fauna management purposes; and
- > the establishment of maintenance access tracks which will generally be aligned with perimeter fencing.

Public access to the HPU's and HRU's will be actively discouraged to enhance the ecological values and functions of the subject areas. Opportunities for public engagement with the HPU's and HRU's will be provided within the adjoining Parkland Reserves and in association with the future roadway crossing of Raff Creek.

4.9 Performance Indicators, Monitoring and Adaptive Management

To achieve the objectives of the RCP it will be necessary to monitor changes in the ecological condition of the Raff Creek HPUs and HRUs that occur in response to:

- > the restoration works;
- > the adjacent RWA development; and/or
- > natural processes operating independently of the above (e.g. drought, flood, fires).

Data obtained from monitoring can be used to document the success or failure of the various management strategies and allow adaptation of the restoration techniques and implementation schedule to achieve the project objectives in a cost effective manner.

Monitoring of restoration works is to be carried out using a combination of:

- > fixed point photographic monitoring;
- > plot based quantitative monitoring within the HPUs and HRUs to measure changes in ecological equivalence or bio-condition overtime against the established benchmarks for the prescribed habitat (ecosystem type); and
- > threatened fauna monitoring, to detect the presence or absence of threatened fauna within the different HPUs and HRUs.

Monitoring of the HPUs and HRUs will occur on a biannual basis for whichever is the longer of the following periods of:

- > 5 years from the completion of restoration works within a given area; or
- > until the RWA and adjacent MIBA developments have been completed; or
- > the relevant Performance Indicators have been met.

4.10 Restoration Personnel and Contractors

The services of a restoration practitioner with the necessary qualifications, experience and resources will be engaged to design and implement the restoration program.

Minimum qualification for the restoration practitioner will be a certificate in Conservation Land Management - Natural Area Restoration from a TAFE college or a university degree in a related field such as ecology or vegetation management.

4.11 Case Studies

The program of landform modification and restoration of natural ecosystems such as that which is to occur within Raff Creek has some similarities with other programs that have been carried out as part of large scale urban development projects within south-east Queensland.

The South East Queensland Ecological Restoration Framework (Chenoweth EPLA and Bushland Restoration Services, 2012) contains some useful case studies that involved works analogous to the Raff Creek restoration works and from which guidance should be drawn during the preparation of detailed Restoration Implementation Plans.

Appendix B also contains some additional examples of large scale wetland/riparian habitat restoration projects that Cardno has been directly involved with.

5 Restoration Implementation Plans

A Restoration Implementation Plan (RIP) will be prepared in conjunction with the development of civil engineering plans for each relevant phase of the RWA development. It is essential that each RIP be prepared in conjunction with the preparation of plans detailing the design and sequencing of the civil engineering works as the success, or otherwise, of the restoration works will be strongly influenced by the manner in which the civil works program is designed and implemented.

Each RIP is to be based on the specifications of this RCP and the South East Queensland Ecological Restoration Framework: Manual (Chenoweth EPLA and Bushland Restoration Services, 2012). Each RIP is to include:

1. a brief review of the progress, success and/or failures of the works that have been carried out as part of a previous stage of works and adaptations to previous restoration specifications that have been incorporated into the RIP to address identified failures or deficiencies in the previous;
2. a statement of objectives;
3. a description of the locations, extents and ecological characteristics of the areas that are to be the subject of restoration works, including the Topsoil Source Areas;
4. engineering plans detailing the existing surface levels, interim finished levels and design finished levels within the restoration site;
5. information concerning the soil profile throughout the restoration site and any treatments required to facilitate restoration;
6. the nature and location of erosion and sediment controls;
7. vegetation clearance, stockpiling, reuse and disposal specifications;
8. topsoil stripping, stockpiling and translocation (respreding) specifications, including information concerning:
 - a. the types of machinery to be used;
 - b. the sequencing of works to avoid (or minimise) the stockpiling of topsoil with a high regeneration potential;
 - c. the strategies to be used to manage any potential deficiencies in the volume of suitable topsoil;
9. details concerning any direct seeding or planting programs that are to be implemented as part of the restoration works;
10. specific measures to be taken in respect of:
 - a. potential impacts on threatened species inhabiting the restoration site and Topsoil Source Areas, including consideration of :
 - i. pre-works capture and translocation strategies;
 - ii. equipment hygiene and work practices to minimise the potential for the spread of Chytrid fungus and associated impacts on threatened frog species;
 - b. weeds and pests;
 - c. mosquito and biting midge breeding habitat;
 - d. bushfire;
11. a set of quantifiable Performance Indicators that are related to the following:
 - a. the species composition, structure, density and height of the vegetation within the restoration area at time intervals of 1, 2, 3 and 5 years post completion of restoration works;

- b. the presence and abundance of weeds;
 - c. the presence of threatened fauna identified in Section 4.3 as being likely to occur within the restoration area;
12. monitoring specifications, including details on methodology, locations and frequency;
 13. a record keeping, reporting and review process; and
 14. an implementation schedule.

6 References

Cardno Chenoweth and Bushland Restoration Services (2012). South East Queensland Ecological Restoration Framework: Code of Practice; Guideline; Manual. Prepared on behalf of SEQ Catchments and South East Queensland Local Governments, Brisbane;

EPA (1998). Coastal Wetlands of South-east Queensland. Report prepared by the Queensland Herbarium and authored by Ralph Dowling and Kathy Stephens. Queensland State Government.

