Attachment 2 – Clearing area

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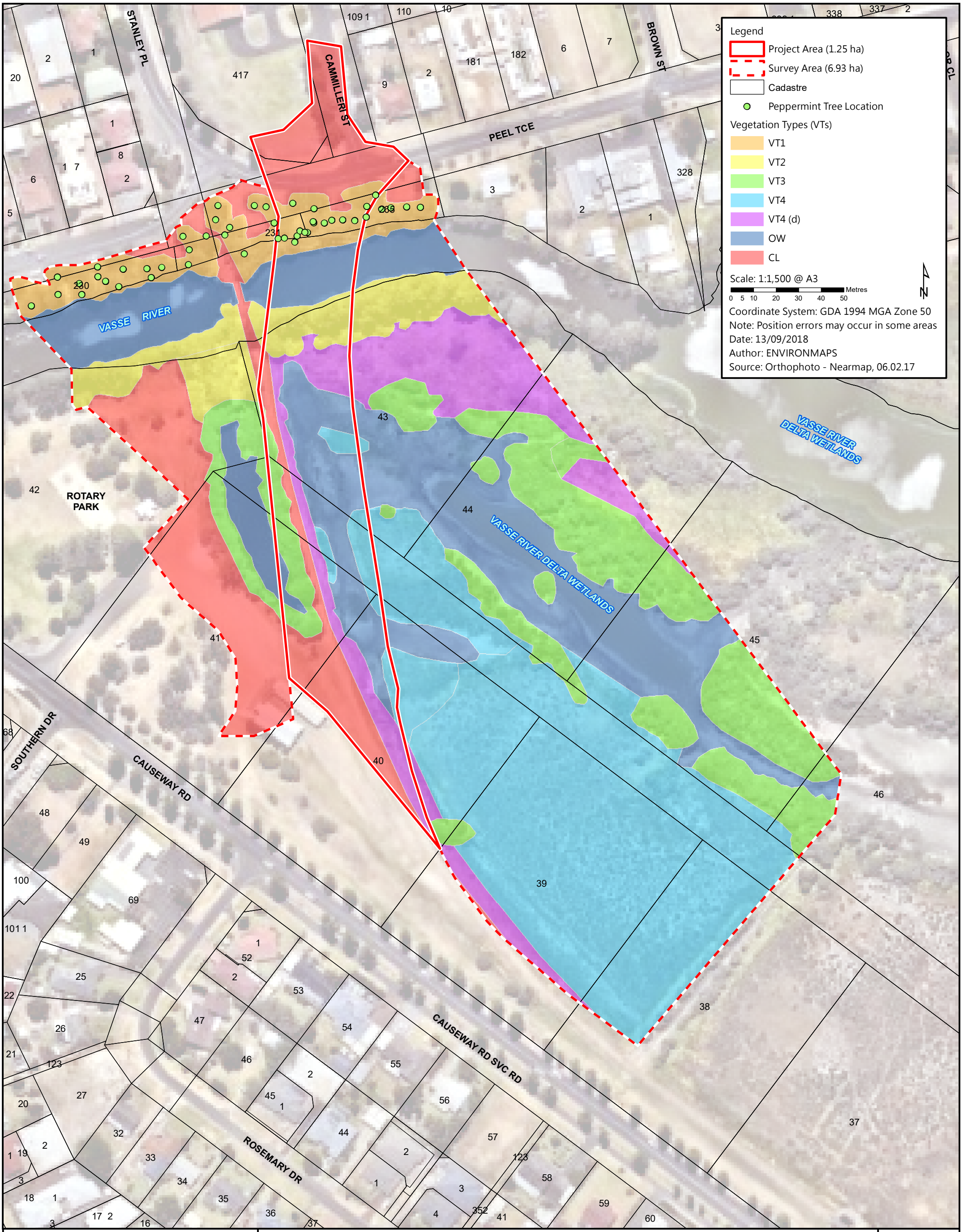

Busselton Eastern Link – Clearing Permit Application

Vegetation Types (VTs)

Attachment 2

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Attachment 3 – Native Vegetation Clearing Permit Application - Supporting Documentation

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Busselton Eastern Link Project

Native vegetation clearing permit application - supporting documentation

Prepared for
City of Busselton
by Strategen

September 2018

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Busselton Eastern Link Project

Native vegetation clearing permit application - supporting documentation

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Level 1, 50 Subiaco Square Road Subiaco WA 6008
ACN: 056 190 419

September 2018

Limitations

Scope of services

This report ("the report") has been prepared by Strategen Environmental Consultants Pty Ltd (Strategen) in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen has also not attempted to determine whether any material matter has been omitted from the data. Strategen will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen. The making of any assumption does not imply that Strategen has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: City of Busselton

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Draft Report	A	Client Review	C Lehman / H Morgan, T Sleigh, D Walsh	Electronic	4 September 2018
Final Report	0	Submission to DWER	C Lehman / H Morgan, T Sleigh, D Walsh	Electronic	14 September 2018

Filename: CIB16605.03 R001 Rev 0 - 14 September 2018

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1. Introduction

1.1 Purpose and scope

This Native Vegetation Clearing Permit (NVCP) application is for a purpose permit prepared for assessment and approval to clear native vegetation for the Busselton Eastern Link Project (the Project). The clearing of native vegetation is proposed in Rotary Park on Causeway Road and in Arthur and Norah Breeden Park on Peel Terrace, within the City of Busselton (the City). The NVCP relates to clearing a maximum of 0.49 ha of native vegetation for the construction of a new two lane road linking Causeway Rd to Peel Terrace / Cammilleri Street, which will include construction of a new bridge over the Lower Vasse River (the Project area, Figure 1).

The total construction footprint within the Project Area is 1.25 ha. Due to much of the alignment of the proposed activities across already disturbed areas and public open space (POS), the extent of native vegetation clearing within the Project Area amounts to 0.49 ha. Clearing for the Project will comprise of the construction of the two-lane road on both the northern and southern side of the river and a bridge across the Vasse River to assist with easing forecasted congestion within the City.

This document has been prepared to support the application for a Negative Vegetation Clearing Permit proposed by the City for assessment under s 51 E of the *Environmental Protection Act 1986* (EP Act), including the following information:

- an overview of the existing environmental conditions of the project area
- an evaluation of the potential impacts of the vegetation clearing
- an evaluation of the proposed clearing against the 10 clearing principles listed under Schedule 5 of the EP Act
- environmental approvals and management requirements.

1.2 Project

The City has undertaken extensive work over recent years to identify an overall strategic direction for the ongoing development, management and improvement of the local road network in and around Busselton. A key outcome of this work is the identified need to develop the Eastern Link (the Project) as an alternative and more efficient route into Busselton to ease existing and forecast congestion on Causeway Road and Queen Street.

The Project is to construct a new two-lane crossing linking Causeway Road to Cammilleri Street including a new bridge over the Vasse River.

The new road will be approximately 240 m in length and connect to new roundabouts on Causeway Road and Peel Terrace / Cammilleri Street. The new road will run along a disused railway embankment for part of its length, to minimise disturbance to wetlands east of the embankment. The road will drain to the south, away from the river and into bio-filtration gardens. The bio-filtration gardens will treat stormwater runoff prior to discharging into the wetland west of the new road, which is disconnected from the river and the wetlands east of the road. The road will have a new dual use path on its western side, to minimise public access to wetlands east of the road. The dual use path will connect to an existing footbridge over the Lower Vasse River and a new dual use path to be established along Peel Terrace.

The new bridge will be developed over the Lower Vasse River and comprise a 22 m long (between abutments), 12 m wide deck. The bridge will comprise a single span without piers, to minimise impacts to Aboriginal cultural values. The banks beneath the bridge abutments will be planted with Sword Sedge (*Lepidosperma gladiatum*) to encourage fauna passage and provide erosion protection. The bridge will have vehicle / cycle barriers on either side. The bridge will have barrier kerbs and drain northwards away from the river and into new bio-filtration gardens developed adjacent to the new roundabout on Peel Terrace.

Lighting on the bridge and road will be shuttered to direct light onto the road and bridge deck and minimise light spill onto adjacent wetlands and river.

The Project Area is characterised by vegetation of Very Good to Completely Degraded condition with large portions of the Project Area already highly disturbed.

1.2.1 Timing and clearing method

The City proposes to undertake clearing in Q2 – Q3 of 2019. Vegetation clearing will be conducted by stripping the vegetation and topsoil/overburden. Vegetation and topsoil/overburden material will be stockpiled separately to use in potential rehabilitation activities along the Vasse River at the completion of construction.

1.3 Land tenure

Table 1: Land tenure of Project Area

Lot No.	Reserve	Vesting Authority
39 on Plan 222226	Crown reserve 2236	PTA
40 on Plan 222226	Crown reserve 2236	PTA
41 on Plan 222226	Crown reserve 2236	PTA
42 on Plan 222224	n/a	-
43 on Plan 222226	Crown reserve 2237	PTA
231 on Plan 91174	Crown reserve 2241	PTA
265 on Plan 222226	Crown reserve 7443	Department of Planning and Infrastructure

1.4 Environmental referrals

The City referred the Project to the Environment Protection Authority (EPA) under Section 38 of the *Environmental Protection Act 1986* (EP Act). On 4 April 2018, the EPA decided not to assess the Project (CMS17294), providing public advice. In deciding not to the assess the Project, the EPA noted that the impacts of clearing could be managed through a NVCP under Part V of the EP Act.

The EPA decision to not assess the Project was subject to appeals. On 27 August 2018, the Minister determined the appeals (010 of 2018), dismissing the appeals.

The City referred the Project to the Commonwealth Department of the Environment and Energy (DEE) under the *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act). On 25 March 2018, the DEE determined the Project a controlled action under the EPBC Act, with assessment by preliminary documentation. The controlling provisions were listed threatened species and communities, due to the potential significant impact on Western Ringtail Possum (*Pseudocheirus occidentalis*) and Carters Freshwater Mussel (*Westralunio carteri).*

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Legend
Project Area (1.25 ha)
Survey Area (6.93 ha)
Cadastre
Scale: 1:1,500 @ A3
0 5 10 20 30 40 50 Metres
Coordinate System: GDA 1994 MGA Zone 50
Note: Position errors may occur in some areas
Date: 13/09/2018
Author: ENVIRONMAPS
Source: Orthophoto - Nearmap, 06.02.17

STANLEY PL
CAMMILLERI ST
PEEL TCE
BROWN ST
TAYLOR CL
FOOT BRIDGE
ROTARY PARK
OLD RAILWAY EMBANKMENT
VASSE RIVER DELTA WETLANDS
SOUTHERN DR
CAUSEWAY RD
CAUSEWAY RD SVC RD
ROSEMARY DR

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2. Overview of existing environment

2.1 Geology and landform

The Project Area lies at the boundary of two geological units. The land south of the Vasse River comprises silty estuarine deposits of the Vasse land system and land north of the river comprises calcareous Safety Bay Sands of the Quindalup Dune land system (Belford 1987). The estuarine deposits west of the Project Area have been infilled with imported material, including Rotary Park and the land bounded by Causeway Road and Southern Drive (Belford 1987).

Soils within the Project Area are influenced by the geology and imported material in the area. The new road south of the river is expected to lie over:

- disused railway embankment and land adjacent to Causeway Road comprising imported fill
- wetland areas to the east of the railway embankment underlain by silts described as brownish grey, partly calcareous, soft, with some fine sand and shell debris in places, and minor clay content (Belford 1987).

Soils north of the river are expected to comprise calcareous sand described as white, medium grained, rounded quartz and shell debris, well sorted, of aeolian origin (Belford 1987).

2.2 Acid sulfate soils

Land in the vicinity of the Project Area is mapped as being at high to moderate risk of acid sulfate soil (ASS) occurring within 3 m of natural soil surface, reflecting the estuarine / riverine nature of the soils; additionally, there is potential for monosulfidic black ooze (MBO) to be present within the sediments of the Vasse River (P. Hanly [DBCA] 2017, pers. comm. 13 October). MBO is an organic ooze enriched by iron monosulfides. Disturbance of ASS or MBO through excavation, dewatering and/or dredging works has potential to impact on soil and water quality.

An ASS investigation was undertaken by Strategen in July 2017 to determine the nature and extent of the ASS risk posed by soils in the area. The ASS Investigation Report provided in Appendix 1 and a summary is provided below.

Two soil bores were drilled within the Project Area to a depth of depth of 6 metres below ground level (mbgl). One bore was drilled on the northern bank and one bore on the southern bank, as these are locations where excavation and dewatering was more likely to occur. The soil bore on the northern bank of the river was converted to a groundwater bore. The new road south of the bridge will be constructed with imported fill with no excavation proposed, therefore no soil bores were drilled over the road area.

The bore logs and observations during drilling indicate the following local soil profiles adjacent to the Vasse River:

- soil profiles consist predominantly of sand, varying from black to grey to red and brown to yellow
- southern bore soil profile consisted of 0.5 m of gravelly sand over clayey sand to 1.5 mbgl and then sand to 5 m, with a layer of clay present between 2.5 and 3.2 mbgl
- northern soil profile consisted of sand, with the exception of a layer of gravelly sand from 0.5 to 1.5 mbgl and gravely sandy clay becoming sandy clay below 4.2 mbgl.

Field measurements indicated no actual (i.e. oxidised) ASS as present in the soil profile, with field soil samples recording a pH_F above 4 pH units. The average pH_F of samples tested was 8.0 pH units with pH varying between 7.4 and 8.8 (i.e. alkaline soils). However, all of the soil samples showed a difference between pH_F and pH_{FOX} greater than 1.0 pH unit, indicating potential (i.e. un-oxidised) ASS are present throughout the soil profiles.

Laboratory analysis using the SPOCAS method indicated a net acidity of 0.04%S to 1.3%S. The highest sample (1.3%S) was subject to verification using Chromium Reducible Sulphate method (SCr), which indicated a lower value of 0.95% S. Liming rates have been set for the soils based on SCr values, at 82 kg/tonne (Strategen 2017).

Two soil samples were analysed for heavy metals, indicating that all analytes were below environmental investigation levels (EIL) for Public Open Space and below health investigation levels (HIL) for Residential land uses.

Groundwater was encountered within 1 m of the surface. Laboratory analysis of groundwater samples indicated acidity of 12 mg/L $CaCO_3$ and alkalinity of 340 mg/L $CaCO_3$. The sulfate to chloride ratio was less than 0.5, with values between 0.055 and 0.11. These results indicate well buffered waters with a very high alkalinity, with have adequate buffering to maintain an acceptable pH level in the future. The laboratory analysis of groundwater samples showed no exceedance of DWER ASS criteria.

2.3 Hydrology

2.3.1 Surface water

The Lower Vasse River and the Vasse River Delta occur within the Project Area which is categorised as both a Conservation Category Wetland (CCW) and a Multiple Use Wetland (MUW) (Figure 2).

The CCW comprises riparian vegetation along the Lower Vasse River, including parkland cleared vegetation on the northern foreshore and planted vegetation on the southern foreshore (see Section 2.4.2 for vegetation types). The CCW also comprises degraded samphire vegetation associated with ephemeral wetlands east of the Project Area.

The MUW comprises ephemeral wetlands east of the historic (disused) railway embankment that the Project Area lies over. The MUW has been infilled in the past to create land currently occupied by Rotary Park. A hydraulically isolated pocket of wetland lies immediately west of the Project Area and is understood to have been created through excavation to generate fill for the railway embankment construction.

The hydrology of the Lower Vasse River and Vasse River Delta Wetlands is artificially controlled. Upstream flows into the Lower Vasse River flows managed through the Vasse Diversion Drain penstock, which diverts nutrient rich first flush and flood flows away from the river. A weir near the Old Butter Factory downstream of the Project Area retains water in the river during the summer and autumn period. The Lower Vasse River has been dredged in the past and now intersects groundwater during the summer and autumn. Water quality in the river is poor, with high nutrient levels and annual Blue-Green Algal blooms.

The Vasse River Delta Wetlands are expected to have been subject to tidal / salt water inundation in the past, as evidenced by the presence of samphire, however since 1908 tidal / salt water flows have been restricted by the Vasse Estuary surge barrier downstream. Although the surge barrier is opened to allow salt water flows into the Vasse Estuary during summer, the estuary water levels are maintained below the elevation of the Vasse River Delta Wetlands and so the wetlands dry out in the summer and autumn.

The City of Busselton is coordinating implementation of projects to improve water quality and long-term management of the Lower Vasse River, including nutrient reduction trials and upgrading of urban stormwater and drains. Options considered include dredging nutrient rich sediments and infilling to raise the river bed to its natural level to create ephemeral water conditions or a series of pools during summer and autumn rather than the current extended lake-like condition (G. Simpson, [City of Busselton] 2017, pers. comm. 6 September).

The Lower Vasse River has been identified as exceeding criteria for both phosphorous and nitrogen and contributing a disproportionately large share of the nutrient load to the Vasse-Wonnerup Wetlands given its small catchment size (GoWA 2010).

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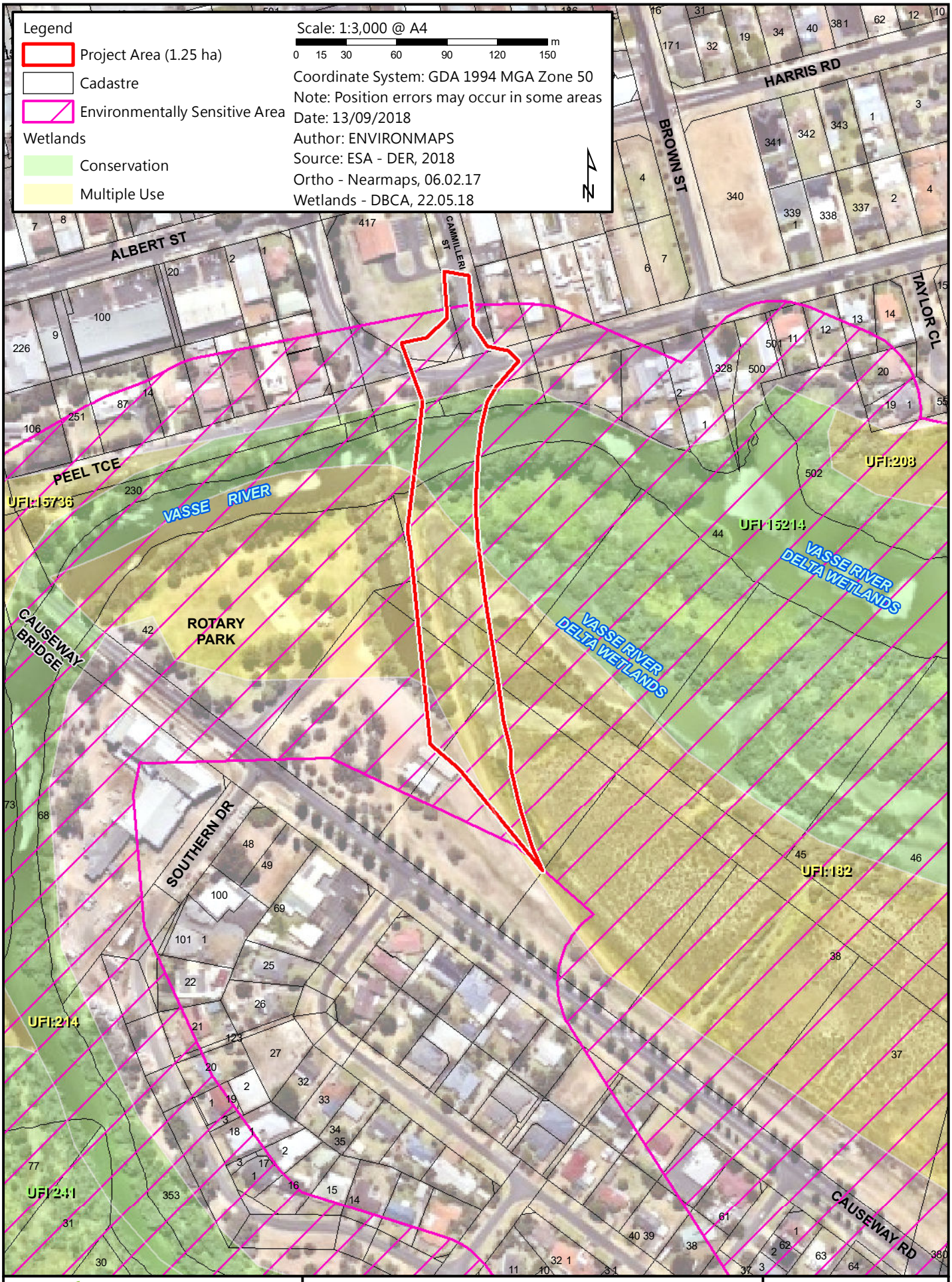

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Surrounding Wetlands

Figure 2

2.3.2 Groundwater

As discussed in section 2.2, groundwater was encountered at depths of less than 1 mbgl at locations close to the Vass River.

The Project will involve a small scale of excavation (up to 2 mbgl and 500 m^3 total volume) and dewatering for landside construction. In addition, the Project will require construction of coffer dams on the north and south bank to enable construction of bridge abutments. River water will be pumped out of the coffer dams and dewatering undertaken to maintain dry conditions during abutment construction. If required, dewatering for construction will be subject to a Section 5C Licence under the *Rights in Irrigation and Water Act 1914* (RIWI Act).

2.4 Vegetation and flora

2.4.1 Regional vegetation

Vegetation occurring within the Busselton area was initially mapped at a broad scale (1:250 000) association level by Beard during the 1970s. This dataset has formed the basis of several regional mapping systems, including physiographic regions defined by Beard (1981); the biogeographical region dataset (Interim Biogeographic Regionalisation for Australia, IBRA) for Western Australia (DEE 2017a) and Regional Forest agreement mapping (Mattiske and Havel [1998]).

Native vegetation in the Project Area has been mapped as the Vasse vegetation complex by Heddle et al 1980 as updated by Webb et al 2016 (referred to as the Swan Coastal Plain dataset), which reflects the extent of Pre-European coastal saltmarsh and Melaleuca woodland south of Vasse River. Vegetation on the northern and southern Vasse River foreshore has been modified and now includes planted 'parkland cleared' Peppermint trees (Agonis flexuosa), Flooded Gum (Eucalyptus rudis) and Melaleuca species. Pre-European vegetation extent indicates vegetation representing the Quindalup vegetation complex occurred in the northern part of the proposed clearing area; however, this area currently does not contain any native vegetation.

Native vegetation (planted and remnant) within the Project Area represents approximately 0.01% of the current extent (4924 ha) of the Vasse vegetation complex. The current extent of the complex represents approximately 31% of the estimated pre-European extent (15 692 ha) (Table 2).

Table 2: Pre-European and current extent of vegetation complexes occurring in the Project Area.

Beard (1990)	Scale	Pre-European extent (ha)	Current extent (ha)	% remaining	Amount proposed to be cleared for project (ha)	% Pre-European extent in IUCN 1-IV (proportion of pre-European extent)
Vasse Complex	State of Western Australia	15,692	4,924	31.38	0.49	8.38
Quindalup Complex	State of Western Australia	54,574	33,079	60.61	0.0	13.06

2.4.2 On-site vegetation

Vegetation

A survey conducted by Strategen in November 2017 identified five vegetation types within the Project Area and an additional two which were identified as open water and cleared manicured grassland (Strategen 2017; Appendix 2). All vegetation types identified within the Project Area and their description are presented below in Table 3 and illustrated in Figure 3.

Table 3: Vegetation types within the proposed clearing area

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	5.05	0.10	7.8
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	5.63	0.08	6.2
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	15.01	0.08	6.2
VT4	*Salicornia quinquefolia*, *Tecticornia indica* subsp. *bidens* and *Salicornia blackiana* low samphire shrubland	1.99	28.72	0.07	5.9
VT4(d)	**Carex divisa* closed sedgeland over **Stenotaphrum secundatum* low open grassland	0.60	8.66	0.17	13.2
CL	Cleared or manicured grassland	0.98	14.14	0.41	32.8
OW	Open Water	1.58	22.80	0.35	27.9

The locations of mature Peppermint trees (Agonis flexuosa) were 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 3, which indicates a total of 17 mature Peppermint trees as located within VT1 within the Project area. 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.

VT1 and VT2 within the Project Area comprise vegetation predominantly planted in the 1990s and 2003/04, as well as mature Peppermint trees within VT1 that existed prior to the planting. VT3 comprises predominantly vegetation planted in the wetland area west of the railway embankment. VT4 and VT4(d) comprise remnant samphire to the east of the railway embankment with varying degrees of invasion by introduced grasses.

Vegetation condition

Vegetation within the Project Area is largely disturbed and ranges from good to completely degraded condition based on the Keighery (1994) condition scale. As shown below in Table 3, there is approximately 0.49 ha of native vegetation within the 1.25 ha Project Area. Of the 0.49 ha of native vegetation within the Project Area 0.10 ha is Completely Degraded, 0.17 ha is Degraded and the remaining 0.23 ha is in Good condition.

Table 4: Vegetation condition surveyed in Project Area

Vegetation Condition	Area (ha) within Project Area	Percentage of Project Area
Good	0.23	18.32
Degraded	0.17	13.19
Completely Degraded	0.51*	40.49
Open Water	0.35	27.94
Total	**1.25**	**100**

*Includes 0.41 ha of completely cleared areas without vegetation

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Legend

- Project Area (1.25 ha)
- Survey Area (6.93 ha)
- Cadastre
- Peppermint Tree Location

Vegetation Types (VTs)

- VT1
- VT2
- VT3
- VT4
- VT4 (d)
- OW
- CL

Scale: 1:1,500 @ A3

0 5 10 20 30 40 50 Metres

N

Coordinate System: GDA 1994 MGA Zone 50
Note: Position errors may occur in some areas
Date: 13/09/2018
Author: ENVIRONMAPS
Source: Orthophoto - Nearmap, 06.02.17

STANLEY PL
CAMMILLERI ST
PEEL TCE
BROWN ST
VASSE RIVER
VASSE RIVER DELTA WETLANDS
ROTARY PARK
SOUTHERN DR
CAUSEWAY RD
CAUSEWAY RD SVC RD
ROSEMARY DR

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Vegetation Types (VTs)

Figure 3

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Legend

Project Area (1.25 ha)

Survey Area (6.93 ha)

Cadastre

Vegetation Condition

Very Good

Good

Degraded

Completely Degraded

Not Applicable

Scale: 1:1,500 @ A3

0 5 10 20 30 40 50 Metres

Coordinate System: GDA 1994 MGA Zone 50

Note: Position errors may occur in some areas

Date: 13/09/2018

Author: ENVIRONMAPS

Source: Orthophoto - Nearmap, 06.02.17

STANLEY PL

CAMMILLERI ST

PEEL TCE

BROWN ST

TAYLOR CL

VASSE RIVER

VASSE RIVER DELTA WETLANDS

ROTARY PARK

SOUTHERN DR

CAUSEWAY RD

CAUSEWAY RD SVC RD

ROSEMARY DR

CD

NA

G

D

VG

Conservation significant vegetation

Threatened ecological communities and priority ecological communities

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):

- 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.

A Reconnaissance Level Survey conducted by Ecosystem Solutions (2017; Appendix 2), identified two TECs and one PEC were identified within 5 km of the Survey area. One TEC overlapped with the Survey area (Table 6).

Table 5: Mapped TECs and PECs identified within the 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 6 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 6: Diagnostic Characteristic

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	Yes	The Project area does not experience tidal / salt water influence. See below for justification

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, which are presented below Table 7.

Table 7: Excluding factors

Exclusion		
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 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.

Flora

A search of the NatureMap database and the EPBC Act Protected Matters Search Tool (PMST) was undertaken as part of the Reconnaissance flora and vegetation assessment of the Project Area (Ecosystem Solutions 2017), to identify conservation significant flora species with the potential to occur within 5 km of the Project Area.

The database searches identified a combined total of 40 conservation significant (17 PMST and 23 NatureMap) species to potential occur within 5 km of the Project Area. An assessment of these species likelihood of occurrence based on their preferred habitat is provided in Appendix 3.

As stated earlier, Strategen conducted a survey of the Project Area in November 2017. The results of the survey identified 21 native vascular plant taxa from seven plant families as well as 25 exotic taxa were recorded within the survey area.

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).

2.4.3 Introduced species and pests

Of the 25 introduced (exotic) taxa were recorded within the Survey area, two are 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 Food1 (DAFWA 2017):

- *Asparagus asparagoides*
- *Zantedeschia aethiopica*.

Both species are listed as 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.

2.5 Fauna

2.5.1 Conservation significant fauna

A search of the EPBC Act Protected Matters Search Tool and NatureMap database were undertaken as part of Ecosystem Solutions 2017 assessment of the Project Area (Ecosystem Solutions 2017) which included a 5 km buffer of the proposed clearing area to determine the likelihood of any Threatened or Priority fauna species occurring. A list of the species identified in the database searches, habitat requirements and their likelihood of occurrence is summarised in Appendix 3.

A Level 1 Fauna Survey was undertaken by Ecosystem Solutions in August 2017 (see Appendix 2) to identify fauna of conservation significance, including threatened and priority species or migratory species listed and protected under Commonwealth and Western Australian legislation.

The desktop assessment identified the potential occurrence of conservation significant fauna including the Western Ringtail Possum (WRP) (*Pseudocheirus occidentalis*), endangered Black Cockatoo species, and migratory waterbirds. The Survey included field surveys for these species including:

- day time visual inspection of the Project Area and adjoining areas for signs of fauna (e.g. scats, diggings, dreys, nests, burrows, feeding signs)
- hollow bearing trees suitable for Black Cockatoos
- direct observations of terrestrial vertebrate fauna and signs
- 20-minute bird survey including observation and recording of waterbirds
- two non-consecutive, night time spotlight surveys
- two pre-dawn and two dusk surveys to determine Black Cockatoo activity.

Field survey results are presented in Figure 5. Apart from WRP observations, the field surveys within the Project Area did not record any threatened, priority or migratory terrestrial vertebrate fauna species listed under Commonwealth or State legislation (Ecosystem Solutions 2017).

Western Ringtail Possum

Busselton forms part of the Core Habitat for the Western Ringtail Possum (*Pseudocheirus occidentalis*) as defined by the Australian Government, with land to the south comprising Primary Corridors. The Project lies across and in the vicinity of stands of Peppermint trees (*Agonis flexuosa*) which comprise habitat and a corridor for the species.

The day time survey identified four areas of WRP scats and one drey observed within Vegetation Type 1 ('parkland cleared' Peppermint woodland) on the northern side of the river (Figure 5) The Peppermint trees in this area are mature and have potential gaps or hollows in their lees which would provide WRP habitat.

During the nocturnal surveys, four WRP were observed in Night 1 and three were observed in Night 2, within the areas of Vegetation Types 1 and 3 (Figure 5).

The Project lies over the WRP Core Habitat Area (Area 1) defined under the EPBC Act Significant Impact Guidelines (DEWHA 2009) and the Swan Coastal Plain management zone defined in the WRP Recovery Plan (Department of Parks and Wildlife 2017). Due to the contiguous canopy of the Peppermint trees and proximity to the Vasse River (which would promote good vegetation condition in summer and autumn), the vegetation of VT1 on the north bank of the Vasse River is expected to support a fauna corridor for the WRP (K. Williams [DBCA] 2017, pers. comm. 17 October). Peppermint trees along riparian areas can provide higher quality food over the critical late summer-autumn period when WRP would otherwise be forced onto a very low protein diet (Shedley and Williams 2014).

To maintain habitat connectivity, the Project design incorporates a possum over-pass (rope bridge) and vegetated underpass (1 in 2 slopes) on the north and south banks of the Vasse River, complimented with planting of understorey native vegetation in a strip approximately 2 m wide along the north bank of the river between the Project Area and Causeway Road. Revegetation within the underpass and northern foreshore will consist of native species Sword Sedge (*Lepidosperma gladiatum*) to encourage native fauna to use the underpass and deter predators.

To replace lost habitat trees, revegetation will be undertaken through planting of at least two Peppermint trees for every tree cleared (at least 34 Peppermint trees). The Peppermint trees will be planted preferably along, and no more than 100 m from, the Lower Vasse River and Vasse River Delta Wetlands to provide replacement habitat for the local WRP populations.

Black cockatoos

The field survey identified tree species known to provide food and potential roosting sites for black cockatoo species (e.g. Marri and Flooded Gums), however there were no signs of foraging, feeding or roosting on or nearby the trees. There were no trees identified as suitable for Black Cockatoo nesting (i.e. there were no hollows) within the Project Area, nor were any Black Cockatoos seen or heard during either of the dawn or dusk surveys.

The Reconnaissance Survey concluded that the Project Area does not comprise significant Black Cockatoo habitat (Ecosystem 2017). The survey conducted in August 2017 (Level 1 survey) assessed the potential for impacts based on guidance by the Australian Government (DSEWPaC 2011) and concluded that the Project poses a low risk of significant impacts to Black Cockatoos (Ecosystem Solutions 2017, Appendix 2).

Waterbirds

The desktop assessment identified eight migratory bird species as known to occur or potentially occurring in the vicinity of the Project Area. The Project Area lies on the western fringe of the Vasse River Delta Wetlands, an area of known habitat for migratory waterbirds.

The field survey did not observe any listed migratory birds on either the Lower Vasse River or the Vasse River Delta Wetlands within or adjacent to the Project Area. Wetlands immediately east of the Project Area are not subject to tidal / salt water inundation and dry out during the summer and autumn (Strategen 2017, 1), however the wetlands may potentially be used by migratory waterbirds on an occasional or opportunistic basis. DBCA database records include the Eastern Great Egret (*Ardea modesta*) and Glossy Ibis (*Plegadis falcinellus*) in the Lower Vasse River and wetlands within 500 m of the Project Area (Figure 5).

Higher value waterbird habitats lie to the east of the Project Area, in the Vasse River Delta Wetlands downstream of the Old Butter Factory (Figure 2) which retains water throughout the summer and autumn, as well as the Vasse Estuary further downstream. DWER release salt water from the surge barrier into the Vasse Estuary to maintain water levels in the summer, however this water is at too low an elevation to reach upstream into the wetlands adjacent to the Project Area (Strategen 2017)

The Project will result in clearing of riparian and wetland vegetation and infilling of open water areas on the Lower Vasse River and the western fringe of the Vasse River Delta Wetlands, which will reduce the habitat for migratory waterbirds that may occasionally or opportunistically use these areas.

Without implementation of construction controls and design measures the Project is likely to have adverse impacts on water quality downstream, which has the potential to impact migratory waterbirds known to be utilising wetlands downstream.

