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Detailed Flora and Vegetation Survey
Eastern Link

Background

Strategen was commissioned to undertake a Detailed Level Flora and Vegetation Survey (the Survey) within the Eastern Link project area (Project area) and surrounds (Survey area) (Figure 1). The Survey is in addition, and as supplement, to the Reconnaissance Level Flora, Vegetation and Fauna Survey undertaken by Ecosystem Solutions in August 2017. The Survey focused on vegetation communities within the Project area.

The scope of this Survey was to undertake a field assessment within the Project area and surrounds consistent with a Detailed Survey as defined by *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016).

The objectives were to:

- collect and identify the vascular plant species present within the Survey area
- define and map the native vegetation communities present within the Survey area
- map vegetation condition within the Survey area
- provide recommendations on the local and regional significance of the vegetation communities
- prepare a report summarising the findings.

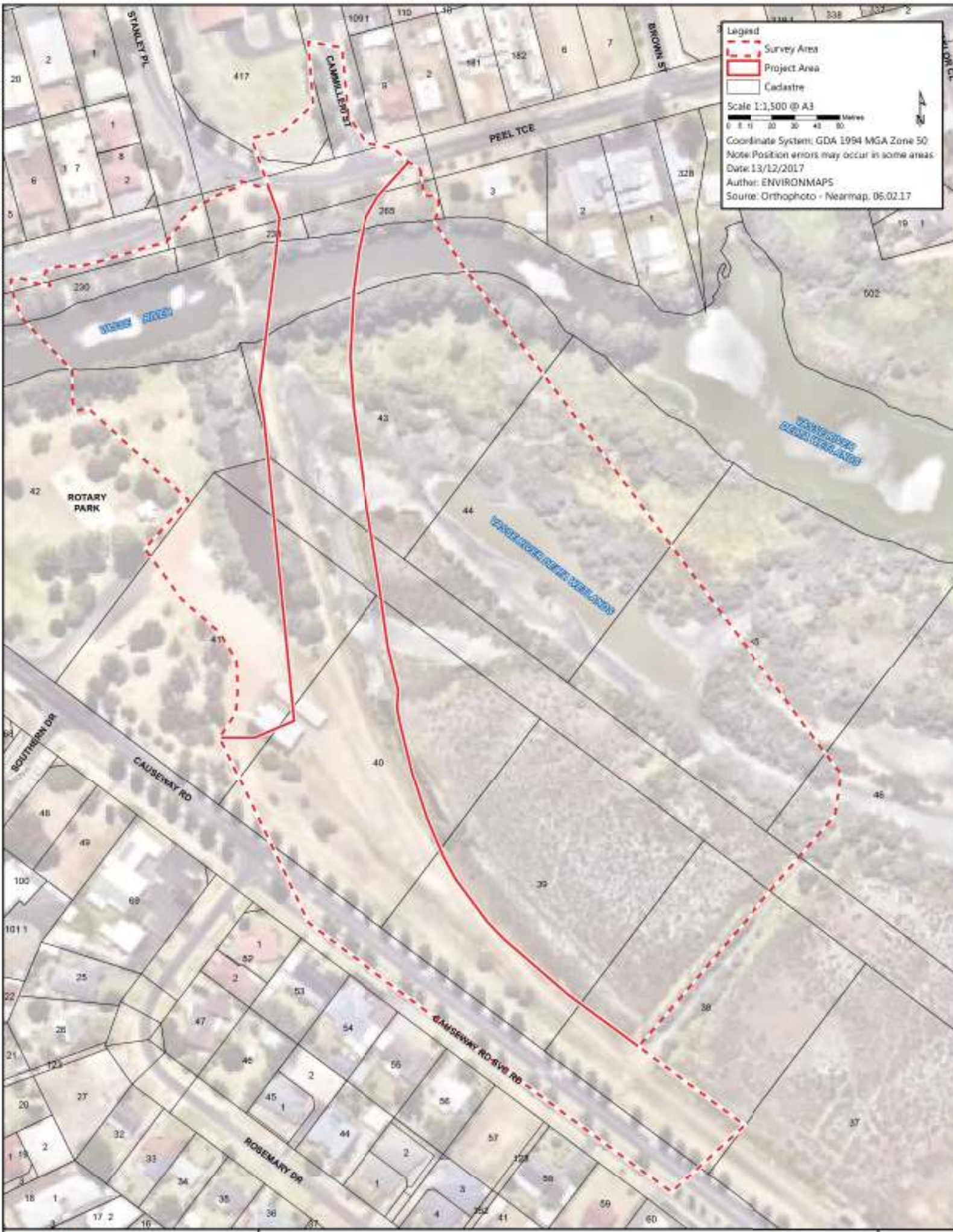
Methods

The field assessment was conducted according to standards set out in *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016). The assessment of flora and vegetation within the Survey area was undertaken by one ecologist from Strategen on 3 November 2017. Table 1 identifies staff involved in the field survey, their role and qualifications. The survey area was traversed on foot to record changes in vegetation structure and type and eight vegetation quadrats were surveyed to identify vegetation types.