FIGURES

Figure 1 Site Location

Figure 2 Raff Creek Open Space Precinct
Zones

Figure 3 RWA Ecosystem Mapping

Figure 4 Habitat Protection and Habitat
Restoration Units

Figure 5 Habitat Restoration Topsoil Source
Areas



River

Caboolture

Waterway

Unnamed

Creek

Raff

Coach Road East







Buckley Road

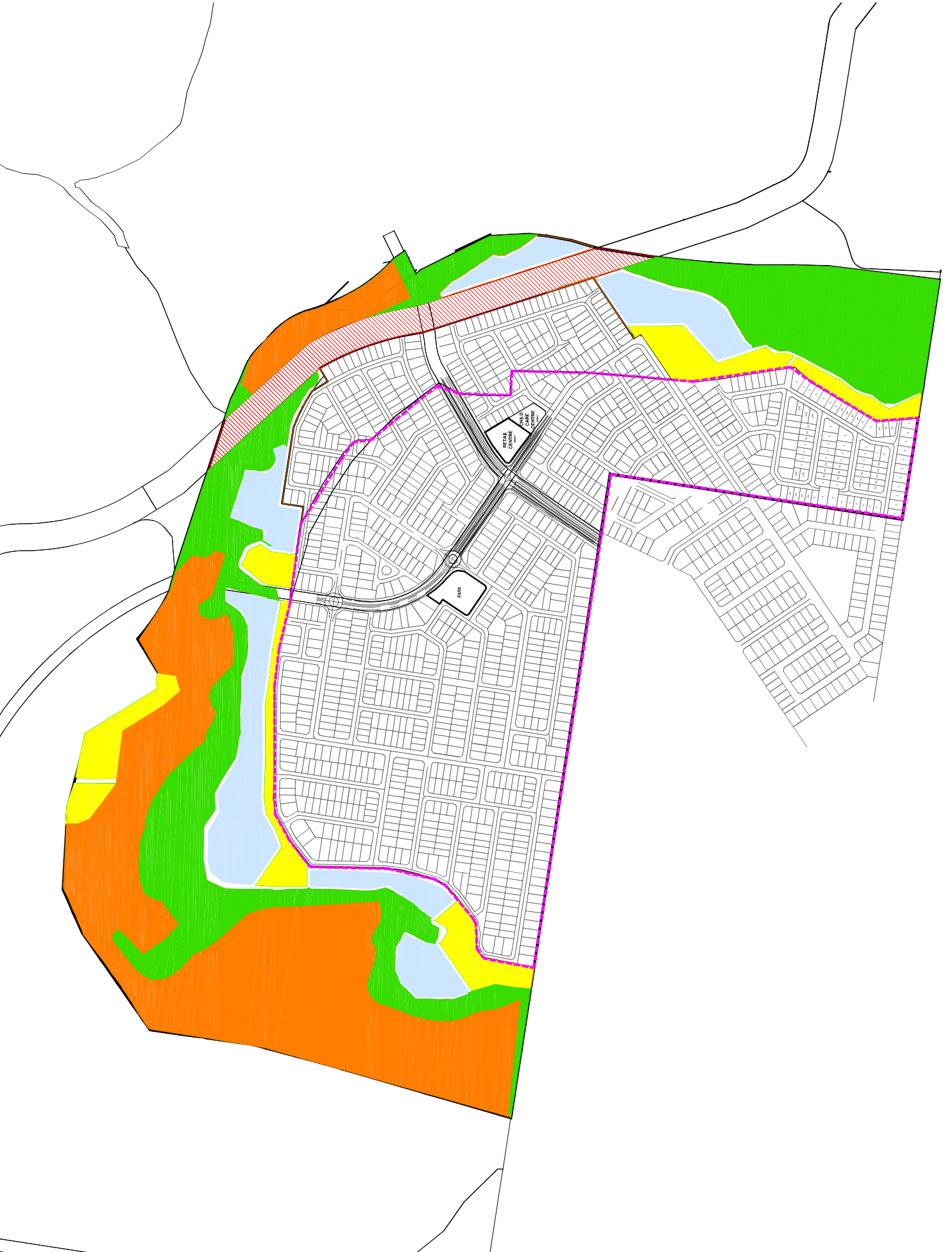
Cobb Road

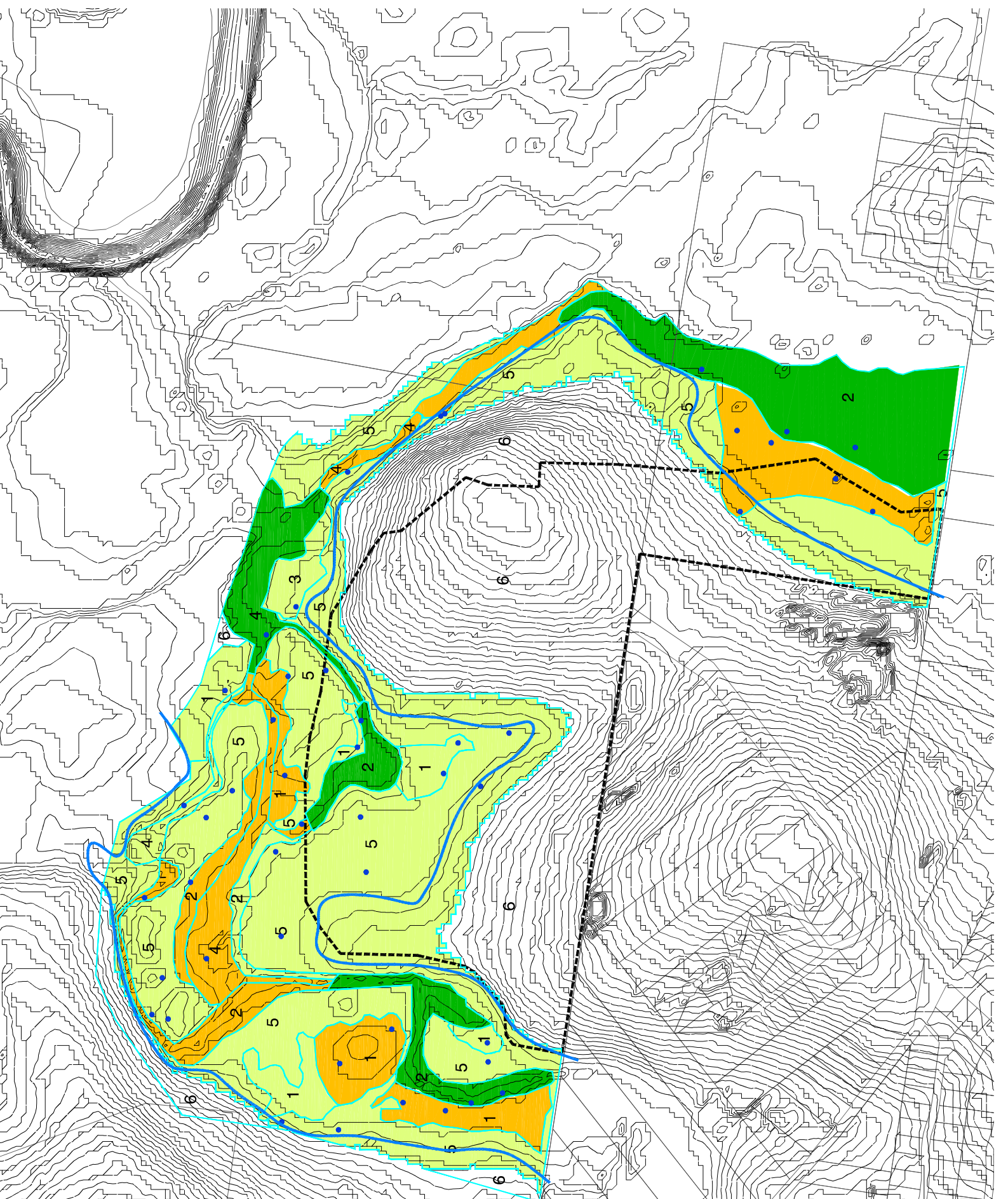
BRUCE HIGHWAY

Farry Road

LEGEND

- NEBP RW Precinct (E) 
- Regional F 
- Constructe 
- Parkland Z 
- Habitat Pr 
- Habitat Re 





LEC



NEBP
Precinn



Wetlan



Flood

Wetland C



1
Flood



2
Flood



3
Saline



4
Mang



5
Distur



6
Distur

Wetland Valu



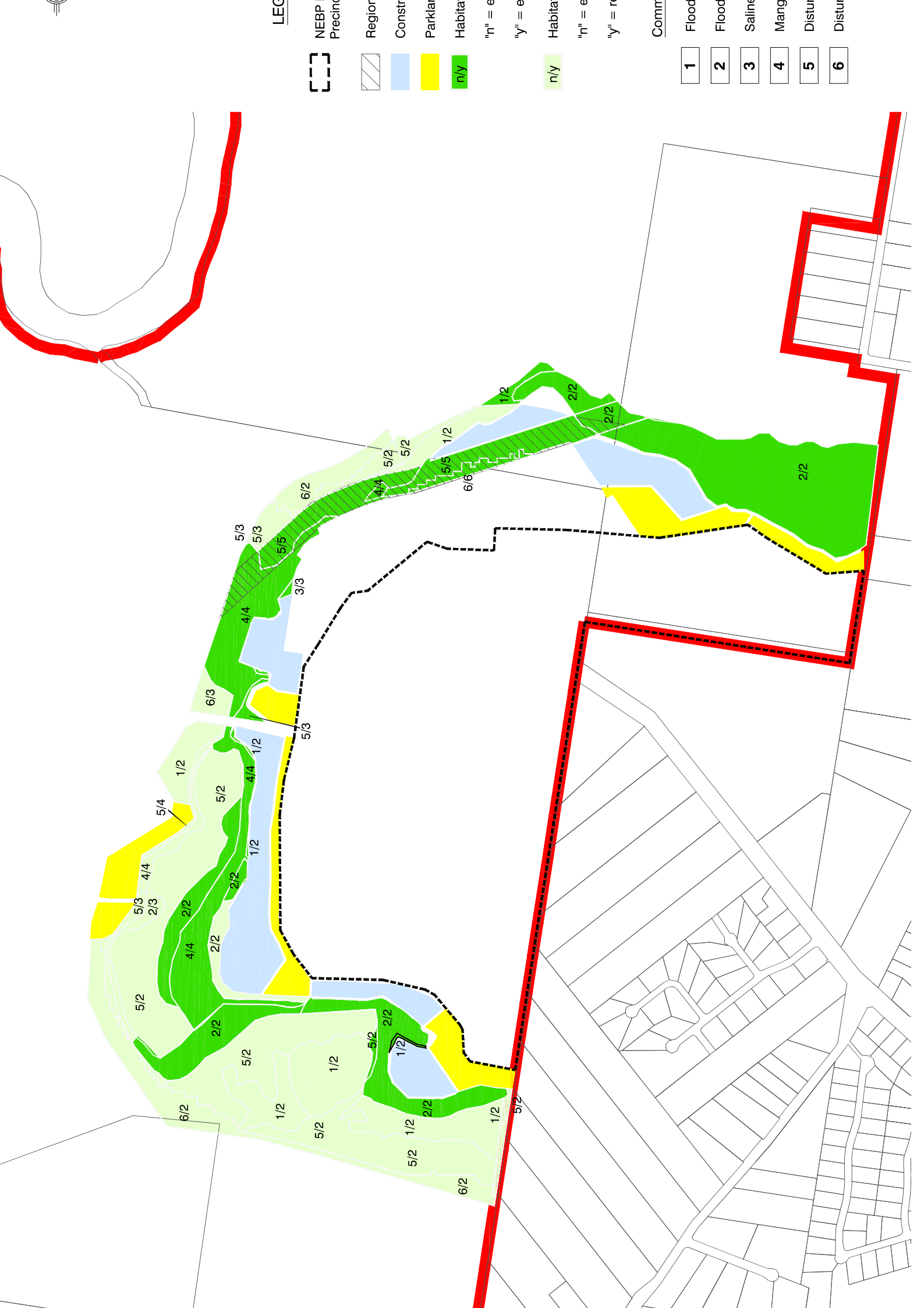
High



Mode



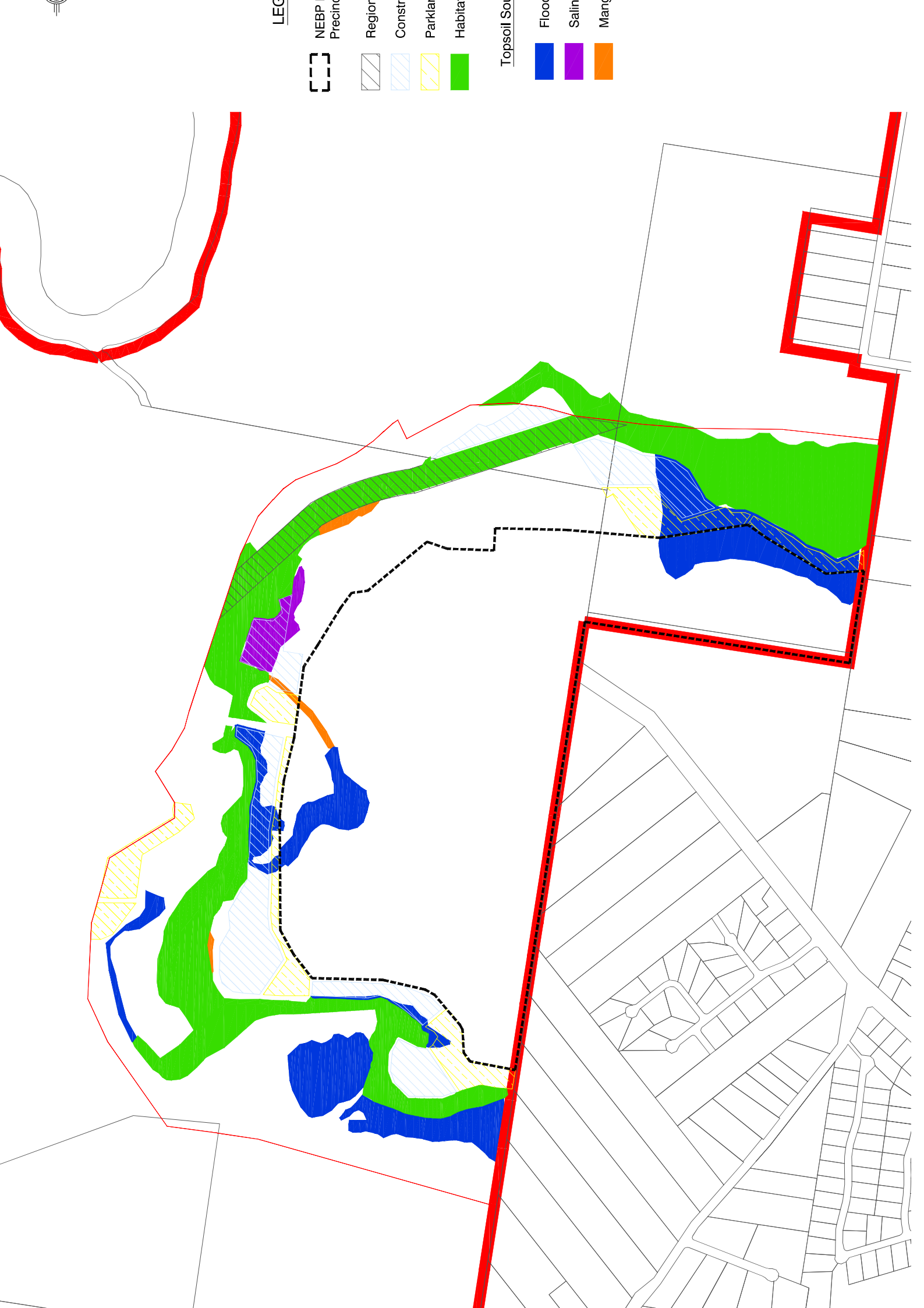
Low



LEG

- NEBP Precinct
- Region
- Constr
- Parkland
- Habitat "n" = e
- Habitat "y" = e
- Habitat "n" = e
- Habitat "y" = e
- Comm
- Flood
- Flood
- Saline
- Mang
- Distur
- Distur