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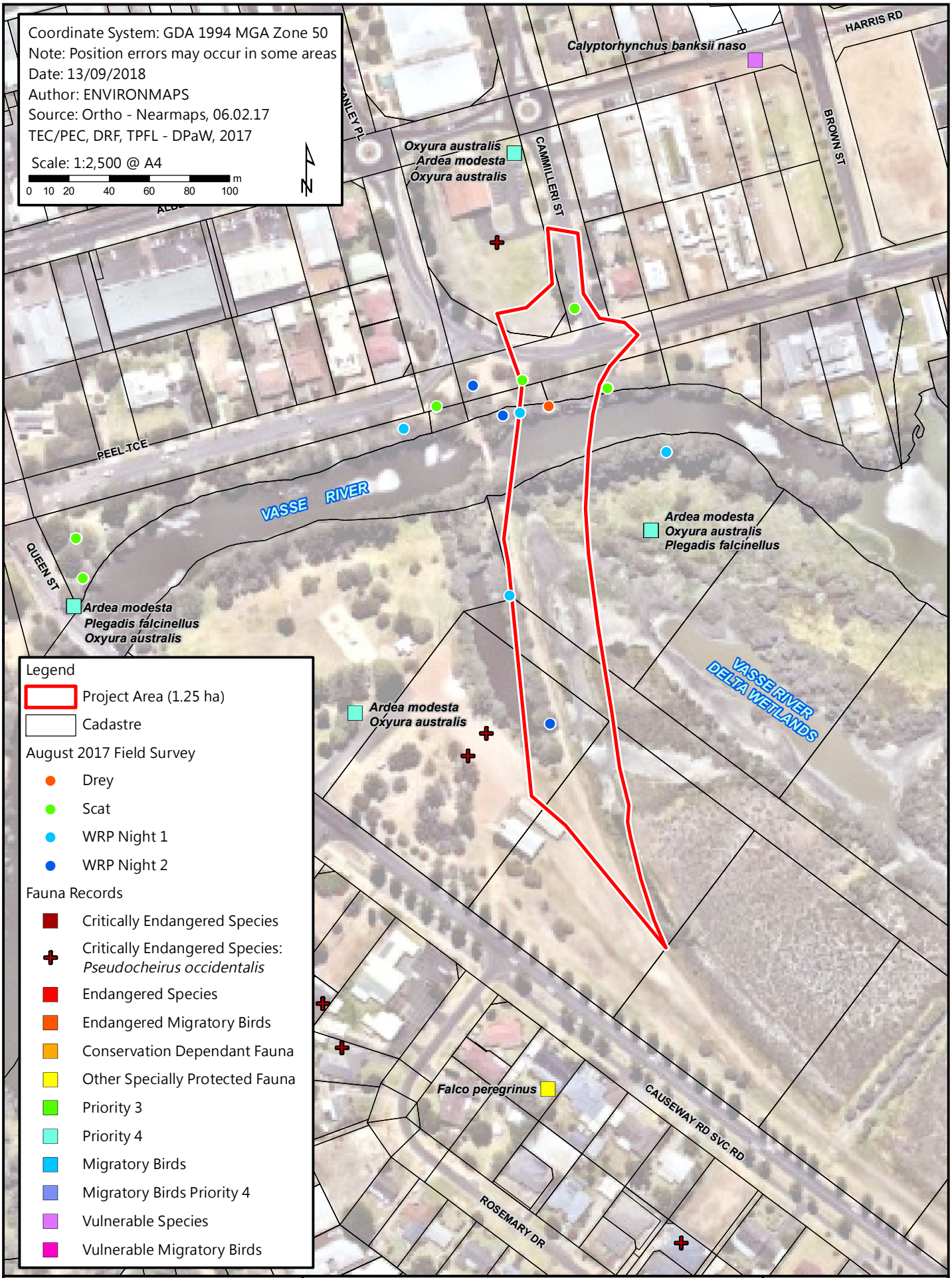

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Fauna Records

Figure 5

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The following mitigation measures are proposed to manage potential impacts on waterbirds:

- the CEMP (Appendix 5) includes spill response procedures and erosion/sediment controls (e.g. silt fences/curtains) to prevent water quality impacts on the Lower Vasse River and Vasse River Delta Wetlands
- the existing Butter factory weir boards, located downstream of the Project Area, will be kept in the same location, so that if a spill occurs the weir can be used to capture spills using absorbent booms/skimmer pumps
- ASS and (if present) MBO will be managed through implementation of approved management plans to prevent water quality impacts to waterbird habitat
- the new road and bridge will drain away from the Vasse River and into biofiltration gardens that will treat and infiltrate stormwater and capture spills if these occur on the road and bridge
- the river banks below the bridge will be thickly vegetated with Sword Sedge to minimise erosion and scour
- establishment of a future shared use path on the western side of the new road, discouraging access by people and domestic animals to wetlands to the east.

2.5.2 Surrounding reserves

The Project Area lies over the Lower Vasse River and adjacent to the western fringe of the Vasse River Delta Wetlands that form the geomorphic interface between the river and the Vasse Estuary downstream.

Busselton forms part of the Core Habitat for the Western Ringtail Possum (*Pseudocheirus occidentalis*) as defined by the Australian Government, with land to the south comprising Primary Corridors. The Project Area lies across and in the vicinity of stands of Peppermint trees (*Agonis flexuosa*) which comprise habitat and a corridor for the species.

Recreational areas in the vicinity of the Project Area include the Lower Vasse River foreshore utilised as Public Open Space; comprising Arthur and Norah Breeden Park on the north bank and Rotary Park on the south bank. The two parks are connected by footpaths that connect with the Causeway Bridge and footbridge, which form part of the Vasse River Trail section of the City of Busselton Wetland Walks and Trails.

Key environmental reserves close to the Project Area include (see Figure 6):

- Vasse-Wonnerup Wetlands Ramsar site approximately 1 km to the east, a significant habitat for waterbirds including migratory birds
- Unclassified Nature Reserve (R 49385) and A Class Nature Reserve (R 50017) approximately 540 m and 840 m respectively to the east, within the Vasse River Delta Wetlands
- Unclassified Nature Reserve (R 48837) approximately 640m to the west
- Vasse River and New River, of which portions are mapped as a conservation category wetland and listed in the *Directory of Important Wetlands of Australia.*

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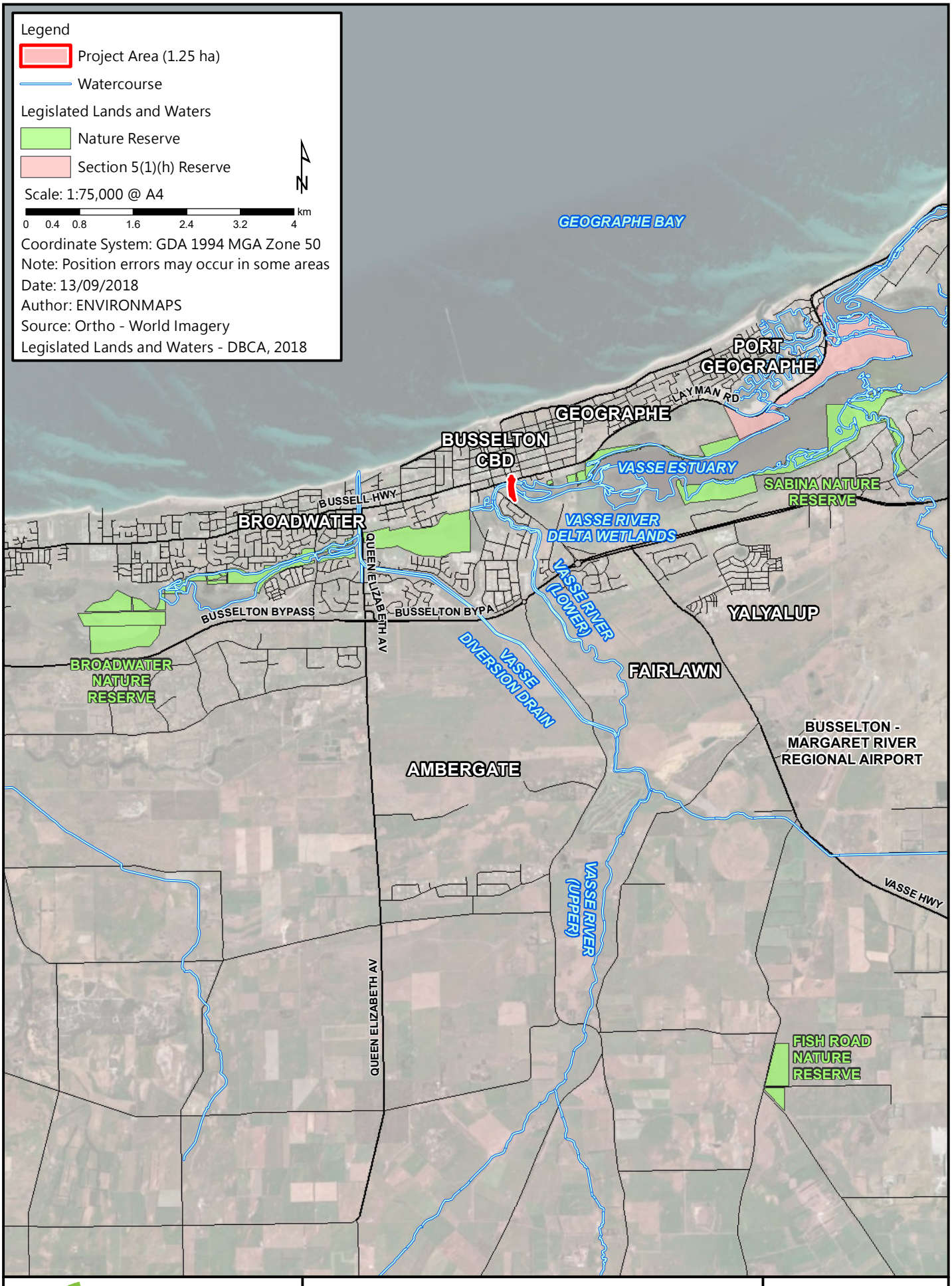

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Busselton Eastern Link
Clearing Permit Application

Surrounding Reserves

Figure 6

3. Assessment against the ten clearing principles

An assessment of the proposed clearing against the ten clearing principles outlined in Schedule 5 of the EP Act is provided in Table 8. This assessment demonstrates that the proposed removal of 0.49 ha of native vegetation is not at variance with the any of the clearing principles. On this basis, the City anticipates that the proposed clearing of 0.49 ha of native vegetation can occur.

Table 8: Assessment against the ten clearing principles

Principle	Assessment	Conclusion
Native vegetation should not be cleared if it comprises a high level of biological diversity.	The vegetation types and the area of disturbance of each within the Project Area include the following: • (VT1) 0.10 ha *Agonis flexuosa* low woodland over **Cynodon dactylon* grassland (managed) • (VT2) 0.08 ha *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 • (VT3) 0.08 ha *Melaleuca rhaphiophylla*, *Melaleuca teretifolia* and *Melaleuca preissii* low open forest over *Melaleuca viminea* mid shrubland over **Cynodon dactylon* and **Cenchrus clandestinus* low grassland • (VT4) 0.07 ha *Salicornia quinquefolia*, *Tecticornia indica subsp. bidens* and *Salicornia blackiana* low samphire shrubland • (VT4 (d)) 0.17 ha *Carex divisa* mid closed sedgeland over **Stenotaphrum secundatum* low open grassland • (CL) 0.41 ha cleared or manicured grassland • (OW) 0.35 ha open water. Only vegetation types (VT) 1, 2, 3, & 4 host native vegetation which together make up 0.49 ha or 39.27% of the total Project Area. Clearing of the 0.49 ha of native vegetation which is well represented locally and regionally will not characterise a significant impact to any vegetation types. The vegetation associations to be cleared all comprise over 30% of the pre-European extent; therefore, the proposed clearance of 0.49 ha of this vegetation association is not considered likely to significantly impact the function or biological diversity of any of the vegetation associations. No PECs, TECs or threatened flora were recorded within the proposed clearing area in the survey of the clearing area (Strategen 2017).	The proposed clearing is not considered to be at variance with this principle as the clearing proposed will not result in an impact to the biological diversity of the area.
Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of, a significant habitat for fauna indigenous to Western Australia.	Only one of the Conservation significant species listed to potentially occur within the Project Area was observed during the fauna survey, the WRP which is listed as Critically Endangered by the EPBC Act and the WA Act (PMST 2017; DBCA 2017). A further nine fauna species were known to be present within the clearing area based on the observation data, the nature of the vegetation present and the known range of those species including the following: • Carnaby's Black Cockatoo; *Calyptorhynchus latirostris* (EPBC Act Endangered; WC Act Endangered) • Southern Brown Bandicoot *Isoodon obesulus* subsp. *Fusciventer (WC Act Priority 4)* • Blue Billed Duck, *Oxyura australis (WC Act Priority 4)* • Eastern Great Egret, Ardea modesta (International Agreement) • Long-toed Stint, Calidris subminuta (International Agreement)	Removal of vegetation within the proposed clearing area, comprising habitat for fauna species is not considered to be at variance with this principle. The habitat proposed to be removed is not considered to be habitat critical for the survival of any of the conservation significant species occurring or potentially occurring in the clearing area. The proposed clearing area is located adjacent to large areas of intact fauna habitat associated with the Vass River and adjacent reserves.

	• Rainbow Bee-eater, Merops ornatus (International Agreement) • Glossy Ibis *Plegadis falcinellus* (International Agreement) • Common Greenshank, Tringa nebularia (International Agreement) • Peregrine Falcon, Falco peregrinus (International Agreement). Ecosystem Solutions (2017) conducted an assessment of the clearing of native vegetation within the Project Area on the local WRP populations observed in the fauna survey. The assessment identified that the population that exists in the Project Area has connectivity along the Vasse River and given the quality of the habitat, the population is unlikely to be critical to the species survival. Any modification of the habitat will need to consider maintaining the connectivity across the area for this species (Ecosystem Solutions 2017). Given the narrow width of the clearing to be conducted within the Project Area, the occupancy range currently experienced by this population is unlikely to decrease as a result of the clearing activities; furthermore, a rope bridge will be constructed to provide connectivity to habitat on both sides of the Vasse River, this feature will effectively mitigate the removal of the 17 mature habitat trees from the Project Area. Given the linear nature of the clearing, construction of the rope bridge and small extent of clearing habitat fragmentation is unlikely to occur and connectivity across the area for this species is considered likely to be retained (Ecosystem Solutions 2017). An assessment of the Black Cockatoo habitat located within the proposed clearing area was undertaken by Ecosystem Solutions as part of the flora and fauna assessment (2017), which found no evidence of trees within the Project Area being used for breeding or foraging. In the report Ecosystems noted "*Trees may be used opportunistically but higher quality nesting sites would be available within their large range, away from urban development*". As such, the proposed clearing will not result in the removal of potential breeding trees. In total, a maximum of approximately 0.16 ha of low to moderate quality foraging habitat for Black Cockatoos will be impacted by clearing activities within the Project Area. Due to the relatively low quality of the habitat and the range of the species, the clearing of 0.16 ha of foraging habitat will not impact on the area of occupancy of the current population. Given the Project Area occurs on the western fringe of the Vass River Delta Wetlands, habitat for various migratory birds protected under international agreements is considered likely to occur within the Project Area. Habitat within the Project Area is not considered vital for the survival of any of the species identified to occur throughout the larger area. Indeed, higher quality habitat is known to exist further to the east of the Project Area (Strategen 2018). Impacting a maximum of 1.25 ha of potential habitat for these migratory species is not considered to be a significant impact due to the presence of substantial habitat of better quality vested in conservation reserves nearby to the Project Area.	The habitat linkage for WRP will be maintained through provision of a rope bridge and vegetated underpasses on the north and south foreshores. Habitat for WRP will be replanted within the Project Area at a replacement of at least two trees for every mature tree cleared.
Native vegetation should not be cleared if it includes, or is necessary for the continued existence of, rare flora.	No Threatened or other conservation significant flora were identified to occur within the Project Area.	Removal of vegetation within the proposed clearing area is not considered to be at variance with this principle.

Native vegetation should not be cleared if it comprises the whole or a part of, or is necessary for the maintenance of a threatened ecological community.	The proposed clearance area does not comprise of vegetation that comprises part of, or is necessary for the maintenance of, a TEC or PEC as neither TECs nor PECs are known from or were recorded within the Project Area during the survey.	No TECs or PECs will be impacted by the proposed clearing or are known from the area. The proposed clearing is therefore not considered to be at variance with this principle.
Native vegetation should not be cleared if it is significant as a remnant of native vegetation in an area that has been extensively cleared.	A total of 0.49 ha of native vegetation is proposed to be permanently cleared. All vegetation types recorded are well represented locally and regionally and the loss of a total of 0.49 ha of native vegetation will not represent a significant impact to any of the vegetation types. The vegetation association to be cleared comprised over 30% of the pre-European extent. The proposed clearance of 0.49 ha of this vegetation association, given the presence of the vegetation association within the regional area is not considered to be significant. Furthermore, significant areas of remnant vegetation vested in conservation reserves surrounding the proposed clearing area are present.	Removal of vegetation within the proposed clearing area is not considered to be at variance with this principle.
Native vegetation should not be cleared if it is growing in, or in association with, an environment associated with a watercourse or wetland.	Vegetation within the Project Area is growing in a watercourse or wetland. Clearing within a CCW has been minimised by locating the Project Area over the historic railway embankment, which minimises the extent of the ephemeral wetlands to the east. The Project will result in minor clearing of parkland cleared (Completely Degraded) vegetation on the north foreshore and planted vegetation on the south foreshore, which lie within the area mapped as a CCW. Clearing of the riparian vegetation has the potential to impact upon water quality within the Lower Vasse River. Potential impacts include: • increased turbidity • the migration of metals through the water • exposure of ASS (although a low risk) • exposure of MBO • lowering of the water quality • aquatic fauna deaths • loss of amenity (localised and downstream). The Project has developed a CEMP to ensure sediment controls and spill control measures are implemented. ASS and MBO will be managed through an approved management plan development in consultation with DWER. Revegetation will occur within the footprint of the new bridge along the shore line to provide bank stability, minimise erosion and scour. Prior to any disturbance of the river banks or bed, an intensive translocation program for the Carters-Freshwater Mussel, in accordance with a Regulation 15 Licence from the Department of Biodiversity, Conservation and Attractions (DBCA), will be undertaken to mitigate the likelihood of impacts. A translocation site will be selected upstream where known suitable habitat exists and at sufficient distance to avoid any adverse conditions that may arise form construction works, such as elevated turbidity. Post translocation the population will undergo continued monitoring at the new site. Based on the proposed mitigation measures for water quality in the Upper Vasse River and downstream wetlands, and the proposed translocation of Carters Freshwater Mussel during construction, the Project is not expected to cause significant impacts to a CCW.	Removal of vegetation within the Project Area is at variance with this principle, however the City has minimised clearing as far as is practicable and will implement management to prevent edge effects and water quality impacts to adjacent wetlands.

Native vegetation should not be cleared if the clearing of the vegetation is likely to cause appreciable land degradation.	The risk of land degradation from vegetation clearing is extremely low given the limited land clearing occurring; however, management measures has been implemented to mitigate the impacts of the clearing within the Project Area and further downstream within the waterway. The major land degradation risk associated with vegetation removal within the proposed clearing area is water erosion. Given that most of the 1.25 ha of the Project Area is non-native vegetation associated with a public open space, the risk of water erosion is only short term and the anticipated impacts are expected to be minimal; furthermore, given the relatively small clearing footprint occurring within the larger Vass River area, any impacts that may occur from vegetation clearing will be localised and will not result in an impact to surrounding vegetated areas.	Removal of vegetation within the proposed clearing area is not considered to be at variance with this principle; however, the City will ensure management measures are implemented to prevent weed spread and land degradation within the Project Area.
Native vegetation should not be cleared if the clearing of the vegetation is likely to have an impact on the environmental values of any adjacent or nearby conservation area.	The Project Area is located within and directly adjacent to a CCW and MUW. Vegetation removal within these wetlands will be highly localised and the vegetation contained within the wetlands is well represented regionally. Management measured will be implemented via the CEMP to ensure any impacts are short in duration and highly localised. Removing 0.49 ha of native vegetation across an already modified landscape is not expected to cause any permanent degradation to the adjacent wetlands; additionally, the banks of the Vasse River where clearing will take place will be rehabilitated and revegetation to ensure bank stability and reduce erosion. Given that the proposed clearing within the CCW is minimal, the clearing is unlikely to result in a decrease in the environmental values of the Vasse River.	Removal of vegetation within the proposed clearing area is not considered to be at variance with this principle; however, the City will ensure management measures are implemented, in particular to prevent potential ASS, MBO and weed spread within the clearing area.
Native vegetation should not be cleared if the clearing of the vegetation is likely to cause deterioration in the quality of surface or underground water.	The clearing to be conducted along the bank of the Vasse River will be minimal and in an already degraded area (Figure 4). Project Activities will be undertaken in accordance with a CEMP which will impose measures designed to minimise the deterioration of the water course outside the Project Area; furthermore, any impact to water quality as a result of the project is expected to be highly localised and short in duration, as the Project Area along the Vasse River bank will be rehabilitated and re-vegetated upon the completion of the construction portion of the Project. Major disturbance or interruption to the surface run-off and natural drainage patterns resulting in downstream contamination of public aquatic ecosystems systems is considered unlikely. Based on the above, clearing of vegetation for the Project may cause localised deterioration in the quality of surface water or underground water over the duration of the construction; however, major deterioration in the surface and groundwater water quality, both regionally and over the long term are not considered to be significant.	Clearing of vegetation is not expected to cause any deterioration in the quality of surface or underground water as the project will not be undertaken near wetlands or drainage channels, therefore the proposed clearing area is not considered to be at variance with this principle.
Native vegetation should not be cleared if clearing the vegetation is likely to cause, or exacerbate, the incidence of flooding.	The Project Area occurs across a low-lying wetland and floodplain as part of the Vasse River Delta. This portion of the Vasse River is periodically inundated during heavy winter rain years in the months of July to September. The removal of 0.49 ha of vegetation is unlikely to cause or exacerbate the incidence of flooding on the Delta Plain.	Removal of vegetation within the proposed clearing area is not considered to be at variance with this principle as the vegetation clearing proposed will not cause or exacerbate the incidence of flooding.

4. Environmental approval and management

4.1 Environmental approvals

The key approval required to support the proposed clearing is a NVCP under S 51 E of the EP Act.

The Project has been deemed a controlled action under the EPBC Act, requiring assessment by preliminary documentation. The City is responding to a DEE request to provide additional information relating to mitigating impacts to Western Ringtail Possum and Carters Freshwater Mussel.

The City is required to submit a Regulation 15 Licence under the Wildlife Conservation Regulations 1970 to translocate Carters Freshwater Mussel. The Regulation 15 Licence will be subject to a Management Plan for the translocation, which will also be submitted to DEE to support the EPBC Act assessment.

The City has undertaken Aboriginal heritage survey for the Project, which found no Aboriginal heritage sites present within or nearby the Project Area. Accordingly, no Section 18 consent is required under the *Aboriginal Heritage Act 1972.*

If required, a Section 5C Licence will be sought for construction dewatering under the RIWI Act.

4.2 Environmental management

To maintain habitat connectivity, the Project design incorporates a possum over-pass (rope bridge) and vegetated underpass (1 in 2 slopes) on the north and south banks of the Vasse River, complimented with planting of understorey native vegetation in a strip approximately 2 m wide along the north bank of the river between the Project Area and Causeway Road. Revegetation within the underpass and northern foreshore will consist of native species Sword Sedge (*Lepidosperma gladiatum*) to encourage native fauna to use the underpass and deter predators.

The City will seek DBCA comment on the design drawings for the possum rope bridge prior to construction commencing.

To replace lost habitat trees, revegetation will be undertaken through planting of at least two Peppermint trees for every tree cleared (at least 34 Peppermint trees). The Peppermint trees will be planted preferably along, and no more than 100 m from, the Lower Vasse River and Vasse River Delta Wetlands to provide replacement habitat for the local WRP populations.

The City has developed a Construction and Environmental Management Plan (CEMP) for the Project, which was submitted to the EPA and DEE as part of the EP Act and EPBC Act referrals. The CEMP was developed in accordance with *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans*

A copy of the CEMP is provided in Appendix 5.

Further to the EPA's public advice on the Section 38 referral, the City is preparing an Acid Sulfate Soil and Dewatering Management Plan (ASSDMP) in accordance with DWER guidelines and for DWER review prior to construction commencing.

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Appendix 1
Causeway Road and Eastern Link Bridges Acid Sulfate Soil Investigation Report (Strategen 2018)

intelligent outcomes | respected experience

Causeway Road and Eastern Link Bridges

Acid Sulfate Soil Investigation Report

Prepared for
City of Busselton
by Strategen

January 2018

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Causeway Road and Eastern Link Bridges

Acid Sulfate Soil Investigation Report

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Level 1, 50 Subiaco Square Road Subiaco WA 6008
ACN: 056 190 419

January 2018

Limitations

Scope of services

This report ("the report") has been prepared by Strategen Environmental Consultants Pty Ltd (Strategen) in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen has also not attempted to determine whether any material matter has been omitted from the data. Strategen will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen. The making of any assumption does not imply that Strategen has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: City of Busselton

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Draft Report	A	For client review	P Hammond, M Dunlop/ G King, H Morgan	PDF	8 Jan 2018
Final Report					

Filename: CIB16605-01 R002 Rev A – 27 October 2017

Executive Summary

City of Busselton is considering various options to improve the local roads in and around Busselton's urban area; known as Strategic Network Corridors project, which includes planning road upgrades for four (4) different initiatives. Two (2) of the proposed linkages, Eastern Link and Causeway Road "the project" involve river crossings in areas which were considered to potentially contain acid sulphate soils.

The objective of the acid sulfate soil (ASS) Investigation report is to determine the nature and extent of the ASS risk to the project. This report incorporates observations and results collected during related field investigations conducted by Strategen in July 2017 and identifies:

- the presence, nature, magnitude and extent of ASS at the site
- assess if ASS will be disturbed by either excavation or dewatering activities on the site
- baseline groundwater quality at the site.

Results

The results indicate that ASS is present below the water table on the site. The liming rates have been based on the SCr values, in accordance with Department of Water and Environmental Regulation (DWER) guidance (DWER 2015b). The maximum liming rate is consequently 82 kg/tonne for EL-N 4-4.5 (Eastern Link north bank at 4-4.5 metres below ground level). Groundwater quality on the site did not indicate that acidification of potential acid sulfate soil (PASS) was currently occurring on the site.

Recommendations

The results indicate that the majority of natural soils sampled during the investigation are PASS and should be treated in accordance with DWER (2015b) guidance. As such the following management actions are recommended:

1. If ground disturbing or dewatering activities are required to construct the two (2) bridges an Acid Sulfate Soil and Dewatering Plan (ASSDMP) should be developed and approved by DWER prior to those construction activities taking place at the sites.
2. Because of the presence of ASS and the environmentally sensitive location of the works, the ASSDMP should recommend the use of lime dosing of excavated soil on the site.
3. Groundwater in the vicinity of the site appears to be well buffered. The need for treatment of any dewatering effluent will be considered as part of the ASSDMP depending on the volume and intended discharge methods for dewatering effluent.

An ASSDMP will be prepared when the construction methods and extent of excavation and dewatering bridges are confirmed.

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1. Introduction

1.1 Background

City of Busselton is considering various options to improve the local roads in and around Busselton's urban area; known as Strategic Network Corridors project, which includes planning road upgrades for four (4) different initiatives. These initiatives comprise 13 parts, of which six (6) have been identified in Table 1 as requiring environmental approvals.

Table 1: Strategic Network Corridors identified as requiring environmental approvals

Initiative	Part	Item	Name
2	(iii)	A	Eastern Link
2	(ii)	B	Causeway Bridge Duplication
3	(ii)	C	Strelly-Barlee-West Street Route
4	(ii)	D	Strelly-Barlee-West Street Duplication
4	(iii)	E	Fairway Drive Duplication
5	(i), (ii)	F	Ford Road 'Transport Corridor' Option Ford Road 'Existing Reserve, Low Level' Option

Strategen were engaged to undertake preliminary environmental approvals for Initiative 2 (Items A and B) of Table 1; Eastern Link and Causeway Road known herein as "the project". In May 2017, Strategen made recommendations in an Environmental Issues Report (Strategen 2017) relating to the project including preliminary acid sulfate soil (ASS) advice which assumed given that excavation/dewatering would be required as part of duplicating the Causeway Road Bridge (CRB) and a new bridge as part of the Eastern Link ('Eastern Link Bridge', ELB), an ASS Investigation was required to be undertaken to clarify the extent of the issue. The proposed location of the two (2) bridges is presented in Figure 1:

- CRB: duplication of existing bridge, extending east and adjacent to existing bridge
- ELB: new bridge located east of existing footbridge and south of Cammilleri Street.

The ASS Investigation was subsequently undertaken by Strategen in July 2017, resulting in this ASS Investigation Report for the project. Outcomes of this report and further discussion with CIB regarding proposed construction methodology for the infrastructure improvements will determine if an ASS and Dewatering Management Plan (ASSDMP) is required in accordance with Department of Water and Environmental Regulation (DWER) ASS guidelines (2015a and 2015b).

It is noted that the Eastern Link initiative includes construction of a road embankment south of the bridge linking to Causeway Road, however it is understood that this embankment will be constructed using imported fill materials and no excavation or dewatering works will be required. Accordingly, the scope of the ASS Investigation for Eastern Link was limited to the bridge footprint.

1.2 Acid sulfate soils

ASS conditions exist naturally in soils that contain iron sulfide or sulfide oxidation products. Although typically benign when undisturbed in the natural environment anoxic state, the dewatering, excavation and/or stockpiling of ASS that lies below the naturally occurring watertable may promote the oxidation of these soils and the occurrence of adverse environmental impacts (DWER 2015a). When ASS are oxidised, the iron sulfides can oxidise to produce sulfuric acid, iron precipitates and acidic groundwater with elevated concentrations of dissolved metals such as aluminium, iron and arsenic.

ASS includes both 'potential acid sulfate soils' (PASS) and 'actual acid sulfate soils' (AASS). PASS predominantly occur in areas prone to waterlogging including low-lying areas close to the coast, waterways, estuaries and wetlands, in particular riverine, estuarine and coastal lowland areas including mangroves, brackish lakes, tidal flats, salt marshes, saltpans, swamps and seasonally inundated plains. PASS occur below the permanent water table and have not been exposed to air (i.e. oxygen). AASS will occur close to the water table and contain iron sulfides or other sulfidic minerals that have previously undergone some oxidation to produce sulfuric acid (DWER 2015a).

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HARRIS RD
STANLEY PL
CAMMILLERI ST
BROWN ST
PEEL TCE
PRIES AV
VASSE RIVER
BUSSELTON MUSEUM
ROTARY PARK
CAUSEWAY RD
SOUTHERN DR
CITY OF BUSSELTON
EL-N
EL-S
CR-N
CR-S

Legend
- Cadastre
- Soil Bore
- Groundwater Monitor Bore

Scale: 1:1,500 @ A3
0 5 10 20 30 40 50 Meters
N
Coordinate System: GDA 1994 MGA Zone 50
Note: Position errors may occur in some areas
Date: 4/10/2017
Author: ENVIRONMAPS
Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 30.05.17

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Strategic Network Corridors – ASS Investigation

Location

Figure 1

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2. Objectives and Scope

2.1 Objectives

The objective of the ASS Investigation is to determine the nature and extent of the ASS risk to the project. The report incorporates observations and results collected during related field investigations conducted by Strategen in July 2017 and assesses:

- the presence, nature, magnitude and extent of ASS at the site
- assess if ASS will be disturbed by either excavation or dewatering activities on the site
- baseline groundwater quality at the site.

2.2 Scope of Works

The project lies over areas of high to moderate risk of ASS due to the estuarine/riverine sediments (Figure 2). The ASS investigation for the project included both soil and groundwater investigations in accordance with the DWER *Identification and investigation of acid sulfate soils and acidic landscapes* (DWER 2015a) guideline with soil sampling occurring at a minimum of 0.25 m depth intervals where practicable.

2.2.1 Soil Sampling

1. Push core drilling of four (4) soil bores (EL-N, EL-S, CR-N & CR-S) with locations selected based on potential areas of disturbance in relation to the preliminary moderate-high risk ASS mapping as detailed in Figure 2.
2. Collection of soil samples at 0.25 to 0.5 m intervals to the base of each borehole and logging soil and indicators of ASS as outlined by the *Identification and investigation of acid sulfate soils and acidic landscapes* guideline (DWER 2015a) including:
   - the presence of waterlogged soils and peaty soils
   - evidence of sulfurous smells
   - jarosite or extensive iron staining of the soil
   - salt tolerant, dead, dying or stunted vegetation
   - scalded or bare low-lying areas of vegetation.

   Pit depths were determined in consultation with CIB engineers and were as follows:
   - EL-S: 6 m
   - EL-N: 6 m
   - CR-N: 6 m
   - CR-S: 5 m.

   CR-N and EL-N were converted to groundwater monitoring bores.
3. Analysis of 55 primary soil samples plus three (3) quality assurance/quality control [QA/QC] samples for initial screening analysis of field pH (pH_F) and field pH after oxidation with hydrogen peroxide (pH_{FOX}) by a National Association of Testing Authority (NATA) registered laboratory.
4. Analysis of soil samples (including one (1) QA/QC sample) for heavy metals by a NATA accredited laboratory for possible future requirements to assess leaching potential.
5. Analysis of nine (9) selected soil samples (plus one (1) QA/QC sample) for Suspension Peroxide Oxidation Combined Acidity and Sulfur (SPOCAS) suite analysis based on initial field screening results and lithology at a NATA accredited laboratory.
6. At EL-S and CR-S, the soil bores were converted into groundwater monitoring bores consistent with the *Minimum Construction Requirements for Water Bores in Australia* (NUDLC 2011). This included installation of screens, gravel pack and bentonite seal as shown in Appendix 2. Bores were completed with steel risers and developed by pumping.

7. Groundwater monitoring bores were surveyed for bore coordinates, top of casing and ground level.

2.2.2 Groundwater Sampling

Groundwater sampling and analysis was undertaken with reference to the following documents:

1. *Schedule B2 Guideline on Site Characterisation* of NEPM 2013.
2. Standards Australia (1998) AS/NZS 5667.11:1998 *Water Quality – Sampling. Guidance on Sampling of Groundwaters.*
3. Standards Australia (1998) AS/NZS 5667.1:1998 *Water Quality – Sampling. Guidance on the Design of Sampling Programs, Sampling Techniques and the Preservation and Handling of Samples.*
4. US EPA (2010) *Low Stress (Low Flow) Purging and Sampling Procedure for the Collection of Groundwater Samples from Monitoring Wells*.

In accordance with above mentioned guidelines, groundwater sampling was implemented as follows:

1. Sampling was undertaken of the two (2) monitoring bores at EL-N and CR-N. Purging will be undertaken until the field parameters stabilise (generally ±0.1 units for pH and ±10% for EC and temperature, plus ±10% for redox and DO where possible) before a sample is collected.
2. A multi-parameter meter will be used to measure pH, electrical conductivity (EC), redox potential (Eh), dissolved oxygen (DO) and temperature.
3. A low flow pump, with intake set just above the middle of the screened interval within the water column, was used to extract water from the two (2) bores for other selected ASS groundwater parameters; plus quality control samples including; one (1) duplicate (1 in 20) and one (1) field blank.
4. Field measurements were taken for total acidity and total alkalinity.

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Legend
- Site Boundary
- Cadastre
- Soil Bore
- Groundwater Monitor Bore

ASS Risk Mapping
- High to Moderate Risk

Scale: 1:1,500 @ A3
0 5 10 20 30 40 50 Meters

Coordinate System: GDA 1994 MGA Zone 50
Note: Position errors may occur in some areas
Date: 4/10/2017
Author: ENVIRONMAPS
Source: Cadastre - Landgate, 2017
ASS Mapping - DER, 22.09.14
Orthophoto - NearMaps, 30.05.17

N

HARRIS RD
ALBERT ST
QUEEN ST
STANLEY PL
CAMMILLERI ST
PEEL TCE
PRES AV
VASSE RIVER
CAUSEWAY RD
SOUTHERN DR
ROTARY PARK
BUSSELTON MUSEUM
CITY OF BUSSELTON

EL-N
EL-S
CR-N
CR-S

Strategic Network Corridors – ASS Investigation

ASS Risk and Bore Investigation Locations

Figure 2

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3. Site identification and context

3.1 Location

The ASS Investigation targeted two (2) sites: Causeway Rd and Eastern Link (Items A and B as per Table 1). The sites are bound by:

- Causeway Road to the west
- Peel Terrace to the north
- Busselton Rotary Park entrance to the south
- wetlands to the east.

The sites are located alongside the Vasse River in Busselton, approximately 240 km southwest of Perth Western Australia. Site identification details are provided in Table 2 and Table 3. Bores were located approximately in the centreline of the bridge alignments. In the case of ELB, the southern side of the bridge lies over a wetland area that was problematic to access and thus the southern bore EL-S was located on the railway embankment immediately west of the proposed bridge location.

Table 2: Site identification details Causeway Rd

CR-N	
Lot address (street number)	230 Peel Terrace
Common name of site	Breeden Park
Current certificate of title	Volume3005/Folio985 Plan222226
Land area	0.34 Ha
Current use	Recreation
Local Government Authority	City of Busselton
Current zoning	Recreation
Proposed future use	Recreation
CR-S	
Lot address (street number)	42 Causeway Rd
Common name of site	Rotary Park
Current certificate of title	Volume1393/Folio754 Plan100013668
Land area	1.546 Ha
Current use	Recreation
Local Government Authority	City of Busselton
Current zoning	Recreation
Proposed future use	Recreation

Table 3: Site identification details Eastern Link

EL-N	
Lot address (street number)	Lot 265 Peel Terrace
Common name of site	Breeden Park - Reserve 7443
Current certificate of title	Volume 3013/Folio791
Land area	0.09 Ha
Current use	Recreation
Local Government Authority	City of Busselton
Current zoning	Recreation
Proposed future use	Recreation
EL-S	
Lot address (street number)	Peel Tce/ corner of Stanley Place
Common name of site	Rotary Park- Reserve 2237
Current certificate of title	Volume 3004/Folio 761 Plan 222226
Land area	1.1164Ha
Current use	Recreation
Local Government Authority	City of Busselton
Current zoning	Recreation
Proposed future use	Recreation

Currently all land subject to this ASS investigation is vested within the City of Busselton.

3.2 Zoning

The site is currently zoned as Recreation under the City of Busselton Local Planning Scheme No. 21. The requirement for the bridge may require a change in land use.

3.3 Present land owner

The site is currently vested to the City of Busselton.