Table 1: Personnel

Name	Role	Flora collection permit	Dates
Mr T Sleigh (Senior Ecologist)	Fieldwork, plant identification, data interpretation and report preparation	SL012160	3 November 2017

Site selection for vegetation mapping was based on differences in structure and species composition of the communities present within the Survey area. Vegetation mapping sites were determined from aerial photographs and confirmed on site. The Survey area was traversed on foot, allowing for opportunistic sites to be placed where a change in vegetation structure or composition was observed.



Eastern Link Project – Detailed Flora and Vegetation Survey

Survey Area and Project Area

Figure 1

Flora and vegetation was described and sampled systematically at each quadrat and additional opportunistic collecting was undertaken wherever previously unrecorded plants were observed. At each site the following floristic and environmental parameters were noted:

- GPS location
- topography
- soil type and colour
- outcropping rocks and their type
- percentage cover and average height of each vegetation stratum
- vegetation condition.

For each vascular plant species, the average height, number of plants and percent cover were recorded. Vegetation condition was rated according to the scale of Keighery (1994) (Table 2).

Table 2: Vegetation condition scale (Keighery 1994)

Condition rating	Description
Pristine (1)	Pristine or nearly so, no obvious sign of disturbance.
Excellent (2)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
Very Good (3)	Vegetation structure altered obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good (4)	Vegetation structure significantly altered by obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback, grazing.
Degraded (5)	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded (6)	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

All plant specimens collected during the field surveys were identified using appropriate reference material or through comparisons with pressed specimens housed at the Western Australian Herbarium where necessary. Nomenclature of the species recorded is in accordance with Western Australian Herbarium (1998-).

Data analysis and vegetation mapping

Vegetation types (VT) were delineated using a combination analysis of quadrat data and site observations. Aerial photography interpretation and field notes taken during the Survey were then used to develop VT mapping polygon boundaries over the Survey area. These polygon boundaries were then digitised using Geographic Information System (GIS) software.

VT descriptions (though floristic in origin) have been adapted from the National Vegetation Information System (NVIS) Australian Vegetation Attribute Manual Version 6.0 (ESCAVI 2003), a system of describing structural vegetation units (based on dominant taxa). This model follows nationally-agreed guidelines to describe and represent vegetation types, so that comparable and consistent data is produced nation-wide. For the purposes of this report, a VT is considered equivalent to a NVIS sub-association as described in ESCAVI (2003).

Vegetation condition was recorded at all quadrats, and also opportunistically within the Survey area during the field assessment where required. Vegetation condition was described using the vegetation condition scale for the South West Botanical Province (Keighery 1994). Vegetation condition polygon boundaries were developed using this information in conjunction with aerial photography interpretation, and were digitised as for vegetation type mapping polygon boundaries.

Survey limitations and constraints

Table 3 displays the evaluation of the flora and vegetation assessment against a range of potential limitations that may have an effect on that assessment. Based on this evaluation, the assessment has not been subject to constraints that would affect the thoroughness of the assessment and the conclusions reached.

Table 3: Flora and vegetation survey potential limitations and constraints

Potential limitation	Impact on assessment	Comment
Sources of information and availability of contextual information (i.e. pre-existing background versus new material).	**Not a constraint.**	The survey has been undertaken on the Swan Coastal Plain which has been well studied and documented with ample literature available (Beard 1990).
Scope (i.e. what life forms, etc., were sampled).	**Not a constraint.**	Number of species recorded, number of quadrats sampled and timing of the survey (i.e. spring) were adequate for this level of survey.
Proportion of flora/fauna collected and identified (based on sampling, timing and intensity).	**Not a constraint.**	The proportion of flora surveyed was adequate. The entire survey area was traversed and flora species were recorded systematically.
Completeness and further work which might be needed (i.e. was the relevant survey area fully surveyed).	**Not a constraint.**	The information collected during the survey was sufficient to assess the vegetation that was present during the time of the survey.
Mapping reliability.	**Not a constraint.**	Aerial photography of a suitable scale was used to map the survey area. Sites were chosen from these aerials to reflect changes in community structure. Opportunistic sites were also used if differences were observed during on ground reconnaissance. Vegetation types were assigned to each site based on topography, soil type and presence/absence and percent foliage cover of vegetation.
Timing, weather, season, cycle.	**Not a constraint.**	Flora and vegetation surveys are normally conducted following winter rainfall in the South-West Province, ideally during spring (EPA 2016). The field assessment was conducted in November in fine weather conditions and therefore these factors are not deemed to be constraints.
Disturbances (fire flood, accidental human intervention, etc.).	**Potentially a constraint.**	The survey area and regional surrounds have been subject to disturbance over a significant period of time. This is likely to have reduced the species richness and influences statistical analyses.
Intensity (in retrospect, was the intensity adequate).	**Not a constraint.**	The survey area was traversed on foot and all differences in vegetation structure were recorded appropriately.
Resources (i.e. were there adequate resources to complete the survey to the required standard).	**Not a constraint.**	The available resources were adequate to complete the survey.
Access problems (i.e. ability to access survey area).	**Not a constraint.**	Existing tracks enabled adequate access to survey the vegetation within the survey area. Where access was not available by car, the area was easily traversed by foot.
Experience levels (e.g. degree of expertise in species identification to taxon level).	**Not a constraint.**	All survey personnel have the appropriate training in sampling and identifying the flora of the region.