- 1**
- 2**
- 3**
- 4**
- 5**
- 6**



LEG

NEBP
Precinct



Region



Constr



Parklat



Habita



Topsoil Soil

Flood



Salin



Mang



NEBP - Residential West Area

APPENDIX

A

Restoration Community Profiles

Regional Ecosystem Technical Descriptions

Technical descriptions provide a detailed description of the full range in structure and floristic composition of regional ecosystems (e.g. 12.3.5) and their component vegetation communities (e.g. 12.3.5a).

The descriptions are compiled using site survey data from the Queensland Herbarium's CORVEG database. Distribution maps, representative images (if available) and the pre-clearing and remnant area (hectares) of each vegetation community derived from the regional ecosystem mapping (spatial) data are included. The technical descriptions should be used in conjunction with the fields from the regional ecosystem description database (REDD) for a full description of the regional ecosystem. Quantitative site data from relatively undisturbed sites are extracted from CORVEG and summarized to provide information specific to each vegetation community.

Technical descriptions include the attributes: tree canopy height and cover and native plant species composition of the predominant layer, which are used to assess the remnant status of vegetation under the *Vegetation Management Act 1999*. However, as technical descriptions reflect the full range in structure and floristic composition across the climatic, natural disturbance and geographic range of the regional ecosystem, local reference sites should be used where possible (Neldner *et al.* 2005 section 3.3.3).

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

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

Field definitions

Description	Description of the species, structural formation and habitat of the vegetation community (this is not the Regulation description)
Area of pre-clearing regional ecosystem	The area of the regional ecosystem vegetation community before clearing in hectares
Area of remnant RE and percentage remaining	The area of the remnant regional ecosystem vegetation community in hectares and as a percentage of pre-clearing extent
Species recorded	Total number; number of woody species; number in the ground layer (some species can be both woody and occur in the ground layer); average number of species per site (using only sites where a completed species list was recorded); standard deviation; number of sites used to calculate the average species number.
Basal area	Site average, range and standard deviation (m ² /hectare)
Structural Formation	Percentage of sites by structural formation. For example: Woodland: 39%; open-forest: 39%; open-woodland: 22%, 23 site(s)
Representative CORVEG sites	Site (id) numbers used in the description
For each stratum present: <ul style="list-style-type: none"> Emergent (E) Canopy (T1), Sub-canopy (T2) and Low tree layers (T3) Shrub (S1) and Sub-shrub layers (S2) Ground (G) 	<ul style="list-style-type: none"> <i>Height</i> - average canopy height in metres, range in metres and number of sites values are based on. <i>Cover</i> - Average percentage canopy cover of the layer, range and number of sites values are based on. <i>Average stem density</i> (stems per hectare), range and number of sites values are based on.
Dominant species (relative cover, frequency):	Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum. For example: <i>Abutilon albescens</i> (78, 46%), means this species occurs in 46% of all sites and when it occurs comprises 78% of total cover (of the stratum)
Frequent species (cover, frequency):	Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. For example: <i>Abutilon albescens</i> (10, 46%), means this species occurs in 46% of all sites and when it occurs has a mean cover of 10% Ground layer species are listed as either graminoid or forbs. Naturalised species have an asterisk (*) after the scientific name. <i>indet.</i> after listed name = indeterminate species or genus



Department of Science, Information Technology, Innovation and the Arts

Conditions of use

Technical descriptions have been developed from information published by the State of Queensland (acting through the Department) and remain the property of the State of Queensland. Technical descriptions are not to be included on internet sites other than the Queensland Government website.

Users should reference information contained in the technical descriptions as: Ryan, T.S. (ed.) (year*) Technical Descriptions of Regional Ecosystems of Southeast Queensland, (month, year*) (Queensland Herbarium, Department of Science, Information Technology, Innovation and the Arts: Brisbane). * Date shown in footnote of individual descriptions.

While every effort has been made to ensure the information presented is as reliable as possible, the State of Queensland accepts no liability and gives no assurance in respect of its accuracy and shall not be liable for any loss or damage arising from its use.

Technical descriptions are based on a combination of quantitative and qualitative information and should be used as a guide only. Technical descriptions are not to be used as a substitute for reference sites. Descriptions are subject to review and are updated as additional data becomes available.

For more information, contact:

Tim Ryan, Biodiversity and Ecosystem Sciences
regional.ecosystem@derm.qld.gov.au

Casuarina glauca woodland on margins of marine clay plains



Pre-clearing area (ha), remnant area (ha) and per cent remaining: 5,860 3,846 66%

Species recorded: Total: 54; woody: 12; ground: 42; Avg. spp./site: 12.0; std dev.: 10.4, 5 site(s)

Basal area: Avg./site: 15.0 m²/ha, range: 4.0 - 44 m²/ha, std. deviation: 15 m²/ha, 5 site(s)

Structural formation: Woodland: 40%; open-forest: 20%; low woodland: 20%; low open-woodland: 20%, 5 site(s)

Representative sites: 13907, 16510, 16526, 19852, 29826.

Stratum: E

Height avg. = 14.0m, 1 site
 Crown cover avg. = 5.0%, 1 site

Frequent species (cover, frequency): Eucalyptus tereticornis (3, 20%)

Stratum: T1

Height avg. = 11.0m, range 7-16m, 5 sites
 Crown cover avg. = 35.0%, range 5.0-55.0%, 5 sites
 Stem density/ha avg. = 320, 1 site

Dominant species (relative cover, frequency): Casuarina glauca (100, 100%)

Frequent species (cover, frequency): Casuarina glauca (35, 100%)

Stratum: T2

Height avg. = 5.5m, range 2.5-8m, 3 sites
 Crown cover avg. = 6.3%, range 2.0-10.0%, 3 sites
 Stem density/ha avg. = 180, 1 site

Dominant species (relative cover, frequency): Casuarina glauca (100, 40%)

Frequent species (cover, frequency): Casuarina glauca (6, 40%), Cryptocarya triplinervis (3, 20%), Parsonsia straminea (4, 20%)

Dominant species: Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum.

Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. Ground layer species are listed as either graminoid or forb.

Naturalised species have an asterisk (*) after the name. indet. after listed name = indeterminate species or genus

Stratum: S1

Height avg. = 2.4m, range 1.5-4m, 4 sites

Crown cover avg. = 4.0%, range 2.0-5.0%, 4 sites

Stem density/ha avg. = 220, 1 site

Frequent species (cover, frequency): *Acacia disparrima* subsp. *disparrima* (1, 20%), *Baccharis halimifolia** (4, 20%), *Casuarina glauca* (5, 20%), *Cinnamomum camphora** (20%), *Cryptocarya triplinervis* (20%), *Cupaniopsis anacardioides* (1, 20%), *Ficus coronata* (20%), *Myoporum acuminatum* (1, 20%), *Parsonsia straminea* (3, 20%), *Pittosporum revolutum* (1, 20%), *Streblus brunonianus* (20%)

Stratum: G

Height avg. = 0.3m, range 0.2-0.4m, 5 sites

PFC avg. = 70.0%, range 20-95%, 5 sites

Dominant species (relative cover, frequency): *Sporobolus virginicus* (83, 80%), *Fimbristylis dichotoma* (7, 60%), *Halosarcia indica* (4, 40%), *Suaeda australis* (1, 40%)

Frequent species (cover, frequency): GRAMINOIDS: *Sporobolus virginicus* (70, 80%), *Fimbristylis dichotoma* (6, 60%), *Abildgaardia vaginata* (1, 20%), *Baumea juncea* (20%), *Chloris gayana** (4, 20%), *Cyperus indet.* (20%), *Cyperus polystachyos* (20%), *Cyperus trinervis* (20%), *Entolasia stricta* (20%), *Eriochloa procera* (20%), *Fimbristylis ferruginea* (20%), *Fimbristylis pauciflora* (20%), *Juncus continuus* (24, 20%), *Leptochloa decipiens* (20%), *Urochloa mutica** (3, 20%)
FORBS: *Halosarcia indica* (4, 40%), *Suaeda australis* (1, 40%), *Ageratum houstonianum** (20%), *Alternanthera denticulata* (20%), *Anredera cordifolia** (20%), *Avicennia marina* (1, 20%), *Centella asiatica* (20%), *Cyclosorus interruptus* (7, 20%), *Enydra fluctuans* (20%), *Eremophila debilis* (20%), *Hydrocotyle verticillata* (20%), *Hypolepis muelleri* (20%), *Ipomoea cairica** (20%), *Lantana camara** (20%), *Maclura cochinchinensis* (20%), *Schenkia australis* (20%), *Schinus terebinthifolius** (20%), *Sesuvium portulacastrum* (20%), *Solanum americanum* (20%), *Solanum seafortianum** (20%), *Sonchus oleraceus** (20%), *Sphagneticola trilobata** (6, 20%), *Stephania japonica* (20%), *Tradescantia fluminensis** (20%), *Triglochin procerum* (20%), *Triglochin striatum* (1, 20%), *Typha domingensis* (20%)

Dominant species: Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum.

Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. Ground layer species are listed as either graminoid or forb.

Naturalised species have an asterisk (*) after the name. indet. after listed name = indeterminate species or genus

Melaleuca quinquenervia open-forest on coastal alluvium



Pre-clearing area (ha), remnant area (ha) and per cent remaining: 45,098 20,106 45%

Species recorded: Total: 163; woody: 33; ground: 150; Avg. spp./site: 20.2; std dev.: 9.5, 17 site(s)

Basal area: Avg./site: 41.1 m²/ha, range: 7.0 - 86 m²/ha, std. deviation: 19 m²/ha, 17 site(s)

Structural formation: Open-forest: 41%; woodland: 35%; open-woodland: 12%; closed-forest: 12%, 17 site(s)

Representative sites: 14093, 16473, 16475, 19828, 19843, 19854, 19863, 27470, 27490, 29828, 29829, 29831, 29833, 29834, 29836, 31484, 39344.

Stratum: E

Height avg. = 28.0m, 1 site
 Crown cover avg. = 2.0%, 1 site

Frequent species (cover, frequency): Eucalyptus tereticornis (2, 6%)

Stratum: T1

Height avg. = 15.6m, range 11-22m, 17 sites
 Crown cover avg. = 54.8%, range 8.0-96.0%, 17 sites
 Stem density/ha avg. = 775, range 420-1400, 4 sites

Dominant species (relative cover, frequency): Melaleuca quinquenervia (94, 100%), Lophostemon suaveolens (15, 35%)

Frequent species (cover, frequency): Melaleuca quinquenervia (51, 100%), Lophostemon suaveolens (9, 35%), Eucalyptus tereticornis (1, 18%)

Dominant species: Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum.

Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. Ground layer species are listed as either graminoid or forb.

Naturalised species have an asterisk (*) after the name. indet. after listed name = indeterminate species or genus

Stratum: T2

Height avg. = 9.0m, range 4-13m, 13 sites

Crown cover avg. = 15.0%, range 0.0-60.0%, 13 sites

Stem density/ha avg. = 500, range 40-1400, 5 sites

Dominant species (relative cover, frequency): Melaleuca quinquenervia (70, 65%), Lophostemon suaveolens (58, 41%)

Frequent species (cover, frequency): Melaleuca quinquenervia (10, 65%), Lophostemon suaveolens (10, 41%), Eucalyptus tereticornis (2, 12%), Glochidion sumatranum (3, 12%), Melaleuca linariifolia (1, 12%), Parsonsia straminea (1, 12%), Cinnamomum camphora (1, 6%), Elaeocarpus obovatus (6%), Melicope elleryana (6%)*

Stratum: S1

Height avg. = 2.9m, range 1-7m, 15 sites

Crown cover avg. = 8.3%, range 1.0-20.0%, 15 sites

Stem density/ha avg. = 1510, range 140-2800, 4 sites

Dominant species (relative cover, frequency): Melaleuca quinquenervia (62, 35%), Glochidion sumatranum (41, 29%)

Frequent species (cover, frequency): Gahnia sieberiana (1, 6%), Melaleuca quinquenervia (5, 35%), Glochidion sumatranum (3, 29%), Hakea actites (5, 18%), Lophostemon suaveolens (1, 18%), Melaleuca linariifolia (7, 18%), Acacia leiocalyx (2, 12%), Baccharis halimifolia (4, 12%), Banksia robur (1, 12%), Glochidion ferdinandi (1, 12%), Lantana camara* (1, 12%), Acacia disparrima subsp. disparrima (2, 6%), Acacia melanoxylon (6%), Alphitonia excelsa (2, 6%), Banksia oblongifolia (6%), Citrus x limon* (6%), Cyathea cooperi (6%), Eucalyptus exserta (1, 6%), Ficus rubiginosa (6%), Hibiscus diversifolius (1, 6%), Jagera pseudorhus (6%), Leptospermum polygalifolium (6%), Melaleuca nodosa (2, 6%), Melaleuca pachyphylla (8, 6%), Schefflera actinophylla (6%), Schinus terebinthifolius* (6%), Solanum mauritianum* (6%), Trema tomentosa (6%)*

Dominant species: Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum.

Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. Ground layer species are listed as either graminoid or forb.

Naturalised species have an asterisk (*) after the name. indet. after listed name = indeterminate species or genus

Stratum: G

Height avg. = 0.9m, range 0.3-1.75m, 17 sites

PFC avg. = 74.1%, range 9-100%, 17 sites

Stem density/ha avg. = 20, 1 site

Dominant species (relative cover, frequency): *Blechnum indicum* (31, 82%), *Baloskion pallens* (25, 24%), *Leersia hexandra* (23, 47%), *Pericaria strigosa* (16, 41%), *Baumea rubiginosa* (16, 35%)

Frequent species (cover, frequency): GRAMINOIDS: *Imperata cylindrica* (8, 47%), *Leersia hexandra* (20, 47%), *Baumea rubiginosa* (14, 35%), *Baumea articulata* (1, 29%), *Lepironia articulata* (12, 29%), *Paspalum scrobiculatum* (29%), *Entolasia marginata* (7, 24%), *Chorizandra cymbaria* (18%), *Cyperus trinervis* (18%), *Phragmites australis* (12, 18%), *Sacciolepis indica* (18%), *Baumea juncea* (12%), *Oplismenus aemulus* (12%), *Panicum effusum* (6, 12%), *Paspalum conjugatum** (32, 12%), *Alloteropsis semialata* (1, 6%), *Arundinella nepalensis* (1, 6%), *Baumea indet.* (8, 6%), *Baumea teretifolia* (6%), *Carex appressa* (6%), *Carex indet.* (6%), *Carex maculata* (2, 6%), *Cyperus exaltatus* (3, 6%), *Cyperus haspan* (6%), *Cyperus lucidus* (8, 6%), *Cyperus pilosus* (6%), *Cyperus prolifer** (6%), *Echinochloa dietrichiana* (6%), *Eleocharis philippinensis* (6%), *Entolasia stricta* (1, 6%), *Eragrostis spartinooides* (1, 6%), *Eremochloa bimaculata* (6%), *Eriachne glabrata* (6%), *Fimbristylis cinnamometorum* (1, 6%), *Fimbristylis nutans* (6%), *Gahnia clarkei* (1, 6%), *Gahnia sieberiana* (10, 6%), *Hemarthria uncinata* (1, 6%), *Ischaemum australe* (1, 6%), *Ischaemum australe var. australe* (1, 6%), *Lepidosperma laterale* (6%), *Microlaena stipoides* (6%), *Panicum paludosum* (6%), *Paspalidium distans* (6%), *Ptilothrix deusta* (6%), *Rhynchospora corymbosa* (6%), *Scleria sphacelata* (6%), *Setaria sphacelata** (6%), *Themeda triandra* (1, 6%)

FORBS: *Blechnum indicum* (26, 82%), *Lygodium microphyllum* (1, 47%), *Pericaria strigosa* (10, 41%), *Banksia robur* (6, 29%), *Hypolepis muelleri* (3, 29%), *Melastoma malabathricum subsp. malabathricum* (29%), *Parsonia straminea* (29%), *Baccharis halimifolia** (24%), *Baloskion pallens* (25, 24%), *Centella asiatica* (24%), *Eclipta prostrata* (24%), *Ageratum houstonianum** (1, 18%), *Philydrum lanuginosum* (18%), *Sporadanthus caudatus* (18%), *Trema tomentosa* (18%), *Ageratina adenophora** (12%), *Alphitonia excelsa* (12%), *Eriocaulon australe* (12%), *Eucalyptus tereticornis* (1, 12%), *Glochidion sumatranum* (5, 12%), *Leptospermum juniperinum* (12%), *Ludwigia octovalvis* (12%), *Melaleuca pachyphylla* (12%), *Ottelia alismoides* (12%), *Tricoryne elatior* (2, 12%), *Triglochin procerum* (12%), *Typha domingensis* (4, 12%), *Typha orientalis* (12%), *Velleia spathulata* (12%), *Villarsia exaltata* (12%), *Acacia maidenii* (6%), *Acacia melanoxylon* (1, 6%), *Acmella grandiflora* (6%), *Acrostichum speciosum* (6%), *Ageratina riparia** (6%), *Alternanthera denticulata* (6%), *Asparagus aethiopicus cv. Sprengeri** (6%), *Bidens pilosa** (6%), *Cassipourea pubescens* (6%), *Chamaecrista rotundifolia var. rotundifolia** (6%), *Christella dentata* (6%), *Commelina diffusa* (6%), *Crassocephalum crepidioides** (6%), *Cyanthillium cinereum* (6%), *Cyclosorus interruptus* (6, 6%), *Davallia pyxidata* (6%), *Dianella brevipedunculata* (6%), *Dianella caerulea var. caerulea* (1, 6%), *Dianella longifolia* (6%), *Dianella longifolia var. stenophylla* (6%), *Elatine gratioioides* (6%), *Erechtites valerianifolius* (6%), *Eucalyptus pilularis* (6%), *Ficus rubiginosa* (6%), *Geitonoplesium cymosum* (6%), *Gomphocarpus physocarpus** (6%), *Gompholobium pinnatum* (6%), *Gonocarpus chinensis subsp. verrucosus* (6%), *Hakea florulenta* (1, 6%), *Hibbertia scandens* (6%), *Hibbertia stricta* (6%), *Hibiscus diversifolius* (6%), *Hydrocotyle acutiloba* (6%), *Hygrophila angustifolia* (6%), *Lantana camara** (6%), *Limnophila aromatica* (6%), *Linaria vulgaris* (6%), *Lomandra longifolia* (1, 6%), *Lophostemon suaveolens* (6%), *Ludwigia peploides* (6%), *Ludwigia peploides subsp. montevidensis* (6%), *Macaranga tanarius* (6%), *Marsilea mutica* (6%), *Melaleuca linariifolia* (6%), *Melaleuca sieberi* (6%), *Melaleuca thymifolia* (42, 6%), *Melicope elleryana* (6%), *Myriophyllum indet.* (6%), *Najas tenuifolia* (6%), *Nymphoides indet.* (6%), *Ottelia ovalifolia* (6%), *Passiflora foetida** (6%), *Passiflora suberosa** (6%), *Patersonia glabrata* (6%), *Pericaria dichotoma* (30, 6%), *Pericaria indet.* (6%), *Phyllanthus virgatus* (6%), *Potamogeton tricarlinatus* (2, 6%), *Pteridium esculentum* (10, 6%), *Ruellia tweediana** (6%), *Schefflera actinophylla* (6%), *Schinus terebinthifolius** (6%), *Sida rhombifolia** (6%), *Solanum mauritanum** (6%), *Solanum pseudocapsicum** (6%), *Spirodela indet.* (1, 6%), *Stephania japonica* (6%), *Vigna luteola** (6%), *Westringia eremicola* (6%), *Xanthorrhoea fulva* (6%), *Xyris complanata* (6%)

Dominant species: Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum.

Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. Ground layer species are listed as either graminoid or forb.

Naturalised species have an asterisk (*) after the name. indet. after listed name = indeterminate species or genus

Melaleuca quinquenervia, Casuarina glauca +/- Eucalyptus tereticornis open-forest on lowest river terraces



Pre-clearing area (ha), remnant area (ha) and per cent remaining: 14,195 2,721 19%

Species recorded: Total: 143; woody: 46; ground: 109; Avg. spp./site: 33.2; std dev.: 12.9, 8 site(s)

Basal area: Avg./site: 33.4 m²/ha, range: 19.0 - 49 m²/ha, std. deviation: 10 m²/ha, 8 site(s)

Structural formation: Open-forest: 63%; woodland: 25%; open-woodland: 13%, 8 site(s)

Representative sites: 14034, 14037, 16428, 16501, 16519, 19846, 19866, 29954.

Stratum: T1

Height avg. = 18.3m, range 13-22m, 8 sites

Crown cover avg. = 45.6%, range 10.0-75.0%, 8 sites

Stem density/ha avg. = 1045, range 20-3000, 4 sites

Dominant species (relative cover, frequency): Melaleuca quinquenervia (76, 88%), Eucalyptus tereticornis (40, 50%), Casuarina glauca (15, 75%)

Frequent species (cover, frequency): Melaleuca quinquenervia (43, 88%), Casuarina glauca (11, 75%), Eucalyptus tereticornis (15, 50%), Corymbia tessellaris (13%), Eucalyptus exserta (3, 13%), Eucalyptus siderophloia (9, 13%), Glochidion sumatranum (2, 13%)

Stratum: T2

Height avg. = 9.1m, range 6-14m, 7 sites

Crown cover avg. = 21.7%, range 5.0-75.0%, 7 sites

Stem density/ha avg. = 453, range 320-700, 3 sites

Dominant species (relative cover, frequency): Melaleuca quinquenervia (61, 50%), Casuarina glauca (27, 63%), Lophostemon suaveolens (16, 25%), Parsonsia straminea (13, 25%)

Frequent species (cover, frequency): Casuarina glauca (4, 63%), Melaleuca quinquenervia (10, 50%), Lophostemon suaveolens (1, 25%), Parsonsia straminea (1, 25%), Corymbia intermedia (13%), Corymbia tessellaris (1, 13%), Eucalyptus siderophloia (5, 13%), Eucalyptus tereticornis (2, 13%), Ficus rubiginosa (13%), Glochidion sumatranum (2, 13%), Schefflera actinophylla (1, 13%), Timonius timon (2, 13%)

Dominant species: Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum.

Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. Ground layer species are listed as either graminoid or forb.

Naturalised species have an asterisk (*) after the name. indet. after listed name = indeterminate species or genus

Stratum: S1

Height avg. = 2.1m, range 1.5-3m, 7 sites

Crown cover avg. = 12.9%, range 1.0-33.0%, 7 sites

Stem density/ha avg. = 2560, range 80-9000, 4 sites

Dominant species (relative cover, frequency): *Lantana camara** (40, 50%), *Casuarina glauca* (36, 38%), *Baccharis halimifolia** (22, 25%), *Glochidion ferdinandi* (21, 38%), *Melaleuca quinquenervia* (19, 25%)

Frequent species (cover, frequency): *Acacia disparrima* subsp. *disparrima* (1, 50%), *Lantana camara** (2, 50%), *Casuarina glauca* (10, 38%), *Glochidion ferdinandi* (1, 38%), *Schinus terebinthifolius** (1, 38%), *Baccharis halimifolia** (1, 25%), *Cupaniopsis anacardioides* (3, 25%), *Jagera pseudorhus* (25%), *Melaleuca quinquenervia* (4, 25%), *Acacia leiocalyx* (13%), *Acacia melanoxylon* (1, 13%), *Alectryon tomentosus* (13%), *Allocasuarina torulosa* (13%), *Alphitonia excelsa* (13%), *Backhousia myrtifolia* (1, 13%), *Buckinghamia celsissima* (13%), *Clematicissus opaca* (13%), *Corymbia tessellaris* (13%), *Corymbia torelliana* (1, 13%), *Cryptocarya hypospodia* (13%), *Cryptocarya triplinervis* (1, 13%), *Cyclophyllum coprosmoides* (13%), *Dianella caerulea* (1, 13%), *Dodonaea lanceolata* (13%), *Elaeocarpus obovatus* (1, 13%), *Eucalyptus siderophloia* (4, 13%), *Eucalyptus tereticornis* (13%), *Ficus fraseri* (13%), *Gomphocarpus physocarpus** (1, 13%), *Guioa semiglaucula* (13%), *Hypolepis muelleri* (15, 13%), *Melaleuca nodosa* (13%), *Melaleuca salicina* (13%), *Melodinus australis* (13%), *Ochna serrulata** (13%), *Scolopia braunii* (13%), *Senna pendula* (13%), *Senna pendula* var. *glabrata** (1, 13%)

Stratum: G

Height avg. = 0.6m, range 0.25-1m, 8 sites

PFC avg. = 58.9%, range 15-90%, 8 sites

Stem density/ha avg. = 500, 1 site

Dominant species (relative cover, frequency): *Cynodon dactylon* (44, 25%), *Phragmites australis* (41, 25%), *Ottochloa gracillima* (32, 38%), *Paspalum conjugatum** (22, 25%), *Cyperus lucidus* (12, 25%)

Frequent species (cover, frequency): GRAMINOIDS: *Imperata cylindrica* (10, 63%), *Paspalum scrobiculatum* (8, 50%), *Cyperus polystachyos* (1, 38%), *Ottochloa gracillima* (17, 38%), *Cynodon dactylon* (9, 25%), *Cyperus lucidus* (10, 25%), *Oplismenus aemulus* (1, 25%), *Paspalidium distans* (8, 25%), *Paspalum conjugatum** (18, 25%), *Phragmites australis* (36, 25%), *Baumea articulata* (8, 13%), *Carex appressa* (1, 13%), *Carex maculata* (13%), *Cyperus trinervis* (13%), *Digitaria didactyla** (25, 13%), *Digitaria parviflora* (13%), *Enteropogon unispiceus* (13%), *Eragrostis spartinooides* (5, 13%), *Gahnia clarkei* (5, 13%), *Hemarthria uncinata* (13%), *Leersia hexandra* (13%), *Leptochloa decipiens* (13%), *Sacciolepis indica* (13%), *Setaria sphacelata** (13%), *Sporobolus virginicus* (8, 13%)

FORBS: *Parsonsia straminea* (1, 63%), *Blechnum indicum* (1, 50%), *Passiflora suberosa** (1, 50%), *Ageratum houstonianum** (1, 38%), *Centella asiatica* (1, 38%), *Emilia sonchifolia** (38%), *Ipomoea cairica** (2, 38%), *Lantana camara** (38%), *Pteridium esculentum* (38%), *Baccharis halimifolia** (1, 25%), *Christella dentata* (1, 25%), *Cirsium vulgare** (25%), *Commelina diffusa* (4, 25%), *Crassocephalum crepidioides** (25%), *Dianella caerulea* (4, 25%), *Einadia hastata* (4, 25%), *Erechtites valerianifolius* (25%), *Geitonoplesium cymosum* (25%), *Glochidion ferdinandi* (25%), *Leptospermum polygalifolium* (25%), *Lygodium microphyllum* (25%), *Ochna serrulata** (25%), *Oxalis indet.* (25%), *Viola hederacea* (2, 25%), *Acrostichum aureum* (25, 13%), *Acrostichum speciosum* (13%), *Adiantum aethiopicum* (13%), *Ageratina adenophora** (13%), *Ageratina riparia** (13%), *Alternanthera denticulata* (13%), *Ardisia crenata** (13%), *Asclepias curassavica** (13%), *Asparagus aethiopicus* cv. *Sprengeri** (10, 13%), *Asparagus africanus** (1, 13%), *Aster subulatus** (13%), *Breynia oblongifolia* (13%), *Casuarina glauca* (13%), *Cheilanthes tenuifolia* (13%), *Conyza bonariensis** (1, 13%), *Corymbia tessellaris* (13%), *Cyclosorus interruptus* (2, 13%), *Cymbidium madidum* (13%), *Desmodium rhytidophyllum* (1, 13%), *Eclipta prostrata* (13%), *Enydra fluctuans* (2, 13%), *Epaltes australis* (2, 13%), *Eucalyptus tereticornis* (13%), *Eustrephus latifolius* (13%), *Ficus fraseri* (13%), *Ficus rubiginosa* (13%), *Flagellaria indica* (13%), *Flemingia parviflora* (13%), *Glochidion sumatranum* (13%), *Gloriosa superba** (13%), *Gomphocarpus fruticosus** (13%), *Hydrocotyle tripartita* (1, 13%), *Lepyrodia indet.* (1, 13%), *Lobelia alata* (1, 13%), *Lobelia purpurascens* (2, 13%), *Maclura cochinchinensis* (13%), *Mallotus philippensis* (13%), *Melicope elleryana* (13%), *Myoporum acuminatum* (5, 13%), *Myrsine porosa* (13%), *Myrsine variabilis* (13%), *Neoachmandra cunninghamii* (13%), *Opuntia stricta** (13%), *Oxalis corniculata** (13%), *Persicaria strigosa* (3, 13%), *Polymeria calycina* (13%), *Psilotum nudum* (1, 13%), *Rhaphiolepis indica** (13%), *Smilax australis* (1, 13%), *Solanum americanum* (13%), *Solanum chrysotrichum** (13%), *Solanum mauritianum** (13%), *Solanum nigrum* (13%), *Solanum seafortianum** (13%), *Sonchus oleraceus** (1, 13%), *Sphagneticola trilobata** (17, 13%), *Stephania japonica* (13%), *Syagrus romanzoffiana** (13%), *Vigna luteola** (13%), *Youngia japonica* (2, 13%)

Dominant species: Relative cover (mean of cover of species / total cover of all species in that stratum for all values > zero) and frequency (percent of total sites) ordered by decreasing relative abundance. Up to five most dominant species with frequency > 20% listed for each stratum.