3.4 Surrounding land use

The site is on the entrance to the town centre of Busselton which is zoned as urban/residential. There is an historic church (St Mary's) adjacent to CR-N. The Busselton Museum is located to the west of EL-N and is listed in the State Heritage Register. The land use west and south of Peel Terrace is residential

The land use north and east is primarily the greater estuarine system/reserves for recreation and conservation purposes. The Vasse River itself feeds into the greater (Nationally significant) Vasse-Wonnerup Wetlands system.

4. Details of development

4.1 Proposed development

The project includes upgrading infrastructure into the city centre of Busselton, to reduce traffic congestion at main entry and exit points including duplication of the existing Causeway Road Bridge and crossing/links at Eastern Link Bridge detailed in Table 4.

Table 4: Proposed works

Name	Proposed works	Project footprint
Eastern Link	New two (2) lane crossing linking Causeway Road to Camilleri Street or Stanley Street including new bridge over Vasse River and widening of existing railway line embankment south of the river. Option to relocate existing weir on Vasse River adjacent to the Busselton Museum upstream to the new bridge crossing.	Footprint takes into account potential for crossing to move further east.
Causeway Bridge Duplication	Widening of existing bridge over Vasse River to four lanes and upgrade of Causeway Road.	Footprint consists of existing road reserve, 50m wide area at river crossing and potential design options at Causeway Road / Queen Street intersection.

4.2 Proposed ground disturbing activities

The proposed bridge duplication(s) at Causeway Road and the Eastern Link sites may require excavation and potentially dewatering in significant wetland/estuarine environment. Due to the environmental and physical constraints of the project areas, bridge pylon foundations may require pile driving into the sediments to minimise clearing and exposing/oxidising potential ASS soils. In terms of ASS management, pile driving would be preferable as it requires less dewatering and disturbance. The method chosen will depend on a number of factors including geotechnical, environmental and safety considerations. The extent of excavation and dewatering required will be confirmed at the detailed design stage.

5. Site conditions and surrounding environment

5.1 Topography

The project area is located on the southern portion of the Swan Coastal Plain, which is characterised by a low-lying coastal plain with undulating dunes at the coastal lakes/wetland systems, rising to older geological formations in the east. Busselton is mapped at the Quindalup dune system, which is underlain by Tamala Limestone.

The site is relatively flat and very low-lying with elevation across the site approximately 2 m Australian Height Datum (m AHD). The lowest lying area is the Vasse River which would be the catchment for all natural drainage/stormwater runoff for the surrounding reserves.

5.2 Geology and soils

5.2.1 Environmental geology

The main geological units for the area are presented in Table 5 and Figure 3.

Table 5: Site geology

Type	Description	Location on site
Made Ground	This area has been built up with imported fill, likely overlying M6: estuarine origin silt.	Entire Rotary Park area including CR-S site – however the underlying sediment is typical of M6: SIILT.
S13: CALCEREOUS SAND	pale and olive-yellow, medium to coarse-grained, sub-angular quartz, moderately sorted, of residual origin modified by marine inundation.	Evident throughout both Causeway Road and Eastern Link sites in upper layers as the dominant unit.
M6-Ms6: SILT	Brownish grey calcareous, some fine sand and shell debris with minor clay content of estuarine origin.	Underlying through both Causeway Road and Eastern link in correlation to the Vasse River. Common at depth for all bores.
Ms5: CALCEREOUS SILT	Brown to mid-grey mottled blocky disseminated fine sands of alluvial origin (hard when dry) – shell fragments common.	NE portion of Eastern Link area.

5.2.2 Acid sulphate soils risk mapping

The project area is classified entirely as moderate to high ASS risk occurring within 3 m of natural soil surface (Figure 2).

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Legend

- Site Boundary
- Cadastre
- Soil Bore
- Groundwater Monitor Bore

Geology

- S13: CALCAREOUS SAND - white, medium grained, rounded quartz and shell debris, well sorted, of eolian origin.
- M6: SILT - brownish grey, calcareous in part, soft, some fine sand and shell debris in places, minor clay content, of estuarine origin.
- M5: CALCAREOUS SILT - dark greyish brown silts and minor clays, some organic matter, shells and shell fragments and limestone are locally common.
- Water
- Made ground

Scale: 1:1,500 @ A3

0 5 10 20 30 40 50 Meters

Coordinate System: GDA 1994 MGA Zone 50
Note: Position errors may occur in some areas
Date: 4/10/2017
Author: ENVIRONMAPS
Source: Cadastre - Landgate, 2017
Orthophoto - NearMaps, 30.05.17
Geology - DoIR: Geological Survey of W.A., 1999

N

QUEEN ST
ALBERT ST
PEEL TCE
PRIES AV
VASSE RIVER
CAUSEWAY RD
SOUTHERN DR
ROTARY PARK
CITY OF BUSSELTON
BUSSELTON MUSEUM
EL-N
EL-S
CR-N
CR-S
S13
M6
M5
Water
Made grd

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5.3 Surface water and wetlands

5.3.1 Surface water

The sites are dissected by the Vasse River which flows from west to east. The Vasse River discharges into the Ramsar Listed conservation category Vasse-Wonnerup Wetland System. Water levels in the Vasse River are controlled by a weir downstream of the sites and consequently the river is not tidal.

5.3.2 Wetlands

The environmental review identified wetlands of significance within the Project Footprints, including Ramsar wetland sites, wetlands of national importance (Directory of Important Wetlands in Australia) and other mapped geomorphic wetlands, including Conservation and Resource Enhancement wetlands.

Table 6 identifies three (3) wetlands within the Eastern Link and Causeway Road greater project footprints. Figure 4 maps the wetlands noted in Table 6.

Table 6: Wetlands within the project footprint

Name	Wetland
Eastern Link	• Nationally Important Wetland – Vasse-Wonnerup Wetland System • Conservation Category (Estuary Waterbody) • Multiple Use (Estuary Peripheral)
Causeway Bridge Duplication	• Nationally Important Wetland - Vasse-Wonnerup Wetland System • Conservation Category (Estuary Waterbody) • Multiple Use (Estuary Peripheral)

5.4 Groundwater

Depth, direction and rate of flow

Groundwater was encountered within 1 m of the surface, during groundwater investigations, in direct correlation with the Vasse River water levels. The flow direction of groundwater in the vicinity of rivers is typically in the direction of river flow, which in this case is easterly towards Wonnerup. It appears there is between the groundwater level and the surface water level, therefore dewatering may be required for any excavations or pile driving below 1m.

Highest beneficial use of groundwater

Department of Water's (DoW) online hydrogeological Atlas describes the site as being underlain by the surficial sediments shallow aquifers. The superficial aquifer at the site consists of Quaternary surficial sediments. The site lies outside the proclaimed areas for groundwater management and there are no P1, P2 or P3 Public Drinking Water Source Areas (PDWSA) in the vicinity of the site (Landgate 2016).

Groundwater in the area is generally brackish, being around 3000–7000 mg/L Total Dissolved Solids (TDS) as per the DWER online *Perth Groundwater Map* (assessed 9 August 2017). Groundwater is therefore considered to be unsuitable for drinking or most non-potable uses. The highest beneficial use of groundwater in the area is provision of environmental water requirements to the Vasse River and associated wetlands, irrigation water and non-potable groundwater uses such as washing cars.

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Legend

- Site Boundary
- Cadastre
- Soil Bore
- Groundwater Monitor Bore

Wetlands

- Conservation
- Resource Enhancement
- Multiple Use

Scale: 1:1,500 @ A3

0 5 10 20 30 40 50 Meters

Coordinate System: GDA 1994 MGA Zone 50
Note: Position errors may occur in some areas
Date: 4/10/2017
Author: ENVIRONMAPS
Source: Wetlands, 2017
Cadastre - Landgate, 2017
Orthophoto - NearMaps, 30.05.17

N

HARRIS RD
QUEEN ST
ALBERT ST
STANLEY PL
CAMMILLERI ST
PEEL TCE
PRIES AV
VASSE RIVER
CAUSEWAY RD
SOUTHERN DR
BUSSELTON MUSEUM
ROTARY PARK
CITY OF BUSSELTON
EL-N
EL-S
CR-N
CR-S
UFI 208
UFI 15214
UFI 15736
UFI 182
UFI 213
UFI 214

strategen ENVIRONMENTAL	Strategic Network Corridors – ASS Investigation Wetlands	Figure 4

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6. Field quality assurance quality control (QA/QC)

Quality control sampling and testing ensures that the soil and groundwater data collected is appropriate, representative and adequate for the purposes of the assessment. Quality control was practiced both in the field and the laboratory.

In order to appropriately identify samples, the sampling containers were clearly labelled with a solvent free permanent marker at the time of collection with the following details:

- job reference number
- unique sample identification, i.e. 'SB1 0.0-0.15' or 'MB1'
- date sample was taken
- initials of sampler
- type of sample preservation (if any).

6.1 Sample collection, storage, preservation and transportation

Disposable, single use nitrile gloves were worn when handling and collecting the samples. Clean, new gloves were worn at each sample location. Reusable sampling equipment was decontaminated between each sample site.

Samples were placed in the applicable acid washed and/or sterilised sample containers provided by the laboratory. Sealed samples were kept cool via ice bricks in an insulated container (esky).

A chain of custody (CoC) form accompanied the samples during transport and delivery to the laboratory. The forms were signed by each individual responsible for the samples including Strategen and laboratory personnel. Sample receipt advice was obtained from the laboratory noting temperature and condition of samples on delivery.

6.1.1 Chain of custody

The CoC forms which accompany samples during transport and delivery included the following information:

- site identification and job reference number
- unique sample ID
- collection date
- name of sampler
- name of Project Manager
- requested analyses
- date and time and authorisation verifying release to the laboratory
- date and time and authorisation verifying acceptance from the laboratory.

The CoC was signed with the time and date recorded by each individual responsible for the relinquishment and receipt of the samples. The laboratory retained the original CoC and a duplicate issued to Strategen confirming arrival.

The receiving laboratories advice included the following information:

- condition in which the samples were received and appropriate container type
- cross checking information on sample IDs and CoC
- confirmation of preservation method.

6.1.2 Calibration records

All field equipment was calibrated in accordance with the instrument's manual. Records of calibration was maintained for field equipment used during the investigation (Appendix 2).

6.1.3 Field quality control samples

Quality control samples were collected during the DSI program as follows.

Field duplicates

Duplicate samples – a replicate sample of the same soil matrix or groundwater (it should match the original or primary sample). A duplicate sample was analysed at the same laboratory as the primary sample and it allows an understanding of the heterogeneity of the soil and assessment of inter-laboratory precision.

Duplicate samples were collected at a minimum rate of one (1) per 20 primary samples per matrix submitted for analysis. Three (3) for soil; DUP CR-S and DUP EL-S, and one (1) for groundwater QC(SN)-1.

Field rinsates

A rinsate blank is a sample of water that has been used to rinse an item of sampling equipment to show there is no potential for cross-contamination.

One (1) rinsate sample; QC(SN)-2was collected during the groundwater investigation program.

7. Laboratory quality assurance quality control (QA/QC)

ARL Laboratories were engaged to perform all primary and duplicate sample analyses. ARL is a NATA accredited laboratory.

Strategen requires that laboratories have a Quality Assurance System including a Quality Control and Quality Assessment program that is endorsed by NATA. The laboratory should be able to demonstrate the following (NEPC 2013c):

- freedom from contamination
- method accuracy and precision is reliably achieved
- conformance to the performance characteristics expected of the method
- confidence in the results produced.

The laboratory should be able to achieve the following criteria:

- relative percent differences (RPDs) between original and duplicate samples: <10 x PQL - no limit, 10-20 x PQL - 0-50%; >20 x PQL - 0-30%
- matrix spike and laboratory control samples: 70-130% for inorganics/metals, 60-140% for organics, 70-140% for VOCs and 60-120% for phenols
- surrogates: 60-140% for general organics and 20-130% for VOCs and phenols
- method blanks to be at or below the nominated limits of detection.

The RPD calculation is used to normalise each pair of results to allow for better QA/QC data interpretation. For those RPD values that exceed acceptable criteria data correlation is considered poor; however, consideration needs to be given to sample homogeneity and the concentrations detected.

The laboratory is normally required to meet these criteria before reporting results to Strategen. In some circumstances if the RPD% or the spike recovery rate exceed the relevant threshold, but the measured concentrations are close to the detection limit and well below guideline concentrations, the laboratory may not be required to re-analyse the sample. If the calculated RPD exceeds 30–50%, then the highest value is used for assessment purposes.

The laboratory used has a QA/QC program that is endorsed by NATA and meets the following criteria:

- all recovery rates to be between 75% and 125%
- RPD values between original and duplicate samples to range between 0–50%.

If the RPD is greater than 30% (organics) to 50% (inorganics), the higher value is used for evaluation purposes.

The RPD calculation was used to normalise each pair of results to allow for better QA/QC data interpretation. For those RPD values which exceed a generally acceptable 30–50% data correlation is considered poor, however, consideration needs to be given to sample homogeneity and the concentrations detected.

Analytical data validation is the process of assessing whether data comply with method requirements and project specifications. The objective of this process is to ensure that data of known and predetermined quality are reported, and identify if the data can be used to fulfil the overall project objectives.

8. QA/QC data evaluation

8.1 Field QA/QC results

Quality control sampling consisted of the collection of duplicate samples at a rate of one (1) per twenty samples. The RPD between the primary and duplicate sample was calculated for seven (7) pH_F / pH_{FOX} samples including 1 SPOCAS suite.

8.1.1 Soil samples

The QA/QC results for soils are presented in Appendix 5.

All RPD values were below 30% with the exception of TPA and TSA, nickel and zinc, which indicates appropriate QA/QC procedures were effective. The TPA and TSA for CR-N 2-2.5 and its duplicate had an RPD of 78%, possibly due to sample heterogeneity. The nickel and zinc results for CR-N 2-2.5 were below five (5) times the limit or reporting, and consequently the high RPDs are considered acceptable.

The duplicates for metals did not meet the RPD requirements with an RPD of 67% for nickel and zinc. As both analytes were less than five (5) times the limit of reporting, this was considered acceptable.

8.1.2 Groundwater samples

The QA/QC results for groundwater are presented in Appendix 6.

For the primary/duplicate sample set all RPD values were below 30%, indicating suitable QA/QC measures were undertaken.

8.2 Laboratory QA/QC results

Laboratory QA/QC results are provided in the laboratory documentation in Appendix 7 (soils) and Appendix 8 (groundwater).

9. Basis for adoption of assessment criteria

9.1 ASS criteria for soils

The *Identification and Investigation of Acid Sulfate Soils and Acidic Landscapes* guideline (DWER 2015a) established action criteria for the assessment of environmental risk of ASS. The action criteria are based on the net acidity excluding ANC which is the sum of existing and potential acidity calculated as equivalent sulfur (e.g. s-TAA + S_{POS} in %S units).

As clay content tends to influence the soil's natural buffering capacity, the action criteria are grouped by three (3) broad categories – coarse, medium, and fine. The criteria are used to determine when disturbance of ASS will require treatment and management. If the proposed construction requires disturbance of less than 1000 t of material, the guidelines (DWER 2015a) define the following equivalent acidities for the three (3) broad soil categories to be used as the action criteria in this assessment:

- 0.03 %S for coarse texture sands to loamy sands
- 0.06 %S for medium texture sandy loams to light clays
- 0.1 %S for fine texture medium to heavy clays and silty clays.

If the proposed construction requires the disturbance of greater than 1000 t of material, the guidelines (DWER 2015a) define an equivalent acidity of 0.03 %S to be used as the action criteria in this assessment.

In addition to the action criteria, the guidelines (DWER 2015a) define indicator pH values for pH_F and pH_{FOX} to assist in characterising likely acid generating soils. The pH indicator values are defined as:

- pH_F <4 pH units oxidation of sulfides probably occurred in the past, indicates presence of AASS
- pH_{FOX} <3 pH units and a significant reaction rate – strongly indicates PASS
- a significantly lower pH_{FOX} value than the pH_F value is used as an indicative trigger value in this assessment, i.e. $pH_F - pH_{FOX}$ >1.0 pH unit.

9.1.1 Heavy metals

Samples analysed for heavy metals will not be assessed against specific investigation criteria; rather the levels will indicate the potential for metals to be leached into groundwater under acidic conditions.

9.2 ASS criteria for groundwater

The vulnerability of groundwater to acidification was assessed by comparison of analytical results to guideline values (DWER 2015a). The following indicator values are used to assess whether groundwater is being affected by the oxidation of sulfides:

- pH less than 5 pH units
- a chloride/sulfate ratio of less than 2
- an alkalinity/sulfate ratio of less than 5
- a soluble aluminium concentration of greater than 1 mg/L.

9.2.1 Groundwater assessment criteria – fresh waters

The groundwater quality was assessed against the Groundwater Investigation Levels for 'fresh waters' as specified in the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC and ARMCANZ 2000) and outlined in Table 7.

Table 7: Groundwater assessment criteria – fresh waters

Analyte	Fresh Waters - Groundwater Investigation Levels
pH	6.5–8.5
Chloride	-
Sulfate	-
Aluminium (Al) (pH 6.5)	55 µg/L
Arsenic (As)	24 µg/L as As(III) 13 µg/L as As(V)
Cadmium (Cd)	0.2 µg/L
Chromium (Cr) (VI)	1 µg/L
Iron (Fe)	-
Manganese (Mn)	1900 µg/L
Nickel (Ni)	11 µg/L
Selenium (Se)	5 µg/L
Zinc (Zn)	8 µg/L
Total Nitrogen	2000 µg/L
Total Nitrogen	200 µg/L
Ammonia as N	900 µg/L

10. Results

10.1 Soil sample results

Tables of the soil results are presented in Appendix 5. Corresponding Chains of Custody (CoCs), laboratory Certificates of Analysis (CoAs) and Quality Control Interpretive Reports for soil analyses are provided in Appendix 7.

10.1.1 Soil profile

Four (4) soil bores were drilled during fieldwork: CR-N, CR-S, EL-N and EL-S, with the northern sites (EL-N and CR-S) being converted to groundwater bores. The bore logs are included in Appendix 2 and have been used along with site observations to summarise soil profile characteristics as follows:

- soil bore depths for the four (4) ASS bores were drilled to a target depth of 6mbgl, with EL-S posing an exception due to refusal on hard material at 5mbgl
- all soil profiles consisted predominantly of sand, varying from black to grey to red and brown to yellow
- at EL-S, the soil profile consisted of 0.5 m of gravelly sand over clayey sand to 1.5 mbgl and then sand to 5 m, with a layer of clay present between 2.5 and 3.2 mbgl
- at EL-N, the soil profile consistent of sand with the exception of a layer of gravelly sand from 0.5 to 1.5 mbgl and gravely sandy clay becoming sandy clay below 4.2 mbgl
- at CR-N and CR-S, the soil profile consisted of sand to 5 mbgl and then clayey sand below 5 mbgl.

It appeared in all bore sites (except for EL-S) that groundwater was intercepted in the first 1m of the soil bores which directly correlates to the level of the Vasse River. At EL-S, groundwater was located at 1.5 mbgl.

10.1.2 Soil field test results

Observations made during the field investigation indicated that there was no ASS present in the top 2 m of the soil profile within the site. Observations included the following:

- parkland vegetation was healthy showing no symptoms of there being acidic soil or groundwater conditions
- strong sulfidic odours noted at CR-N & CR-S were observed below the water table (primarily from 4.5mbgl and below)
- groundwater was generally intercepted in the top 1.0m of the soil profile
- no significant soil mottling or jarosite was observed.

A review of the pH_F and pH_{FOX} results for all 54 samples (plus three (3) duplicates) against the adopted assessment criteria provided the following conclusions:

1. No samples recorded a pH_F <4 pH units, so there is no initial signs of AASS. The average pH_F of the samples tested was 8.0 pH units with pH varying between 7.4 and 8.8 (i.e. alkaline soils).
2. 17 out of 55 samples recorded a pH_{FOX} <3 pH units at CR-N and CR-S:
    - CR-S 2.0-2.5 (pH1.8)
    - CR-S 3.0-3.5 (pH2.2)
    - CR-S 3.5-4.0 (pH2.2)
    - CR-S 4.0-4.5 (pH2.2)

- CR-S 4.5-5.0 (pH1.9)
- CR-S 5.0-5.25 (pH1.9)
- CR-S 5.25-5.5 (pH2.1)
- CR-S 5.5-5.75 (pH1.5)
- CR-S 5.75-6.0 (pH1.5)
- CR-N 2.0-2.5 (pH1.6)
- CR-N 2.5-3.0 (pH1.4)
- CR-N 3.0-3.5 (pH1.4)
- CR-N 3.5-4.0 (pH1.7)
- CR-N 4.0-4.5 (pH1.2)
- CR-N 4.5-5.0 (pH1.7)
- CR-N 5.0-5.5 (pH2.0)
- CR-N 5.5 -6.0 (pH1.3).

3. All of the samples showed a difference between pH_F and the corresponding pH_{FOX} greater than 1.0 pH unit indicating soils with potential presence of sulfides and acid generating potential are common at all sites and throughout entire soil profiles sampled at four (4) boreholes.

A summary table of the pH_F and pH_{FOX} results is presented in Appendix 5.

10.1.3 Soil laboratory analysis results

SPOCAS and Scr

A subset of nine (9) (plus two (2) duplicates) was further analysed for SPOCAS based on one of the following observations and/or field results:

- pH_{FOX} was < 3.0 pH units
- pH_F-pH_{FOX} was > 1.0 pH unit
- representation of the soil lithology present on the site.

The SPOCAS suite includes the following analyses and calculated parameters:

- Titratable Actual Acidity (TAA)
- Titratable Peroxide Acidity (TPA)
- Titratable Sulfidic Acidity (TSA)
- Peroxide Oxidisable Sulfur (S_{POS})
- Sulfidic Excess Acid Neutralising Capacity (ANC)
- Net Acidity
- Net Acidity excluding ANC.

Table 8 presents the SPOCAS results. All samples exceeded the 0.03% S guideline for S_{POS} with percentage sulfur varying from 0.044% at EL-N 1.5-2 to 1.3% at EL-N 4-4.5. On this basis, samples were considered to require liming at rates between 4 and 110 kg/tonne.

Table 8: SPOCAS results summary

		SPOCAS				Action Criteria				
Sample ID	Soil type	Sulphidic - TAA	Sulphidic - TPA	Sulphidic - TSA	Peroxide Oxidisable Sulphur (SPOS)	Net Acidity (SPOCAS)	Net acidity (SPOCAS)	Net Acidity (Scr)	Liming rate	Liming rate SCr ex ANC
Units		% S	% S	% S	% S	%S	Moles H+/tonne	%S	kg CaCO3 /tonne	kg CaCO3 /tonne
Limit of Reporting		0.005	0.005	0.005	0.005	0.005	5		1	2
Assessment Criteria - DER 2015		0.03	0.03	NV	0.03	0.03	18.00	0.03	NV	NV
CR-S 3-3.5	sand	<0.005	0.19	0.19	0.3	0.3	190	-	26	-
CR-S 5.5-5.75	sandy clay	<0.005	0.31	0.31	0.29	0.29	180	-	25	-
CR-N 2-2.5	sand	<0.005	0.59	0.59	0.62	0.62	390	-	54	-
CR-N 2.5-3	sand	<0.005	0.95	0.95	0.94	0.94	590	0.46	82	40
CR-N 5.5-5.75	clayey sand	<0.005	0.48	0.48	0.62	0.62	390	-	54	-
EL-N 1.5-2	sand	<0.005	<0.005	<0.005	0.044	0.044	27	-	4	-
EL-N 4-4.5	sand	<0.005	<0.005	<0.005	1.3	1.3	780	0.95	110	82
EL-S 2.2.5	sand	<0.005	<0.005	<0.005	0.25	0.25	160	-	22	-
EL-S 2.5-3	clay, grey	<0.005	<0.005	<0.005	0.23	0.23	140	-	20	-

To verify the SPOCAS Results, selected samples (CR-N 2.5-3 and EL-N 4-4.5) were also analysed for Chromium Reducible Sulphate method (Scr). The net acidity under the Scr method was significantly lower than for the SPOCAS method, being:

- CR-N 2.5-3: 0.46%S for Scr as compared to 0.94% for SPOCAS
- EL-N 4-4.5: 0.95%S for Scr as compared to 1.3% for SPOCAS (Table 8).

Liming rate

The liming rates have been based on the SCr values, in accordance to DWER Guidance (DER 2015b). The maximum liming rate is consequently 82 kg/tonne for EL-N 4-4.5 (Table 8).

Metals

Two (2) samples (including one (1) duplicate) were analysed for heavy metals (As, Cd, Cr, Cu, Pb, Ni, Zn and Hg) to provide baseline concentrations if there is a requirement to assess the potential for the mobilisation of heavy metals if acidification was to occur. All results were below the relevant Environmental Investigation guideline values for public open space (NEPC 2013). The results are presented in Appendix 5..

10.2 Groundwater sample results

Summary tables of the groundwater levels, field and laboratory results are presented in Appendix 6 and the laboratory reports are provided in Appendix 8.

10.2.1 Groundwater levels

The two (2) groundwater monitoring wells were surveyed by a licenced surveyor (BSO Development Consultants) with detailed provided in Appendix 2. Groundwater levels were measured by Strategen on 9 October 2017 (Table 9).

Table 9: Bore details and water levels

Name	Easting	Northing	Top of casing (mAHD)	Ground level (mAHD)	Water level (mbtoc)	Water level (mAHD)
CR-N	346 618	6 275 036	1.62	1.07	1.068	0.552
EL-N	346 854	6 275 130	2.40	1.82	1.84	0.56

10.2.2 Groundwater results

Groundwater samples were analysed for the following parameters:

- groundwater parameters; pH, temperature, electrical conductivity (EC, uS/cm), redox potential (mV), dissolved oxygen (DO, ppm/% saturation)
- total dissolved solids (TDS)
- total acidity and alkalinity (s mg/L CaCO3)
- sulfate, chloride and sodium (mg/L)
- nutrients including ammonia (as nitrogen), TN and TP (mg/L)
- total metals (Al and Fe) and dissolved metals: Al, As, Cd, Cr, Mn, Ni, Se and Zn (mg/L).

The groundwater laboratory analysis reported the following minor exceedances of:

- EL-N
  - Total Nitrogen (1.6mg/L) ANZECC & ARMCANZ 2000 FWG criteria
  - Total P (0.2mg/L) ANZECC & ARMCANZ 2000 FWG and LIWG criteria
  - Total NOx-N (0.15mg/L) ANZECC & ARMCANZ 2000 FWG criteria
- CR-N:
  - Chloride (200mg/L) - LIWG
  - Iron Dissolved (0.31 mg/L) ANZECC & ARMCANZ 2000 FWG and DWER 2014 NPUG criteria
  - Total P (0.69mg/L) ANZECC & ARMCANZ 2000 FWG criteria
  - Total Nitrogen (4.5 mg/L) ANZECC & ARMCANZ 2000 FWG criteria.

At CR-N, the acidity was 34 mg/L $CaCO_3$ and the alkalinity was 590 mg/L $CaCO_3$. At EL-N, the acidity was 12 mg/L $CaCO_3$ and the alkalinity was 340 mg/L $CaCO_3$. The sulfate to chloride ratio was less than 0.5 in all cases, with values between 0.055 and 0.11. These results indicate well buffered waters with a very high alkalinity (DWER 2015b). Such waters are generally considered to have adequate buffering to maintain an acceptable pH level in future (DWER 2015b).

All other sample results were below guidelines.

The laboratory analysis of groundwater samples showed no exceedance of DWER (2015a) ASS criteria. Results tables are presented in Appendix 6.

11. Risk assessment

A desktop risk assessment was undertaken based on the framework provided in the Schedule B5a of NEPM (NEPC 2013).

11.1 Problem identification

ASS are naturally occurring soils that are commonly found in low-lying land bordering the coast or estuarine and saline wetlands and freshwater groundwater-dependent wetlands throughout Western Australia. In an anoxic state, these materials remain benign and do not pose a significant risk to human health or the environment. However, disturbing ASS, and exposing it to oxygen, has the potential to cause significant environmental impacts.

11.2 Receptor identification

The bridges will span a Conservation Category Wetland (CCW). Groundwater travelling beneath may become acidic if ASS is allowed to oxidise (through soil disturbance and / or lowering of the water table during construction works) resulting in lower pH, higher acidity and the mobilisation of metals. This may pose a risk to flora and fauna both at the site, in CCWs near the site and at locations down gradient from the site.

The DWER (2015a) guidance identifies the following impacts that may result from poor management of ASS.

- fish kills and loss of biodiversity in wetlands and waterways
- contamination of groundwater resources by acid, arsenic, heavy metals and other contaminants
- loss of agricultural productivity
- corrosion of concrete and steel infrastructure by acidic soil and water.

11.3 Exposure assessment

Exposure pathways can be described as either being due to:

- lowering of water table; groundwater dependent species may be impacted by lowering of the water table
- oxidation of ASS due to dewatering; ASS may oxidise *in situ* if not managed properly, resulting in the transfer of acidity to groundwater
- oxidation of ASS due to excavation; excavated ASS may oxidise prior to being returned to the environment, resulting in the transfer of acidity to groundwater.

11.4 Toxicity assessment

11.4.1 Ecological health

The groundwater investigation levels (GILs) used are based on the ANZECC and ARMCANZ (2000) *Australian and New Zealand Water Quality Guidelines for Fresh and Marie Water Quality* and provide guidelines for groundwater quality parameters that may impact ecological health in fresh waters (i.e. Fresh and Marine water guidelines).

Monitoring prior to, during and following dewatering and excavation activities provide reference data to assess the impacts to groundwater and provide contingencies to minimise ecological risk due these disturbing activities.

11.4.2 Human health

Groundwater assessment criteria derived from DWER (2014) *Assessment and management of contaminated sites*, provide groundwater quality parameters that may impact human health (i.e. non-potable groundwater use and long term irrigation water guidelines).

Monitoring prior to, during and following dewatering and excavation activities provide reference data to assess the impacts to groundwater and provide contingencies to minimise human health risk due these disturbing activities.

11.5 Risk characterisation

The DWER ASS risk mapping indicates that there is high to moderate risk of ASS occurring within 3 m of natural soil surface throughout the site (Figure 2).

As such, there is sufficient risk associated with the excavation and dewatering of soils at the site to warrant a thorough ASS investigation (this report) and subsequent ASS Dewatering and Management Plan(s) to demonstrate that risk has been minimised.

12. Health, safety and environmental plan (HSEP)

All works at the site were undertaken in accordance with Strategen's Health and Safety Management System.

The Safety Management System consists of numerous documents relating to all aspects of occupational health and safety procedures that includes, but is not limited to:

- Personal Protective Equipment (PPE)
- Hazard Identification and Risk Management
- Incident Reporting and Investigation
- Working Alone
- Heat Stress
- Communication
- Safety Inductions.

13. Conclusions and recommendations

13.1 Summary of results

The results indicate that ASS is present below the water table on the site. The liming rates have been based on the SCr values, in accordance to DWER Guidance (DWER 2015b). The maximum liming rate is consequently 82 kg/tonne for EL-N 4-4.5. Groundwater quality on the site did not indicate that acidification of PASS was currently occurring on the site.

13.2 Recommendations

The results indicate that majority of natural soils encountered during the investigation are potentially acid sulphate soils and should be treated in accordance with (DWER 2015b) guidance. As such the following management actions are recommended:

1. If ground disturbing activities, dewatering activities are required to construct the two (2) bridges an Acid Sulfate Soil and Dewatering Plan (ASSDMP) should be developed and approved by DWER prior to those construction activities taking place at the sites.
2. Because of the presence of ASS and the environmentally sensitive location of the works, the ASSDMP should recommend the use of lime dosing of excavated soil on the site.
3. Groundwater in the vicinity of the site appears to be well buffered. The need for treatment of any dewatering effluent will be considered as part of the ASSDMP depending on the volume and intended discharge methods for dewatering effluent.

An ASSDMP will be prepared when the construction methods for the bridges are confirmed.

13.3 Assumptions, uncertainty and limitations

The conclusions drawn and recommendations made here have been developed on the assumption that the data collected accurately represents the conditions within the investigation area. Uncertainties pertaining to the data collected include spatial uncertainty as no sampling program can provide complete certainty that no contamination exists anywhere in the investigation area.

It is assumed that the samples were collected at a density and depth, sufficient to allow an adequate spatial characterisation of the soil and groundwater within the vicinity of the investigation area.

Although uncertainties exist, the assumptions made are well founded and give confidence that the conclusions and recommendations reached regarding the investigation area are sound and justifiable.