Results

Native flora

A total of 21 native vascular plant taxa from seven plant families were recorded within the Survey area (Appendix 1). The majority of taxa were recorded within the Chenopodiaceae and Myrtaceae families.

Threatened and Priority flora

No Threatened flora species as listed under section 178 of the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) were recorded within the Survey area. No Threatened flora species pursuant to Schedule 1 of the Western Australian *Wildlife Conservation Act 1950* (WC Act) and as listed by Department of Biodiversity, Conservation and Attractions DBCA (2017) and no Priority flora species as listed by Western Australian Herbarium (1998-) were recorded within the Survey area.

Introduced (exotic) taxa

A total of 25 introduced (exotic) taxa were recorded within the Survey area, as follows:

- **Asparagus asparagoides*
- **Avena barbata*
- **Callistemon sp. (planted)*
- **Carex divisa*
- **Cenchrus clandestinus*
- **Cynodon dactylon*
- **Ehrharta calycina*
- **Eucalyptus grandis*
- **Eucalyptus petiolaris*
- **Eucalyptus robusta*
- **Fumaria capreolata*
- **Hordeum leporinum*
- **Lolium perenne*
- **Lysimachia arvensis*
- **Malva parviflora*
- **Melilotus indicus*
- **Morus sp.*
- **Pelargonium capitatum*
- **Romulea rosea*
- **Solanum nigrum*
- **Sonchus oleraceus*
- **Stenotaphrum secundatum*
- **Vicia sativa*
- **Zantedeschia aethiopica*
- **Zanthoxylum piperitum*

Two of these species area Declared Plant species in Western Australia pursuant to section 22 of the *Biosecurity and Agriculture Management Act 2007* (BAM Act) according to the Western Australian Department of Agriculture and Food[1] (DAFWA 2017). Both **Asparagus asparagoides* and **Zantedeschia aethiopica* listed under category 3 (c3) for all areas of Western Australia. This requires the infested area to be managed in such a way that alleviates the impact, reduces the number or distribution or prevents or contains the spread of the declared pest in the surrounding area. It also requires that any person conducting an activity on the land is aware that measures are required to be taken to control the declared pest.

Vegetation types

Four native vegetation types (VTs) were defined and mapped within the Survey area (Figure 2). Areas containing vegetation in parkland cleared or highly degraded state have not been counted as unique native VTs but have been included in Table 4 for area calculation purposes. The VTs defined in this Survey refine and supersede the Vegetation Groups defined in the Reconnaissance Level Survey (Ecosystem Solutions 2017).

The total area mapped within the Survey area was 8.31 ha which includes cleared and manicured grassland, and areas of open water. The Project area is 2.64 ha and occupies a portion of the Survey area.

The location of mature Peppermint trees (*Agonis flexuosa*) was mapped within the Survey area, acknowledging the importance of this species as habitat for the threatened Western Ringtail Possum (*Pseudocheirus occidentalis*). The locations of mature Peppermint trees are presented in Figure 2, which indicates a total of 17 mature Peppermint trees as located within VT1 within the Project area. It is noted that scattered, juvenile Peppermint trees are also present within VT2, however these are considered to have limited habitat value for Western Ringtail Possum and have not been mapped.

Table 4: Vegetation types

Vegetation Type	Description	Area (ha) within Survey area	Percentage of the survey area	Area (ha) within Project area	Percentage of the Project area
VT1	*Agonis flexuosa* low woodland over **Cynodon dactylon* grassland (managed)	0.35	4.2	0.10	3.7
VT2	*Eucalyptus rudis*, *Eucalyptus cornuta* and **Eucalyptus grandis* mid woodland over *Melaleuca rhaphiophylla* and *Agonis flexuosa* low open woodland over *Callistemon* sp. low open shrubland over **Cenchrus clandestinus* and *Bolboschoenus caldwellii* low grassland/sedgeland	0.39	4.7	0.08	2.9
VT3	*Melaleuca rhaphiophylla*, *Melaleuca teretifolia* and *Melaleuca preissii* low open forest over *Melaleuca viminea* mid shrubland over **Cynodon dactylon* and **Cenchrus clandestinus* low grassland	1.04	12.5	0.08	3.0
VT4	*Salicornia quinquefolia*, *Tecticornia indica* subsp. *bidens* and *Salicornia blackiana* low samphire shrubland	2.03	24.4	0.11	4.2
VT4(d)	**Carex divisa* closed sedgeland over **Stenotaphrum secundatum* low open grassland	0.62	7.4	0.19	7.4
CL	Cleared or manicured grassland	2.30	27.7	1.73	65.6
OW	Open Water	1.58	19.1	0.35	13.3