Frequent species: Cover (mean of all values > zero) and frequency (percent of total sites) of all species occurring in more than 5% of sites ordered by decreasing frequency. Ground layer species are listed as either graminoid or forb.

Naturalised species have an asterisk (*) after the name. indet. after listed name = indeterminate species or genus

BioCondition Benchmarks for Regional Ecosystem Condition Assessment

Benchmarks are quantitative values derived from reference sites for each condition attribute assessed in BioCondition, and are used as a reference value for comparison purposes. Benchmarks have been developed from information published by the State of Queensland (acting through the Department of Science, Information Technology, Innovation and the Arts). They have been developed primarily to be used with the condition assessment tools, [BioCondition](#) (Eyre *et al.* 2011), the [Delbessie Agreement Guidelines](#) for Determining Lease Land Condition (Version 2.0, 2011), the Queensland Biodiversity Offset policy and the Vegetation Management Offset policy. Benchmarks are subject to review based on additional data and expert opinion.

The benchmarks are compiled using site survey data from the Queensland Herbarium's CORVEG database and quantitative site data from reference sites and are summarized to provide information specific to each regional ecosystem vegetation community. BioCondition benchmarks aim to reflect the natural variability in structure and floristic composition under a range of climatic and natural disturbance regimes throughout the geographic extent of a RE. Local reference sites should be assessed where possible to account for this spatial and temporal (seasonal and annual) variability. When conducting BioCondition assessments, the technical descriptions, if available, should be used in conjunction with the benchmarks and the regional ecosystem description database (REDD) for the specific regional ecosystem.

In rangeland ecosystems, seasonal conditions can account for wide variation in the values obtained for some attributes assessed in BioCondition. Therefore in these ecosystems a range is expressed instead of a single benchmark value. When using rangeland regional ecosystem benchmarks to assess condition, the lower value of the benchmark range can be used as the benchmark, or if assessing a site under good seasonal conditions then use of the average value as the benchmark.

Definitions

Attribute	Brief description
Recruitment of dominant canopy species	Proportion of the dominant canopy (ecologically dominant layer) species with evidence of recruitment.
Native plant species richness	The number of species expected in four life form groups, i.e. tree, shrub, grass, forbs and other species
Tree strata: <ul style="list-style-type: none"> • Canopy • Sub-canopy • Large trees 	<ul style="list-style-type: none"> • <i>Height</i> – median height in metres • <i>Cover</i> – percentage cover (assessed as opaque crowns) • <i>DBH (Diameter at Breast Height)</i> – For large trees only; dbh threshold (cm). • <i>Typical tree species for benchmark sites</i>
Shrub strata: <ul style="list-style-type: none"> • Native shrub cover 	<ul style="list-style-type: none"> • <i>Cover</i> – percentage cover (assessed as opaque crowns) • <i>Typical shrub species</i>
Ground cover: <ul style="list-style-type: none"> • Native perennial grass cover • Litter cover 	<ul style="list-style-type: none"> • <i>Cover</i> – percentage cover (assessed as projected foliage cover) • <i>Typical ground cover species</i>
Coarse woody debris	<ul style="list-style-type: none"> • Total length in metres of woody debris > 10 cm diameter and > 0.5 m per hectare
Non-native plant cover	<ul style="list-style-type: none"> • <i>Cover</i> – The percentage cover of non-native plants • <i>Typical non-native species</i> listed with common names and declared pest status¹

Conditions of use

BioCondition benchmarks have been developed from information published by the State of Queensland (acting through the Department of Science, Information Technology, Innovation and the Arts) and remain the property of the State of Queensland. BioCondition benchmarks are not to be included on internet sites other than the departmental website.

Users should reference information contained in the BioCondition benchmarks as: Queensland Herbarium (year*) BioCondition benchmarks of Regional Ecosystems, (month, year*) (Department of Science, Information Technology, Innovation and the Arts: Brisbane). * Date shown in footnote of individual descriptions.

While every effort has been made to ensure the information presented is as reliable as possible, the State of Queensland accepts no liability and gives no assurance in respect of its accuracy and shall not be liable for any loss or damage arising from its use. BioCondition benchmarks are based on a combination of quantitative and qualitative information and should be used as a guide only. BioCondition benchmarks are subject to review and are updated as additional data becomes available.

For more information, contact:

Annie Kelly, [Queensland Herbarium](#), Science Delivery, DSITIA
Brisbane Botanic Gardens (Mt Coot-tha), Mt Coot-tha Road, Toowong QLD 4066

¹ **Declared**—either:

a) a plant or animal species listed in Schedule 2 of the Land Protection (Pest and Stock Route Management) Regulation 2003; or b) an exotic plant that is listed in a local government pest management plan.

Melaleuca quinquenervia open-forest on coastal alluvium



Melinda Laidlaw

BioCondition attribute	Benchmark
Recruitment of dominant canopy species (%):	100
Native plant species richness:	
Tree:	2
Shrub:	1
Grass:	4
Forbs and other:	15
Trees:	
Tree canopy	
Tree canopy median height (m):	14
Tree canopy cover (%):	96
Tree sub-canopy	
Tree sub-canopy median height (m):	na
Tree sub-canopy cover (%):	na
Large trees	
Large eucalypt tree dbh threshold (cm):	na
Number of large eucalypt trees per hectare:	na
Large non-eucalypt tree dbh threshold (cm):	33
Number of large non-eucalypt trees per hectare:	168
Typical tree species: <i>Melaleuca quinquenervia</i> (swamp paperbark), <i>Lophostemon suaveolens</i> (swamp box), <i>Eucalyptus tereticornis</i> (blue gum)	
Shrubs:	
Native shrub cover (%):	1
Typical shrub species: <i>Melaleuca quinquenervia</i> (swamp paperbark), <i>Lophostemon suaveolens</i> (swamp box), <i>Alphitonia excelsa</i> (soap tree)	
Ground cover (%):	
Native perennial grass cover (%):	2
Organic litter cover (%):	20
Typical ground cover species: <i>Leersia hexandra</i> (swamp rice grass), <i>Imperata cylindrica</i> (blady grass), <i>Gahnia clarkei</i> (tall sawsedge), <i>Blechnum indicum</i> (swamp water fern), <i>Lepironia articulata</i>	
Coarse woody debris: Total length (m) of debris \geq 10cm diameter and \geq 0.5m in length per hectare	898
Non-native plant cover	0
None listed	

Selected typical species are those that characterize the ecosystem, community or stratum at reference sites. Up to five frequently occurring species for each stratum are selected. Users should refer to the regional ecosystem description database (REDD) and/or the technical description for more complete lists of characteristic species. Only the most frequently used common name is given. Other common names may be used in other regions. Declared pest species in Queensland are designated (*).



Coastal Wetlands *of* South East Queensland

Mapping and survey
February 2001



Queensland Government
Environmental Protection Agency

Volume 1

This document was produced by the Queensland Herbarium, 1998.
Authored by Ralph Dowling and Kathy Stephens.

This material has been prepared for the purposes of consideration as part of the development of the draft South East Queensland Regional Coastal Management Plan. This document does not represent Government policy and does not commit the Queensland Government or the Environmental Protection Agency to any future action. Neither the Queensland Government nor the Environmental Protection Agency accepts liability for any actions taken by individuals or organisations on the basis of this document.

Map Unit: 1B(ii)b *Avicennia marina* subsp. *australasica* tall shrubland



Description: *Avicennia marina* subsp. *australasica* predominates with the sparse canopy usually being about 3m tall. Other mangrove species are frequently present, notably *Ceriops tagal* and *Rhizophora stylosa*. There are occasional emergent trees of *Avicennia marina* subsp. *australasica* to 6m tall. The ground layer is mid-dense and consists of *Sporobolus virginicus* and samphires.

Structural Formation Range: tall shrubland (71%), tall open shrubland (29%).

Basal Area Estimate m^2ha^{-1} : mean 3.9; range 0.0-19.0.
Avicennia marina subsp. *australasica* ($3.9 m^2ha^{-1}$).

Emergent Layer

Height: mean 5.0m; range: 4.0-6.0.

Crown Cover: mean 5.0%; range: 5.0-5.0.

Frequent species: *Avicennia marina* subsp. *australasica* (9%).

Shrub Layer

Height: mean 2.5m; range: 0.3-8.0.

Crown Cover: mean 24.7%; range: 2.0-69.0.

Frequent species: *Avicennia marina* subsp. *australasica* (100%), *Ceriops tagal* (33%), *Rhizophora stylosa* (14%).

Ground Layer

Height: mean 0.3m; range: 0.1-1.0.

Crown Cover: mean 41.6%; range: 1.0-100.0.

Frequent species: *Sporobolus virginicus* (42%), *Avicennia marina* subsp. *australasica* (38%), *Sarcocornia quinqueflora* subsp. *quinqueflora* (28%), *Suaeda australis* (23%), *Suaeda arbusculoides* (9%).