14. References

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Appendix 1

Certificates of Title

Appendix 2

Soil and groundwater bore logs

Project: **Busselton Strategic Network Corridors**	MW EL-S
Project Location: **Busselton**	**Sheet 1 of 1**
Project Number: **CIB16605.01**	

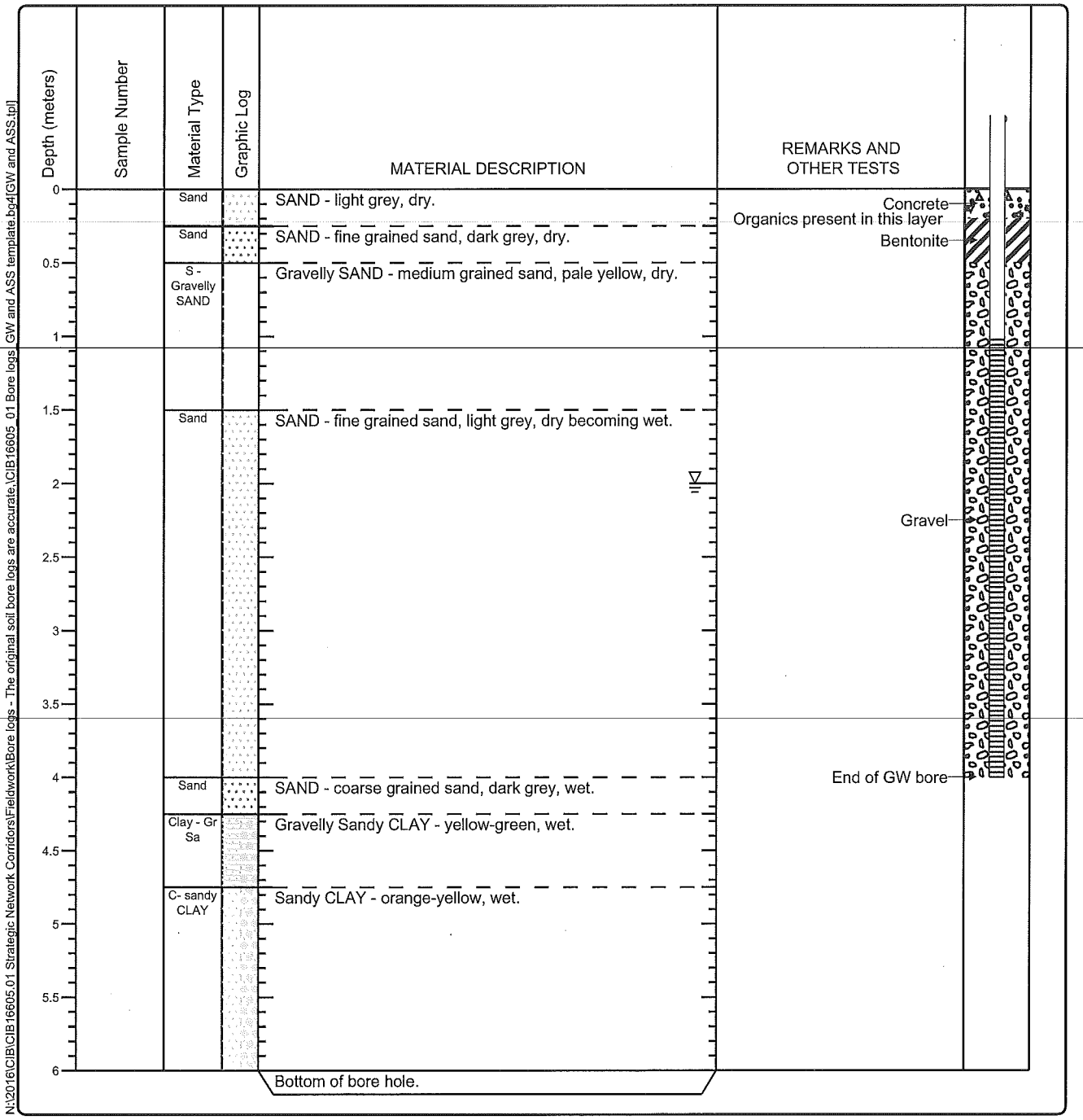
Date(s) Drilled **05/07/2017**	Logged By **Polly Hammond**	Checked By **DR**
Drilling Method **Push Core**	Drill Bit Size/Type **100 mm**	Total Depth of Borehole **5.00 m**
Drill Rig Type **Tractor mounted**	Drilling Contractor **Strataprobe**	
Groundwater Level and Date Measured **1.50 m**	Sampling Method(s)	
	Location **GDA94 (MGA50) -** **Eastings (m)** **Northings (m)**	

Depth (meters)	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS	Well Log
0	0.00-0.50	S - Gravelly SAND		Gravelly SAND - brown, dry.	Pea gravel present in this layer	
0.5	0.50-1.00	S - Clayey SAND		Clayey SAND - fine grained sand, white, dry.		
1	1.00-1.50					
1.5	1.50-2.00	Sand		SAND - coarse grained sand, grey, wet.		
2	2.00-2.50					
2.5	2.50-3.00	Clay		CLAY - grey, wet.	Brown organics present in this layer	
3	3.00-3.50	Sand		SAND - pale yellow with brown mottling, wet.		
3.5	3.50-4.00	Sand		SAND - course sand, grey, wet.		
4	4.00-4.50					
4.5	4.50-5.00	Sand		SAND - brown, wet.	Strong odour from this layer	
5				Bottom of bore hole (gained refusal).		
5.5						
6						

N:\2016\CIB\CIB16605.01 Strategic Network Corridors\Fieldwork\Bore logs - The original soil bore logs are accurate,\CIB16605_01 Bore logs_GW and ASS template.bg4[GW and ASS.tpl]

Project: **Busselton Strategic Network Corridors** Project Location: **Busselton** Project Number: **CIB16605.01**	MW EL-N **Sheet 1 of 1**

Date(s) Drilled **05/07/2017**	Logged By **Polly Hammond**	Checked By **DR**
Drilling Method **Push Core**	Drill Bit Size/Type **100 mm**	Total Depth of Borehole **6.00 m**
Drill Rig Type **Tractor mounted**	Drilling Contractor **Strataprobe**	
Groundwater Level and Date Measured **2.00 m**	Sampling Method(s)	
	Location **GDA94 (MGA50) - 346853.76 Eastings (m) 6275129.92 Northings (m)**	



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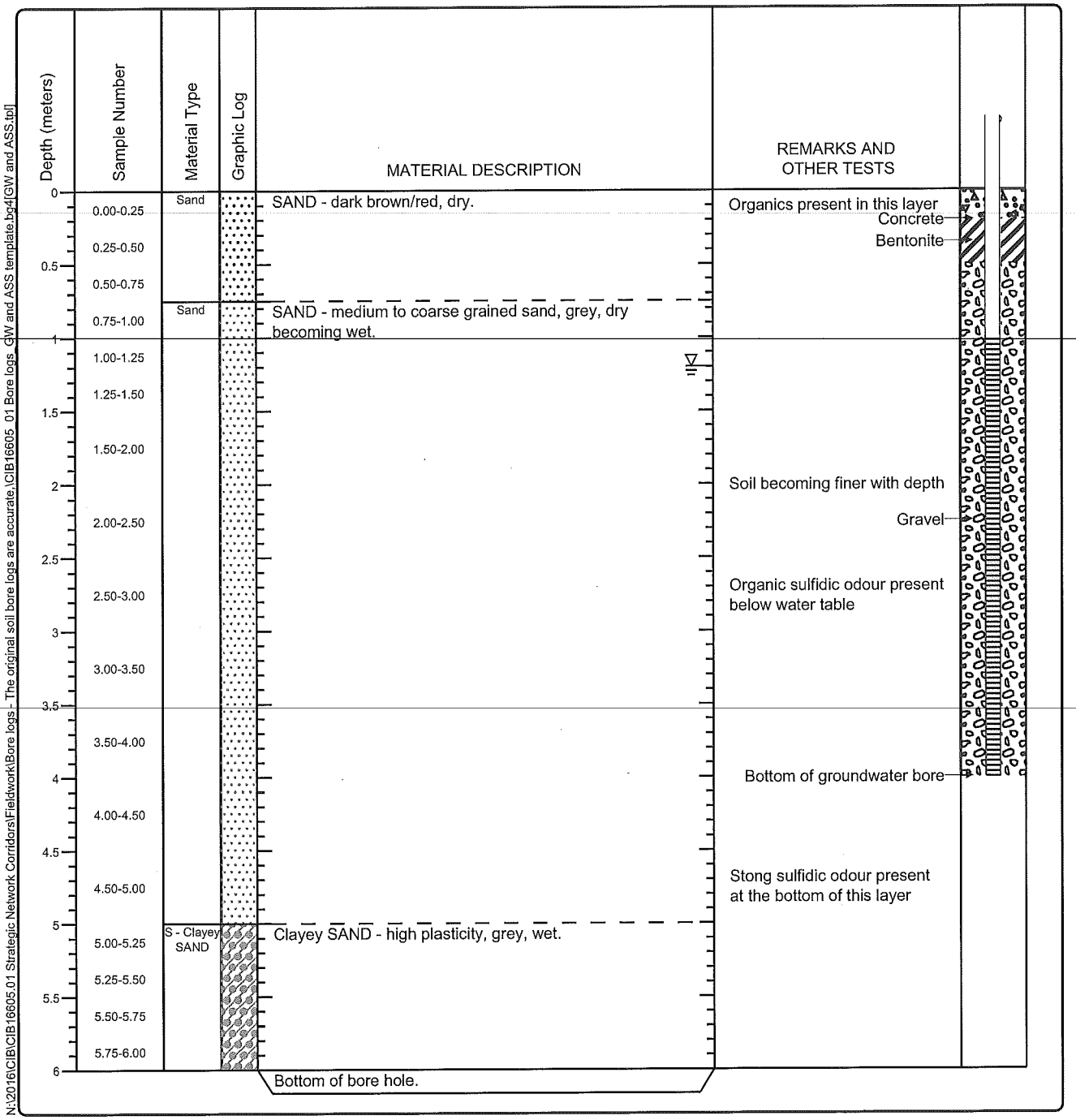
Project: **Busselton Strategic Network Corridors** Project Location: **Busselton** Project Number: **CIB16605.01**	MW CR-N **Sheet 1 of 1**

Date(s) Drilled **05/07/2017**	Logged By **Polly Hammond**	Checked By **DR**
Drilling Method **Push Core**	Drill Bit Size/Type **100 mm**	Total Depth of Borehole **6.00 m**
Drill Rig Type **Tractor mounted**	Drilling Contractor **Strataprobe**	
Groundwater Level and Date Measured **1.20 m**	Sampling Method(s)	
	Location **GDA94 (MGA50) - 346618.01 Eastings (m) 6275036.44 Northings (m)**	



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Project: **Busselton Strategic Network Corridors** Project Location: **Busselton** Project Number: **CIB16605.01**	MW CRS **Sheet 1 of 1**

Date(s) Drilled **05/07/2017**	Logged By **Polly Hammond**	Checked By **DR**
Drilling Method **Push Core**	Drill Bit Size/Type **100 mm**	Total Depth of Borehole **6.00 m**
Drill Rig Type **Tractor mounted**	Drilling Contractor **Strataprobe**	
Groundwater Level and Date Measured **1.00 m**	Sampling Method(s)	
	Location **GDA94 (MGA50) -** **Eastings (m)** **Northings (m)**	

Depth (meters)	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS	Well Log
0	0.00-0.25	Sand		SAND - brown with yellow mottling, dry.	Organics present in this layer	
	0.25-0.50	Sand		SAND - coarse grained sand, black, dry.	Crumbly black large particulate sand in this layer	
0.5	0.50-0.75	Sand		SAND - mottled red and brown sand, dry.		
	0.75-1.00	Sand		SAND - medium grained sand, light grey, dry becoming wet. ▽		
1	1.00-1.50					
1.5	1.50-2.00					
2	2.00-2.50				Becoming finer in grain size and lighter in colour with depth	
2.5	2.50-3.00					
3	3.00-3.50					
3.5	3.50-4.00					
4	4.00-4.50					
4.5	4.50-5.00					
5	5.00-5.25	C- sandy CLAY		Sandy CLAY - fine grained sand, dark grey, wet.		
5.5	5.25-5.50				Strong sulphur odour in this layer	
	5.50-5.75					
6	5.75-6.00			Bottom of bore hole.		

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Project: **Busselton Strategic Network Corridors** Project Location: **Busselton** Project Number: **CIB16605.01**	Key to Bore Logs **Sheet 1 of 1**

Depth (meters)	Sample Number	Material Type	Graphic Log	MATERIAL DESCRIPTION	REMARKS AND OTHER TESTS	Well Log
1	2	3	4	5	6	7

COLUMN DESCRIPTIONS

1. Depth (meters): Depth in meters below the ground surface.
2. Sample Number: Sample identification number.
3. Material Type: Type of material encountered.
4. Graphic Log: Graphic depiction of the subsurface material encountered.
5. MATERIAL DESCRIPTION: Description of material encountered. May include consistency, moisture, color, and other descriptive text.
6. REMARKS AND OTHER TESTS: Comments and observations regarding drilling or sampling made by driller or field personnel.
7. Well Log: Graphical representation of well installed upon completion of drilling and sampling.

FIELD AND LABORATORY TEST ABBREVIATIONS

CHEM: Chemical tests to assess corrosivity
COMP: Compaction test
CONS: One-dimensional consolidation test
LL: Liquid Limit, percent
PI: Plasticity Index, percent
SA: Sieve analysis (percent passing No. 200 Sieve)
UC: Unconfined compressive strength test, Qu, in ksf
WA: Wash sieve (percent passing No. 200 Sieve)

MATERIAL GRAPHIC SYMBOLS

Bentonite
sandy CLAY
Clay
Gravelly Sandy Clay
Concrete
Gravel
Clayey Sand
Gravelly SAND
Sand

TYPICAL SAMPLER GRAPHIC SYMBOLS

Auger sampler
Bulk Sample
3-inch-OD California w/ brass rings
CME Sampler
Grab Sample
2.5-inch-OD Modified California w/ brass liners
Pitcher Sample
2-inch-OD unlined split spoon (SPT)
Shelby Tube (Thin-walled, fixed head)

OTHER GRAPHIC SYMBOLS

Water level (at time of drilling, ATD)
Water level (after waiting)
Minor change in material properties within a stratum
Inferred/gradational contact between strata
Queried contact between strata

GENERAL NOTES

1: Soil classifications are based on the Unified Soil Classification System. Descriptions and stratum lines are interpretive, and actual lithologic changes may be gradual. Field descriptions may have been modified to reflect results of lab tests.
2: Descriptions on these logs apply only at the specific boring locations and at the time the borings were advanced. They are not warranted to be representative of subsurface conditions at other locations or times.

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Figure B-1

CR-N
E: 346,618.01
N: 6,275,036.44
Top of Casing RL = 1.62m AHD
Natural Surface Ground Level = 1.07m AHD

EL-N
E: 346,853.76
N: 6,275,129.92
Top of Casing RL = 2.40m AHD
Natural Surface Ground Level = 1.82m AHD

NOTE
This is a site survey and the boundaries shown should be used as a reference only as they have not been re-established as part of this survey.

This survey has been carried out using GPS survey equipment.

Co-ordinates are MGA94 Zone 50.

Levels are AHD.

Cadastral boundaries have been positioned using Landgate co-ordinates.

Areas and dimensions are subject to final survey.

Scale 1:2000 (A3L).

BSO DEVELOPMENT CONSULTANTS
Licensed Surveyors 8 Fairbairn Road, P.O. Box 414
Project Managers Busselton W.A. 6280
Town Planning T: (08) 9754 1188 F: (08) 9754 2828
Residential/Commercial Projects E: admin@bsodc.com.au

GROUND WATER MONITORING BORES

LOTS 230 (Reserve 7442) & 265 (Reserve 7443)
PEEL TERRACE , BUSSELTON

DP 222226

CITY OF BUSSELTON

CLIENT	STRATAGEN ENVIRONMENTAL				
DRAWN BY	HJ BURTON			DATE	20-July-2017
SCALE (A3)	1:2000	MAGNET JOB No	1209s1962.mjo	DRAWING	REV.
DATUM	AHD(GPS)	FILE	1209s1962	Draws1962-Peel	0

Appendix 3

Calibration certificates

ECO Environmental

Environmental monitoring
& sampling equipment
Rentals and sales.

Tel: +61 8 9328 2900
fax: +61 8 9328 2677
eco@ecoenvironmental.com.au
www.ecoenvironmental.com.au
214 Lord St Perth WA 6000

EQUIPMENT INFORMATION

Instrument: YSIPP7

Serial Number: 14C100712 (Display)

Lot Number: 13B100111 (Sonde)

EQUIPMENT CHECK	Enclosed	Comment
YSI Pro Plus Display	✓	
YSI Quatro Sonde	✓	
Flow Cell	✓	
Probe Guard	✓	
Rubber Storage/Calibration	✓	
Sleeve Calibration Cup + Cap	✓	
YSI Pro Series ProComm II Kit	✓	
Instruction Manual & Field Sheets	✓	
Spare Batteries (x 2)	✓	

SENSOR CALIBRATION DETAILS

		Calibration Undertaken		Accuracy	Pass	Fail
Temperature		Factory Calibrated		±0.2°C	☐	☐
Dissolved Oxygen	✓	100% Saturation		±2%	☐	☐
		Pressure Compensation		1024.1hPa	☐	☐
Conductivity	✓	1288mS/cm		±0.5%	☐	☐
	✓	Check linearity at 1.4mS/cm		±0.5%	☐	☐
Salinity		Auto Calibrated		±1%	☐	☐
pH	✓	pH 7.00		± 0.2	☐	☐
	✓	pH 4.00		± 0.2	☐	☐
ORP	✓	240 mV at	20 °C	±20mV	☐	☐

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturer's calibration procedure as recommended in the instrument service manual.

ECO Standard Rental Terms & Conditions apply to all equipment calibrations.

Regards,

Mitchell Lawson

ECO Environmental Equipment Specialist

Date: 13.07.2017

ECO Environmental

Environmental monitoring
& sampling equipment
Rentals and sales.

Tel: +61 8 9328 2900
fax: +61 8 9328 2677
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214 Lord St Perth WA 6000

EQUIPMENT INFORMATION

Instrument: YSIPP7

Serial Number: 14C100712 (Display)

Lot Number: 13B100111 (Sonde)

EQUIPMENT CHECK	Enclosed	Comment
YSI Pro Plus Display	✓	
YSI Quatro Sonde	✓	
Flow Cell	✓	
Probe Guard	✓	
Rubber Storage/Calibration	✓	
Sleeve Calibration Cup + Cap	✓	
YSI Pro Series ProComm II Kit	✓	
Instruction Manual & Field Sheets	✓	
Spare Batteries (x 2)	✓	

SENSOR CALIBRATION DETAILS

		Calibration Undertaken		Accuracy	Pass	Fail
Temperature		Factory Calibrated		±0.2°C	☐	☐
Dissolved Oxygen	✓	100% Saturation		±2%	☐	☐
		Pressure Compensation		1024.1hPa	☐	☐
Conductivity	✓	1288mS/cm		±0.5%	☐	☐
	✓	Check linearity at 1.4mS/cm		±0.5%	☐	☐
Salinity		Auto Calibrated		±1%	☐	☐
pH	✓	pH 7.00		± 0.2	☐	☐
	✓	pH 4.00		± 0.2	☐	☐
ORP	✓	240 mV at	20 °C	±20mV	☐	☐

This is to certify that where possible, this instrument has been calibrated in accordance with the manufacturer's calibration procedure as recommended in the instrument service manual.

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Regards,

Mitchell Lawson

ECO Environmental Equipment Specialist

Date: 13.07.2017

Appendix 4

Soil and groundwater field logs

STRATEGEN

ACIDITY TESTS

Job no:		**Location ID**	
Client	City of Busselton	**Sampling date:**	19/07/17
Site location	Causeway Rd - north		
Start time (2400 hour):			

Determination of Methyl Orange Acidity

	Solution result	Methyl Orange Acidity	HI 3820-0 syringe reading	$CaCO_3$ (mg/L) 5mL = syringe reading x 500) 25mL = syringe reading x 100)	Additional site information:
	550mg/L CaCO3				
5 ml container					
Dechlorinating agent + Bromophenol	Green/Blue	0	If green/blue Methyl Orange acidity = Zero		
	Yellow	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops =
25 ml container (precision test)					
Dechlorinating agent + Bromophenol	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops =

Determination of Phenolphthalein

5 ml container					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops = 4
25 ml container (precision test)					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops =

STRATEGEN

ACIDITY TESTS

Job no:		**Location ID**	
Client	City of Busselton	**Sampling date:**	19/07/17
Site location	Causeway Rd - north		
Start time (2400 hour):			

Determination of Methyl Orange Acidity

	Solution result	Methyl Orange Acidity	HI 3820-0 syringe reading	$CaCO_3$ (mg/L) 5mL = syringe reading x 500) 25mL = syringe reading x 100)	Additional site information:
	550mg/L CaCO3				
5 ml container					
Dechlorinating agent + Bromophenol	Green/Blue	0	If green/blue Methyl Orange acidity = Zero		
	Yellow	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops =
25 ml container (precision test)					
Dechlorinating agent + Bromophenol	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops =

Determination of Phenolphthalein

5 ml container					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops = 45
25 ml container (precision test)					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops =

STRATEGEN

GROUNDWATER FIELD PARAMETERS

Job no:			
Client	City of Busselton		
Site location	Malloy St SE	**Sampling date:**	18/07/17
Bore locked/covered?:	yes		
Cap type:	50mm PVC		
Well condition:	as new		

Other comments and observations:

Field results

Bore Site	Depth to groundwater (mBTOC)	Time	pH	EC (_S/cm)	Redox (mV)	DO units % ☐	DO units ppm ☐	Temp °C
M-SE	1.7	12:30	6.06	14.93	152.5	50	4.73	14.2
M-SE								~~15.9~~

Are the field results acceptable?:

Weather Conditions

Cold ☑ Cool ☐ Mild ☐ Warm ☐ Hot ☐	Clear ☐ Medium ☐ Cloudy ☐	Dry ☐ ☐ ☐ Medium Humid Rain ☑	Still ☐ Breeze ☐ Windy ☑	Dusty ☐

Samplers Initials:

GROUNDWATER FIELD PARAMETERS

STRATEGEN

Job no:			
Client	City of Busselton		
Site location	Malloy St - West	Sampling date:	18/07/17
Bore locked/covered?:	covered, not locked		
Cap type:			
Well condition:	as new		

Other comments and observations:

* the outer casing lid does not close, it will not be lockable.

Field results

Bore Site	Depth to groundwater (mBTOC)	Time	pH	EC (µS/cm)	Redox (mV)	DO units % ☐	DO units ppm ☐	Temp °C
M-W	1.3	1:30	8.17	6.35	36.0	69	0.45	14

Are the field results acceptable?:

Weather Conditions

☐ Cold ☐ Cool ☐ Mild ☐ Warm ☐ Hot	☐ Clear ☐ Medium ☐ Cloudy	☐ Dry ☐ ☐ ☐ Medium ☐ Humid ☐ Rain	☐ Still ☐ Breeze ☐ Windy ☐ Dusty

Samplers Initials:

STRATEGEN

GROUNDWATER FIELD PARAMETERS

STRATEGEN

Job no:			
Client	City of Busselton		
Site location	Malloy St & Rotary Park	Sampling date:	18/07/17
Bore locked/covered?:	all covered but no locks.		
Cap type:	pvc 50mm.		
Well condition:	~~OS new~~	dodgey	

Other comments and observations:

* M~~W~~-NE - cap stuck on very tight, the casing lifts up and down and twists - could not get cap off.

- photos taken - sampling attempt ceased until bore cemented properly.

Field results

Bore Site	Depth to groundwater (mBTOC)	Time	pH	EC (_S/cm)	Redox (mV)	DO units % ☐	DO units ppm ☐	Temp °C
M-NE								
M-~~SW~~	1.7	12:30	6.06	14.93	152.5	50	4.73	14.2
M-W								
EL-N								
CR-N								

Are the field results acceptable?:

Weather Conditions

Cold ☐ Cool ☐ Mild ☐ Warm ☐ Hot ☐	Clear ☐ Medium ☐ Cloudy ☐	Dry ☐ Medium ☐ Humid ☐ Rain ☐	Still ☐ Breeze ☐ Windy ☐	Dusty ☐

Samplers Initials:

GROUNDWATER FIELD PARAMETERS

STRATEGEN

Job no:			
Client	City of Busselton		
Site location	Eastern Link - North	Sampling date:	18/07/17
Bore locked/covered?:		+	19/07/17
Cap type:			
Well condition:	as new		

Other comments and observations:

lots of fine clay in bore clogged up pump was difficult to purge.

acidity test over

Field results

Bore Site	Depth to groundwater (mBTOC)	Time	pH	EC (_S/cm)	Redox (mV)	DO units % ☐	DO units ppm ☐	Temp °C	
EL-N	1.95m	2pm	8.7	0.67	~~+100~~ .65	22.	1.91	18.4	
EL-N	1.97m	9am	9.66	0.66	-128.6	17.5	1.65	18.1	
1m		4pm	7.83	7.77	-118.7	59.9	3.5 +2	16.5	MB3

Are the field results acceptable?:

Weather Conditions

Cold ☐ Cool ☐ Mild ☐ Warm ☐ Hot ☐	Clear ☐ Medium ☐ Cloudy ☐	Dry ☐ Medium ☐ Humid ☐ Rain ☐	Still ☐ Breeze ☐ Windy ☐	Dusty ☐

Samplers Initials:

STRATEGEN

STRATEGEN

ACIDITY TESTS

Job no:		Location ID	EL-N
Client	CIB	Sampling date:	19/07/01
Site location	Eastern Link - N		
Start time (2400 hour):			

Determination of Methyl Orange Acidity

	Solution result	Methyl Orange Acidity	HI 3820-0 syringe reading	$CaCO_3$ (mg/L) 5mL = syringe reading x 500) 25mL = syringe reading x 100)	Additional site information:
	1000mg/L CaCO3				
5 ml container					
Dechlorinating agent + Bromophenol	Green/Blue	0	If green/blue Methyl Orange acidity = Zero		
	Yellow	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops =
25 ml container (precision test)					
Dechlorinating agent + Bromophenol	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops =

Determination of Phenolphthalein

5 ml container					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops = 3.5
25 ml container (precision test)					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops =

STRATEGEN

GROUNDWATER FIELD PARAMETERS

CR-N

Job no:	CIB16605.01	Well name/number:	~~H~~ ~~CR-N~~
Client		Sampling personnel	PR
Site location	Peel Terrace	Sampling date:	09/10/17
Casing diameter (mm):	50mm	Depth to floating product (mBTOC):	
Casing height above-ground level (mAGL):	0.682m	Depth to groundwater (mBTOC):	1.068m
Bore locked/covered?:	Covered / not locked	Product thickness (mm):	
Cap type:	PVC	Well depth from TOC (m):	4.302m
Well condition:	good	Depth to be purged (m):	

Purging information Sampled at 3m

Purge 5 casing volumes or until 'dry': *1 casing volume = 2 L/m for 50 mm ID wells.*	*1 casing volume = 8 L/m for 100 mm ID wells.*
Method/Pump type: Bailer ☐ Waterra ☐ Peristaltic ☒ Bladder ☐ 12V Cyclone ☐	Planned purge volume: _____Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☐ PVC ☐ Other: _____	Actual purge volume: 19.5 Litres
Start time (2400 hour): 12.50	Did well purge 'dry'? No ☒ Yes ☐ At?: _____ Litres

Field results while purging

	Time	pH	EC (mS/cm)	Redox (mV)	DO units (% Sat)	DO units (Ppm)	Temp °C
After **1** purge volume:	12.55	7.27	3.24	~~3.24~~ 269	11.3	1.18	16.19
After **2** purge volume:	1.00	7.25	3.23	-276	4.4	0.43	15.98
After **3** purge volume:	1.05	7.25	3.20	-283	3.7	0.34	15.94
After **4** purge volume:	1.60	7.25	3.16	-287	3.5	0.34	15.90
After **5** purge volume:	1.15	7.25	3.06	-290	3.4	0.33	15.83
After **6** purge volume:	1.20	7.24	2.99	-291	~~3.9~~ 3.2	0.31	15.85
After **7** purge volume:	1.25	7.24	2.86	-291	3.1	0.30	15.80
After **8** purge volume:	1.30	7.22	2.84	-290	2.9	0.29	15.84
After **9** purge volume:							
After **10** purge volume:							
Additional volume:							
Acceptable variation:	N/A	+/-0.05	+/-10%	+/-10%	+/-10%	N/A	+/-10%

Are the field results acceptable?:

Sampling details		Analysis details			
Method/Pump type: Bailer ☐ Waterra ☐ Peristaltic ☒ Bladder ☐ 12V Cyclone ☐		TPH	☐	VOCs	☐
Material: Teflon ☐ S/steel ☐ HDPE ☐ PVC ☐ Other: _____		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☐ Decontaminated ☐ Other: _____		PAHs	☐	Inorganics	☐
Is there a hydrocarbon sheen? Yes ☐ No ☒		Metals	☐	DOC/TOC	☐
Colour: light brown / clear	Odour: light tarin smell	Sample ID:		Duplicate ID:	
Turbidity: Low ☐ Medium ☒ High ☐	Rinse Blank after: Yes ☐ No ☐			Triplicate ID:	

Weather Conditions

Cold ☐ Cool ☐ Mild ☒ Warm ☐ Hot ☐	Clear ☒ Medium ☐ Cloudy ☐	Dry ☒ Medium ☐ Humid ☐ Rain ☐	Still ☐ Breeze ☒ Windy ☒	Dusty ☐

Other comments and observations:

Padlock installed.

STRATEGEN

ACIDITY TESTS

Job no:	CIB16605.01	**Location ID**	CR-N
Client		**Sampling date:**	09/10/17
Site location	Peel terrace	**Sample name:**	
Start time (2400 hour):	1.15		

Determination of Methyl Orange Acidity

	Solution result	Methyl Orange Acidity	HI 3820-0 syringe reading	$CaCO_3$ (mg/L) 5mL = syringe reading x 500) 25mL = syringe reading x 100)	Additional site information:
5 ml container					
Dechlorinating agent + Bromophenol	Green/Blue	0	If green/blue Methyl Orange acidity = Zero		
	Yellow	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops = 0
25 ml container (precision test)					
Dechlorinating agent + Bromophenol	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops =

Determination of Phenolphthalein

5 ml container					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops = 0.14ml × 500 = 70mg/L $CaCO_3$
25 ml container (precision test)					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops = 0.89 ml × 100 = 89 mg/L $CaCO_3$

STRATEGEN

ALKALINITY TESTS

Job no:	CIB16605·01	**Location ID**	CR-N
Client		**Sampling date:**	09/10/17
Site location	Peel Terrace	**Sample name:**	
Start time (2400 hour):	1·25		

Determination of Phenolphthalein Alkalinity

	Solution result	Phenolphthalein Alkalinity	HI 3811-0 syringe reading	$CaCO_3$ (mg/L)	Additional site information:
Big container					
Add **Phenolphthalein Indicator**	No colour	0	Phenolphthalein Alkalinity = Zero, go to total alkalinity		
	Pink or red	Proceed with adding 3811-0			
Adding HI 3811-0 syringe reading					**Comments:** No. drops = 0
25 ml container (precision test)					

Determination of Total Alkalinity – always rinse between samples

25 ml container, 5mL sample.					
Bromophenol blue	Yellow	Acidity test must be carried out			
	Green or blue	Proceed with adding HI 3811-0			
Use 5 mL of sample. Adding HI 3811-0 until solution turns yellow		Drops x 300 = total alkalinity in mg/L $CaCO_3$. If less than 100, proceed to precision test and use precision test result.			**Comments:** No. drops = 2.092 ml × 300 = 627.6 mg/L $CaCO_3$
100 ml container (precision test)					
Use 15 mL of sample. Adding HI 3811-0 until solution turns yellow		Drops x 100 = total alkalinity in mg/L $CaCO_3$			**Comments:** No. drops =

GROUNDWATER FIELD PARAMETERS

STRATEGEN

Job no:	CIB16605.01	**Well name/number:**	EL-N
Client		**Sampling personnel**	PR
Site location	Peel Terrace	**Sampling date:**	09/10/17
Casing diameter (mm):	50 mm	**Depth to floating product (mBTOC):**	
Casing height above-ground level (mAGL):	1.018m	**Depth to groundwater (mBTOC):**	1.840 m
Bore locked/covered?:	Covered | not locked	**Product thickness (mm):**	
Cap type:	PVC	**Well depth from TOC (m):**	4.439m
Well condition:	Good	**Depth to be purged (m):**	

Purging information Sampled at. 3.0m

Purge 5 casing volumes or until 'dry': *1 casing volume = 2 L/m for 50 mm ID wells.*	*1 casing volume = 8 L/m for 100 mm ID wells.*
Method/Pump type: Bailer ☐ Waterra ☐ Peristaltic ☒ Bladder ☐ 12V Cyclone ☐	Planned purge volume: _____Litres (5 well vols)
Material: Teflon ☐ S/steel ☐ HDPE ☐ PVC ☐ Other: _____	Actual purge volume: 23 Litres
Start time (2400 hour): 11.25	Did well purge 'dry'? No ☒ Yes ☐ At?: _____ Litres

Field results while purging

	Time	pH	EC (m S/cm)	Redox (mV)	DO units (% Sat)	DO units (Ppm)	Temp °C
After **1** purge volume:	11.30	7.34	1.222	-231	26.7	2.50	17.92
After **2** purge volume:	11.35	7.37	1.149	-241	19.6	1.95	17.76
After **3** purge volume:	11.40	7.40	1.143	-242	14.9	1.44	17.76
After **4** purge volume:	11.45	7.40	1.119	-244	11.6	1.10	17.72
After **5** purge volume:	11.50	7.40	1.112	-245	9.3	0.88	17.71
After **6** purge volume:	11.55	7.41	1.109	-245	7.5	0.73	17.77
After **7** purge volume:	12.00	7.43	1.102	-247	6.8	0.67	17.68
After **8** purge volume:	12.05	7.44	1.095	-246	6.2	0.59	17.72
After **9** purge volume:	12.10	7.44	1.097	-248	5.4	0.52	17.74
After **10** purge volume:	12.15	7.44	1.096	-248	5.1	0.48	17.72
Additional volume:	12.20	7.44	1.087	-250	4.8	0.45	17.79
Acceptable variation:	N/A	+/-0.05	+/-10%	+/-10%	+/-10%	N/A	+/-10%

Are the field results acceptable?: Y

Sampling details		**Analysis details**			
Method/Pump type: Bailer ☐ Waterra ☐ Peristaltic ☒ Bladder ☐ 12V Cyclone ☐		TPH	☐	VOCs	☐
Material: Teflon ☐ S/steel ☐ HDPE ☐ PVC ☐ Other: _____		BTEX	☐	SVOCs	☐
Equipment: Dedicated ☒ Decontaminated ☐ Other: _____		PAHs	☐	Inorganics	☐
Is there a hydrocarbon sheen? Yes ☐ No ☐		Metals	☐	DOC/TOC	☐
Colour: Clear	Odour: tannin smell	Sample ID:		Duplicate ID:	
Turbidity: Low ☐ Medium ☒ High ☐	Rinse Blank after: Yes ☐ No ☐			Triplicate ID:	

Weather Conditions

Cold ☐ Cool ☐ Mild ☒ Warm ☐ Hot ☐	Clear ☒ Medium ☐ Cloudy ☐	Dry ☒ Medium ☐ Humid ☐ Rain ☐	Still ☒ Breeze ☐ Windy ☐	Dusty ☐

Other comments and observations: Added padlock

STRATEGEN

ALKALINITY TESTS

Job no:	CIB16605.01	**Location ID**	EL-N
Client		**Sampling date:**	09/10/17
Site location	Peel Terrace	**Sample name:**	
Start time (2400 hour):	12-17		

Determination of Phenolphthalein Alkalinity

	Solution result	Phenolphthalein Alkalinity	HI 3811-0 syringe reading	$CaCO_3$ (mg/L)	Additional site information:
Big container					
Add **Phenolphthalein Indicator**	No colour	0	Phenolphthalein Alkalinity = Zero, go to total alkalinity		
	Pink or red	Proceed with adding 3811-0			
Adding HI 3811-0 syringe reading					**Comments:** No. drops =
25 ml container (precision test)					

Determination of Total Alkalinity – always rinse between samples

25 ml container, 5mL sample.					
Bromophenol blue	Yellow	Acidity test must be carried out			
	Green or blue	Proceed with adding HI 3811-0			
Use 5 mL of sample. Adding HI 3811-0 until solution turns yellow	blue	Drops x 300 = total alkalinity in mg/L $CaCO_3$. If less than 100, proceed to precision test and use precision test result.			**Comments:** No. drops = 1.97 mL x 300 = 591 mg/L $CaCO_3$
100 ml container (precision test)					
Use 15 mL of sample. Adding HI 3811-0 until solution turns yellow		Drops x 100 = total alkalinity in mg/L $CaCO_3$			**Comments:** No. drops =

modify form.