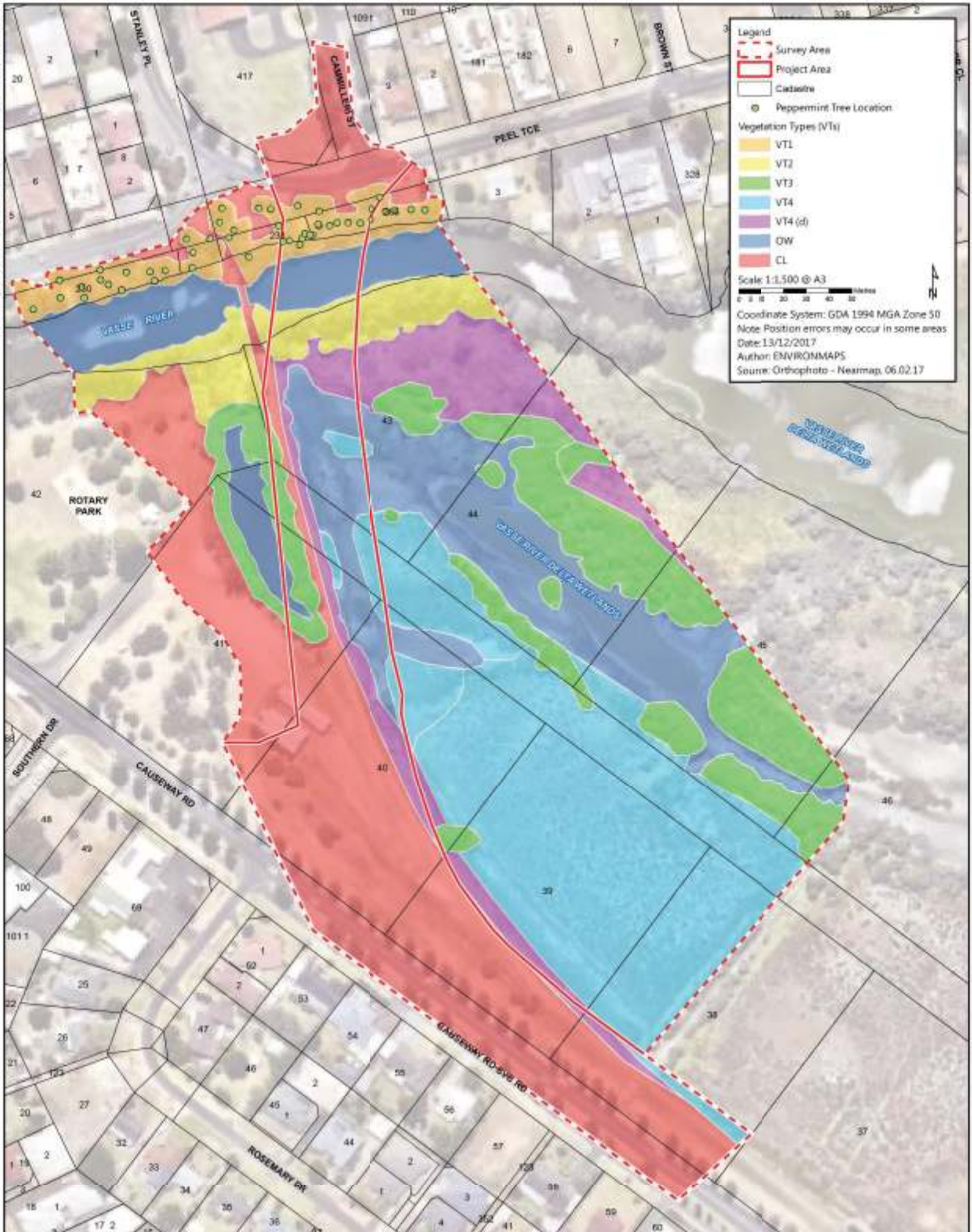
[1] Now the Department of Primary Industries and Regional Development

Vegetation condition

The Survey area contains a mixture of relatively undisturbed land as well as areas which show signs of having been degraded for a long period of time through historical clearing and weed invasion. As such, vegetation condition within the Survey area ranged from Completely Degraded to Excellent (Keighery 1994) (Figure 3). Table 5 gives a numerical breakdown of the area occupied by each vegetation condition rating within the Survey area and Project area.