Total species recorded: 13. **Mean species per site:** 3 with a s.d. of 2.

Number of Sites: 21.

Sampling Index: 1 site per 91 ha.

Representative Sites: 35, 123, 144, 148, 155, 175, 180, 187, 197, 227, 247, 255, 263, 268, 289, 296, 297, 298, 302, 303, 322.

Ecological Notes:

This community is commonly found towards the upper tidal limits, often adjacent to or intermingled with areas of marine couch, samphires and claypans.

Regional Ecosystem:

Regional Ecosystem which contains this map unit: 12.1.3.

The Regional Ecosystem to which this belongs is of no concern at present.

Of a total of 1912.8 ha of this vegetation unit, 327.1 ha (17.1%) is presently in reserve.

**Map Unit: 3A(i) *Sarcocornia* spp., *Suaeda australis*, *Suaeda arbusculoides*
dwarf closed-shrubland**



Description: A dwarf ground cover community with a cover that varies from very sparse to dense. It is usually patchy in nature, with areas of bare marine clay and patches of *Sporobolus virginicus*. Composition of species varies seasonally, with *Sarcocornia quinqueflora* subsp. *quinqueflora* and *Suaeda australis* being predominant during the time of our sampling. The maximum community height is about 20cm.

Structural Formation Range: dwarf closed-shrubland (49%), dwarf shrubland (17%), dwarf open-shrubland (17%), dwarf sparse-shrubland (17%).

Basal Area Estimate m^2ha^{-1} : 0.

Ground Layer

Height: mean 0.1m; range: 0.1-0.2.

Crown Cover: mean 62.8%; range: 14.0-99.0.

Frequent species: *Sarcocornia quinqueflora* subsp. *quinqueflora* (83%), *Suaeda australis* (83%), *Sporobolus virginicus* (66%), *Avicennia marina* subsp. *australasica* (16%), *Fimbristylis polytrichoides* (16%), *Halosarcia pergranulata* subsp. *queenslandica* (16%), *Suaeda arbusculoides* (16%).

Total species recorded: 12. **Mean species per site:** 5 with a s.d. of 3.

Number of Sites: 6.

Sampling Index: 1 site per 66 ha.

Representative Sites: 124, 167, 189, 252, 283, 325.

Ecological Notes:

The species composition of the samphire communities is seasonal in nature and varies over time. This variation over time is probably due to rainfall changes. Associations of claypan, samphire and marine couch form a mosaic commonly known as saltmarsh. The saltmarshes are commonly found behind the mangroves at the upper tidal limits though they may extend to river banks where the river has eroded into them. The soils in which the samphire communities occur are generally highly saline. The samphire communities commonly revert to areas of bare clay in extended periods of low rainfall or drought.

Regional Ecosystem:

Regional Ecosystem which contains this map unit: 12.1.2.

The Regional Ecosystem to which this belongs is of no concern at present.

Of a total of 398.6 ha of this vegetation unit, 94.9 ha (23.8%) is presently in reserve.

Map Unit: 4A(i) *Sporobolus virginicus* closed-grassland



Description: *Sporobolus virginicus* forms a dense ground cover usually about 20cm high. Patches of samphire occur, with *Sarcocornia quinqueflora* subsp. *quinqueflora* being the most frequent samphire species under these conditions. In infrequently disturbed situations, hummocking occurs due to a build up of organic matter around the base of the plants. Rarely isolated emergent low shrubs of *Avicennia marina* subsp. *australasica* may be present in these grasslands.

Structural Formation Range: closed-grassland (64%), grassland (36%).

Basal Area Estimate m^2ha^{-1} : mean 0.5; range 0.0-1.0.
Avicennia marina subsp. *australasica* ($0.5 m^2ha^{-1}$).

Emergent Layer

Height: mean 1.5m; range: 1.0-2.0.

Crown Cover: mean 4.0%; range: 4.0-4.0.

Frequent species: *Avicennia marina* subsp. *australasica* (9%).

Ground Layer

Height: mean 0.2m; range: 0.1-0.5.

Crown Cover: mean 91.7%; range: 53.0-100.0.

Frequent species: *Sporobolus virginicus* (100%), *Sarcocornia quinqueflora* subsp. *quinqueflora* (63%), *Suaeda australis* (27%), *Fimbristylis ferruginea* (9%), *Halosarcia pergranulata* subsp. *queenslandica* (9%).

Total species recorded: 10. **Mean species per site:** 3 with a s.d. of 1.

Number of Sites: 11.

Sampling Index: 1 site per 135 ha.

Representative Sites: 15, 19, 29, 174, 188, 195, 213, 229, 233, 321, 327.

Ecological Notes:

Sporobolus virginicus often occurs as a dense community which may form in patchy distribution together with samphires and claypan. Extensive meadows of this low springy grass are common. The soils in which they occur are often waterlogged due to the density of the *Sporobolus virginicus* which collects rainfall that falls on them as well as restricting saltwater intrusion. These grasslands appear to be recovering their original structure due to changing land use patterns. They were previously grazed and burnt on a regular basis to promote fresh growth for grazing purposes as *Sporobolus virginicus* is an excellent fodder. Due to continued coastal urbanisation, grazing and firing of *Sporobolus virginicus* areas no longer occurs, which has allowed them to regrow and thicken. In thick stands that are ungrazed or burnt, these grasslands take on a hummocky character due to the build up in peat at the base of the clumps.

Regional Ecosystem:

Regional Ecosystem which contains this map unit: 12.1.2.

The Regional Ecosystem to which this belongs is of no concern at present.

Of a total of 1480.9 ha of this vegetation unit, 178.7 ha (12.1%) is presently in reserve.

Map Unit: 4C(i) *Phragmites australis* grassland



Description: *Phragmites australis* dominates a mid-dense grassland to 2m tall with patches of shorter salt-tolerant species such as *Sporobolus virginicus*, *Fimbristylis ferruginea*, and *Sesuvium portulacastrum* occurring in the more open areas. Scattered emergent low trees of *Casuarina glauca* and *Melaleuca quinquenervia* are sometimes present.

Structural Formation Range: grassland (80%), open-grassland (20%).

Basal Area Estimate m²ha⁻¹: 0.

Emergent Layer

Height: mean 4.2m; range: 3.0-6.0.

Crown Cover: mean 5.7%; range: 2.0-10.0.

Frequent species: *Baccharis halimifolia* (20%), *Casuarina glauca* (20%), *Melaleuca quinquenervia* (20%).

Ground Layer

Height: mean 1.5m; range: 0.2-2.0.

Crown Cover: mean 68.0%; range: 30.0-100.0.

Frequent species: *Phragmites australis* (100%), *Sporobolus virginicus* (40%), *Fimbristylis ferruginea* (20%), *Paspalum vaginatum* (20%), *Sesuvium portulacastrum* (20%).

Total species recorded: 20.

Mean species per site: 6 with a s.d. of 3.

Number of Sites: 5.

Sampling Index: 1 site per 29 ha.

Representative Sites: 94, 113, 153, 224, 226.

Ecological Notes:

This unit usually occurs in areas that are shallowly inundated with brackish to fresh water. It commonly dies back in winter and grows again in spring. In many areas *Phragmites australis* has invaded areas that were originally *Sporobolus virginicus* grasslands but which for a number of reasons now pond fresh or brackish water.

Regional Ecosystem:

Regional Ecosystem which contains this map unit: 12.1.2.

The Regional Ecosystem to which this belongs is of no concern at present.

Of a total of 143.8 ha of this vegetation unit, 31.5 ha (21.9%) is presently in reserve.

Map Unit: 5C(ii) *Casuarina glauca*, *Avicennia marina* subsp. *australasica* low open-forest



Description: An uneven canopy usually about 8-10m tall is dominated by *Casuarina glauca* with *Avicennia marina* subsp. *australasica* comprising about 40% of the canopy. A mid-dense second layer is usually present, and may contain other mangroves such as *Excoecaria agallocha* and *Ceriops tagal*, as well as young plants of the upper canopy species. *Myoporum acuminatum* and *Melaleuca quinquenervia* also be present. The ground layer has pools of water with patches of *Suaeda australis*, *Acrostichum speciosum* and *Phragmites australis*. In places, this community has a canopy reaching 18-20m in height.

Structural Formation Range: open-forest (50%), low open-forest (50%).

Basal Area Estimate m^2ha^{-1} : mean 29.5; range 22.0-37.0.
Casuarina glauca ($22.5 \text{ m}^2\text{ha}^{-1}$), *Excoecaria agallocha* ($4.0 \text{ m}^2\text{ha}^{-1}$), *Avicennia marina* subsp. *australasica* ($2.5 \text{ m}^2\text{ha}^{-1}$), *Melaleuca quinquenervia* ($0.5 \text{ m}^2\text{ha}^{-1}$).

Canopy Layer

Height: mean 14.0m; range: 8.0-20.0.

Crown Cover: mean 83.5%; range: 77.0-90.0.

Frequent species: *Avicennia marina* subsp. *australasica* (100%), *Casuarina glauca* (100%), *Excoecaria agallocha* (50%), *Melaleuca quinquenervia* (50%).

Subcanopy Layer

Height: mean 9.5m; range: 6.0-14.0.

Crown Cover: mean 35.0%; range: 30.0-40.0.

Frequent species: *Casuarina glauca* (100%), *Avicennia marina* subsp. *australasica* (50%), *Ceriops tagal* (50%), *Excoecaria agallocha* (50%), *Melaleuca quinquenervia* (50%), *Myoporum acuminatum* (50%).

Ground Layer

Height: mean 0.8m; range: 0.2-2.0.

Crown Cover: mean 35.0%; range: 10.0-60.0.

Frequent species: *Acrostichum speciosum* (50%), *Phragmites australis* (50%), *Sarcocornia quinqueflora* subsp. *quinqueflora* (50%), *Suaeda australis* (50%).

Total species recorded: 21. **Mean species per site:** 12 with a s.d. of 6.

Number of Sites: 2.

Sampling Index: 1 site per 4 ha.

Representative Sites: 16, 202.

Ecological Notes:

This community occurs at the interface between *Casuarina glauca* and mangroves in areas in which there is substantial freshwater seepage, but over which the highest spring tides may occur.