STRATEGEN

ACIDITY TESTS

Job no:	CIB16605.01	**Location ID**	EL-W
Client		**Sampling date:**	09/10/17
Site location	Peel Terrace.	**Sample name:**	
Start time (2400 hour):	12.01		

Determination of Methyl Orange Acidity

	Solution result	Methyl Orange Acidity	HI 3820-0 syringe reading	$CaCO_3$ (mg/L) 5mL = syringe reading x 500) 25mL = syringe reading x 100)	Additional site information:
5 ml container					
Dechlorinating agent + Bromophenol	~~Green/Blue~~	0	If green/blue Methyl Orange acidity = Zero		
	Yellow	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops = 0
25 ml container (precision test)					
Dechlorinating agent + Bromophenol	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns green					**Comments:** No. drops = 0.05 x 500 = 25
Determination of Phenolphthalein					
5 ml container					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops = 0.4 0.05 x 100 x 500 = 40 = 25
25 ml container (precision test)					
Phenolphthalein	Red/pink	Alkalinity test must be carried out			
	Colourless	Proceed with adding HI 3820-0			
Adding HI 3820-0 until solution turns pink					**Comments:** No. drops = 0.4 x 100 = 40 mg/L $CaCO_3$

Appendix 5

Soil analysis summary tables

Table 1: ASS Field analysis results

Sample ID	Soil bore #	Sample reference	Date	Soil type	pH (Field)	pH (Fox)	pH (Field - Fox)	Reaction rate
Units					**pH units**	**pH units**	**pH units**	**X/XX/XXX**
Limit of Reporting					**0.1**	**0.1**	**0.1**	**-**
Assessment Criteria - DER 2015					**4.0**	**3.0**	**1.0**	**XXX**
CR-S 0.0-0.25	1	17-0372 1	05-07-2017	sand	8.2	6	2.2	XX
CR-S 0.25-0.5	1	17-0372 2	05-07-2017	sand	8.1	6.1	2.0	XXX
CR-S 0.5-0.75	1	17-0372 4	05-07-2017	sand	8.5	6.2	2.3	XXX
CR-S 0.75-1	1	17-0372 5	05-07-2017	sand	8.5	6.2	2.3	XX
CR-S 1-1.5	1	17-0372 6	05-07-2017	sand	7.7	5.8	1.9	X
CR-S 1.5-2	1	17-0372 7	05-07-2017	sand	7.5	5.5	2.0	XX
CR-S 2-2.5	1	17-0372 8	05-07-2017	sand	7.4	1.8	5.6	XXXX
CR-S 2.5-3	1	17-0372 9	05-07-2017	sand	7.4	5.5	1.9	XX
CR-S 3-3.5	1	17-0372 10	05-07-2017	sand	7.9	2.2	5.7	XX
CR-S 3.5-4	1	17-0372 11	05-07-2017	sand	7.5	2.2	5.3	X
CR-S 4-4.5	1	17-0372 12	05-07-2017	sand	8.2	2.2	6.0	XXXX
CR-S 4.5-5	1	17-0372 13	05-07-2017	sand	7.9	1.9	6.0	XXXX
CR-S 5.0-5.25	1	17-0372 14	05-07-2017	sandy clay	7.9	1.9	6.0	XXXX
CR-S 5.25-5.5	1	17-0372 15	05-07-2017	sandy clay	7.9	2.1	5.8	XXXX
CR-S 5.5-5.75	1	17-0372 16	05-07-2017	sandy clay	8	1.5	6.5	X
CR-S 5.75-6.0	1	17-0372 17	05-07-2017	sandy clay	7.8	1.5	6.3	X
CR-N 0-0.25	2	17-0372 18	05-07-2017	sand	8.4	5.9	2.5	XXX
CR-N 0.25-0.5	2	17-0372 19	05-07-2017	sand	8.3	6.4	1.9	XX
CR-N 0.5-0.75	2	17-0372 20	05-07-2017	sand	8	6.2	1.8	XX
CR-N 0.75-1	2	17-0372 21	05-07-2017	sand	7.6	6.2	1.4	XX
CR-N 1-1.5	2	17-0372 22	05-07-2017	sand	7.6	6.3	1.3	XX
CR-N 1.5-2	2	17-0372 23	05-07-2017	sand	7.4	6.1	1.3	XX
CR-N 2-2.5	2	17-0372 24	05-07-2017	sand	7.8	1.6	6.2	XXXX
CR-N 2.5-3	2	17-0372 26	05-07-2017	sand	8.8	1.4	7.4	XXXX
CR-N 3.0-3.5	2	17-0372 27	05-07-2017	sand	7.8	1.4	6.4	XXXX
CR-N 3.5-4	2	17-0372 28	05-07-2017	sand	7.9	1.7	6.2	XXXX
CR-N 4-4.5	2	17-0372 29	05-07-2017	sand	8.1	1.2	6.9	XXXX
CR-N 4.5-5	2	17-0372 30	05-07-2017	clayey sand	8.2	1.7	6.5	XXXX
CR-N 5.25-5.5	2	17-0372 31	05-07-2017	clayey sand	8.7	3.1	5.6	X
CR-N 5.5-5.75	2	17-0372 32	05-07-2017	clayey sand	8.8	2	6.8	XXXX
CR-N 5.75-6	2	17-0372 33	05-07-2017	clayey sand	7.9	1.3	6.6	XXXX
EL-N 0-0.25	3	17-0372 34	05-07-2017	sand	8.7	5.9	2.8	XX
EL-N 0.25-0.5	3	17-0372 35	05-07-2017	sand	8.1	5.9	2.2	XX
EL-N 0.5-0.75	3	17-0372 36	05-07-2017	gravelly sand	8	6.4	1.6	XX
EL-N 0.75-1	3	17-0372 37	05-07-2017	gravelly sand	8.4	6.9	1.5	XX
EL-N 1-1.5	3	17-0372 38	05-07-2017	gravelly sand	8.1	6.8	1.3	XX
EL-N 1.5-2	3	17-0372 39	05-07-2017	sand	8.5	5.4	3.1	XX
EL-N 2-2.5	3	17-0372 40	05-07-2017	sand	8.1	6.6	1.5	XX
EL-N 2.5-3	3	17-0372 41	05-07-2017	sand	8.1	6.7	1.4	XX
EL-N 3-3.5	3	17-0372 42	05-07-2017	sand	7.8	6.5	1.3	XX
EL-N 3.5-4	3	17-0372 43	05-07-2017	sand	7.7	6.2	1.5	XX
EL-N 4-4.5	3	17-0372 44	05-07-2017	sand	8.2	6	2.2	XX
EL-N 4.5-5	3	17-0372 45	05-07-2017	gravelly sandy clay	8.3	7.3	1.0	XXXX
EL-N 5-5.5	3	17-0372 46	05-07-2017	sandy clay	8.8	6.9	1.9	XX
EL-N 5.5-6	3	17-0372 47	05-07-2017	sandy clay	8.5	7	1.5	XX
EL-S 0-0.5	4	17-0372 48	05-07-2017	gravelly sand	7.5	5.8	1.7	XX
EL-S 0.5-1	4	17-0372 49	05-07-2017	clayey sand	7.5	5.9	1.6	XX
EL-S 1-1.5	4	17-0372 50	05-07-2017	clayey sand	7.8	6	1.8	XX
EL-S 1.5-2	4	17-0372 51	05-07-2017	sand	7.5	6	1.5	XX
EL-S 2.2.5	4	17-0372 52	05-07-2017	sand	7.9	5.9	2.0	XX
EL-S 2.5-3	4	17-0372 53	05-07-2017	clay, grey	8.2	6.1	2.1	XX
EL-S 3-3.5	4	17-0372 54	05-07-2017	sand	7.8	6	1.8	XX
EL-S 3.5-4	4	17-0372 55	05-07-2017	sand	7.6	6	1.6	XX
EL-S 4-4.5	4	17-0372 56	05-07-2017	sand	7.4	5.9	1.5	XX
EL-S 4.5-5	4	17-0372 58	05-07-2017	sand	7.4	5.9	1.5	XX

Table 2: ASS SPOCAS analysis results

					Field Test				Lab pH		SPOCAS			
Sample ID	Sample reference		Date	Soil type	pH (Field)	pH (Fox)	pH (Field - Fox)	Reaction rate	pHKCl	pHox	Sulphidic - TAA	Sulphidic - TPA	Sulphidic - TSA	Peroxide Oxidisable Sulphur (SPOS)
Units					pH units	pH units	pH units	X/XX/XXX	pH units	pH units	% S	% S	% S	% S
Limit of Reporting					0.1	0.1	0.1	-	-	-	0.005	0.005	0.005	0.005
Assessment Criteria - DER 2015					4.0	3.0	1.0	NV	NV	NV	0.03	0.03	NV	0.03
CR-S 3-3.5	17-10372	10	05-07-2017	sand	7.9	2.2	5.7	XX	9	2.3	<0.005	0.19	0.19	0.3
CR-S 5.5-5.75	17-10372	16	05-07-2017	sandy clay	8	1.5	6.5	X	7.4	2.1	<0.005	0.31	0.31	0.29
CR-N 2-2.5	17-10372	24	05-07-2017	sand	7.8	1.6	6.2	XXXX	7.9	2.1	<0.005	0.59	0.59	0.62
CR-N 2.5-3	17-10372	26	05-07-2017	sand	8.8	1.4	7.4	XXXX	8	2	<0.005	0.95	0.95	0.94
CR-N 5.5-5.75	17-10372	32	05-07-2017	clayey sand	8.8	2	6.8	XXXX	7.9	2.6	<0.005	0.48	0.48	0.62
EL-N 1.5-2	17-10372	39	05-07-2017	sand	8.5	5.4	3.1	XX	9.7	7.8	<0.005	<0.005	<0.005	0.044
EL-N 4-4.5	17-10372	44	05-07-2017	sand	8.2	6	2.2	XX	9	7.3	<0.005	<0.005	<0.005	1.3
EL-S 2.2.5	17-10372	52	05-07-2017	sand	7.9	5.9	2.0	XX	8.8	7.7	<0.005	<0.005	<0.005	0.25
EL-S 2.5-3	17-10372	53	05-07-2017	clay, grey	8.2	6.1	2.1	XX	8.7	7.8	<0.005	<0.005	<0.005	0.23

Table 3
Soil Analytical Results - Metals

			Metals							
			Arsenic	Cadmium	Chromium^{+}	Copper	Mercury (inorganic)	Nickel	Lead	Zinc
EIL - Urban residential and public open space			100	NG	NG	250	NG	580	1000	940
HIL-A (Residential A)			100	20	100	6,000	40	400	300	7,400
Limits of Reporting (LOR)			5	0.1	1	1	0.2	1	1	1
Sample ID	**Lab ID**	**Date Sampled**	mg/kg							
CR-S 5.5-5.75	17-10372-B-16	5/07/2017	<5	0.6	4	<1	<0.02	1	5	13
CR-N 2-2.5	17-10372-B-24	5/07/2017	<5	0.8	5	<1	<0.02	2	6	6
CR-N 2-2.5 (DUP)	17-10372-B-25	5/07/2017	<5	0.6	4	<1	<0.02	1	4	3
EL-N 5-5.5	17-10372-B-46	5/07/2017	10	<0.1	51	5	<0.02	9	15	140
EL-S 3-3.5	17-10372-B-54	5/07/2017	<5	0.4	9	8	<0.02	2	3	4

Notes:
NG = Regulatory guideline value not established
< Indicates sample results below the laboratory limit of reporting (LOR)
- Not Analysed

Regulatory Guidelines:
Guidelines are derived from the *National Environment Protection (Assessment of Site Contamination) Measure* (NEPC, 2013) and the *Assessment and Management of Contamir*

	shading indicates concentration exceeds the NEPC (2013) Ecological Investigation Levels (EIL)
	shading indicates concentration exceeds the NEPC (2013) Health Investigation Levels (HIL)

Table 4: ASS field testing quality control results

Sample Description				Field Test				Lab pH		SPOCAS				Action Criteria			
Reference	Sample ID	QA Sample type	Sample date	pH (Field)	pH (Fox)	pH (Field - Fox)	Reaction rate	pHKCl	pHox	Sulphidic - TAA	Sulphidic - TPA	Sulphidic - TSA	Peroxide Oxidisable Sulphur (SPOS)	Net Acidity (SPOCAS)	Net acidity (SPOCAS)	Net Acidity (Scr)	Liming rate
Units				**pH units**	**pH units**	**pH units**	**-**	**pH units**	**pH units**	**% S**	**% S**	**% S**	**% S**	**% S**	**% S**	**mole H+/t**	**% S**
Limit of Reporting				**0.1**	**0.1**	**0.1**	**-**			**0.005**	**0.005**	**0.005**	**0.005**	**0.005**	**0.005**	**5**	**0.01**
Duplicates																	
17-0372-2	CR-S 0.25-0.5	Primary	5/07/2017	8.1	6.1	2	xxx	-	-	-	-	-	-	-	-	-	-
17-0372-3	CR-S 0.25-0.5 Dup	Duplicate	5/07/2017	8.1	5.8	2.3	XXX	-	-	-	-	-	-	-	-	-	-
			Relative Percent Difference	0.0	5.0	14.0	-	-	-	-	-	-	-	-	-	-	-
17-0372-24	CR-N 2-2.5	Primary	5/07/2017	7.8	1.6	6.2	XXXX	7.9	2.1	<0.005	0.59	0.59	0.62	0.62	390	-	53
17-0372-25	CR-N 2-2.5 (DUP)	Duplicate	5/07/2017	7.7	1.7	6.0	XXXX	8.8	2.1	<0.005	0.26	0.26	0.49	0.49	300	0.46	41
			Relative Percent Difference	1.3	6.1	3.3	-	10.8	0.0	-	77.6	77.6	23.4	23.4	26.1	-	25.5
17-0372-56	EL-S 4.5-5	Primary	5/07/2017	7.4	5.9	1.5	XX	-	-	-	-	-	-	-	-	-	-
17-0372-57	EL-S 4.5-5 (DUP)	Duplicate	5/07/2017	7.3	5.9	1.4	XX	-	-	-	-	-	-	-	-	-	-
			Relative Percent Difference	1.4	0.0	6.9	-	-	-	-	-	-	-	-	-	-	-

Notes:

- Not Analysed

< Indicates sample results below the laboratory limit of reporting (LOR)

 # indicates RPD not calculable, as primary and duplicate concentrations <LOR.

***Bold** font indicates results above the LOR*

***Red** font indicates RPD > 50% (for inorganics)*

Table 5
Soil QA/QC Results - Metals

			Metals							
			Arsenic	Cadmium	Chromium*	Copper	Mercury (inorganic)	Nickel	Lead	Zinc
		LOR	5	0.1	1	1	0.2	1	1	1
Sample ID	Lab ID	Date Sampled	mg/kg							
Field Duplicates										
CR-N 2-2.5	17-10372-B-24	3/07/2017	<5	0.8	5	<1	<0.02	2	6	6
CR-N 2-2.5 (DUP)	17-10372-B-25		<5	0.6	4	<1	<0.02	1	4	3
		%RPD	#	29	22	#	#	67	40	67

Notes:
- Not Analysed
< Indicates sample results below the laboratory limit of reporting (LOR)
 # indicates RPD not calculable, as primary and duplicate concentrations <LOR.
Bold *font indicates results above the LOR*
Red *font indicates RPD > 50% (for inorganics)*

Appendix 6

Groundwater analysis summary tables

Table 1
Field testing results

		Field Parameters					
		pH	Electrical Conductivity	Redox	Dissolved oxygen	Total Acidity (as CaCO3)	Total Alkalinity (as CaCO3)
FWG		**6.5-8.5[1]**	**300-1,500 [2]**	NE	NE	NE	NE
LIWG		**NE**	**1,900-4,500 [3]**	**NE**	**NE**	**NE**	**NE**
NPUG		NE	NE	NE	NE	NE	NE
ASS criteria		**6 - 8.**	NE	NE	NE	**40**	NE
Limits of Reporting (LOR)		**0.1**	**0.01**	**0.1**		**5**	**5**
Sample ID	**Date Sampled**	**pH units**	**µs/cm**	**mg/L**	**mg/L**	**mg/L**	**mg/L**
EL-N	9/10/2017	**7.44**	**1087**	**-250**	**0.45**	**25**	**590**
CR-N	9/10/2017	**7.22**	**2840**	**-290**	**0.29**	**89**	**630**

Notes:
NE = Regulatory guideline value not established
[1] value derived from ANZECC (2000) - wetland ecosystems in South-west Australia
[2] value derived from ANZECC (2000) - lakes, reservoirs & wetland ecosystems in South-west Australia
[3] value derived from ANZECC (2000) - for moderately tolerant crops
[4] value derived from ANZECC (2000) - for sensitive crops
< Indicates sample results below the laboratory limit of reporting (LOR)
- Not Analysed

Regulatory Guidelines:
Guidelines are derived from DWER (2014) *Assessment and management of contaminated sites - Contaminated sites guidelines,*
NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1),*
NHMRC & NRMMC (2011) *Australian Drinking Water Guidelines* and ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

	shading indicates concentration exceeds the FWG (Fresh Water Guidelines for slightly - moderately disturbed systems).
200	red bold text indicates concentration exceeds the LIWG (Long-term Irrigation Water Guidelines).
	shading indicates concentration exceeds the NPUG (Non-Potable Groundwater Use - Department of Health, 2014).
	shading indicates concentration exceeds DWER 2015a ASS critieria

Table 2
Groundwater Analytical Results

			Lab Parameters																					ASS Ratios	
			pH	Electrical Conductivity	TDS	Acidity	Total Alkalinity (as CaCO3)	Chloride	Sulphate (as SO4)	TDS	Aluminium - Dissolved	Arsenic - Dissolved	Chromium - Dissolved	Iron - Dissolved	Manganese - Dissolved	Nickel - Dissolved	Selenium - Dissolved	Zinc - Dissolved	Total Nitrogen	Total Phosphorus	Filterble Reactive Phosphorus	NOx-N	Nitrate-N	Chloride	Sulphate	Acidity: Alkalinity	Sulfate: Chloride
FWG			6.5-8.5[1]	300-1,500 [2]	NE	NE	NE	NE	NE	NE	0.055	NE	0.001*	NE	1.9	0.011	0.005	0.008	1	0.1	NE	0.1	NE	NE	NE	NE	NE
LIWG			NE	1,900-4,500 [3]	NE	NE	NE	175 [4]	NE	1,500	5	0.1	0.1	0.2	0.2	0.2	0.02	2	5	0.05	NE	NE	NE	NE	NE	NE	NE
NPUG			NE	NE	NE	NE	NE	250	1,000	NE	0.2	0.1	0.05	0.3	0.5	0.2	0.1	NE	NE	NE	NE	NE	NE	113	NE	NE	NE	NE
ASS criteria						40					1															>1	>0.5
Limits of Reporting (LOR)			0.1	0.01	0.1	5	5	5	1	5	0.01	0.001	0.0001	0.001	0.001	0.001	0.01	0.0001	0.01	0.001	0.01	0.01	0.01	0.001	0.005	-	-
Sample ID	**Lab ID**	**Date Sampled**	**pH units**	**µs/cm**	**mg/L**																						
EL-N	17-11290-1	19/07/2017	**7.9**	**900**	**460**	**12**	**340**	**100**	**11**	**460**	<0.01	<0.001	<0.001	**0.13**	**0.01**	**0.002**	<0.001	<0.001	**1.6**	**0.2**	**0.03**	**0.15**	**0.12**	**100**	**11**	**0.04**	**0.11**
CR-N	17-11290-2	19/07/2017	**7.6**	**1500**	**710**	**34**	**590**	**200**	**11**	**710**	<0.01	<0.001	<0.001	**0.31**	**0.03**	**0.002**	<0.001	<0.001	**4.5**	**0.69**	**0.06**	**0.11**	**0.07**	**200**	**11**	**0.06**	**0.055**

Notes:
NE = Regulatory guideline value not established
[1] value derived from ANZECC (2000) - wetland ecosystems in South-west Australia
[2] value derived from ANZECC (2000) - lakes, reservoirs & wetland ecosystems in South-west Australia
[3] value derived from ANZECC (2000) - for moderately tolerant crops
[4] value derived from ANZECC (2000) - for sensitive crops
< Indicates sample results below the laboratory limit of reporting (LOR)
- Not Analysed

Regulatory Guidelines:
Guidelines are derived from DER (2014) *Assessment and management of contaminated sites - Contaminated sites guidelines,*
NEPC (2013) *National Environment Protection (Assessment of Site Contamination) Amendment Measure 2013 (No. 1),*
NHMRC & NRMMC (2011) *Australian Drinking Water Guidelines* and ANZECC & ARMCANZ (2000) *Australian and New Zealand Guidelines for Fresh and Marine Water Quality.*

	shading indicates concentration exceeds the FWG (Fresh Water Guidelines for slightly - moderately disturbed systems).
200	red bold text indicates concentration exceeds the LIWG (Long-term Irrigation Water Guidelines).
	shading indicates concentration exceeds the NPUG (Non-Potable Groundwater Use - Department of Health, 2014).
	shading indicates concentration exceeds DWER 2015a ASS critieria

Table 3
Groundwater Analytical Results - Physiochemical Parameters

			Lab Parameters																						ASS Ratios	
			pH	Electrical Conductivity	TDS	Acidity	Total Alkalinity (as CaCO3)	Chloride	Sulphate (as SO4)	TDS	Aluminium - Dissolved	Arsenic - Dissolved	Chromium - Dissolved	Iron - Dissolved	Manganese - Dissolved	Nickel - Dissolved	Selenium - Dissolved	Zinc - Dissolved	Total Nitrogen	Total Phosphorus	Filterble Reactive Phosphorus	NOx-N	Nitrate-N	Chloride	Sulphate	Acidity: Alkalinity	Sulfate: Chloride
Limits of Reporting (LOR)			**0.1**	**0.01**	**0.1**	**5**	**5**	**5**	**1**	**5**	**0.01**	**0.001**	**0.0001**	**0.001**	**0.001**	**0.001**	**0.01**	**0.0001**	**0.01**	**0.001**	**0.01**	**0.01**	**0.01**	**0.001**	**0.005**	-	-
Sample ID	**Lab ID**	**Date Sampled**	**pH units**	**µs/cm**	**mg/L**																						
Duplicates																											
CR-N	17-11290-2	19/07/2017	**7.6**	**1500**	**710**	**34**	**590**	**200**	**11**	**710**	<0.01	<0.001	<0.001	**0.31**	**0.03**	**0.002**	<0.001	<0.001	**4.5**	**0.69**	**0.06**	**0.11**	**0.07**	**200**	**11**	**0.06**	**0.055**
QC(SN)1	17-11290-3	19/07/2017	**7.4**	**1600**	**790**	**47**	**500**	**240**	**12**	**790**	-	-	-	-	-	-	-	-	-	-	-	-	-	**240**	**12**	**0.09**	**0.05**
		%RPD	2.7	6.5	10.7	32.1	16.5	18.2	8.7	10.7														18.2	8.7	NA	NA
Blank																											
QC(SN)2	17-11290-4	19/07/2017	6	<0.01	-	<5	<5	-	-	<5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-		
Notes:																											

Notes:
- Not Analysed
< Indicates sample results below the laboratory limit of reporting (LOR)
 # indicates RPD not calculable, as primary and duplicate concentrations <LOR.
Bold *font indicates results above the LOR*
Red *font indicates RPD > 50% (for inorganics)*

Appendix 7

Soil CoCs, CoAs and QCIRs

CHAIN OF CUSTODY DOCUMENTATION

strategen ENVIRONMENTAL
Level 1,
50 Subiaco Square Road
Subiaco WA 6008
PO Box 243
Subiaco WA 6904
Ph: (08) 9380 3100

Client: City of Busselton
Site: CIB - Vasse River Causeway Rd
Project Manager: Heath Morgan
Project No.:
Report To:
Sampled By: Polly Hammad
Page: 1 of 1
Date requested:
Phone: 93803100
Quote No.:
Invoice To: accounts@strategen.com.au
COMMENTS

17-10372

LAB No.	SAMPLE ID.	DATE	SOIL/WATER (S/W)	NO. SAMPLE CONTAINERS	ANALYSIS: pH(F) + pH FOX								Hold
-1	CR-5 0-0.25	05/07/17	S	1	✓								
-2, -3	CR-5 dup 0.25-0.5 DUP	05/07/17											
-4	CR-5 0.5-0.75												
-5	CR-5 0.75-1												
-6	CR-5 1-1.5												
-7	1.5-2												
-8	2-2.5												
-9	2.5-3												
-10	3-3.5												
-11	3.5-4												
-12	4-4.5												
-13	4.5-5												
-14	5.0-5.25												
-15	5.25-5.5												
-16	5.5-5.75												
-17	5.75-6.0				✓								
~~-18~~	~~DUP~~												

Strategen Environmental

RELINQUISHED BY	Date:	Time:
Name:		
Signature:		

Laboratory

RECEIVED BY	Date:	Time:
Name: Maja G.	6/7/17	9:20 am
Signature:		

CHAIN OF CUSTODY DOCUMENTATION

2 4

strategen ENVIRONMENTAL

Level 1,
50 Subiaco Square Road
Subiaco WA 6008
PO Box 243
Subiaco WA 6904
Ph: (08) 9380 3100

Client:	**Project No.:**	**Page:** 1 of 1	
	Report To:	**Date requested:**	
Site:		**Phone:** 93803100	
Project Manager:	**Sampled By:**	**Quote No.:**	

Invoice To: accounts@strategen.com.au

LAB No.	SAMPLE ID.	DATE	SOIL/WATER (S/W)	NO. SAMPLE CONTAINERS	ANALYSIS: pH, pH Fox, Hold	COMMENTS
-18	CR-N 0-0.25	05/07/17	S	1	✓	
-19	0.25-0.5		S			
-20	0.5-0.75					
-21	0.75-1.					
-22	1-1.5					
-23	1.5-2.					
-24	2-2.5					
-25	Dup 2.25 - DUP2					
-26	2.5-3.0					
-27	3.0-3.5					
-28	3.5-4					
-29	4.0-4.5					
-30	4.5-5					
-31	5.25-5.5					
-32	5.5-5.75					
-33	5.75-6	D			✓	

Strategen Environmental			Laboratory		
RELINQUISHED BY	Date:	Time:	RECEIVED BY	Date:	Time:
Name:			Name: Maja G	6/7/17	9:20am
Signature:			Signature:		

CHAIN OF CUSTODY DOCUMENTATION

3 4

stategen ENVIRONMENTAL

Level 1,
50 Subiaco Square Road
Subiaco WA 6008
PO Box 243
Subiaco WA 6904
Ph: (08) 9380 3100

Client:	**Project No.:**	**Page:** 1 of 1	
	Report To:	**Date requested:**	
Site:		**Phone:** 93803100	
Project Manager:	**Sampled By:**	**Quote No.:**	

Invoice To: accounts@stategen.com.au

COMMENTS

LAB No.	SAMPLE ID.	DATE	SOIL/WATER (S/W)	NO. SAMPLE CONTAINERS	ANALYSIS: PAH phenols								Hold
-34	EL-N 0.-0.25	5/7/17	S	1	✓								
-35	0.25-0.5												
-36	0.5-0.75												
-37	0.75-1												
-38	1-1.5												
-39	1.5-2												
-40	2-2.5												
-41	2.5-3												
-42	3-3.5												
-43	3.5-4												
-44	4-4.5												
-45	4.5-5												
-47	EL-N 5.5-6												
-48	EL-S 0-0.5												
-49	0.5-1												
-50	1-1.5												
-51	1.5-2				✓								

Strategen Environmental			Laboratory		
RELINQUISHED BY	Date:	Time:	RECEIVED BY	Date:	Time:
Name:			Name		
Signature:			Signature:	6/7/17	9:20 am

CHAIN OF CUSTODY DOCUMENTATION

strategen ENVIRONMENTAL
Level 1,
50 Subiaco Square Road
Subiaco WA 6008
PO Box 243
Subiaco WA 6904
Ph: (08) 9380 3100

Client:		**Project No.:**	**Page:** 1 of 1
		Report To:	**Date requested:**
Site:			**Phone:** 93803100
Project Manager:		**Sampled By:**	**Quote No.:**

Invoice To: accounts@strategen.com.au

LAB No.	SAMPLE ID.	DATE	SOIL/WATER (S/W)	NO. SAMPLE CONTAINERS	ANALYSIS: pH for	ANALYSIS: Hold	COMMENTS
-52	EL-5 2-2.5	05/07/17	S	1			
-53	2.5-3						
-54	3-3.5						
-55	3.5-4						
-56	4-4.5						
-57	EL-5 (Dup 3) 4.5-5						
-58	EL-5 4.5-5						
~~-59~~	5-5.5						
No Sample	~~5.5-6~~						
	END						
-46	EL-N 5-5.5						

Strategen Environmental			Laboratory		
RELINQUISHED BY	Date:	Time:	RECEIVED BY	Date:	Time:
Name:			Name	6/7/17	9:20 am
Signature:			Signature:		

17-10372-B
Updated COC

Reference	Description	Sample Description	Sample Date	Sample No.	Replicate	QC Type	ample Dept	ample Matr	ample Note	pH_f 4	pH_{fox} 3	te of Reacti	phf-Phfox 1	SPOCAS	metals (As, Cd, Cr, Cu, Hg, Ni, Pb, Zn)
Units										pH units	pH units				
PQL										0.1	0.1				
Method										ARL No. 20	ARL No. 20	23A and 23B			
17-10372	CIB - Vasse River (Causeway	CR-S 0.0-0.25	5/07/17 0:00	A7P7	1	0	Regular		Soil/Solid	8.2	6	XX	2.2		
17-10372	CIB - Vasse River (Causeway	CR-S 0.25-0.5	5/07/17 0:00	A7P7	2	0	Regular		Soil/Solid	8.1	6.1	XXX	2		
17-10372	CIB - Vasse River (Causeway	CR-S 0.25-0.5 (DUP)	5/07/17 0:00	A7P7	3	0	Regular		Soil/Solid	8.1	5.8	XXX	2.3		
17-10372	CIB - Vasse River (Causeway	CR-S 0.5-0.75	5/07/17 0:00	A7P7	4	0	Regular		Soil/Solid	8.5	6.2	XXX	2.3		
17-10372	CIB - Vasse River (Causeway	CR-S 0.75-1	5/07/17 0:00	A7P7	5	0	Regular		Soil/Solid	8.5	6.2	XX	2.3		
17-10372	CIB - Vasse River (Causeway	CR-S 1-1.5	5/07/17 0:00	A7P7	6	0	Regular		Soil/Solid	7.7	5.8	X	1.9		
17-10372	CIB - Vasse River (Causeway	CR-S 1.5-2	5/07/17 0:00	A7P7	7	0	Regular		Soil/Solid	7.5	5.5	XX	2		
17-10372	CIB - Vasse River (Causeway	CR-S 2-2.5	5/07/17 0:00	A7P7	8	0	Regular		Soil/Solid	7.4	1.8	XXXX	5.6		
17-10372	CIB - Vasse River (Causeway	CR-S 2.5-3	5/07/17 0:00	A7P7	9	0	Regular		Soil/Solid	7.4	5.5	XX	1.9		
17-10372	CIB - Vasse River (Causeway	CR-S 3-3.5	5/07/17 0:00	A7P7	10	0	Regular		Soil/Solid	7.9	2.2	XX	5.7	x	
17-10372	CIB - Vasse River (Causeway	CR-S 3.5-4	5/07/17 0:00	A7P7	11	0	Regular		Soil/Solid	7.5	2.2	X	5.3		
17-10372	CIB - Vasse River (Causeway	CR-S 4-4.5	5/07/17 0:00	A7P7	12	0	Regular		Soil/Solid	8.2	2.2	XXXX	6		
17-10372	CIB - Vasse River (Causeway	CR-S 4.5-5	5/07/17 0:00	A7P7	13	0	Regular		Soil/Solid	7.9	1.9	XXXX	6		
17-10372	CIB - Vasse River (Causeway	CR-S 5.0-5.25	5/07/17 0:00	A7P7	14	0	Regular		Soil/Solid	7.9	1.9	XXXX	6		
17-10372	CIB - Vasse River (Causeway	CR-S 5.25-5.5	5/07/17 0:00	A7P7	15	0	Regular		Soil/Solid	7.9	2.1	XXXX	5.8		
17-10372	CIB - Vasse River (Causeway	CR-S 5.5-5.75	5/07/17 0:00	A7P7	16	0	Regular		Soil/Solid	8	1.5	X	6.5	x	x
17-10372	CIB - Vasse River (Causeway	CR-S 5.75-6.0	5/07/17 0:00	A7P7	17	0	Regular		Soil/Solid	7.8	1.5	X	6.3		
17-10372	CIB - Vasse River (Causeway	CR-N 0-0.25	5/07/17 0:00	A7P7	18	0	Regular		Soil/Solid	8.4	5.9	XXX	2.5		
17-10372	CIB - Vasse River (Causeway	CR-N 0.25-0.5	5/07/17 0:00	A7P7	19	0	Regular		Soil/Solid	8.3	6.4	XX	1.9		
17-10372	CIB - Vasse River (Causeway	CR-N 0.5-0.75	5/07/17 0:00	A7P7	20	0	Regular		Soil/Solid	8	6.2	XX	1.8		
17-10372	CIB - Vasse River (Causeway	CR-N 0.75-1	5/07/17 0:00	A7P7	21	0	Regular		Soil/Solid	7.6	6.2	XX	1.4		
17-10372	CIB - Vasse River (Causeway	CR-N 1-1.5	5/07/17 0:00	A7P7	22	0	Regular		Soil/Solid	7.6	6.3	XX	1.3		
17-10372	CIB - Vasse River (Causeway	CR-N 1.5-2	5/07/17 0:00	A7P7	23	0	Regular		Soil/Solid	7.4	6.1	XX	1.3		
17-10372	CIB - Vasse River (Causeway	CR-N 2-2.5	5/07/17 0:00	A7P7	24	0	Regular		Soil/Solid	7.8	1.6	XXXX	6.2	x	x
17-10372	CIB - Vasse River (Causeway	CR-N 2-2.5 (DUP)	5/07/17 0:00	A7P7	25	0	Regular		Soil/Solid	7.7	1.7	XXXX	6	x	x
17-10372	CIB - Vasse River (Causeway	CR-N 2.5-3	5/07/17 0:00	A7P7	26	0	Regular		Soil/Solid	8.8	1.4	XXXX	7.4	x	
17-10372	CIB - Vasse River (Causeway	CR-N 3.0-3.5	5/07/17 0:00	A7P7	27	0	Regular		Soil/Solid	7.8	1.4	XXXX	6.4		
17-10372	CIB - Vasse River (Causeway	CR-N 3.5-4	5/07/17 0:00	A7P7	28	0	Regular		Soil/Solid	7.9	1.7	XXXX	6.2		
17-10372	CIB - Vasse River (Causeway	CR-N 4-4.5	5/07/17 0:00	A7P7	29	0	Regular		Soil/Solid	8.1	1.2	XXXX	6.9		
17-10372	CIB - Vasse River (Causeway	CR-N 4.5-5	5/07/17 0:00	A7P7	30	0	Regular		Soil/Solid	8.2	1.7	XXXX	6.5		
17-10372	CIB - Vasse River (Causeway	CR-N 5.25-5.5	5/07/17 0:00	A7P7	31	0	Regular		Soil/Solid	8.7	3.1	X	5.6		
17-10372	CIB - Vasse River (Causeway	CR-N 5.5-5.75	5/07/17 0:00	A7P7	32	0	Regular		Soil/Solid	8.8	2	XXXX	6.8	x	
17-10372	CIB - Vasse River (Causeway	CR-N 5.75-6	5/07/17 0:00	A7P7	33	0	Regular		Soil/Solid	7.9	1.3	XXXX	6.6		
17-10372	CIB - Vasse River (Causeway	EL-N 0-0.25	5/07/17 0:00	A7P7	34	0	Regular		Soil/Solid	8.7	5.9	XX	2.8		
17-10372	CIB - Vasse River (Causeway	EL-N 0.25-0.5	5/07/17 0:00	A7P7	35	0	Regular		Soil/Solid	8.1	5.9	XX	2.2		
17-10372	CIB - Vasse River (Causeway	EL-N 0.5-0.75	5/07/17 0:00	A7P7	36	0	Regular		Soil/Solid	8	6.4	XX	1.6		
17-10372	CIB - Vasse River (Causeway	EL-N 0.75-1	5/07/17 0:00	A7P7	37	0	Regular		Soil/Solid	8.4	6.9	XX	1.5		
17-10372	CIB - Vasse River (Causeway	EL-N 1-1.5	5/07/17 0:00	A7P7	38	0	Regular		Soil/Solid	8.1	6.8	XX	1.3		
17-10372	CIB - Vasse River (Causeway	EL-N 1.5-2	5/07/17 0:00	A7P7	39	0	Regular		Soil/Solid	8.5	5.4	XX	3.1	x	
17-10372	CIB - Vasse River (Causeway	EL-N 2-2.5	5/07/17 0:00	A7P7	40	0	Regular		Soil/Solid	8.1	6.6	XX	1.5		
17-10372	CIB - Vasse River (Causeway	EL-N 2.5-3	5/07/17 0:00	A7P7	41	0	Regular		Soil/Solid	8.1	6.7	XX	1.4		
17-10372	CIB - Vasse River (Causeway	EL-N 3-3.5	5/07/17 0:00	A7P7	42	0	Regular		Soil/Solid	7.8	6.5	XX	1.3		
17-10372	CIB - Vasse River (Causeway	EL-N 3.5-4	5/07/17 0:00	A7P7	43	0	Regular		Soil/Solid	7.7	6.2	XX	1.5		
17-10372	CIB - Vasse River (Causeway	EL-N 4-4.5	5/07/17 0:00	A7P7	44	0	Regular		Soil/Solid	8.2	6	XX	2.2	x	
17-10372	CIB - Vasse River (Causeway	EL-N 4.5-5	5/07/17 0:00	A7P7	45	0	Regular		Soil/Solid	8.3	7.3	XXXX	1		
17-10372	CIB - Vasse River (Causeway	EL-N 5-5.5	5/07/17 0:00	A7P7	46	0	Regular		Soil/Solid	8.8	6.9	XX	1.9		x
17-10372	CIB - Vasse River (Causeway	EL-N 5.5-6	5/07/17 0:00	A7P7	47	0	Regular		Soil/Solid	8.5	7	XX	1.5		
17-10372	CIB - Vasse River (Causeway	EL-S 0-0.5	5/07/17 0:00	A7P7	48	0	Regular		Soil/Solid	7.5	5.8	XX	1.7		

17-10372 - B
Updated COC

17-10372	CIB - Vasse River (Causeway	EL-S 0.5-1	5/07/17 0:00	A7P7	49	0	Regular		Soil/Solid	
17-10372	CIB - Vasse River (Causeway	EL-S 1-1.5	5/07/17 0:00	A7P7	50	0	Regular		Soil/Solid	
17-10372	CIB - Vasse River (Causeway	EL-S 1.5-2	5/07/17 0:00	A7P7	51	0	Regular		Soil/Solid	
17-10372	CIB - Vasse River (Causeway	EL-S 2.2.5	5/07/17 0:00	A7P7	52	0	Regular		Soil/Solid	
17-10372	CIB - Vasse River (Causeway	EL-S 2.5-3	5/07/17 0:00	A7P7	53	0	Regular		Soil/Solid	
17-10372	CIB - Vasse River (Causeway	EL-S 3-3.5	5/07/17 0:00	A7P7	54	0	Regular		Soil/Solid	
17-10372	CIB - Vasse River (Causeway	EL-S 3.5-4	5/07/17 0:00	A7P7	55	0	Regular		Soil/Solid	
17-10372	CIB - Vasse River (Causeway	EL-S 4-4.5	5/07/17 0:00	A7P7	56	0	Regular		Soil/Solid	
17-10372	CIB - Vasse River (Causeway	EL-S 4.5-5 (DUP)	5/07/17 0:00	A7P7	57	0	Regular		Soil/Solid	
17-10372	CIB - Vasse River (Causeway	EL-S 4.5-5	5/07/17 0:00	A7P7	58	0	Regular		Soil/Solid	

17-10372	CIB - Vasse River (Causeway	EL-S 0.5-1	5/07/17 0:00	A7P7	49	0	Regular		Soil/Solid	7.5	5.9	XX	1.6	
17-10372	CIB - Vasse River (Causeway	EL-S 1-1.5	5/07/17 0:00	A7P7	50	0	Regular		Soil/Solid	7.8	6	XX	1.8	
17-10372	CIB - Vasse River (Causeway	EL-S 1.5-2	5/07/17 0:00	A7P7	51	0	Regular		Soil/Solid	7.5	6	XX	1.5	
17-10372	CIB - Vasse River (Causeway	EL-S 2.2.5	5/07/17 0:00	A7P7	52	0	Regular		Soil/Solid	7.9	5.9	XX	2	x
17-10372	CIB - Vasse River (Causeway	EL-S 2.5-3	5/07/17 0:00	A7P7	53	0	Regular		Soil/Solid	8.2	6.1	XX	2.1	x
17-10372	CIB - Vasse River (Causeway	EL-S 3-3.5	5/07/17 0:00	A7P7	54	0	Regular		Soil/Solid	7.8	6	XX	1.8	x
17-10372	CIB - Vasse River (Causeway	EL-S 3.5-4	5/07/17 0:00	A7P7	55	0	Regular		Soil/Solid	7.6	6	XX	1.6	
17-10372	CIB - Vasse River (Causeway	EL-S 4-4.5	5/07/17 0:00	A7P7	56	0	Regular		Soil/Solid	7.4	5.9	XX	1.5	
17-10372	CIB - Vasse River (Causeway	EL-S 4.5-5 (DUP)	5/07/17 0:00	A7P7	57	0	Regular		Soil/Solid	7.3	5.9	XX	1.4	
17-10372	CIB - Vasse River (Causeway	EL-S 4.5-5	5/07/17 0:00	A7P7	58	0	Regular		Soil/Solid	7.4	5.9	XX	1.5	

ARL Samples

From: Douglas Todd
Sent: Thursday, 17 August 2017 10:27 AM
To: ARL Samples
Subject: FW: Strategen ASS samples - further analysis request

Can we please book these ones in for CRS Suite?