Table 5: Area (ha) covered by each vegetation condition category within the survey area

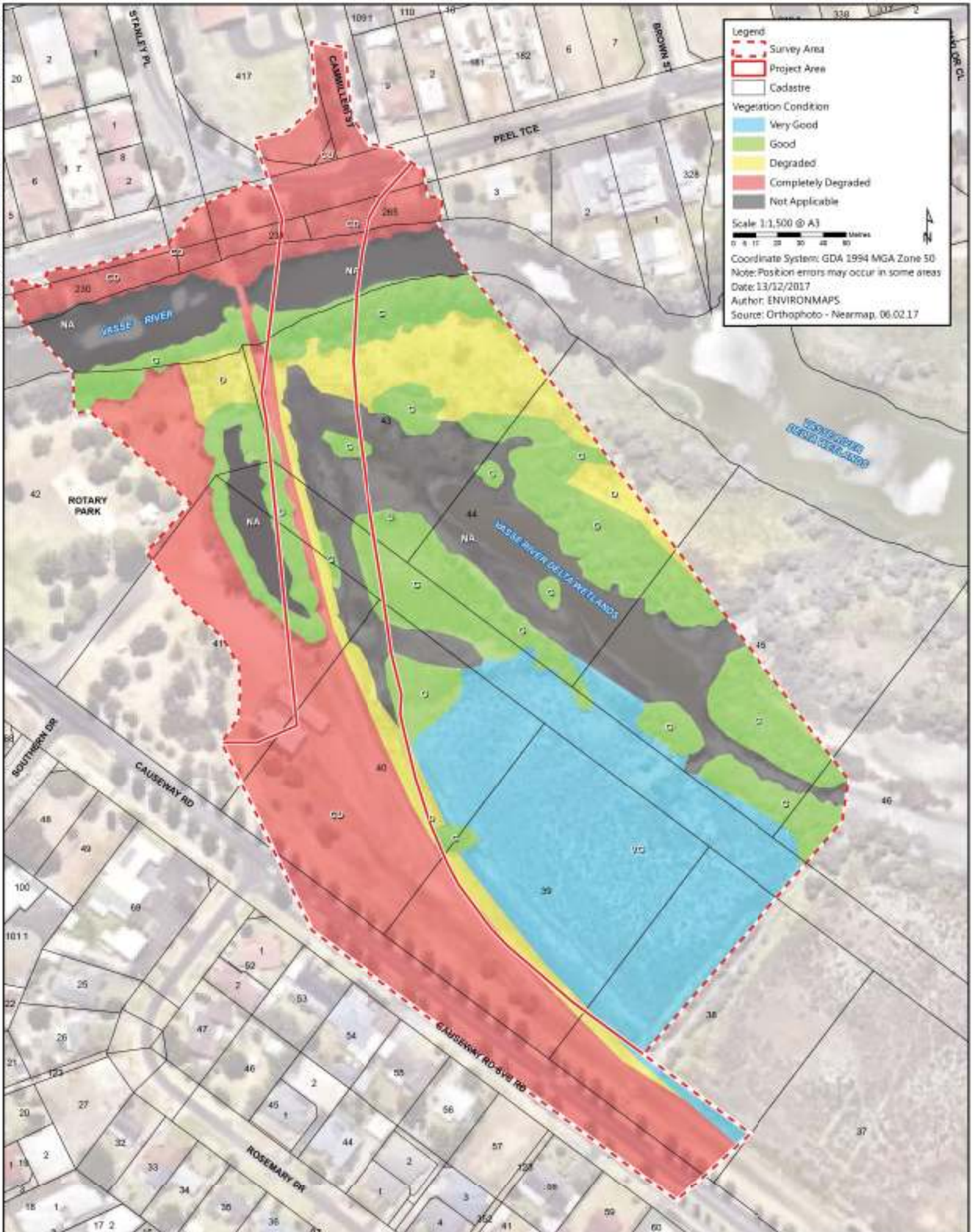
Vegetation Condition	Area (ha) within the Survey area	Percentage of the Survey area	Area (ha) within the Project area	Percentage of the Project area
Very Good	1.67	20.1	0.04	1.3
Good	1.70	20.5	0.23	8.7
Degraded	0.70	8.4	0.19	7.4
Completely Degraded	2.65	31.9	1.83	69.3
Open Water	1.58	19.1	0.35	13.3
Total	**8.31**	**100%**	**2.64**	**100**



Eastern Link Project – Detailed Flora and Vegetation Survey

Vegetation Types (VTs)

Figure 2



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Vegetation Condition

Figure 3

Threatened and Priority Ecological Communities

A threatened ecological community (TEC) is defined under the EP Act as an ecological community listed, designated or declared under a written law or a law of the Australian Government as Threatened, Endangered or Vulnerable. There are four State categories of TECs (DEC 2010)[2]:

- presumed totally destroyed (PD)
- critically endangered (CR)
- endangered (EN)
- vulnerable (VU).