Regional Ecosystem:

Regional Ecosystem which contains this map unit: 12.1.1.

The Regional Ecosystem to which this belongs is of concern.

Of a total of 7.4 ha of this vegetation unit, 1.2 ha (16.2%) is presently in reserve.

Map Unit: 5C(iii) *Casuarina glauca*, *Avicennia marina* subsp. *australasica*,
Aegiceras corniculatum open-forest

Description: A canopy usually about 10-14m tall is dominated by *Casuarina glauca*, with *Avicennia marina* subsp. *australasica* always contributing significantly to the canopy. A dense lower tree layer is present and is dominated by *Aegiceras corniculatum*. The ground layer is mostly bare due to the shading effects of the dense mangrove understorey.

Structural Formation Range: open-forest, woodland.

Basal Area Estimate m²ha⁻¹: No estimates.

Canopy Layer

Height: mean 14.0m; range: 10.0-18.0.

Crown Cover: mean 60.0%; range: 20.0-80.0.

Frequent species: *Avicennia marina* subsp. *australasica*, *Casuarina glauca*.

Subcanopy Layer

Height: mean 2.0m; range: 1.5-3.0.

Crown Cover: mean 70.0%; range: 60.0-100.0.

Frequent species: *Aegiceras corniculatum*.

Number of Sites: 0.

Sampling Index: not sampled.

Representative Sites: Not sampled.

Ecological Notes:

This community occurs along the lower reaches of King John Creek and was probably more extensive than at present but due to clearing it is now limited in extent. It represents the interface between low lying areas under tidal influence and adjacent areas under freshwater influence.

Regional Ecosystem:

Regional Ecosystem which contains this map unit: 12.1.1.

The Regional Ecosystem to which this belongs is of concern.

Of a total of 17.4 ha of this vegetation unit, none is presently in reserve.

NEBP - Residential West Area

APPENDIX

B

Restoration Case Studies

Moreton Drive Mangrove Revegetation

Brisbane



Client:
Brisbane Airport Corporation
(BAC)

Location:
Brisbane Airport, QLD, Australia

Sector:
Natural Areas Management

Project value:
AUD\$ 55,000

Start date:
June 2009

Completion date:
July 2009

Office responsible:
Brisbane

Key services:

- > Rehabilitation Report
- > Design of Rehabilitation works
- > Quality inspections for both propagule collection/propagation and works

Re-vegetating a realigned tidal drain with marine species.

Overview

As part of the Brisbane Airport upgrade, the "Landers Pocket" tidal drain was diverted around the newly constructed Moreton Drive (formally known as the Northern Access Road). The drain was treated for Acid Sulphate and left as a straight trapezoidal channel.

As the BAC landscape design consultant, Cardno coordinated the rehabilitation of the newly aligned drain to represent a tidal waterway.

A detailed rehabilitation report was developed which required the use of state protected species that are not commercially available.

To overcome this, the team managed the permit process and the collection of Grey Mangrove (*Avicennia marina*) seeds. These were then propagated off site in a nearby tidal drain. The seedlings were closely monitored and planted in the drain at the ideal time to ensure a high level of survival.

To aid in the stabilisation of the drain batters Marine Couch (*Sporobolus virginicus*) was sourced locally and 200 x 200mm Marine Couch plugs were installed.

Contact Cardno:
Phone: + 61 7 33699822
Email: landscape@cardno.com
www.cardno.com

Highland Reserve

Coomera



Client:
Stockland Development Pty Ltd

Location:
Coomera, QLD, Australia

Sector:
Natural Areas Management

Project value:
AUD\$ 1.1M

Start date:
2003

Completion date:
ongoing

Office responsible:
Gold Coast

Key services:

- > Site Assessment
- > Detailed Design
- > DA Coordination
- > Contract Administration

Contact Cardno:
Phone: + 61 7 5534 7533
Email: landscape@cardno.com
www.cardno.com

Cardno has been involved in natural area management at Highland Reserve since 2003. This residential estate is located at the base of the Gold Coast hinterland, which forms a green backdrop to the residential zone.

Overview

Historically, this site had been heavily degraded over many decades through clearing, agriculture and recreational vehicles.

Project challenges included dense weed infestation (Lantana, Madeira Vine and Morning Glory), steep slopes, high soil nutrient loads and stringent legislative assessment.

Major environmental outcomes include the rehabilitation of wildlife corridors through the residential zones, incorporating fauna crossings to link the western foothills to the Coomera River to the east; coordinating the restoration of state listed wetlands with estate construction works; stabilisation of storm water management systems; environmental covenant management; and restoration of 160 ha of bushland which buffers the estate from the hills of the Gold Coast Hinterland including revegetation across 4 separate Regional Ecosystems.

Achievements:

- > 200,000 tubestock planted;
- > 130 hectares of bushland rehabilitated; and
- > Planting out 12 bio-detention basins as part of the estate storm water treatment system.

Images:

From left to right: rehabilitation of bushland buffers; implementing natural areas restoration with staged development delivery

Woogaroo Creek Restoration

Augustine Heights



Client:
Stockland Development Pty. Ltd.

Location:
Augustine Heights, QLD,
Australia

Sector:
Natural Areas Management

Administration Project value:
AUD\$ 370,000

Start date:
January 2011

Completion date:
July 2012

Office responsible:
Gold Coast

Key services:

- > Rehabilitation Guidelines
- > Design of Rehabilitation works
- > Contract Administration

Contact Cardno:
Phone: + 61 7 5534 7533
Email: landscape@cardno.com
www.cardno.com

Creek rehabilitation and natural amenity enhancement with in an estate.

Overview

Woogaroo Creek forms a 3.5 kilometre environmental spine running through the Augustine Heights residential development near Ipswich, Queensland.

Historically, this riparian corridor has been heavily degraded over many decades through clearing, nearby quarrying and the construction of an adjacent golf course.

Project challenges included dense weed infestation through all vegetation strata, high soil nutrient loads, stream bank erosion, deep sediment loads and stringent legislative assessment.

The involvement of Cardno's Natural Areas Management team over the past four years has ensured successful rehabilitation of the riparian corridor. In fact, the project has been described by Ipswich Council officers as one of the best rehabilitation projects in the city.

Rehabilitation works have been undertaken seamlessly within overall estate works, ensuring no delays in assessment or handover to the local authority.

To date, there has been approximately 81,000 tube stock planted into 9 hectares. This ensures the stabilisation of 1km of creek line, while creating a fauna corridor through the estate.

Pig Creek Restoration

Riverstone Crossing



Client:
Stockland Development Pty Ltd

Location:
Gold Coast, Qld, Australia

Sector:
Creek Rehabilitation

Project value:
\$ 1,000,000

Start date:
January 2012

Completion date:
TBC

Office responsible:
Gold Coast

Key services:

- > Creek revegetation
- > Pedestrian linkages through natural setting
- > Stormwater treatment

Converting a degraded drainage line into an environmental and recreational asset for the community.

Overview

Riverstone Crossing is a variable density residential development on an ex-dairy property in the Gold Coast hinterland.

Pig Creek is a degraded drainage channel running for 800m through the middle of the extensively cleared property.

The original treatment proposed for the creek was a simple trapezoidal drain. However Cardno reviewed and amended the design to provide a multi-function corridor allowing active recreation, environmental restoration and stormwater treatment.

Design embellishments include formal path linkages along and across the creek with open grassy nodes for active recreation.

Ecological rehabilitation along the creek will create a vital habitat link between the wooded hills to the west and the Coomera River in the east across what is now exotic pasture.

As well as forming an environmental corridor, Pig Creek will receive stormwater from the whole estate. The stormwater will be treated through a series of bio-detention basins before entering the Coomera River. These detention basins have been designed to complement the other functions of the corridor – habitat creation and passive recreation (e.g. birdwatching).

Contact Cardno:

Phone: + 61 7 5534 7533

Email: landsape@cardno.com

www.cardno.com

Images:

From left to right: existing creekline; creek masterplan

Greenwood Lakes Reserve

Forestdale



Client:

Allconnex Water

Location:

Forestdale, QLD, Australia

Sector:

Natural Areas Management

Project value:

AUD\$ 1.9M

Start date:

August 2011

Completion date:

December 2014

Office responsible:

Brisbane

Key services:

- > Design of Rehabilitation works
- > Project Management
- > Monitoring and Reporting to DERM
- > Manage 3 year maintenance period
- > Co-ordinate/ manage and design future mitigation

Contact Cardno:

Phone: + 61 7 3369 9822

Email: landscape@cardno.com

www.cardno.com

GLRRP is a broad scale vegetation mitigation project, inclusive of pest plant treatment, installation of 92,500 native plants and the installation of nest boxes.

Overview

Since 2010, the Cardno Natural Areas Management (NAM) team has worked on the Logan Water Alliance. This Alliance was formed to design and manage construction of 300 million dollars' worth of sewerage and water infrastructure for Allconnex Water. As conditioned by the Nature Conservation Act 1992 all native vegetation that was cleared for the capital works had to be mitigated within the Logan City Council (LCC) shire. A 35 hectares riparian corridor known as Greenwood Lakes Reserve was provided by LCC for the mitigation project. Currently 14 hectares of the reserve is being rehabilitated as per the conditions, leaving the remaining reserve as expansion area if required.

Historically, this riparian corridor has been heavily degraded over many decades by sand mining, clearing, and heavy development. Project challenges included dense pest plant infestation through all vegetation strata, seasonal sedimentation dispersal; development of a management plan for Department of Environment and Heritage Protection (DEHP) / LCC approval, reinstatement of fauna habitat and community consultation.

The works were broken into two stages, the first being the rehabilitation of 12 hectare riparian forest which was finished in January 2012, where a 3 year maintenance period has now commenced. The second stage of the works will be complete by the end of September, upon complete a separate 3 year maintenance period will commence. To raise awareness for the project the NAM team organised and held two community tree planting events where 1350 plants were planted and 1500 plants given away, and local environmental awareness was provided to the community.

Images:

From left to right: 1 of 29 Nest Boxes; Greenwood Lakes Reserve Stage 1 planting