Regards

Doug

Douglas Todd | Laboratory Manager
Phone. +61 8 6253 4444 | Fax: +61 8 6253 4440
Email. douglastodd@arlwa.com.au
Website. http://www.arlwa.com.au
Address. 46-48 Banksia Road, WELSHPOOL, WA, 6106

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http://www.arlwa.com.au http://promicro.com.au

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ARL
Analytical Reference Laboratory

From: Polly Hammond [mailto:p.hammond@strategen.com.au]
Sent: Thursday, 17 August 2017 10:22 AM
To: Kim Rodgers; Douglas Todd
Subject: Strategen ASS samples - further analysis request

Hi Kim & Doug,

Can we please get Scr (Chromium Reducible Sulfur method) tested for the following samples:

ARL 17-10372-B – Vasse River, Busselton:
CR-N 2.5-3 -26
EL-N 4-4.5 -44

ARL 17-10224 – Lot 2 kookaburra wy, Vasse
ASS1 5.75-6.0

Can you also let me know how long this might take? I am mid-writing the Kookaburra Way investigation report and these results will help with interpretation.

Thank you

Polly Hammond
Senior Consultant

strategen
ENVIRONMENTAL

Ph 9792 4797 Fax 9792 4708
Mobile 0466 962 375
Email P.Hammond@strategen.com.au
Web www.strategen.com.au
177 Spencer Street Bunbury WA 6230
PO Box 287 Bunbury WA 6231

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LABORATORY REPORT

Job Number: 17-10372
Revision: 00
Date: 10 July 2017

ADDRESS: **Strategen Environmental Consultants Pty Ltd**
Level 1, 50 Subiaco Square Road
Subiaco WA 6008

ATTENTION: Heath Morgan

DATE RECEIVED: 6/07/2017

YOUR REFERENCE: CIB - Vasse River (Causeway Rd)

PURCHASE ORDER:

APPROVALS:

Sam Becker
Inorganics Manager

REPORT COMMENTS:

This report is issued by Analytical Reference Laboratory (WA) Pty Ltd
Samples are analysed on an as received basis unless otherwise noted.
Rates of Reaction are determined by visual observation and are based on
Acid Sulphate Soils Laboratory Methods Guidelines: Section H - Table H1.1

RATES OF REACTION
Slight Reaction = X
Moderate Reaction = XX
Vigorous Reaction = XXX
Very Vigorous Reaction = XXXX

METHOD REFERENCES:

ARL No. 208	"Field" pH measurements
23A and 23B	QASSIT et al Method Code

LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd

ARL Job No: 17-10372 *Revision: 00* *Date:* 10 July 2017

RESULTS:

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-1 CR-S 0.0-0.25 5/07/17	17-10372-2 CR-S 0.25-0.5 5/07/17	17-10372-3 CR-S 0.25-0.5 (DUP) 5/07/17	17-10372-4 CR-S 0.5-0.75 5/07/17	17-10372-5 CR-S 0.75-1 5/07/17
pH_f	0.1	pH units	8.2	8.1	8.1	8.5	8.5
pH_{fox}	0.1	pH units	6.0	6.1	5.8	6.2	6.2
Rate of Reaction			XX	XXX	XXX	XXX	XX

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-6 CR-S 1-1.5 5/07/17	17-10372-7 CR-S 1.5-2 5/07/17	17-10372-8 CR-S 2-2.5 5/07/17	17-10372-9 CR-S 2.5-3 5/07/17	17-10372-10 CR-S 3-3.5 5/07/17
pH_f	0.1	pH units	7.7	7.5	7.4	7.4	7.9
pH_{fox}	0.1	pH units	5.8	5.5	1.8	5.5	2.2
Rate of Reaction			X	XX	XXXX	XX	XX

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-11 CR-S 3.5-4 5/07/17	17-10372-12 CR-S 4-4.5 5/07/17	17-10372-13 CR-S 4.5-5 5/07/17	17-10372-14 CR-S 5.0-5.25 5/07/17	17-10372-15 CR-S 5.25-5.5 5/07/17
pH_f	0.1	pH units	7.5	8.2	7.9	7.9	7.9
pH_{fox}	0.1	pH units	2.2	2.2	1.9	1.9	2.1
Rate of Reaction			X	XXXX	XXXX	XXXX	XXXX

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-16 CR-S 5.5-5.75 5/07/17	17-10372-17 CR-S 5.75-6.0 5/07/17	17-10372-18 CR-N 0-0.25 5/07/17	17-10372-19 CR-N 0.25-0.5 5/07/17	17-10372-20 CR-N 0.5-0.75 5/07/17
pH_f	0.1	pH units	8.0	7.8	8.4	8.3	8.0
pH_{fox}	0.1	pH units	1.5	1.5	5.9	6.4	6.2
Rate of Reaction			X	X	XXX	XX	XX

LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd

ARL Job No: 17-10372 Revision: 00 *Date:* 10 July 2017

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-21 CR-N 0.75-1 5/07/17	17-10372-22 CR-N 1-1.5 5/07/17	17-10372-23 CR-N 1.5-2 5/07/17	17-10372-24 CR-N 2-2.5 5/07/17	17-10372-25 CR-N 2-2.5 (DUP) 5/07/17
pH_f	0.1	pH units	7.6	7.6	7.4	7.8	7.7
pH_{fox}	0.1	pH units	6.2	6.3	6.1	1.6	1.7
Rate of Reaction			XX	XX	XX	XXXX	XXXX

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-26 CR-N 2.5-3 5/07/17	17-10372-27 CR-N 3.0-3.5 5/07/17	17-10372-28 CR-N 3.5-4 5/07/17	17-10372-29 CR-N 4-4.5 5/07/17	17-10372-30 CR-N 4.5-5 5/07/17
pH_f	0.1	pH units	8.8	7.8	7.9	8.1	8.2
pH_{fox}	0.1	pH units	1.4	1.4	1.7	1.2	1.7
Rate of Reaction			XXXX	XXXX	XXXX	XXXX	XXXX

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-31 CR-N 5.25-5.5 5/07/17	17-10372-32 CR-N 5.5-5.75 5/07/17	17-10372-33 CR-N 5.75-6 5/07/17	17-10372-34 EL-N 0-0.25 5/07/17	17-10372-35 EL-N 0.25-0.5 5/07/17
pH_f	0.1	pH units	8.7	8.8	7.9	8.7	8.1
pH_{fox}	0.1	pH units	3.1	2.0	1.3	5.9	5.9
Rate of Reaction			X	XXXX	XXXX	XX	XX

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-36 EL-N 0.5-0.75 5/07/17	17-10372-37 EL-N 0.75-1 5/07/17	17-10372-38 EL-N 1-1.5 5/07/17	17-10372-39 EL-N 1.5-2 5/07/17	17-10372-40 EL-N 2-2.5 5/07/17
pH_f	0.1	pH units	8.0	8.4	8.1	8.5	8.1
pH_{fox}	0.1	pH units	6.4	6.9	6.8	5.4	6.6
Rate of Reaction			XX	XX	XX	XX	XX

LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd

ARL Job No: 17-10372 *Revision: 00* *Date:* 10 July 2017

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-41 EL-N 2.5-3 5/07/17	17-10372-42 EL-N 3-3.5 5/07/17	17-10372-43 EL-N 3.5-4 5/07/17	17-10372-44 EL-N 4-4.5 5/07/17	17-10372-45 EL-N 4.5-5 5/07/17
pH_f	0.1	pH units	8.1	7.8	7.7	8.2	8.3
pH_{fox}	0.1	pH units	6.7	6.5	6.2	6.0	7.3
Rate of Reaction			XX	XX	XX	XX	XXXX

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-46 EL-N 5-5.5 5/07/17	17-10372-47 EL-N 5.5-6 5/07/17	17-10372-48 EL-S 0-0.5 5/07/17	17-10372-49 EL-S 0.5-1 5/07/17	17-10372-50 EL-S 1-1.5 5/07/17
pH_f	0.1	pH units	8.8	8.5	7.5	7.5	7.8
pH_{fox}	0.1	pH units	6.9	7.0	5.8	5.9	6.0
Rate of Reaction			XX	XX	XX	XX	XX

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-51 EL-S 1.5-2 5/07/17	17-10372-52 EL-S 2.2.5 5/07/17	17-10372-53 EL-S 2.5-3 5/07/17	17-10372-54 EL-S 3-3.5 5/07/17	17-10372-55 EL-S 3.5-4 5/07/17
pH_f	0.1	pH units	7.5	7.9	8.2	7.8	7.6
pH_{fox}	0.1	pH units	6.0	5.9	6.1	6.0	6.0
Rate of Reaction			XX	XX	XX	XX	XX

Acid Sulphate Soils Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-56 EL-S 4-4.5 5/07/17	17-10372-57 EL-S 4.5-5 (DUP) 5/07/17	17-10372-58 EL-S 4.5-5 5/07/17
pH_f	0.1	pH units	7.4	7.3	7.4
pH_{fox}	0.1	pH units	5.9	5.9	5.9
Rate of Reaction			XX	XX	XX

Result Definitions

LOR Limit of Reporting [NT] Not Tested [ND] Not Detected at indicated Limit of Reporting

* Denotes test not covered by NATA Accreditation

FOR MICROBIOLOGICAL TESTING - The data in this report may not be representative of a lot, batch or other samples and may not necessarily justify the acceptance or rejection of a lot or batch, a product recall or support legal proceedings. Tests are not routinely performed as duplicates unless specifically requested. Changes occur in the bacterial content of biological samples. Samples should be examined as soon as possible after collection, preferably within 6 hrs and must be stored at 4 degrees Celsius or below. Samples tested after 24 hrs cannot be regarded as satisfactory because of temperature abuse and variations.

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LABORATORY REPORT

Job Number: 17-10372-B
Revision: 00
Date: 11 August 2017

ADDRESS: **Strategen Environmental Consultants Pty Ltd**
Level 1, 50 Subiaco Square Road
Subiaco WA 6008

ATTENTION: Sarah Breheny

DATE RECEIVED: 6/07/2017

YOUR REFERENCE: CIB - Vasse River (Causeway Rd)

PURCHASE ORDER:

APPROVALS:

Fiona Reid
Inorganics Supervisor

Kim Rodgers
General Manager

REPORT COMMENTS:

This report is issued by Analytical Reference Laboratory (WA) Pty Ltd
Samples are analysed on an as received basis unless otherwise noted.
Metals in soils analysis was conducted on a dry weight basis.

METHOD REFERENCES:

Methods prefixed with "ARL" are covered under NATA Accreditation Number: 2377
Methods prefixed with "PM" are covered under NATA Accreditation Number: 2561

ARL No. 401/403	Metals in Soil and Sediment by ICPOES/MS
ARL No. 406	Mercury by Cold Vapour Atomic Absorption Spectrophotometry
23A and 23B	QASSIT et al Method Code
ARL No. 201	KCL Extractable pH and TAA
ARL No. 202	Peroxide Extractable pH, TPA and ANCe
ARL No. 204	Sulphur, Calcium and Magnesium by KCl Extraction
ARL No. 203	Sulphur, Calcium and Magnesium by Peroxide Extraction
ARL No. 205	Sulphur, Calcium and Magnesium by 4M HCl Extraction
ARL No. 210	Acid Sulphate Soils Method Codes and Further Calculations

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Accredited for compliance with ISO/IEC 17025 - Testing

LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd

ARL Job No: 17-10372-B Revision: 00 Date: 11 August 2017

8 Heavy Metals in Soil Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-B-16 CR-S 5.5-5.75	17-10372-B-24 CR-N 2-2.5	17-10372-B-25 CR-N 2-2.5 (DUP)	17-10372-B-46 EL-N 5-5.5
Arsenic	5	mg/kg	<5	<5	<5	10
Cadmium	0.1	mg/kg	0.6	0.8	0.6	<0.1
Chromium	1	mg/kg	4	5	4	51
Copper	1	mg/kg	<1	<1	<1	5
Mercury	0.02	mg/kg	<0.02	<0.02	<0.02	<0.02
Nickel	1	mg/kg	1	2	1	9
Lead	1	mg/kg	5	6	4	15
Zinc	1	mg/kg	13	6	3	140

8 Heavy Metals in Soil Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-B-54 EL-S 3-3.5
Arsenic	5	mg/kg	<5
Cadmium	0.1	mg/kg	0.4
Chromium	1	mg/kg	9
Copper	1	mg/kg	8
Mercury	0.02	mg/kg	<0.02
Nickel	1	mg/kg	2
Lead	1	mg/kg	3
Zinc	1	mg/kg	4

SPOCAS Suite Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-B-10 CR-S 3-3.5	17-10372-B-16 CR-S 5.5-5.75	17-10372-B-24 CR-N 2-2.5	17-10372-B-25 CR-N 2-2.5 (DUP)
Moisture	1	% w/w	20	22	24	24
pH_{KCl}	0.1	pH Units	9.0	7.4	7.9	8.8
pH_{ox}	0.1	pH Units	2.3	2.1	2.1	2.1
Titratable Actual Acidity	2	mol H^+/t	<2	<2	<2	<2
Titratable Peroxide Acidity	2	mol H^+/t	120	190	370	160
Titratable Sulphidic Acidity	2	mol H^+/t	120	190	370	160
Sulphidic - TAA	0.005	% Pyrite Sulphur	<0.005	<0.005	<0.005	<0.005
Sulphidic - TPA	0.005	% Pyrite Sulphur	0.19	0.31	0.59	0.26
Sulphidic - TSA	0.005	% Pyrite Sulphur	0.19	0.31	0.59	0.26
KCl Extractable Sulphur	0.005	% S	0.029	0.061	0.066	0.042
Peroxide Extractable Sulphur	0.005	% S	0.33	0.35	0.69	0.53
Peroxide Oxidisable Sulphur	0.005	% S	0.30	0.29	0.62	0.49
Acidic S_{pos}	4	mol H^+/t	190	180	390	300
Residual Acid Soluble Sulphur	0.005	% S	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED

LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd

ARL Job No: 17-10372-B Revision: 00 Date: 11 August 2017

SPOCAS Suite Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-B-10 CR-S 3-3.5	17-10372-B-16 CR-S 5.5-5.75	17-10372-B-24 CR-N 2-2.5	17-10372-B-25 CR-N 2-2.5 (DUP)
S_{cras} - Pyrite S	0.005	% Pyrite S	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED
S_{cras} - Acidic	4	mol H^+/t	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED
KCl Extractable Calcium	0.005	% Ca	0.089	0.030	0.15	0.15
Peroxide Extractable Calcium	0.005	% Ca	0.094	0.030	0.15	0.17
Acid Reacted Calcium	0.005	% Ca	0.005	<0.005	<0.005	0.020
Acidity - Ca	4	mol H^+/t	<4	<4	<4	10
Sulphidic - Ca	0.005	% Pyrite S	<0.005	<0.005	<0.005	0.016
KCl Extractable Magnesium	0.005	% Mg	0.019	0.046	0.043	0.026
Peroxide Extractable Magnesium	0.005	% Mg	0.035	0.048	0.059	0.034
Acid Reacted Magnesium	0.005	% Mg	0.016	<0.005	0.016	0.008
Acidity - Mg	4	mol H^+/t	13	<4	13	7
Sulphidic - Mg	0.005	% Pyrite S	0.021	<0.005	0.021	0.011
Excess Acid Neutral. Capacity	0.02	% $CaCO_3$	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED
Excess ANC - Acidity	4	mole H^+/t	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED
Excess ANC - Sulphidic	0.005	% Pyrite S	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED	NOTREQUIRED
ANC Fineness Factor	0.5	-	1.5	1.5	1.5	1.5
Net Acidity excluding ANC	0.005	% S	0.30	0.29	0.62	0.49
Net Acidity excluding ANC	5	mole H^+/t	190	180	390	300
Liming Rate excluding ANC	1	kg $CaCO_3$/t	26	25	54	42
Net Acidity	0.005	% S	0.29	0.29	0.61	0.47
Net Acidity	5	mole H^+/t	180	180	380	290
Liming Rate	1	kg $CaCO_3$/t	25	25	53	41

SPOCAS Suite Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-B-26 CR-N 2.5-3	17-10372-B-32 CR-N 5.5-5.75	17-10372-B-39 EL-N 1.5-2	17-10372-B-44 EL-N 4-4.5
Moisture	1	% w/w	23	34	17	16
pH_{KCl}	0.1	pH Units	8.0	7.9	9.7	9.0
pH_{ox}	0.1	pH Units	2.0	2.6	7.8	7.3
Titratable Actual Acidity	2	mol H^+/t	<2	<2	<2	<2
Titratable Peroxide Acidity	2	mol H^+/t	590	300	<2	<2
Titratable Sulphidic Acidity	2	mol H^+/t	590	300	<2	<2
Sulphidic - TAA	0.005	% Pyrite Sulphur	<0.005	<0.005	<0.005	<0.005
Sulphidic - TPA	0.005	% Pyrite Sulphur	0.95	0.48	<0.005	<0.005
Sulphidic - TSA	0.005	% Pyrite Sulphur	0.95	0.48	<0.005	<0.005
KCl Extractable Sulphur	0.005	% S	0.058	0.12	<0.005	0.049
Peroxide Extractable Sulphur	0.005	% S	1.0	0.74	0.044	1.3

LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd

ARL Job No: 17-10372-B Revision: 00 Date: 11 August 2017

SPOCAS Suite Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-B-26 CR-N 2.5-3	17-10372-B-32 CR-N 5.5-5.75	17-10372-B-39 EL-N 1.5-2	17-10372-B-44 EL-N 4-4.5
Peroxide Oxidisable Sulphur	0.005	% S	0.94	0.62	0.044	1.3
Acidic S_{pos}	4	mol H^+/t	590	390	27	780
Residual Acid Soluble Sulphur	0.005	% S	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED
S_{ras} - Pyrite S	0.005	% Pyrite S	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED
S_{ras} - Acidic	4	mol H^+/t	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED	NOT REQUIRED
KCl Extractable Calcium	0.005	% Ca	0.12	0.090	0.19	0.27
Peroxide Extractable Calcium	0.005	% Ca	0.12	0.12	2.3	0.91
Acid Reacted Calcium	0.005	% Ca	<0.005	0.030	2.1	0.64
Acidity - Ca	4	mol H^+/t	<4	15	1,100	320
Sulphidic - Ca	0.005	% Pyrite S	<0.005	0.024	1.7	0.51
KCl Extractable Magnesium	0.005	% Mg	0.041	0.23	0.016	0.032
Peroxide Extractable Magnesium	0.005	% Mg	0.051	0.28	0.23	0.086
Acid Reacted Magnesium	0.005	% Mg	0.010	0.050	0.21	0.054
Acidity - Mg	4	mol H^+/t	8	41	180	44
Sulphidic - Mg	0.005	% Pyrite S	0.013	0.066	0.28	0.071
Excess Acid Neutral. Capacity	0.02	% $CaCO_3$	NOT REQUIRED	NOT REQUIRED	13	1.2
Excess ANC - Acidity	4	mole H^+/t	NOT REQUIRED	NOT REQUIRED	2,600	240
Excess ANC - Sulphidic	0.005	% Pyrite S	NOT REQUIRED	NOT REQUIRED	4.2	0.38
ANC Fineness Factor	0.5	-	1.5	1.5	1.5	1.5
Net Acidity excluding ANC	0.005	% S	0.94	0.62	0.044	1.3
Net Acidity excluding ANC	5	mole H^+/t	590	390	27	780
Liming Rate excluding ANC	1	kg $CaCO_3$/t	82	54	4	110
Net Acidity	0.005	% S	0.93	0.56	<0.005	0.86
Net Acidity	5	mole H^+/t	580	350	<5	540
Liming Rate	1	kg $CaCO_3$/t	81	49	<1	75

SPOCAS Suite Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-B-52 EL-S 2.2.5	17-10372-B-53 EL-S 2.5-3
Moisture	1	% w/w	30	33
pH_{KCl}	0.1	pH Units	8.8	8.7
pH_{ox}	0.1	pH Units	7.7	7.8
Titratable Actual Acidity	2	mol H^+/t	<2	<2
Titratable Peroxide Acidity	2	mol H^+/t	<2	<2
Titratable Sulphidic Acidity	2	mol H^+/t	<2	<2
Sulphidic - TAA	0.005	% Pyrite Sulphur	<0.005	<0.005
Sulphidic - TPA	0.005	% Pyrite Sulphur	<0.005	<0.005
Sulphidic - TSA	0.005	% Pyrite Sulphur	<0.005	<0.005

LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd

ARL Job No: *17-10372-B* *Revision:* *00* *Date:* 11 August 2017

SPOCAS Suite Sample No: Sample Description: Sample Date:	LOR	UNITS	17-10372-B-52 EL-S 2.2.5	17-10372-B-53 EL-S 2.5-3
KCl Extractable Sulphur	0.005	% S	0.017	<0.005
Peroxide Extractable Sulphur	0.005	% S	0.27	0.23
Peroxide Oxidisable Sulphur	0.005	% S	0.25	0.23
Acidic S_{pos}	4	mol H^+/t	160	140
Residual Acid Soluble Sulphur	0.005	% S	NOT REQUIRED	NOT REQUIRED
S_{ras} - Pyrite S	0.005	% Pyrite S	NOT REQUIRED	NOT REQUIRED
S_{ras} - Acidic	4	mol H^+/t	NOT REQUIRED	NOT REQUIRED
KCl Extractable Calcium	0.005	% Ca	0.27	0.29
Peroxide Extractable Calcium	0.005	% Ca	0.35	0.41
Acid Reacted Calcium	0.005	% Ca	0.080	0.12
Acidity - Ca	4	mol H^+/t	40	60
Sulphidic - Ca	0.005	% Pyrite S	0.064	0.096
KCl Extractable Magnesium	0.005	% Mg	0.076	0.092
Peroxide Extractable Magnesium	0.005	% Mg	0.095	0.11
Acid Reacted Magnesium	0.005	% Mg	0.019	0.018
Acidity - Mg	4	mol H^+/t	16	15
Sulphidic - Mg	0.005	% Pyrite S	0.025	0.024
Excess Acid Neutral. Capacity	0.02	% $CaCO_3$	0.72	1.2
Excess ANC - Acidity	4	mole H^+/t	140	240
Excess ANC - Sulphidic	0.005	% Pyrite S	0.23	0.38
ANC Fineness Factor	0.5	-	1.5	1.5
Net Acidity excluding ANC	0.005	% S	0.25	0.23
Net Acidity excluding ANC	5	mole H^+/t	160	140
Liming Rate excluding ANC	1	kg $CaCO_3$/t	22	20
Net Acidity	0.005	% S	0.19	0.15
Net Acidity	5	mole H^+/t	120	94
Liming Rate	1	kg $CaCO_3$/t	17	13

Result Definitions

LOR Limit of Reporting [NT] Not Tested [ND] Not Detected at indicated Limit of Reporting

* Denotes test not covered by NATA Accreditation

FOR MICROBIOLOGICAL TESTING - The data in this report may not be representative of a lot, batch or other samples and may not necessarily justify the acceptance or rejection of a lot or batch, a product recall or support legal proceedings. Tests are not routinely performed as duplicates unless specifically requested. Changes occur in the bacterial content of biological samples. Samples should be examined as soon as possible after collection, preferably within 6 hrs and must be stored at 4 degrees Celsius or below. Samples tested after 24 hrs cannot be regarded as satisfactory because of temperature abuse and variations.

ARL
Analytical Reference Laboratory

ARL GROUP

ProMicro
Science with Ethics

LABORATORY REPORT

Job Number: 17-10372-C
Revision: 00
Date: 31 August 2017

ADDRESS: **Strategen Environmental Consultants Pty Ltd**
Level 1, 50 Subiaco Square Road
Subiaco WA 6008

ATTENTION: Polly Hammond

DATE RECEIVED: 6/07/2017

YOUR REFERENCE: CIB - Vasse River (Causeway Rd)

PURCHASE ORDER:

APPROVALS:

Kim Rodgers
General Manager

REPORT COMMENTS:

This report is issued by Analytical Reference Laboratory (WA) Pty Ltd
Samples are analysed on an as received basis unless otherwise noted.

METHOD REFERENCES:

Methods prefixed with "ARL" are covered under NATA Accreditation Number: 2377
Methods prefixed with "PM" are covered under NATA Accreditation Number: 2561

23A and 23B	QASSIT et al Method Code
ARL No. 201	KCL Extractable pH and TAA
ARL No. 204	Sulphur, Calcium and Magnesium by KCl Extraction
ARL No. 205	Sulphur, Calcium and Magnesium by 4M HCl Extraction
ARL No. 207	Chromium Reducible Sulphur
ARL No. 136	Lime Equivalence in Biosolids
ARL No. 210	Acid Sulphate Soils Method Codes and Further Calculations

NATA
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ACCREDITATION
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LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd

ARL Job No: *17-10372-C* *Revision:* *00* *Date:* 31 August 2017

Chromium Reducible Sulphur Sample No: Sample Description: Sample Date:	**LOR**	**UNITS**	**17-10372-C-26 CR-N 2.5-3**	**17-10372-C-44 EL-N 4-4.5**
Moisture	1	% w/w	23	16
pH_{KCl}	0.1	pH Units	8.0	9.0
Titratable Actual Acidity	2	mol H^+/t	<2	<2
Sulphidic - TAA	0.005	% Pyrite Sulphur	<0.005	<0.005
KCl Extractable Sulphur	0.005	% S	0.058	0.049
HCl Extractable Sulphur	0.005	% S	NOT REQUIRED	NOT REQUIRED
Net Acid Soluble Sulphur	0.005	% S	NOT REQUIRED	NOT REQUIRED
Net Acid Soluble Sulphur	4	mole H^+/t	NOT REQUIRED	NOT REQUIRED
Net Acid Soluble Sulphur	0.005	% Pyrite S	NOT REQUIRED	NOT REQUIRED
Chromium Reducible Sulphur	0.01	% S	0.46	0.95
Chromium Reducible Sulphur	8	mole H^+/t	290	590
Acid Neutralising Capacity BT	0.05	% $CaCO_3$	<0.05	8.4
Acid Neutralising Capacity BT	10	mole H^+/t	<10	1,700
Acid Neutralising Capacity BT	0.02	% Pyrite S	<0.02	2.7
ANC Fineness Factor	0.5	-	1.5	1.5
Net Acidity	0.01	% S	0.46	<0.01
Net Acidity	10	mole H^+/t	290	<10
Liming Rate	1	kg $CaCO_3$/t	40	<1
Net Acidity excluding ANC	0.01	% S	0.46	0.95
Net Acidity excluding ANC	10	mole H^+/t	290	590
Liming Rate excluding ANC	1	kg $CaCO_3$/t	40	82

Result Definitions

LOR Limit of Reporting [NT] Not Tested [ND] Not Detected at indicated Limit of Reporting

* Denotes test not covered by NATA Accreditation

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Quality Control Report

Job Number: 17-10372

Date: 10/07/17

Environmental and Analytical Laboratory

This Quality Control Report is issued in accordance with Section 18 of the ARL Quality Management Manual. All QC parameters are contained within the relevant ARL Method as indicated by the method reference, either on this report or the Laboratory Report.

Acceptance of Holding Times, Duplicate RPD, Spike, LCS and CRM Recoveries are determined at the time of analysis by the Signatory indicated on the Laboratory Report.

DEFINITIONS

Duplicate Analysis

A sample, chosen randomly by the analyst at the time of sample preparation, analysed in duplicate.

RPD

Relative Percent Difference is the absolute difference between the sample and a duplicate analysis compared to the average of the two analytical results. Acceptance Limits can be exceeded by matrix interference or when the result is less than 5 times the LOR.

Matrix Spike

An additional portion of sample to which known amounts of the target analytes are added before sample preparation. Acceptance Limits can be exceeded by matrix interference or when the target analytes are present in the sample.

Certified Reference Material (CRM)

A commercially available certified solution/mixture of the target analyte of known concentration.

Laboratory Control Sample (LCS)

An in-house certified solution/mixture of the target analyte of known concentration.

Analytical Reference Laboratory (WA) PTY. Ltd
46-48 Banksia Road, Welshpool, Western Australia 6106 Telephone: 08 6253 4444 Facsmile 08 6253 4440
www.arlwa.com.au ABN: 91 050 159 898

Quality Control Report

Job Number: 17-10372

Date: 10/07/17

Environmental and Analytical Laboratory

'Field' pH in Acid Sulphate Soils

Holding Time Criteria	Date	
Analysed	10/07/2017	
Duplicate Analysis (17-10372-1)	**RPD (%)**	**Limits (%)**
pH_f	0	25
pH_{fox}	0	25
Duplicate Analysis (17-10372-11)	**RPD (%)**	**Limits (%)**
pH_f	0	25
pH_{fox}	0	25
Duplicate Analysis (17-10372-21)	**RPD (%)**	**Limits (%)**
pH_f	0	25
pH_{fox}	0	25
Duplicate Analysis (17-10372-31)	**RPD (%)**	**Limits (%)**
pH_f	0	25
pH_{fox}	0	25
Duplicate Analysis (17-10372-41)	**RPD (%)**	**Limits (%)**
pH_f	0	25
pH_{fox}	0	25
Duplicate Analysis (17-10372-51)	**RPD (%)**	**Limits (%)**
pH_f	0	25
pH_{fox}	2	25
Blank Analysis	**Result (pH units)**	**Limit (pH units)**
pH_f	5.8	0.1
pH_{fox}	5.6	0.1
Blank Analysis	**Result (pH units)**	**Limit (pH units)**
pH_f	5.6	0.1
pH_{fox}	5.6	0.1
Blank Analysis	**Result (pH units)**	**Limit (pH units)**
pH_f	5.6	0.1
pH_{fox}	5.4	0.1
Certified Reference Material	**Recovery (%)**	**Limits (%)**
pH_f	100	95 - 105
pH_{fox}	100	95 - 105
pH_f	100	95 - 105
pH_{fox}	100	95 - 105
pH_f	100	95 - 105
pH_{fox}	100	95 - 105

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Quality Control Report

Job Number: 17-10372-B

Date: 11/08/2017

Environmental and Analytical Laboratory

This Quality Control Report is issued in accordance with Section 18 of the ARL Quality Management Manual. All QC parameters are contained within the relevant ARL Method as indicated by the method reference, either on this report or the Laboratory Report.

Acceptance of Holding Times, Duplicate RPD, Spike, LCS and CRM Recoveries are determined at the time of analysis by the Signatory indicated on the Laboratory Report.

DEFINITIONS

Duplicate Analysis

A sample, chosen randomly by the analyst at the time of sample preparation, analysed in duplicate.

RPD

Relative Percent Difference is the absolute difference between the sample and a duplicate analysis compared to the average of the two analytical results. Acceptance Limits can be exceeded by matrix interference or when the result is less than 5 times the LOR.

Matrix Spike

An additional portion of sample to which known amounts of the target analytes are added before sample preparation. Acceptance Limits can be exceeded by matrix interference or when the target analytes are present in the sample.

Certified Reference Material (CRM)

A commercially available certified solution/mixture of the target analyte of known concentration.

Laboratory Control Sample (LCS)

An in-house certified solution/mixture of the target analyte of known concentration.