Ecological communities identified as Threatened, but not listed as TECs, are classified as Priority Ecological Communities (PECs). These communities are under threat, but there is insufficient information available concerning their distribution to make a proper evaluation of their conservation status. DBCA categorises PECs according to their conservation priority, using five categories, P1 (highest conservation significance) to P5 (lowest conservation significance), to denote the conservation priority status of such ecological communities.

As detailed in the Reconnaissance Level Survey (Ecosystem Solutions 2017), two TECs and one PEC were identified within 5 km of the Survey area. One TEC overlapped with the Survey area (Table 6).

Table 6: Mapped TECs and PECs identified within survey area

Community name	Listing under WC Act	Listing under EPBC Act
Subtropical and Temperate Coastal Saltmarsh	P3 (DBCA)	Vulnerable

One vegetation type mapped within the Survey area (VT4), exhibits floristic and structural similarities to the Subtropical and Temperate Coastal Saltmarsh TEC. The dominant species within the mapped vegetation type, *Salicornia quinquefolia, Tecticornia indica* subsp*. bidens and Salicornia blackiana*, are included in the list of coastal saltmarsh plants from Western Australia (Department of Sustainability, Environment, Water, Population and Communities 2013). Vegetation Type VT4(d) is likely to have been of similar floristic composition to VT4; however, disturbance and weed infestation have changed the floristic composition such that it no longer representative of the TEC.

Table 5 provides and assessment of VT4 against the key diagnostic characteristics of the Subtropical and Temperate Coastal Saltmarsh TEC outlined in the Conservation Advice (DSEWPAC 2013).

Table 7: Diagnostic Characteristics

Diagnostic Characteristic	Diagnostic characteristic met	Reason
occurs south of 23° 37' S latitude - from the central Mackay coast on the east coast of Australia, southerly around to Shark Bay on the west coast of Australia (26° latitude), and including the Tasmanian coast and islands within the above range	Yes	Project area lies on the west coast of Australia at an approximate latitude of 33˚
occurs on the coastal margin, along estuaries and coastal embayments and on low wave energy coasts	Yes	Project area is located on the western margin of the Vasse River Delta Wetlands, which adjoin the Vasse Estuary
occurs on places with at least some tidal connection, including rarely -inundated supratidal areas , intermittently opened or closed lagoons, and groundwater tidal influences, but not areas receiving only aerosol spray	No	The Project area does not experience tidal / salt water influence. See below for justification

[2] The Department of Environment and Conservation is still listed as the author of all TEC and PEC databases and have been referred to as such in this document instead of the Department of Biodiversity, Conservation and Attractions [DBCA]).

Diagnostic Characteristic	Diagnostic characteristic met	Reason
occurs on sandy or muddy substrate and may include coastal clay pans (and the like)	Yes	Vegetation Type VT4 is situated on sandy clay substrates.
consists of dense to patchy areas of characteristic coastal saltmarsh plant species (i.e. salt- tolerant herbs, succulent shrubs or grasses, that may also include bare sediment as part of the mosaic)	Yes	The dominant species of VT4 are characteristic of coastal salt marsh plant species in Western Australia
proportional cover by tree canopy such as mangroves, Melaleucas or Casuarinas is not greater than 50%, nor is proportional ground cover by seagrass greater than 50%	Yes	No tree canopy cover or seagrass ground cover is present within VT4

In addition to the diagnostic characteristics, the Conservation Advice lists a number of exclusions from the Coastal Saltmarsh TEC. These are listed in Table 8.

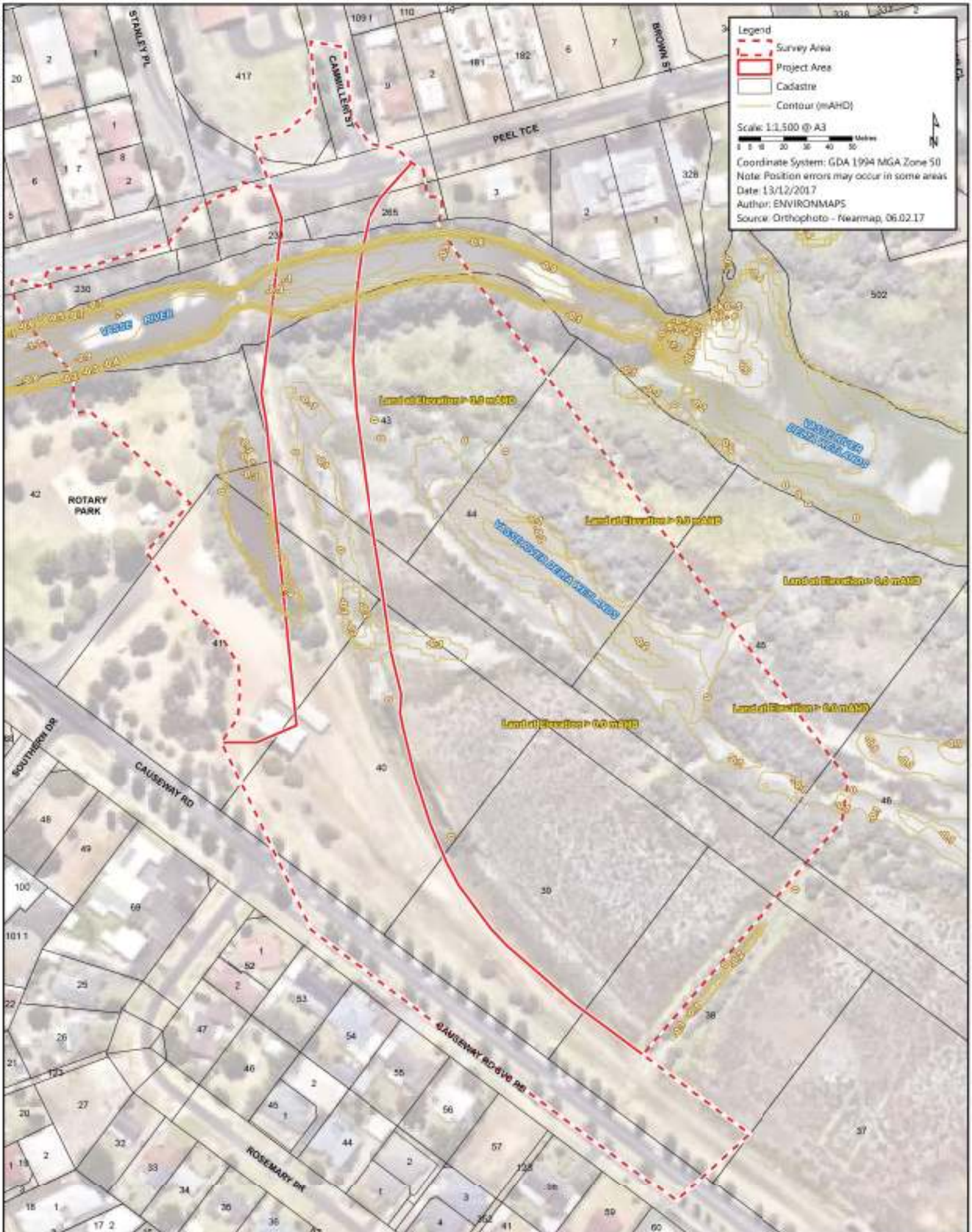
Table 8: Excluding factors

Exclusion	Applicable	Reason
saltmarsh occurring in seepage zones on sea cliffs and elevated rock platforms above the tidal limit and on elevated headlands subject only to aerosolic salt	No	N/A
saltmarsh occurring on inland saline soils with no tidal connection	No	N/A
isolated patches of saltmarsh < 0.1 ha	No	N/A
patches or areas of saltmarsh that contain > 50% weeds (i.e. patches must be dominated by native saltmarsh plant species to be the ecological community)	Yes	This exclusion is applicable to Vegetation Type VT4(d) which is dominated by introduced species and contains no native saltmarsh plant species
patches of saltmarsh (possibly senescent) within the coastal margin that are disconnected (either naturally or artificially) from a tidal regime but were once connected.	Yes	The Project area does not experience tidal / salt water influence. See below for justification.

The lack of tidal / saltwater influence within the Survey area has been determined through consultation with Department of Water and Environmental Regulation (DWER) and review of topographic data and historic aerial imagery. DWER (P. Kelsey, 6/12/2017, pers. comm.) advise that the Vasse Estuary (downstream of the Survey area) has had a surge barrier in place since 1908 and that until 1988 salt water was not intentionally let into the estuary. From 1988 onwards salt water was let in to the estuary every summer to maintain water levels at minus 0.1 metres Australian Height Datum (AHD). LiDAR topographic demonstrates that the beds of the wetlands within the Survey area, while lying at elevations as low as minus 0.3 to 0.4 mAHD, are separated by land at elevations greater than minus 0.1 mAHD. Accordingly, salt water released from the Vasse Estuary surge barrier during summer is not expected to inundate the wetlands within the Survey area, as the salt water within the estuary would need to cross land at higher elevations than the estuary water level. A review of historic aerial imagery[3] indicates that the wetlands within the Survey area dry out during the summer and autumn period, rather than experiencing inundation with salt water as occurs within the Vasse Estuary.

Based on the factors presented in Table 7 and Table 8, the Survey area is not expected to contain the Subtropical and Temperate Coastal Saltmarsh TEC.