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Quality Control Report

Job Number: 17-10372-B

Date: 11/08/2017

Environmental and Analytical Laboratory

Metals in Soil and Sediment

Holding Time Criteria	Date	
Extracted	18/07/2017	
Analysed	18/07/2017	
Duplicate Analysis (17-10686-B-2)	**RPD (%)**	**Limits (%)**
Arsenic	0	200
Cadmium	40	200
Chromium	0	200
Copper	67	200
Nickel	0	200
Lead	200	200
Zinc	200	200
Duplicate Analysis (17-10980-B-1)	**RPD (%)**	**Limits (%)**
Arsenic	0	200
Cadmium	40	200
Chromium	67	200
Nickel	0	200
Duplicate Analysis (17-10980-B-10)	**RPD (%)**	**Limits (%)**
Arsenic	0	200
Cadmium	0	200
Chromium	18	50
Copper	1	25
Nickel	67	200
Lead	0	25
Zinc	17	25
Duplicate Analysis (17-11018-B-3)	**RPD (%)**	**Limits (%)**
Arsenic	5	50
Cadmium	46	50
Copper	3	25
Nickel	0	50
Zinc	2	25
Duplicate Analysis (17-11018-B-51)	**RPD (%)**	**Limits (%)**
Arsenic	1	50
Cadmium	67	200
Copper	8	25
Nickel	8	50
Lead	7	25
Blank Analysis	**Result (mg/kg)**	**Limit (mg/kg)**
Arsenic	<5	5
Cadmium	<0.1	0.1
Chromium	<1	1
Copper	<1	1

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Quality Control Report

Job Number: 17-10372-B

Date: 11/08/2017

Environmental and Analytical Laboratory

Blank Analysis	Result (mg/kg)	Limit (mg/kg)
Nickel	<1	1
Lead	<1	1
Zinc	<1	1
Blank Analysis	**Result (mg/kg)**	**Limit (mg/kg)**
Arsenic	<5	5
Cadmium	<0.1	0.1
Chromium	<1	1
Copper	<1	1
Nickel	<1	1
Lead	<1	1
Zinc	<1	1
Blank Analysis	**Result (mg/kg)**	**Limit (mg/kg)**
Arsenic	<5	5
Cadmium	<0.1	0.1
Chromium	<1	1
Copper	<1	1
Nickel	<1	1
Lead	<1	1
Zinc	<1	1
Matrix Spike (17-10606-B-3)	**Recovery (%)**	**Limits (%)**
Arsenic	115	80 - 120
Cadmium	101	80 - 120
Chromium	120	80 - 120
Copper	111	80 - 120
Nickel	102	80 - 120
Lead	110	80 - 120
Zinc	105	80 - 120
Matrix Spike (17-10980-B-1)	**Recovery (%)**	**Limits (%)**
Cadmium	91	80 - 120
Chromium	108	80 - 120
Copper	104	80 - 120
Nickel	120	80 - 120
Zinc	120	80 - 120
Matrix Spike (17-11018-B-3)	**Recovery (%)**	**Limits (%)**
Arsenic	91	80 - 120
Cadmium	110	80 - 120
Chromium	103	80 - 120
Copper	91	80 - 120
Nickel	106	80 - 120
Lead	80	80 - 120
Zinc	112	80 - 120
Certified Reference Material	**Recovery (%)**	**Limits (%)**
Arsenic	97	80 - 120

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Quality Control Report

Job Number: 17-10372-B

Date: 11/08/2017

Environmental and Analytical Laboratory

Certified Reference Material	Recovery (%)	Limits (%)
Cadmium	99	80 - 120
Chromium	100	80 - 120
Copper	99	80 - 120
Nickel	99	80 - 120
Lead	98	80 - 120
Zinc	110	80 - 120
Arsenic	103	80 - 120
Cadmium	105	80 - 120
Chromium	109	80 - 120
Copper	104	80 - 120
Nickel	111	80 - 120
Lead	102	80 - 120
Zinc	107	80 - 120
Arsenic	97	80 - 120
Cadmium	90	80 - 120
Chromium	98	80 - 120
Copper	94	80 - 120
Nickel	97	80 - 120
Lead	97	80 - 120
Zinc	95	80 - 120
Duplicate Analysis (17-10606-B-3)	**RPD (%)**	**Limits (%)**
Mercury	16	50
Duplicate Analysis (17-10686-B-2)	**RPD (%)**	**Limits (%)**
Mercury	0	200
Duplicate Analysis (17-11018-B-3)	**RPD (%)**	**Limits (%)**
Mercury	12	200
Duplicate Analysis (17-11018-B-51)	**RPD (%)**	**Limits (%)**
Mercury	0	50
Blank Analysis	**Result (mg/kg)**	**Limit (mg/kg)**
Mercury	<0.02	0.02
Matrix Spike (17-10606-B-3)	**Recovery (%)**	**Limits (%)**
Mercury	113	80 - 120
Matrix Spike (17-11018-B-3)	**Recovery (%)**	**Limits (%)**
Mercury	87	80 - 120
Certified Reference Material	**Recovery (%)**	**Limits (%)**
Mercury	91	80 - 120
Mercury	90	80 - 120

Soil Parameters

Holding Time Criteria	Date
Analysed	14/07/2017

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Quality Control Report

Job Number: 17-10372-B

Date: 11/08/2017

Environmental and Analytical Laboratory

pH KCL and TAA in Soil

Holding Time Criteria	**Date**	
Extracted	19/07/2017	
Analysed	20/07/2017	
Blank Analysis	**Result (pH Units)**	**Limit (pH Units)**
pH_{KCl}	6.0	0.1
Titratable Actual Acidity	<2	2
Laboratory Control Sample	**Recovery (%)**	**Limits (%)**
pH_{KCl}	99	80 - 120
Titratable Actual Acidity	97	80 - 120
Duplicate Analysis (17-10528-B-5)	**RPD (%)**	**Limits (%)**
pH_{ox}	1	25
Titratable Peroxide Acidity	0	25
Duplicate Analysis (17-11282-1)	**RPD (%)**	**Limits (%)**
pH_{ox}	1	25
Titratable Peroxide Acidity	0	25
Blank Analysis	**Result (pH Units)**	**Limit (pH Units)**
pH_{ox}	6.5	0.1
Titratable Peroxide Acidity	<2	2
Laboratory Control Sample	**Recovery (%)**	**Limits (%)**
pH_{ox}	92	80 - 120
Titratable Peroxide Acidity	102	80 - 120
Duplicate Analysis (17-10260-B-1)	**RPD (%)**	**Limits (%)**
KCl Extractable Sulphur	0	25
Duplicate Analysis (17-10260-B-6)	**RPD (%)**	**Limits (%)**
KCl Extractable Sulphur	0	25
Blank Analysis	**Result (% S)**	**Limit (% S)**
KCl Extractable Sulphur	<0.005	0.005
Peroxide Extractable Sulphur	<0.005	0.005
Laboratory Control Sample	**Recovery (%)**	**Limits (%)**
KCl Extractable Sulphur	101	80 - 120
Peroxide Extractable Sulphur	95	80 - 120
Duplicate Analysis (17-10260-B-1)	**RPD (%)**	**Limits (%)**
KCl Extractable Calcium	8	25
KCl Extractable Magnesium	50	25
Duplicate Analysis (17-10260-B-6)	**RPD (%)**	**Limits (%)**
KCl Extractable Calcium	0	25
KCl Extractable Magnesium	21	25
Blank Analysis	**Result (% Ca)**	**Limit (% Ca)**
KCl Extractable Calcium	<0.005	0.005
Peroxide Extractable Calcium	<0.005	0.005
KCl Extractable Magnesium	<0.005	0.005
Peroxide Extractable Magnesium	<0.005	0.005
Laboratory Control Sample	**Recovery (%)**	**Limits (%)**
KCl Extractable Calcium	85	80 - 120

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Quality Control Report

Job Number: 17-10372-B

Date: 11/08/2017

Environmental and Analytical Laboratory

Laboratory Control Sample	Recovery (%)	Limits (%)
Peroxide Extractable Calcium	83	80 - 120
KCl Extractable Magnesium	101	80 - 120
Peroxide Extractable Magnesium	108	80 - 120

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Quality Control Report

Job Number: 17-10372-C
Date: 31/08/2017

ARL
Environmental and Analytical Laboratory

This Quality Control Report is issued in accordance with Section 18 of the ARL Quality Management Manual. All QC parameters are contained within the relevant ARL Method as indicated by the method reference, either on this report or the Laboratory Report.

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DEFINITIONS

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Laboratory Control Sample (LCS)
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Analytical Reference Laboratory (WA) PTY. Ltd
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www.arlwa.com.au ABN: 91 050 159 898

Quality Control Report

Job Number: 17-10372-C

Date: 31/08/2017

Environmental and Analytical Laboratory

Chromium Reducible Sulphur in Soil

Holding Time Criteria	Date	
Analysed	25/08/2017	
Duplicate Analysis (17-10260-C-33)	**RPD (%)**	**Limits (%)**
Chromium Reducible Sulphur	10	25
Blank Analysis	**Result (% S)**	**Limit (% S)**
Chromium Reducible Sulphur	<0.01	0.01
Laboratory Control Sample	**Recovery (%)**	**Limits (%)**
Chromium Reducible Sulphur	104	80 - 120

Analytical Reference Laboratory (WA) PTY. Ltd
46-48 Banksia Road, Welshpool, Western Australia 6106 Telephone: 08 6253 4444 Facsmile 08 6253 4440
www.arlwa.com.au ABN: 91 050 159 898

Appendix 8

Groundwater CoCs, CoAs and QCIRs

CHAIN OF CUSTODY DOCUMENTATION

stategen ENVIRONMENTAL

Level 1,
50 Subiaco Square Road
Subiaco WA 6008
PO Box 243
Subiaco WA 6904
Ph: (08) 9380 3100

Client: city of Busselton
Site: Strategic Network
Project Manager: Heath Morgan
Project No.:
Report To:
Sampled By: Polly Hammond

Page: 1 of 1
Date requested:
Phone: 93803100
Quote No.:

Invoice To: accounts@strategen.com.au
COMMENTS
email to:
p.hammond@strategen.com.au
phone: 0466962375

17-11290

LAB No.	SAMPLE ID.	DATE	SOIL/WATER (S/W)	NO. SAMPLE CONTAINERS	ANALYSIS: Nutrients (TN, Nox, NH3, TP, FRP)	Major Ions (Sulfate+chloride)	Total acidity, pH + alkalinity	EC + TDS	Metals (Filtered): Al, As, Cr, Fe, Mn, Ni, Zn, Se (dissolved)			Hold
1	EL-N	19/07/17	W		✓	✓	✓	✓	✓			
2	CR-N	↓	↓		✓	✓	✓	✓	✓			
	~~[illegible]~~											
	~~M SC~~											
3	QC (SN)-1				✓	✓	✓	✓	✓			
4	QC[illegible](SN)-2	↓	↓		✓	✓	✓	✓	✓			

Strategen Environmental

RELINQUISHED BY
Name:
Signature:
Date:
Time:

Laboratory

RECEIVED BY
Name: Ryan Scott
Signature:
Date: 20/07/17
Time: 16:00

ARL
Analytical Reference Laboratory

ARL GROUP

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Science with Ethics

LABORATORY REPORT

Job Number: 17-11290
Revision: 00
Date: 31 July 2017

ADDRESS: **Strategen Environmental Consultants Pty Ltd**
Level 1, 50 Subiaco Square Road
Subiaco WA 6008

ATTENTION: Sarah Breheny

DATE RECEIVED: 20/07/2017

YOUR REFERENCE: City of Busselton

PURCHASE ORDER:

APPROVALS:

Fiona Reid
Inorganics Supervisor

Sam Becker
Inorganics Manager

REPORT COMMENTS:

This report is issued by Analytical Reference Laboratory (WA) Pty Ltd
Samples are analysed on an as received basis unless otherwise noted.

METHOD REFERENCES:

Methods prefixed with "ARL" are covered under NATA Accreditation Number: 2377
Methods prefixed with "PM" are covered under NATA Accreditation Number: 2561

ARL No. 29/402/403	Metals in Water by AAS/ICPOES/ICPMS
ARL No. 040	Arsenic by Hydride Atomic Absorption
ARL No. 330	Persulphate Method for Simultaneous Determination of TN & TP
ARL No. 308	Total Phosphorus in Water by Discrete Analyser
ARL No. 305	Chloride in Water by Discrete Analyser
ARL No. 301	Sulphate in Water by Discrete Analyser
ARL No. 309	Filterable Reactive Phosphorus in Water by Discrete Analyser
ARL No. 313/319	NOx in Water by Discrete Analyser
ARL No. 311	Nitrite in Water by Discrete Analyser
ARL No. 021	Acidity in Water
ARL No. 037	Alkalinity in Water
ARL No. 014	pH in Water
ARL No. 019	Conductivity and Salinity in Water
ARL No. 017	Total Dissolved Solids (At 105^{o}C)

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ACCREDITATION
Accredited for compliance with ISO/IEC 17025 - Testing

LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd

ARL Job No: *17-11290* *Revision:* *00* *Date:* 31 July 2017

Metals in Water **Sample No:** **Sample Description:** **Sample Date:**	**LOR**	**UNITS**	**17-11290-1** **EL-N** **19/07/2017**	**17-11290-2** **CR-N** **19/07/2017**
Aluminium - Dissolved	0.01	mg/L	<0.01	<0.01
Arsenic - Dissolved	0.001	mg/L	<0.001	<0.001
Chromium - Dissolved	0.001	mg/L	<0.001	<0.001
Iron - Dissolved	0.01	mg/L	0.13	0.31
Manganese - Dissolved	0.01	mg/L	0.01	0.03
Nickel - Dissolved	0.001	mg/L	0.002	0.002
Selenium - Dissolved	0.001	mg/L	<0.001	<0.001
Zinc - Dissolved	0.001	mg/L	<0.001	<0.001

Total Nitrogen in Water **Sample No:** **Sample Description:** **Sample Date:**	**LOR**	**UNITS**	**17-11290-1** **EL-N** **19/07/2017**	**17-11290-2** **CR-N** **19/07/2017**
Total Nitrogen	0.2	mg/L	1.6	4.5

Total Phosphorus in Water **Sample No:** **Sample Description:** **Sample Date:**	**LOR**	**UNITS**	**17-11290-1** **EL-N** **19/07/2017**	**17-11290-2** **CR-N** **19/07/2017**
Total Phosphorus	0.01	mg/L	0.20	0.69

Ions by Discrete Analyser **Sample No:** **Sample Description:** **Sample Date:**	**LOR**	**UNITS**	**17-11290-1** **EL-N** **19/07/2017**	**17-11290-2** **CR-N** **19/07/2017**	**17-11290-3** **QC(SN)-1** **19/07/2017**
Chloride	5	mg/L	100	200	240
Sulphate	1	mg/L	11	11	12
Filterable Reactive Phosphorus	0.01	mg/L	0.03	0.06	[NA]
NOx-N	0.01	mg/L	0.15	0.11	[NA]
Nitrite-N	0.01	mg/L	0.03	0.04	[NA]

Physical Parameters **Sample No:** **Sample Description:** **Sample Date:**	**LOR**	**UNITS**	**17-11290-1** **EL-N** **19/07/2017**	**17-11290-2** **CR-N** **19/07/2017**	**17-11290-3** **QC(SN)-1** **19/07/2017**	**17-11290-4** **QC(SN)-2** **19/07/2017**
Acidity	5	mg $CaCO_3$/L	12	34	47	<5
Alkalinity	5	mg $CaCO_3$/L	340	590	500	<5
pH	0.1	pH units	7.9	7.6	7.4	6.0
Conductivity	0.01	mS/cm	0.90	1.5	1.6	<0.01
Total Dissolved Solids	5	mg/L	460	710	790	<5

LABORATORY REPORT

Strategen Environmental Consultants Pty Ltd
ARL Job No: 17-11290 *Revision: 00* *Date:* 31 July 2017

Result Definitions

LOR Limit of Reporting [NT] Not Tested [ND] Not Detected at indicated Limit of Reporting
* Denotes test not covered by NATA Accreditation

FOR MICROBIOLOGICAL TESTING - The data in this report may not be representative of a lot, batch or other samples and may not necessarily justify the acceptance or rejection of a lot or batch, a product recall or support legal proceedings. Tests are not routinely performed as duplicates unless specifically requested. Changes occur in the bacterial content of biological samples. Samples should be examined as soon as possible after collection, preferably within 6 hrs and must be stored at 4 degrees Celsius or below. Samples tested after 24 hrs cannot be regarded as satisfactory because of temperature abuse and variations.

Quality Control Report

Job Number: 17-11290
Date: 31/07/2017

Environmental and Analytical Laboratory

This Quality Control Report is issued in accordance with Section 18 of the ARL Quality Management Manual. All QC parameters are contained within the relevant ARL Method as indicated by the method reference, either on this report or the Laboratory Report.

Acceptance of Holding Times, Duplicate RPD, Spike, LCS and CRM Recoveries are determined at the time of analysis by the Signatory indicated on the Laboratory Report.

DEFINITIONS

Duplicate Analysis
A sample, chosen randomly by the analyst at the time of sample preparation, analysed in duplicate.

RPD
Relative Percent Difference is the absolute difference between the sample and a duplicate analysis compared to the average of the two analytical results. Acceptance Limits can be exceeded by matrix interference or when the result is less than 5 times the LOR.

Matrix Spike
An additional portion of sample to which known amounts of the target analytes are added before sample preparation. Acceptance Limits can be exceeded by matrix interference or when the target analytes are present in the sample.

Certified Reference Material (CRM)
A commercially available certified solution/mixture of the target analyte of known concentration.

Laboratory Control Sample (LCS)
An in-house certified solution/mixture of the target analyte of known concentration.

Analytical Reference Laboratory (WA) PTY. Ltd
46-48 Banksia Road, Welshpool, Western Australia 6106 Telephone: 08 6253 4444 Facsmile 08 6253 4440
www.arlwa.com.au ABN: 91 050 159 898

Quality Control Report

Job Number: 17-11290

Date: 31/07/2017

Environmental and Analytical Laboratory

Dissolved Metals in Water

Holding Time Criteria	Date	
Analysed	21/07/2017	
Duplicate Analysis (17-10961-B-4)	**RPD (%)**	**Limits (%)**
Arsenic - Dissolved	0	200
Duplicate Analysis (17-11147-1)	**RPD (%)**	**Limits (%)**
Arsenic - Dissolved	0	200
Iron - Dissolved	200	200
Duplicate Analysis (17-11177-6)	**RPD (%)**	**Limits (%)**
Arsenic - Dissolved	0	200
Iron - Dissolved	0	50
Manganese - Dissolved	0	200
Duplicate Analysis (17-11250-7)	**RPD (%)**	**Limits (%)**
Iron - Dissolved	0	25
Manganese - Dissolved	0	25
Duplicate Analysis (17-11265-2)	**RPD (%)**	**Limits (%)**
Arsenic - Dissolved	0	200
Manganese - Dissolved	0	200
Selenium - Dissolved	0	200
Duplicate Analysis (17-11281-7)	**RPD (%)**	**Limits (%)**
Arsenic - Dissolved	40	200
Iron - Dissolved	7	25
Manganese - Dissolved	0	50
Selenium - Dissolved	0	200
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Arsenic - Dissolved	<0.001	0.001
Iron - Dissolved	<0.01	0.01
Manganese - Dissolved	<0.01	0.01
Selenium - Dissolved	<0.001	0.001
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Arsenic - Dissolved	<0.001	0.001
Iron - Dissolved	<0.01	0.01
Manganese - Dissolved	<0.01	0.01
Matrix Spike (17-10961-B-4)	**Recovery (%)**	**Limits (%)**
Arsenic - Dissolved	115	80 - 120
Matrix Spike (17-11147-1)	**Recovery (%)**	**Limits (%)**
Iron - Dissolved	98	80 - 120
Matrix Spike (17-11177-6)	**Recovery (%)**	**Limits (%)**
Iron - Dissolved	94	80 - 120
Manganese - Dissolved	100	80 - 120
Matrix Spike (17-11250-7)	**Recovery (%)**	**Limits (%)**
Iron - Dissolved	96	80 - 120
Manganese - Dissolved	100	80 - 120
Matrix Spike (17-11265-2)	**Recovery (%)**	**Limits (%)**
Manganese - Dissolved	100	80 - 120
Selenium - Dissolved	108	80 - 120

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Matrix Spike (17-11281-7)	Recovery (%)	Limits (%)
Iron - Dissolved	96	80 - 120
Manganese - Dissolved	100	80 - 120
Selenium - Dissolved	120	80 - 120
Certified Reference Material	**Recovery (%)**	**Limits (%)**
Arsenic - Dissolved	94	80 - 120
Iron - Dissolved	102	80 - 120
Manganese - Dissolved	103	80 - 120
Selenium - Dissolved	112	80 - 120
Iron - Dissolved	100	80 - 120
Manganese - Dissolved	99	80 - 120
Duplicate Analysis (17-11281-7)	**RPD (%)**	**Limits (%)**
Aluminium - Dissolved	1	25
Chromium - Dissolved	0	200
Nickel - Dissolved	0	200
Zinc - Dissolved	7	200
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Aluminium - Dissolved	<0.01	0.01
Chromium - Dissolved	<0.001	0.001
Nickel - Dissolved	<0.001	0.001
Zinc - Dissolved	<0.005	0.005
Matrix Spike (17-11281-7)	**Recovery (%)**	**Limits (%)**
Aluminium - Dissolved	112	80 - 120
Chromium - Dissolved	96	80 - 120
Nickel - Dissolved	97	80 - 120
Zinc - Dissolved	120	80 - 120
Certified Reference Material	**Recovery (%)**	**Limits (%)**
Aluminium - Dissolved	110	80 - 120
Chromium - Dissolved	101	80 - 120
Nickel - Dissolved	104	80 - 120
Zinc - Dissolved	107	80 - 120

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Quality Control Report

Job Number: 17-11290

Date: 31/07/2017

Environmental and Analytical Laboratory

Total Nitrogen in Water

Holding Time Criteria	Date	
Extracted	24/07/2017	
Analysed	25/07/2017	
Duplicate Analysis (17-11257-1)	**RPD (%)**	**Limits (%)**
Total Nitrogen	8	50
Duplicate Analysis (17-11259-5)	**RPD (%)**	**Limits (%)**
Total Nitrogen	10	50
Duplicate Analysis (17-11289-1)	**RPD (%)**	**Limits (%)**
Total Nitrogen	0	200
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Total Nitrogen	<0.2	0.2
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Total Nitrogen	<0.2	0.2
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Total Nitrogen	<0.2	0.2
Matrix Spike (17-11257-1)	**Recovery (%)**	**Limits (%)**
Total Nitrogen	98	80 - 120
Matrix Spike (17-11259-5)	**Recovery (%)**	**Limits (%)**
Total Nitrogen	105	80 - 120
Matrix Spike (17-11289-1)	**Recovery (%)**	**Limits (%)**
Total Nitrogen	100	80 - 120
Certified Reference Material	**Recovery (%)**	**Limits (%)**
Total Nitrogen	97	80 - 120
Total Nitrogen	95	80 - 120
Total Nitrogen	101	80 - 120

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Quality Control Report

Job Number: 17-11290

Date: 31/07/2017

Environmental and Analytical Laboratory

Total Phosphorus in Water

Holding Time Criteria	**Date**	
Extracted	24/07/2017	
Analysed	25/07/2017	
Duplicate Analysis (17-11257-1)	**RPD (%)**	**Limits (%)**
Total Phosphorus	17	25
Duplicate Analysis (17-11259-5)	**RPD (%)**	**Limits (%)**
Total Phosphorus	25	50
Duplicate Analysis (17-11289-1)	**RPD (%)**	**Limits (%)**
Total Phosphorus	0	200
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Total Phosphorus	<0.01	0.01
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Total Phosphorus	<0.01	0.01
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Total Phosphorus	<0.01	0.01
Matrix Spike (17-11259-5)	**Recovery (%)**	**Limits (%)**
Total Phosphorus	102	80 - 120
Certified Reference Material	**Recovery (%)**	**Limits (%)**
Total Phosphorus	98	80 - 120
Total Phosphorus	104	80 - 120
Total Phosphorus	92	80 - 120

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Quality Control Report

Job Number: 17-11290

Date: 31/07/2017

Environmental and Analytical Laboratory

FRP in Water

Holding Time Criteria	Date	
Analysed	21/07/2017	
Duplicate Analysis (17-11259-5)	**RPD (%)**	**Limits (%)**
Filterable Reactive Phosphorus	0	200
Duplicate Analysis (17-11290-1)	**RPD (%)**	**Limits (%)**
Filterable Reactive Phosphorus	40	200
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Filterable Reactive Phosphorus	<0.01	0.01
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Filterable Reactive Phosphorus	<0.01	0.01
Matrix Spike (17-11259-5)	**Recovery (%)**	**Limits (%)**
Filterable Reactive Phosphorus	106	80 - 120
Matrix Spike (17-11290-1)	**Recovery (%)**	**Limits (%)**
Filterable Reactive Phosphorus	108	80 - 120
Certified Reference Material	**Recovery (%)**	**Limits (%)**
Filterable Reactive Phosphorus	106	80 - 120
Filterable Reactive Phosphorus	107	80 - 120
Duplicate Analysis (17-11252-1)	**RPD (%)**	**Limits (%)**
Chloride	0	200
Sulphate	0	200
Nitrite-N	0	200
Duplicate Analysis (17-11257-2)	**RPD (%)**	**Limits (%)**
NOx-N	0	200
Duplicate Analysis (17-11291-1)	**RPD (%)**	**Limits (%)**
Chloride	29	50
Sulphate	20	25
Duplicate Analysis (17-11375-5)	**RPD (%)**	**Limits (%)**
Chloride	1	50
Sulphate	15	50
Duplicate Analysis (17-11375-6)	**RPD (%)**	**Limits (%)**
NOx-N	0	200
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Chloride	<5	5
Sulphate	<1	1
NOx-N	<0.01	0.01
Nitrite-N	<0.01	0.01
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Chloride	<5	5
Sulphate	<1	1
NOx-N	<0.01	0.01
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Chloride	<5	5
Sulphate	<1	1
Matrix Spike (17-11252-1)	**Recovery (%)**	**Limits (%)**
Chloride	106	80 - 120

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Environmental and Analytical Laboratory

Matrix Spike (17-11252-1)	Recovery (%)	Limits (%)
Sulphate	106	80 - 120
Nitrite-N	99	80 - 120
Matrix Spike (17-11257-2)	**Recovery (%)**	**Limits (%)**
NOx-N	97	80 - 120
Matrix Spike (17-11291-1)	**Recovery (%)**	**Limits (%)**
Chloride	109	80 - 120
Sulphate	110	80 - 120
Matrix Spike (17-11375-5)	**Recovery (%)**	**Limits (%)**
Chloride	116	80 - 120
Sulphate	112	80 - 120
Matrix Spike (17-11375-6)	**Recovery (%)**	**Limits (%)**
NOx-N	89	80 - 120
Certified Reference Material	**Recovery (%)**	**Limits (%)**
Nitrite-N	93	80 - 120
NOx-N	106	80 - 120
Chloride	99	80 - 120
Sulphate	111	80 - 120
NOx-N	106	80 - 120
Chloride	113	80 - 120
Sulphate	115	80 - 120
Chloride	117	80 - 120
Sulphate	119	80 - 120

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Quality Control Report

Job Number: 17-11290

Date: 31/07/2017

Environmental and Analytical Laboratory

Alkalinity and Acidity in Water

Holding Time Criteria	Date	
Analysed	21/07/2017	
Duplicate Analysis (17-11265-2)	**RPD (%)**	**Limits (%)**
Alkalinity	0	25
Duplicate Analysis (17-11281-7)	**RPD (%)**	**Limits (%)**
Acidity	0	50
Alkalinity	7	25
Blank Analysis	**Result (mg $CaCO_3$/L)**	**Limit (mg $CaCO_3$/L)**
Acidity	<5	5
Alkalinity	<5	5
Blank Analysis	**Result (mg $CaCO_3$/L)**	**Limit (mg $CaCO_3$/L)**
Alkalinity	<5	5
Certified Reference Material	**Recovery (%)**	**Limits (%)**
Alkalinity	101	80 - 120
Acidity	107	80 - 120
Alkalinity	112	80 - 120
Duplicate Analysis (17-11252-1)	**RPD (%)**	**Limits (%)**
pH	2	25
Conductivity	0	50
Duplicate Analysis (17-11259-12)	**RPD (%)**	**Limits (%)**
pH	0	25
Duplicate Analysis (17-11281-7)	**RPD (%)**	**Limits (%)**
pH	0	25
Conductivity	0	25
Blank Analysis	**Result (pH units)**	**Limit (pH units)**
pH	5.1	0.1
Conductivity	<0.01	0.01
Blank Analysis	**Result (pH units)**	**Limit (pH units)**
pH	5.2	0.1
Conductivity	<0.01	0.01
Blank Analysis	**Result (pH units)**	**Limit (pH units)**
pH	5.0	0.1
Certified Reference Material	**Recovery (%)**	**Limits (%)**
pH	100	95 - 105
Conductivity	102	95 - 105
pH	100	95 - 105
Conductivity	98	95 - 105
pH	100	95 - 105
Duplicate Analysis (17-11281-1)	**RPD (%)**	**Limits (%)**
Total Dissolved Solids	8	25
Duplicate Analysis (17-11283-1)	**RPD (%)**	**Limits (%)**
Total Dissolved Solids	7	25

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Blank Analysis	Result (mg/L)	Limit (mg/L)
Total Dissolved Solids	<5	5
Blank Analysis	**Result (mg/L)**	**Limit (mg/L)**
Total Dissolved Solids	<5	5
Laboratory Control Sample	**Recovery (%)**	**Limits (%)**
Total Dissolved Solids	95	80 - 120
Laboratory Control Sample	**Recovery (%)**	**Limits (%)**
Total Dissolved Solids	100	80 - 120

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SAMPLE RECEIPT NOTICE

Analytical Reference Laboratory

Job Number: 17-10372-B

Expected Due Date: 19/07/17

Customer Information

Attention:	Sarah Breheny
Customer:	Strategen Environmental Consultants Pty Ltd
Address:	Level 1, 50 Subiaco Square Road Subiaco WA 6008
Phone Number:	(08) 9380 3100
Fax Number:	(08) 9380 4606
Report to:	Sarah Breheny
Report email:	info@strategen.com.au

Job Information

Project Reference:	CIB - Vasse River (Causeway Rd)
Purchase Order:	
ARL Quote Number:	

Receival Information

Date Received:	6/07/2017	**Delivery Mode:**	Courier
Condition of Samples:	Chilled	**Relinquished by:**	Heath Morgan/Polly Hammond
Security Seal:	Not Present		

Contact Details

Registered by: Maja Golias

Any queries relating to sample condition (ie breakages/missing samples), registered analyses or sample labeling please email: samples@arlwa.com.au

ARL Contact: Douglas Todd

Any queries relating to analytical capability, status or explanation of results, please email: douglastodd@arlwa.com.au

Registration Comments

Disposal of samples will occur after the following time from date of issue of Final Report:

Aqueous Sample - 3 Months *Solid Samples - 6 Months*

Please refer to the signed Chain of Custody attached to this document for details of analyses registered.

Appendix 2
Flora and Fauna Surveys (Ecosystem Solutions 2017; Strategen 2017)

ecosystem solutions
PO Box 685
DUNSBOROUGH WA 6281
Ph: +61 8 9759 1960
Fax: +61 8 9759 1920
Mobile: 0427 591 960
info@ecosystemsolutions.com.au
www.ecosystemsolutions.com.au

Reconnaissance Flora, Vegetation and Fauna Survey

Busselton Strategic Network Corridors

17 November 2017

Prepared for:
City of Busselton
C/- Strategen Environmental

Limitations Statement

This report has been solely prepared for City of Busselton (C/- Strategen Environmental). No express or implied warranties are made by Ecosystem Solutions Pty Ltd regarding the findings and data contained in this report. No new research or field studies were conducted other than those specifically outlined in this report. All of the information details included in this report are based upon the research provided and obtained at the time Ecosystem Solutions Pty Ltd conducted its analysis.

In undertaking this work the authors have made every effort to ensure the accuracy of the information used. Any conclusions drawn or recommendations made in the report are done in good faith and the consultants take no responsibility for how this information and the report are used subsequently by others.

Please note that the contents in this report may not be directly applicable towards another organisation's needs. Ecosystem Solutions Pty Ltd accepts no liability whatsoever for a third party's use of, or reliance upon, this specific report.

Document Control

City of Busselton

Busselton Strategic Network Corridors

Version	Revision	Purpose	Author	Reviewer	Submitted	
					Form	Date
Draft Report	V 1	Draft Report	GM	GM	Electronic (email)	26/9/2017
Draft Report	V2	Update Strategen Comments	GM	GM	Electronic (email)	6/10/2017
Draft Report	V3	Update Strategen Comments	GM	GM	Electronic (email)	10/10/2017
Draft Report	V4	Update DBCA Comments	GM	GM	Electronic (email)	17/11/2017
Draft Report	V5	Update comments	GM	GM	Electronic (email)	8/12/2017

Filename: z:\projects\17365 busseltonstrategic network corridors survey cob april 2017\reports\busselton strategic network corridors signficance assessment v5.docx

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Appendices

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1 Introduction

Ecosystem Solutions were contracted by Strategen Environmental on behalf of the City of Busselton to undertake a Reconnaissance Flora, Vegetation and Fauna Survey for the proposed Strategic Network Corridors project in Busselton.

The Busselton Strategic Network Corridors program has been developed based on extensive work over recent years to identify the strategic direction for ongoing development, management and improvement of the road network in and around Busselton. This strategic direction is critical to managing current and future traffic flows and supporting the town's growth as a key tourism hub in the South West region.

The program involves a number of upgraded or newly constructed roads and bridge crossings within the town of Busselton, as presented in Table 1 and Map 1.

Table 1: Strategic Network Corridor projects and footprints

Initiative	Part	Item	Name	Proposed works
2	(iii)	A	Eastern Link	New two lane crossing linking Causeway Road to Cammilleri Street or Stanley Street including new bridge over Vasse River and widening of existing railway line embankment south of the river.
2	(ii)	B	Causeway Bridge Duplication	Widening of existing bridge over Vasse River to four lanes and upgrade of Causeway Road.
3	(ii)	C	Strelly-Barlee-West Street Route	Three intersection treatments along West Street and Barlee Street, at intersections with Bussell Highway, Frederick Street and Strelly Street.
4	(ii)	D	Strelly-Barlee-West Street Duplication	Upgrade West Street to four lanes and widening of existing embankment/culverts over New River. Development of two lanes along Roe Terrace and Frederick Street.
4	(iii)	E	Fairway Drive Duplication	Upgrade Fairway Drive to four lanes and widening of existing embankment/culverts over New River.
5	(i), (ii)	F	Ford Road 'Transport Corridor' Option Ford Road 'Existing Reserve, Low Level' Option Molloy Street Option	New two lane road between Peel Terrace / Layman Road intersection and Bussell Highway. New bridge over Vasse Estuary. Two route options between new bridge and Bussell Highway: Option 1: southern route to Korden Place. Option 2: eastern route to Vasse Highway intersection. Additional Option 3: Ford Rd connection to Molloy St

This report provides the methodology and results of our surveys on the sites.

2 Site Details

The project was split up into five discrete survey areas, as shown in Map 1.

Item A -Initiative 2 (iii) Eastern Link

New two lane crossing linking Causeway Road to Cammilleri Street or Stanley Street including new bridge over Vasse River and widening of existing railway line embankment south of the river (Map 2).

Item B – Initiative 2 (ii) Causeway Bridge Duplication

Widening of existing bridge over Vasse River to four lanes and upgrade of Causeway Road (Map 3).

Item C – Initiative 3 (ii) Strelly-Barlee-West Street Route

Three intersection treatments along West Street and Barlee Street, at intersections with Bussell Highway, Frederick Street and Strelly Street (Map 4).

Item D – Initiative 4 (ii) Strelly-Barlee-West Street Duplication

Upgrade West Street to four lanes and widening of existing embankment/culverts over New River.

Development of two lanes along Roe Terrace and Frederick Street (Map 4).

Item E – Initiative 4 (iii) Fairway Drive Duplication

Upgrade Fairway Drive to four lanes and widening of existing embankment/culverts over New River (Map 5).

Item F -Initiative 5 (i), (ii) Ford Rd "Transport Corridor" Option, Ford Rd "Existing Reserve, Low Level" Option & Molloy St Option.

New two lane road between Peel Terrace / Layman Road intersection and Bussell Highway. New bridge over Vasse Estuary (Map 6).

Two route options between new bridge and Bussell Highway:

- Option 1: southern route to Korden Place.
- Option 2: eastern route to Vasse Highway intersection.
- Additional Option 3: Ford Rd connection to Molloy St

3 Flora, Vegetation & Communities

3.1 Objectives

To assess the flora and vegetation of the site with regard to its conservation value and report on these.

3.2 Legislation & Guidance Statements

Flora and vegetation are protected by various legislative and non-legislative instruments. These include

- Environmental Protection and Biodiversity Conservation Act 1999 (Cwth) (EPBC Act);
- Wildlife Conservation Act 1950 (WA) (WC Act)
- Environmental Protection Act 1986 (WA) (EP Act)
- Department of Biodiversity, Conservation and Attractions (DBCA) Priority lists for flora and vegetation.

A reconnaissance level flora and vegetation survey was conducted to be compliant with the Environment Protection Authority's (EPA's) requirements for the environmental survey and reporting for flora and vegetation in Western Australia.

These requirements are set out in the following documents:

- Technical Guidance – Flora and Vegetation Surveys for Environmental Impact Assessment (EPA, December 2016);
- Environmental Factor Guideline – Flora and Vegetation (EPA December 2016);
- Environmental Protection of Native Vegetation in Western Australia: Clearing of Native Vegetation with particular reference to Agricultural Areas: Position Statement No. 2 (EPA, 2000).

The EPA categorises a number of levels of flora study/survey as detailed in Technical Guidance Statement Flora and Vegetation Surveys for EIA (2016):

- Desktop Study – used to gather contextual information on the site based on existing surveys, literature, database searches and spatial information. At the completion of the desktop study, there should be sufficient information to identify the potential range of flora and vegetation that may be impacted by a proposal. Note this is not a survey but a study of the available information used to determine a survey effort.
- Reconnaissance Survey: used to provide contexts and gather broad information about an area. It is generally used to verify the information obtained from a desktop study, to characterise the flora and delineate the vegetation units present. It involved low intensity sampling of the flora and vegetation

to describe the general vegetation characteristics and condition. The reconnaissance survey should clarify whether any significant flora may be present and may recommend a higher level of survey.

- Targeted Survey: used to gather comprehensive information on significant flora and/or vegetation. It aims to determine the size and extent of all significant flora populations or vegetation in a survey area and place any impacts in contexts.
- Detailed Survey: provides adequate local and regional context relative to the flora and vegetation with the survey area. This survey required detailed comprehensive survey design, ensuring optimal survey timing for the botanical province, disturbance events that may affect sampling result and supplementary survey requirements.

The methodology adopted in this survey complies with those of a reconnaissance survey, providing contextual information obtained from a desktop survey, ground-truthed via a field survey. The methodology is presented in Section 3.3.

3.3 Methodology

3.3.1 Desktop Review

The desktop review gathered background information on the survey area and the flora species and vegetation communities that may be present. This involved a search of the literature, public data, aerial imagery and maps of the physical and biological characteristics of the study area (topography, soil types, Soil-Landscapes and previous vegetation mapping).

For this analysis the following resources were used:

- DBCA Threatened Flora Database (extract obtained from Strategen Environmental)
- DBCA Threatened Ecological Community Database (extract obtained from Strategen Environmental)
- NatureMap (DBCA);
- Florabase (Western Australian Herbarium);
- EPBC Act List of Threated Flora;
- EPBC Act List of Threatened Ecological Communities;
- Australian Government's EPBC Act Protected Matters Search Tool (Dept. of Environment and Energy) extract obtained August 2017; and
- Landgate's Shared Land Information Platform (SLIP) Database (accessed August 2017).