[3] Landgate Map Viewer Plus: *https://maps.landgate.wa.gov.au/maps-landgate/registered/* imagery dated 4 April 2001, 5 April 2003, 24 March 2007, 22 February 2008, 7 February 2009, 24 December 2010, 1 March 2012, 31 March 2013, 11 March 2014, 6 February 2016, 23 February 2017.



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Topography of Wetlands

Figure 4

Discussion and conclusions

The flora and vegetation assessment of the Survey area was conducted during November 2017, which was prime flowering time for majority of species within the region. The field survey focussed on traversing the entire Survey area to delineate vegetation types and is consistent with the requirements of a detailed flora and vegetation survey as specified in *Technical Guidance: Flora and Vegetation Surveys for Environmental Impact Assessment* (EPA 2016).

Four VTs were mapped within the Survey area, as well as cleared and highly disturbed vegetation. The Survey area was dominated *Salicornia quinquefolia*, *Tecticornia indica* subsp. *bidens* and *Salicornia blackiana* low samphire shrubland.

Twenty-one native vascular plant taxa from seven plant families as well as 25 exotic taxa were recorded within the survey area. Two Declared Plant species pursuant to section 22 of the BAM Act were recorded within the survey area. Both **Asparagus asparagoides* and **Zantedeschia aethiopica* listed under c3 for all areas of Western Australia.

No Threatened flora species as listed under section 178 of the EPBC Act or pursuant to Schedule 1 of the WC Act and as listed by DBCA (2017) were recorded within the Survey area. Additionally, no Priority flora species as listed by Western Australian Herbarium (1998-).

Vegetation containing VT4 exhibits floristic and structural similarities to the Subtropical and Temperate Coastal Saltmarsh TEC. While the vegetation meets most of the diagnostic characteristics of the TEC, one characteristic was not met as VT4 lies about wetlands that are not subject to tidal / salt water influence due to the presence of the Vasse Estuary surge barrier downstream. This also aligns with an exclusion as outlined in the Conservation Advice (DSEWPAC 2013). Given these factors, Vegetation Type VT4 is not expected to form part of the Subtropical and Temperate Coastal Saltmarsh TEC.

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Appendix 1
Vascular plant taxa recorded by site and vegetation type

FAMILY		Taxa	Q01	Q02	Q03	Q04	Q05	Q06	Q07	Q08	Q09	Q10
Apiaceae		Apium annuum	+									+
		Daucus glochidiatus	+									
Araceae	*	Zantedeschia aethiopica		+	+	+	+	+	+	+		
Asparagaceae	*	Asparagus asparagoides								+		
Asteraceae		Asteraceae sp.	+	+								
		Podolepis lessonii	+									
	*	Sonchus oleraceus	+	+	+	+				+		
Chenopodiaceae		Salicornia blackiana	+									+
		Salicornia quinquefolia	+	+								+
		Suaeda australis	+									+
		Tecticornia indica subsp. bidens	+									
		Tecticornia lepidosperma	+	+								+
Cyperaceae	*	Carex divisa		+		+						
		Gahnia trifida		+								
		Lepidosperma gladiatum						+				
		Tetraria capillaris									+	
Fabaceae		Acacia divergens						+				
	*	Melilotus indicus	+	+						+	+	+
	*	Vicia sativa								+		
Geraniaceae	*	Pelargonium capitatum					+					
Iridaceae	*	Romulea rosea		+								
Juncaceae		Juncus kraussii					+	+	+		+	
Malvaceae	*	Malva parviflora			+							
Moraceae	*	Morus sp.					+					
Myrtaceae		Agonis flexuosa					+	+		+		
		Callistemon sp. (planted)					+	+	+			
		Eucalyptus cornuta					+		+			
	*	Eucalyptus grandis					+		+			
	*	Eucalyptus petiolaris								+		
	*	Eucalyptus robusta							+			
		Eucalyptus rudis					+		+	+		
		Melaleuca preissiana			+					+	+	
		Melaleuca rhaphiophylla			+				+		+	
		Melaleuca teretifolia									+	
		Melaleuca viminea			+		+	+	+		+	
Papaveraceae	*	Fumaria capreolata			+					+		
Poaceae	*	Avena barbata			+						+	
	*	Cenchrus clandestinus			+		+	+	+	+	+	
	*	Cynodon dactylon								+	+	
	*	Ehrharta calycina			+							

FAMILY	Taxa	Q01	Q02	Q03	Q04	Q05	Q06	Q07	Q08	Q09	Q10
	* Hordeum leporinum	+		+						+	
	* Lolium perenne	+	+								+
	Poaceae sp.	+									+
	* Stenotaphrum secundatum				+						
Primulaceae	* Lysimachia arvensis	+									+
Rutaceae	* Zanthoxylum piperitum								+	+	
Solanaceae	* Solanum nigrum			+							

Appendix 2
Photographic record of vegetation types

Plate 1: VT1

Plate 2: VT2

Plate 3: VT3

Plate 4: VT4

Plate 5: VT4(d)

Plate 6: CL