3.3.2 Field Survey

A field survey was conducted in August 2017. The field survey involved walking all of the five survey areas on foot inspecting all of the vegetation on both sides of the road.

Along with survey, the vegetation was assessed using the releve method whereby the following information was collected at unmarked survey sites;

- GPS coordinates;
- Dominant or important plant species and the differing strata layers, within approximately 10 m radius of the observer;
- Notes on vegetation structure using the method of Muir (1977);
- Vegetation condition score (Keighery, 1994);
- Surface soil texture and colour;
- Species other than the dominant were also recorded.

This method is more compatible to long narrow strips of vegetation like the road reserves in the study area. A releve point was taken in where the native vegetation composition or structure changed.

A standardised field data sheet was used to collect field data. Vegetation condition was assessed using the scale developed by Keighery (1994) which is the standard for the South West region.

Note that a spring flora survey was not conducted as part of this survey and as such, a number of potential species would not be flowering or able to be identified.

3.4 Declared Rare & Priority Flora

Species of flora and fauna are defined as Declared Rare or Priority conservation status where their populations are restricted geographically or threatened by local processes. DBCA recognises these threats of extinction and consequently applies regulations towards population and species protection. Declared rare flora species are gazetted under subsection 2 of section 23F of the WC Act (1950) and therefore it is an offence to "take" or damage rare flora without Ministerial approval. Section 23F of the WC Act (1950) defines "to take" as "… to gather, pick, cut, pull up, destroy, dig up, remove or injure the flora or to cause or permit the same to be done by any means" (Government of Western Australia, 2010).

Priority List Flora are under consideration for declaration as "rare flora", but are in urgent need of further survey (Priority One to Three) or require monitoring every 5-10 years (Priority Four). Table 1 presents the definitions of Declared Rare and the four Priority ratings under the WC Act (1950) (Department of Environment and Conservation, 2010a).

Table 2: Rare & Priority Flora Categories

CONSERVATION CODE	CATEGORY
T	"Taxa which have been adequately searched for and are deemed to be in the wild either rare, in danger of extinction, or otherwise in need of special protection and have been gazetted as such.'
P1	"Taxa which are known from one or a few (generally <5) populations which are under threat, either due to small population size, or being on lands under immediate threat. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey."
P2	Taxa which are known from one or a few (generally <5) populations, at least some of which are not believed to be under immediate threat. Such taxa are under consideration for declaration as 'rare flora', but are in urgent need of further survey."
P3	"Taxa which are known from several populations, and the taxa are not believed to be under immediate threat (i.e. not currently endangered), either due to the number of known populations (generally >5), or known populations being large, and either widespread or protected. Such taxa are under consideration for declaration as 'rare flora', but are in need of further survey."
P4	"Taxa which are considered to have been adequately surveyed and which, while being rare (in Australia), are not currently threatened by any identifiable factors. These taxa require monitoring every 5-10 years."

3.5 Threatened & Priority Ecological Communities

An ecological community is a naturally occurring biological assemblage that occurring in a particular type of habitat. A threatened ecological community (TEC) is one which found to fit into one of the following categories: Presumed Totally Destroyed; Critically Endangered; Endangered, or Vulnerable.

Possible TECs that do not meet survey criteria are added to the DBCA's Priority Ecological Community Lists, under Priority 1, 2 and 3. These are ranked in order of priority for survey and/or the definition of the community and evaluation of its conservation status.

3.6 Field Survey limitations

Limitations with the survey are listed in Table

Table 3: Field Survey Limitations.

Issue	Limitation	Comment
Sources of Information	No constraint	The area of survey has been reasonably well surveyed and adequate data are available.
Intensity of survey	No constraint	For a reconnaissance survey, the level of investigation and data collection was sufficient for this project.
Seasonality of survey	Moderate constraint	One species, *Caladenia procera*, is known within the study area. This species would not be detectable during the timeframe of this study. A detailed spring flora survey was not conducted as part of this reconnaissance survey.
Expertise	No constraints	Gary McMahon has 20 years of survey experience for flora within the Swan Coastal Plain. Additional flora identification was provided by Nathan McQuoid, who has extensive botanical experience in the south west.
Completeness	No constraints	The survey sites were linear road verge areas, where easy access and the ability to walk though most areas. 27 hours were spent in all of the sites.

3.7 Desktop Study Findings

3.7.1 Flora

A desktop study of the flora values within the study area reveal a total of 46 flora species of significance occurring within 5 kms of the sites (Table 2).

Table 4: Threatened and Priority Flora within a 5 km radius of the sites.

SPECIES	STATUS	LIFE FORM	HABITAT	Eastern Link	Causeway Bridge	West-Strelly St	Fairway Drive	Ford St-Molloy St
Andersonia gracilis	Endangered	Shrub	Seasonally damp, black sandy clay flats near the margins of swamps.	Possible	Unlikely	Possible	Possible	Unlikely
Banksia nivea subsp uliginosa	Threatened	Shrub	Sandy clay, gravel	Unlikely	Possible	Possible	Possible	Unlikely
Banksia squarrosa subs argillacea	Vulnerable	Shrub	Winter wet clay over ironstone	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Brachyscias verecundus	Critically Endangered	Herb	Winter wet clays over ironstone	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Caladenia huegelii	Threatened	Herb	Grey or brown sand, clay loam	Unlikely	Possible	Possible	Possible	Possible
Caladenia procera	Threatened	Herb	Alluvial loamy flats	Unlikely	Unlikely	Unlikely	Known	Unlikely
Chamelaucium sp SCP	Threatened	Shrub	Swamp margins, winter wet sandy clays.	Possible	Unlikely	Possible	Possible	Possible
Darwinia whicherensis	Endangered	Shrub	Winter wet areas over shallow red clay over ironstone	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

SPECIES	STATUS	LIFE FORM	HABITAT	Eastern Link	Causeway Bridge	West-Strelly St	Fairway Drive	Ford St-Molloy St
Diuris micrantha	Vulnerable	Herb	Dark, grey to blackish, sandy clay loams in winter wet depressions or swamps.	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Drakaea elastica	Threatened	Herb	White or grey sand, low lying situations adjoining winter wet swamps.	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Drakaea micrantha	Vulnerable	Herb	White Grey Sand	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Gastrolobium papilio	Endangered	Shrub	Peaty Grey brown sandy clay over ironstones or winter wet flats	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Grevillea elongata	Vulnerable	Shrub	Gravelly Clay, sandy clay and sand on road verges, swamps and creek banks.	Unlikely	Possible	Possible	Possible	Possible
Kennedia lateritia	Threatened	G/cover		Unlikely	Possible	Possible	Possible	Unlikely
Lambertia echinata subsp occidentalis	Endangered	Shrub	Shallow soils over sheet ironstone and white sandy soils over laterite. Winter wet rich heathlands.	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Lambertia orbifolia subs Scot River Plain	Threatened	Shrub	Grey brown white gravelly sandy loam over ironstone	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Petrophile latericola	Endangered	Shrub	Winter wet flats of red sandy clay over ironstone	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Verticordia densiflora var pedunculata	Threatened	Shrub	Light yellow or grey sands in low lying winter wet areas.	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

SPECIES	STATUS	LIFE FORM	HABITAT	Eastern Link	Causeway Bridge	West-Strelly St	Fairway Drive	Ford St-Molloy St
Verticordia plumose var vassensis	Threatened	Shrub	Variety of sands and swampy clay soils in mostly winter wet flats and depressions.	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Gastrolobium sp Yoongarillup	P1	Shrub	Sandy soils, lateritic gravelly soils	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Puccinellia vassica	P1	Grass like herb	Saline soils. On the outer margins of coastal saltmarshes	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Stachystemon sp Keysbrook	P1	Shrub	To 0.2 m	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Amperea micrantha	P2	Herb	Sandy Soils	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Calystegia sepium subs roseate	P2	Twining herb	Damp places	Possible	Unlikely	Possible	Known	Possible
Leucopogon sp Busselton	P2	Shrub	Variety of habitats	Possible	Likely	Likely	Possible	Likely
Chorizema carinatum	P3	Shrub	Sand or sandy clays.	Unlikely	Possible	Possible	Possible	Possible
Conospermum paniculatum	P3	Open shrub	Sandy or clayey soils, Swampy areas plains and slopes	Unlikely	Unlikely	Possible	Possible	Unlikely
Grevillea brachystylis subsp brachystylis	P3	Shrub	Flowers: red, Aug to Nov.	Possible	Unlikely	Possible	Possible	Unlikely

SPECIES	STATUS	LIFE FORM	HABITAT	Eastern Link	Causeway Bridge	West-Strelly St	Fairway Drive	Ford St-Molloy St
Grevillea bronwenae	P3	Shrub	Grey sand over laterite, lateritic loams, Hillslopes.	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Hakea oldfieldii	P3	Open shrub	Red clay or sand over laterite, seasonally wet flats.	Unlikely	Possible	Possible	Possible	Unlikely
Isopogon formosum subsp dasylepis	P3	Shrub	Sand, sand clay, gravelly sandy soils over laterite. Often swampy areas	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Jacksonia gracillima	P3	Shrub	Sandy soils, Sandplains rises swampy depressions.	Unlikely	Unlikely	Possible	Possible	Unlikely
Johnsonia inconspicua	P3	Grass like herb	White-grey or black sand. Low dunes, winter-wet flats	Unlikely	Unlikely	Possible	Possible	Unlikely
Lasiopetalum laxiflorum	P3	Shrub	Heavy soils in tuart woodlands	Unlikely	Unlikely	Possible	Possible	Unlikely
Loxocarya magna	P3	Sedge like herb	Sand, loam, clay, ironstone, seasonally inundated or damp habitats.	Unlikely	Possible	Possible	Possible	Possible
Pimelea ciliata subsp. longituba	P3	Shrub	Grey sand over clay, loam	Unlikely	Possible	Possible	Possible	Possible
Pultenaea pinifolia	P3	Shrub	Loam or clay, floodplains, swampy areas.	Unlikely	Possible	Possible	Possible	Possible
Synaphea hians	P3	Shrub	Sandy soils and rises.	Unlikely	Possible	Possible	Possible	Unlikely

SPECIES	STATUS	LIFE FORM	HABITAT	Eastern Link	Causeway Bridge	West-Strelly St	Fairway Drive	Ford St-Molloy St
Synaphea petiolaris subsp. simplex	P3	Shrub	Sandy Soils, Flats, Winter Wet Areas	Unlikely	Possible	Possible	Possible	Unlikely
Acacia flagelliformis	P4	Rush like erect or sprawling shrub.	Sandy Soils and winter wet areas.	Unlikely	Possible	Possible	Possible	Unlikely
Acacia semitrullata	P4	Shrub	White /Grey sands, Sandplains and swampy areas.	Unlikely	Unlikely	Possible	Possible	Unlikely
Chamelaucium sp. Yoongarillup	P4	Evergreen shrub	Variety of soil types.	Unlikely	Possible	Possible	Possible	Unlikely
Franklandia triaristata	P4	Shrub	White or grey sand	Unlikely	Unlikely	Possible	Possible	Unlikely
Laxmannia jamesii	P4	Herb	Grey Sand, winter wet areas	Unlikely	Possible	Possible	Possible	Unlikely
Ornduffia submersa	P4	Herb	Freshwater lakes swamps and Claypans.	Unlikely	Possible	Possible	Possible	Possible
Thysanotus glaucus	P4	Herb	White, grey or yellow sand, sandy gravel.	Unlikely	Possible	Possible	Possible	Unlikely

Within the five survey areas, the extracts from DBCA, highlighted three flora species known within of the survey areas:

- *Synaphea hians* – within Item F (Ford Road) survey area, although not directly within the site boundary;
- *Caladenia procera* – in Item E (Fairway Drive). The author is aware of this population from previous studies;

- *Calystegia sepium* subsp *roseata* – in Item E (Fairway Drive) within the northern part of the site.

3.7.2 Vegetation & Ecological Communities

Heddle, et.al (1980) mapping, classifies remnant vegetation into a number of vegetation complexes and systems.

Within the five study areas, the following complexes were determined (Map 8):

- Ludlow Complex (Lw) – Open woodland of Melaleuca rhaphiophylla and sedgelands of Cyperaceae-Restionaceae spp. on broad depressions in the subhumid zone
- Quindalup Complex (Qw, Qwy, QD) - Tall shrubland of Acacia saligna-Agonis flexuosa and open heath on depressions amongst recent dunes in the subhumid zone.

Table 2 summarises the vegetation complexes within each of the five areas.

Table 5 Vegetation Complexes (Heddle et al, 1980)

Complex	% Present Extent	% in Formal Reserves	Item A - Eastern Link	Item B - Causeway Bridge Duplication	Item C & D - Strelly-Barlee, West St Route & Duplication	Item E - Fairway Dve Duplication	Item F - Ford Rd & Molly St Options
Ludlow	25	11				✓	
Quindalup	44	16	✓		✓	✓	✓

The amount of the Ludlow Vegetation Complex remaining places it in a category requiring further consideration from any potential clearing.

The desktop study revealed three known Threatened or Priority Ecological Communities within the five survey areas.

Banksia Woodlands of the Swan Coastal Plain - Endangered

The ecological community can be identified by these general features:

- It typically occurs on well drained, low nutrient soils in sands of dune landforms, in particular deep Bassendean and Spearwood sands, or occasionally on Quindalup sands. It is also common on sandy colluvium and aeolian (wind-blown) sands of the Ridge Hill Shelf, Whicher Scarp and Dandaragan Plateau.
- Banksia Woodlands vary in their structure (height, cover, density) and species composition across the region where they occur. These variations can occur over small distances, but the woodlands are united by having a generally dominant Banksia component, which includes at least one of four key species— Banksia attenuata (candlestick banksia), B. menziesii (firewood banksia), B. prionotes (acorn banksia) and/or B. ilicifolia (holly-leaved banksia) Banksia littoralis (swamp banksia) and B. burdettii (Burdett's banksia) may be co-dominant in some areas, but where they become dominant, they typically form other communities and are not considered the Banksia Woodlands of the Swan Coastal Plain ecological community.
- Other trees of a medium height that may be present, and may be co-dominant with the Banksia species across a patch, include Eucalyptus todtiana (blackbutt, pricklybark), Nuytsia floribunda (Western Australian Christmas tree), Allocasuarina fraseriana (western sheoak), Callitris arenaria (sandplain cypress), Callitris pyramidalis (swamp cypress) and Xylomelum occidentale (woody pear).
- Emergent taller trees that can occur above the Banksia canopy may include Corymbia calophylla (marri), Eucalyptus gomphocephala (tuart) and E. marginata (jarrah).
- Key species in the sclerophyllous shrub layer include members of the families Asteraceae, Dilleniaceae, Ericaceae, Fabaceae, Myrtaceae and Proteaceae. Widespread species include Adenanthos cygnorum (woolly bush), Allocasuarina humilis (dwarf sheoak), Bossiaea eriocarpa (common brown pea), Conostephium pendulum (pearl flower), Daviesia spp., Eremaea pauciflora, Gompholobium tomentosum (hairy yellow pea), Hibbertia hypericoides (yellow buttercups), Hypolaena exsulca, Jacksonia spp., Kunzea glabrescens, Petrophile linearis (pixie mops), Phlebocarya ciliata, Philotheca spicata (pepper and salt), Stirlingia latifolia (blueboy) and Xanthorrhoea preissii (balga, grass tree).
- Key species in the herbaceous ground layer include members of the families Cyperaceae, Droseraceae, Haemodoraceae, Orchidaceae, Restionaceae and "lilies" from various families. Widespread species include Amphipogon turbinatus (tufted beard grass), Burchardia congesta (milkmaids), Caladenia spp. (spider orchids), Dasypogon bromeliifolius (pineapple bush), Desmocladus flexuosus, Drosera erythrorhiza (red ink sun dew), Lepidosperma squamatum (a tufted sedge), Lomandra hermaphrodita, Lyginia barbata (southern rush), Lyginia imberbis, Mesomelaena pseudostygia (semaphore sedge), Patersonia occidentalis (purple flag), Podolepis spp., Stylidium brunonianum (pink fountain trigger plant), Stylidium piliferum (common butterfly trigger plant), Trachymene pilosa (dwarf parsnip), and

Xanthosia huegelii (heath Xanthosia). The development of a ground layer may vary depending on the density of the shrub layer and disturbance history

Subtropical and Temperate Coastal Saltmarsh – Vulnerable (Cwth), P3 WA

This is wide ranging community associates with saltmarsh in coastal regions of sub-tropical and temperate Australia (south of 23^0 S latitude). The habitat is defined as coastal areas under tidal influence. It is typically restricted to the upper intertidal environment, generally between elevation of the mean high tide, and the mean spring tide. The community consists mainly of salt-tolerant vegetation (halophytes) including: grasses, herbs, reeds, sedges and shrubs. Succulent herbs and grasses generally dominate and vegetation is generally <0.5m tall with the exception of some reeds and sedges. Many species of non-vascular plants are also found in saltmarsh, including epiphytic algae, diatoms and cyanobacterial mats. Saltmarsh consists of many vascular plant species but is dominated by relatively few families. There is also typically a high degree of endemism at the species level. The two most widely represented coastal saltmarsh plant families are the Chenopodiaceae and Poaceae. Four structural saltmarsh forms are currently recognised based on dominance of a particular vegetation type:

- dominance by succulent shrubs (e.g. Tecticornia)
- dominance by grasses (e.g. Sporobolus virginicus)
- dominance by sedges and grasses (e.g. Juncus kraussii, Gahnia trifida)
- dominance by herbs (e.g. low-growing creeping plants such as Wilsonia backhousei, Samolus repens, Schoenus nitens).

The Coastal Saltmarsh ecological community also include areas that have groundwater connectivity to tidal water bodies. Thus it occurs at places with at least some tidal connection, including rarely-inundated supratidal areas and intermittently opened or closed lagoons, but not areas receiving only aerosol spray (i.e. such as cliff tops). Western Australian coastal areas support an entire series of saline coastal wetlands that abut typical coastal saltmarshes. These include: saline lakes on the coast and offshore islands, coastal lagoons (open and closed) and the birridas (gypsum claypans) of Shark Bay. These wetlands are all connected to the sea in various ways, and contain typical saltmarsh vegetation (Keighery and Keighery, 2013a). As such they would be included within the ecological community. Many similar wetlands along the Western Australian coastline have lost their connection to the sea, for example the lagoon saline lakes of the Swan Coastal Plain (Keighery and Keighery 2013b), and it is likely that eventually others will also (G. Keighery, pers. comm.). These would not be considered as part of the ecological community if the disconnection were permanent.

Eucalyptus rudis, Corymbia calophylla, Agonis flexuosa Closed Low Forest – P1 (WA)

Eucalyptus rudis, Corymbia calophylla, Agonis flexuosa Closed Low Forest (near Busselton) Priority 1 A low lying Spearwood Dune plant community associated with shallow sandy soils over Tamala limestone that in places is exposed at the surface. The plant community on these soils supports a unique mixture of wetland and upland flora. Typically low forest dominated by Eucalyptus rudis, Eucalyptus calophylla, Agonis flexuosa over a diverse understorey including Hibbertia hypericoides, Logania vaginalis, Conospermum caeruleum, Agrostocrinum hirsutum and Lomandra micrantha. Other associated species include Eucalyptus decipiens, Melaleuca rhaphiophylla, Banksia littoralis, Hakea varia and the sedge species Baumea juncea and Gahnia trifida.

3.8 Results & Discussion

The field surveys were conducted over 4 days in August 2017 by Gary McMahon with assistance and taxonomic advice from Nathan McQuoid. The flora survey was conducted under Scientific and Other Prescribed Purposes Licence SL 011148 and SL 011557 and Permit to Take DRF No. 57-1516.

The vegetation was classified and mapped as "Vegetation Groups" each of which comprises a combination of vegetation type and condition.

3.8.1.1 Item A - Eastern Link

Four releve points were taken in this area. Areas of maintained, introduced grassland are noted but were not used as survey points. The vegetation groups are shown in Map 2.

Table 4 summarises the results based on the structural and species classification by Muir (1977) and Aplin (1979)(Appendix A). The condition ratings are based on the scale devised by Keighery (1994)(Appendix B).

Table 6:Descriptions of Vegetation Points in Eastern Link Survey Area

Vegetation Group	Description	Condition
Eastern Link 1	Low Woodland of Agonis flexuosa and Eucalyptus rudis over grasses (managed *Cynodon dactylon) (Figures 1 & 2)	Degraded on river edge to Completely degraded in parkland cleared area
Eastern Link 2	Low Woodland of Agonis flexuosa, E. rudis, E. cornuta, Melaleuca rhaphiophylla (& planted eucalypts), over open shrubland of Acacia littoralis, over closed grassland of Bolboschoenus caldwellii and assorted pasture grasses (*Cenchrus clandestinum) (Figures 3 & 4)	Degraded to Good

Vegetation Group	Description	Condition
Eastern Link 3	Low Open Forest of M. rhaphiophylla, M. preissii, over Open Scrub of M. viminea, over pasture grasses (dominated by *Cenchrus clandestinum & *Cynodon dactylon) (Figure 5)	Degraded
Eastern Link 4	Closed sedge land of samphire species (predominantly Sarcocornia quinqueflora, though includes Suaeda australis and Halosarcia indica) and Juncus kraussii and J pallidus. incursions of introduced grasses (Figures 5 & 6)	Good – Very Good.

Figure 1 Eastern Link Vegetation Group 1

Figure 2 Eastern Link Vegetation Group 1

Figure 3 Eastern Link Vegetation Group 2

Figure 4 Eastern Link Vegetation Group 2

Figure 5 Eastern Link Vegetation Group 3 (area to the left)

Figure 6 Eastern Link Vegetation Group 4

Appendix C itemises the species found in the reconnaissance survey within this area.

No threatened or priority flora species listed under Commonwealth or WA legislation were observed in the survey area.

No Weeds of National Significance were observed and only one species, Arum Lily (*Zantedeschia aethiopica*) which is declared under the Biosecurity and Agriculture Management Act (2007) (BAM Act) was found in the survey area.

Vegetation Group 4 was dominated by samphire and is potentially subject to tidal influences of the Vasse Estuary (seen in Figure 6). Discussions with the Department of Biodiversity, Conservation and Attractions (DBCA) has confirmed that the species within of this association are consistent with the definition of the EPBC listed TEC (WA listed PEC) – Subtropical and Temperate Coastal Saltmarsh community (A. Webb, Regional Botanist SW DBCA, *pers comm* Sept 2017). Further investigations would be required to determine the specific extent of salt water inundation in this area to determine if the TEC is present.

3.8.1.2 Item B – Causeway Bridge Duplication

Three vegetation groups were found in this area. Areas of maintained, introduced grassland are noted but were not assessed. The vegetation groups are shown in Map 3.

Table 5 summarises the results based on the structural and species classification and condition

Table 7: Vegetation Groups in Causeway Bridge Survey Area

Vegetation Point	Description	Condition
Causeway 1	Low Woodland of Agonis flexuosa over managed grasses.	Completely Degraded - parkland cleared area
Causeway 2	Low Woodland of Agonis flexuosa, over sedgeland of Juncus spp on river with . managed grasses (Figures 7 & 8)	Degraded to Good on river edge
Causeway 3	Low Woodland of E. rudis, M. rhaphiophylla, M. preissii and A. flexuosa, Open sedgeland of Lepidosperma gladiatum, J. pallidus and J kraussii, with incursions of managed grasses. (Figure 9)	Degraded to Good on river edge.

Figure 7 Causeway Vegetation Group 2

Figure 8 Causeway Vegetation Group2 – note good quality of vegetation along edge of river

Figure 9 Causeway Vegetation Group 3

Appendix A itemises the species found in the reconnaissance survey within this area.

No threatened or priority flora species listed under Commonwealth or WA legislation were observed in the survey area.

No Weeds of National Significance were observed and only one species, Arum Lily (*Zantedeschia aethiopica*) which is declared under the Biosecurity and Agriculture Management Act (2007) (BAM Act) was found in the survey area.

None of the areas within this site were consistent with any of the known TEC/PECs.

3.8.1.3 Item C & D – Strelly- Barlee-West St Route and Duplication

Six vegetation groups were identified within this area as described in Table 6 and shown in Map 4. There were other areas of vegetation, such as planted street trees, garden escapees and grassed areas that couldn't be categorised as a functional vegetation group. While these are noted in map 4 they were not categorised as a distinct vegetation group.

Vegetation Group 1 was predominantly inundated (refer Figure 11) and complete descriptions were not available as any ground cover species were not observable.

Table 8: Vegetation Groups in Strelly West St Survey Area

Vegetation Group	Description	Condition
Strelly-West 1	Tall Open Scrub of Melaleuca viminea, over low open Heath of M. viminea and Acacia saligna, over Sedgeland of Gahnia trifida, Juncus pallidus, Ficinia nodosa, over herbland of *Zantedeschia aethiopica, Edges affected by *Cenchrus clandestinum and other grasses)(Figures 10 & 11)	Very Good, with edges Degraded due to weeds
Strelly-West 2	Tall Open Scrub of M. viminea, A. flexuosa and Acacia littoralis, over Low open heath of M. viminea, over sedgeland of Lepidosperma gladiatum, Juncus pallidus and Gahnia trifida, over open herbland of *Zantedeschia aethiopica, Edges affected by *Cenchrus clandestinum and other introduced grasses and Clover spp., very wet areas covered by *Typha orientalis (Figures 12 & 13)..	Good to Degraded on edges
Strelly-West 3	Tall open Scrub of Acacia saligna, Agonis flexuosa, over Low shrubland of A. saligna over Closed sedgeland of Gahnia trifida. Edges affected by clovers and introduced annual grasses very wet areas covered by *Typha orientalis (Figures 14 & 15)	Good to Degraded on edges
Strelly-West 4	Sedge land of samphire species (predominantly Sarcocornia quinqueflora, though includes Suaeda australis and Halosarcia indica) and Juncus kraussii and J pallidus. incursions of introduced grasses (Figures 16 & 17)	Good.
Strelly-West 5	Open Scrub of Melaleuca raphiophylla and M. viminea, with scatted *Pittosporum undulatum, * Cortaderia selloana, over introduced grasses	Degraded
Strelly-West 6	Scattered Low Trees of E. rudis, M. raphiophylla, over Scattered shrubs of Spyridium globulosum and Callistemon spp.	Degraded

No threatened or priority flora species listed under Commonwealth or WA legislation were observed in the survey area.

No Weeds of National Significance were observed and only one species, Arum Lily (Zantedeschia aethiopica) which is declared under the Biosecurity and Agriculture Management Act (2007) (BAM Act) was found in the survey area.

The samphire areas (Group 4) is potentially subject to tidal inundation and while it would not be considered to be in a very good condition, it would be prudent to consider its potential to be the EPBC listed TEC (WA Listed PEC) Coastal Saltmarsh complex, unless further detailed investigation can precisely describe the dynamics of this site.

Figure 10 Strelly-West Vegetation Group 1

Figure 11 Strelly-West Vegetation Group 1

Figure 12 Strelly-West Vegetation Group 2

Figure 13 Strelly-West Vegetation Group 2, looking west

Figure 14 Strelly-West Vegetation Group 3

Figure 15 Strelly-West Vegetation Group 3

Figure 16 Strelly-West Vegetation Group 4

Figure 17 Strelly-West Vegetation Group 4, Northern Samphire

3.8.1.4 Item E- Fairway Drive Duplication

Seven vegetation groups were assessed in this survey area, as described in Table 7 and shown in Map 5.

Table 9: Vegetation Groups within Fairway Drive Survey Area

Vegetation Group	Description	Condition
Fairway 1	Open forest of Agonis flexuosa, Corymbia calophylla with scatted Eucalyptus rudis, over Tall Shrubland of A. flexuosa and Melaleuca rhaphiophylla and M. viminea, over Open shrubland of Agonis and Melaleuca, over scattered Lepidosperma squamatum, and open herbland of Lomandra spp, Phyllanthus calycinus and grassland of introduced pasture grasses. (Figure 18)	Good
Fairway 2	Low Open Forest of C. calophylla, A. flexuosa, M. raphiophylla, over open shrubland of Acacia saligna, M. raphiophylla, over herbland of Lomandra spp and Patersonia umbrosa, Hibbertia furfuracea, and grassland of *Avena fatua with scattered *Zantedeschia aethiopica (Figure 19)	Degraded – Good Due to weed and lack of structure
Fairway 3	Low Open Forest of A. flexuosa and M. raphiophylla, over Tall open Scrub of M. viminea, A flexuosa, A saligna and M. preissiana over tall shrubland of A. saligna and M viminea, over herbland of Sparaxis spp over grassland (some managed)	Degraded
Fairway 4	Low Open Woodland of planted A. flexuosa, Acacia spp, Melaleuca spp, over closed managed grassland.	Completely degraded
Fairway 5	Low Woodland of Corymbia calophylla, and A. flexuosa, over open shrubland of A. flexuosa, over open grassland of *Avena fatua, Hypochaeris spp and annual grasses	Degraded
Fairway 6	Low Open Woodland of C. calophylla, Callitris preissii, E. rudis, M. raphiophylla, M. viminea, M preissii, over open shrubland of M. viminea, over scattered Adenanthos and a closed grassland of perennial grasses..	Very good
Fairway 7	Low Open Forest of A. flexuosa, over Tall open scrub of A. flexuosa, Spyridium globulosum, M. viminea, M, raphiophylla and M. preissiana over scattered low shrubs of A. saligna, over closed grassland of *Cenchrus clandestinum and *Cynodon dactylon	Degraded

Figure 18 Fairway Vegetation Group 1

Figure 19 Fairway Vegetation Group 2

Figure 20 Fairway Vegetation Group 3

Figure 21 Fairway Vegetation Group 4

Figure 22 Fairway Vegetation Group 5

Figure 23 Fairway Vegetation Group 6

Figure 24 Fairway Vegetation Group 7

No threatened or priority flora species listed under Commonwealth or WA legislation were observed in the survey area.

No Weeds of National Significance were observed and only one species, Arum Lily (Zantedeschia aethiopica) which is declared under the Biosecurity and Agriculture Management Act (2007) (BAM Act) was found in the survey area.

While no species of significance was observed, Fairway 1 vegetation group is known to support a population of *Caladenia procera* (Critically Endangered taxa). This species can only be identified during flowering

season, however it is known to populate this area as evidenced from previous studies Ecosystem Solutions have competed in previous projects.

Vegetation Groups 1, 2 and 6 have species consistent with the Priority 1 PEC, *Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Forest. While these areas vary in condition from Degraded to Very Good, they should be considered as the PEC unless proven otherwise.

3.8.1.5 Item F- Ford Road Options 1 and 2 & Molloy St Option

This survey area consists of the length of Ford Road from Bussell Highway to Peel Terrace and Ford Road connecting south to Molloy St and crossing the Vasse River Delta Wetlands. There was an additional area to the east of Ford Road, as indicated on Map 6.

Ford Road is an unmade road reserve for the full length and this is dominated by annual grass weeds (Figures 25, 27 & 28).

Areas were noted where change occurred, but only native vegetation association were assessed. Other area are noted and shown in Map 6.

In total, 4 sites were assessed in the Ford Road area (Map 6) and 3 within the Molloy St survey area (Map 7), as shown in Table 8

Table 10: Vegetation Groups within Ford Road Options and Molloy St Survey Areas

Vegetation Group	Description	Condition
Ford Rd 1	Closed Grassland of introduced pasture grasses, *Trifolium spp, *Cenchrus clandestinum and *Cynodon dactylon with scattered *Zantedeschia aethiopica (Figure 25)	Completely Degraded
Ford Rd 2	Scattered Tall Trees of Eucalyptus gomphocephala over pasture grasses (Figure 26)	Completely Degraded
Ford Rd 3	Closed sedge land of samphire species (predominantly Sarcocornia quinqueflora, though includes Suaeda australis and Halosarcia indica) and Juncus kraussii and J pallidus. incursions of introduced grasses (Figure 27)	Good .
Ford Rd 4	Closed grassland of Typha orientalis with Scattered Melaleuca raphiophylla (Figure 28) .	Degraded to Completely Degraded
Molloy St - 1	Closed sedge land of samphire species (predominantly Sarcocornia quinqueflora, though includes Suaeda australis and Halosarcia	Good – Very Good.

Vegetation Group	Description	Condition
	indica) and Juncus kraussii and J pallidus. incursions of introduced grasses and scattered *Zantedeschia aethiopica (Figure 29)	
Molloy St 2	Closed Grassland of Bolboschoenus caldwellii and assorted pasture grasses (*Cenchrus clandestinum, *Cynodon dactylon with scattered *Zantedeschia aethiopica (Figure 30).	Completely Degraded
Molloy St 3	Closed grassland of Typha orientalis with Scattered Melaleuca raphiophylla (Figure 31).	Degraded to Completely Degraded
Molloy St 4	Open Shrubland of Melaleuca raphiophylla and Acacia spp, over introduced grasses	Degraded

Figure 25 Ford Rd Vegetation Group 1

Figure 26 Ford Rd Vegetation Group 2

Figure 27 Ford Rd Vegetation Group 3

Figure 28 Ford Rd Vegetation Group 4

Figure 29 Molloy Vegetation Group 1

Figure 30 Molloy Vegetation Group 2

Figure 31 Molloy Vegetation Group 1 in foreground and Vegetation Group 3 in background

No threatened or priority flora species listed under Commonwealth or WA legislation were observed in the survey area.

No Weeds of National Significance were observed and only one species, Arum Lily (*Zantedeschia aethiopica*) which is declared under the Biosecurity and Agriculture Management Act (2007) (BAM Act) was found in the survey area.

Most of the vegetation groups within Ford Rd are degraded to completely degraded. However Vegetation Group 3 within Ford Road and Lot 80 contain the species consistent with the EPBC listed TEC(WA listed PEC) Coastal Saltmarsh. They are appear to be influenced by coastal/tidal movements and therefore should be considered to be the TEC unless they can be proven otherwise from further investigations.

4 Fauna

4.1 Objectives

The objective of the reconnaissance fauna survey was to identify fauna of conservation significance, including threatened and priority species or migratory species listed and protected under Commonwealth or Western Australian legislation.

Key conservation significant fauna expected with the five survey areas include Western Ringtail Possum (WRP), endangered Black Cockatoo species, and migratory waterbirds.

4.2 Methodology

This survey was conducted to be compliant with the EPA's requirement for the environmental survey and reporting for flora and vegetation in Western Australia.

These requirements are set out in the following documents:

- Technical Guidance – Sampling Methods for Terrestrial Vertebrate Fauna (EPA, December 2016);
- Technical Guidance – Terrestrial Fauna Surveys (EPA, December 2016);
- Environmental Factor Guideline – Terrestrial Fauna (EPA December 2016);
- Development Planning Guidelines for Western Ringtail Possums (CALM, 2003 (now DBCA); and
- Guidelines for the three Black Cockatoo species (Department of Sustainability, Environment, Water, Populations and Communities, 2011, now Department of Environment and Energy) .

A desktop study and analysis of the records of the DBCA's (Nature Map) and the Australian Government's Department of the Environment and Energy's EPBC Act Protected Matters Search Tool (Appendix A & B) were made to determine the presence or likely presence of fauna or faunal assemblages within the Site. The analysis primarily targeted terrestrial threatened vertebrate species listed under the Environmental Protection and Biodiversity Conservation Act 1999 (Cwth), (EPBC Act) and the Western Australian WC Act (WA) 1950.

Based on the finding of the desktop study and considering the vegetation groups present, a field survey of each of the five sites was conducted. The approach adopted for this survey was:

- A Satellite Image of the study area, incorporating all five survey areas was acquired;
- A day time visual inspection of each survey area and adjoining vegetation for any signs of fauna (e.g. scats, diggings, dreys, nests, burrows, feeding signs) was conducted;
- Hollow bearing trees or trees suitable for Black Cockatoos were recorded;

- Direct observations of terrestrial vertebrate fauna and signs of that fauna were recorded using a Trimble Global Positioning System (GPS) and ArcPad© (Version 8- ESRI);
- A 20 minute bird survey, including observation and recording of any waterbirds within the Vasse River, New River and Vasse Estuary within each survey area;
- Two, non-consecutive, night time spotlight surveys were conducted to determine nocturnal fauna activity. A 40 w LightForce hand-held spotlight was used with white light. Observations were recorded using GPS and ArcPad©;
- Two pre-dawn and two dusk surveys were conducted to determine Black Cockatoo activity. A spotting scope was used in these surveys to identify any other birds within the site; and
- Field observations were analysed and mapped with ArcGis (ArcMap V10.3©).

Each of the five survey areas were inspected via a walked transect and the trees were inspected via a visual inspection for hollows or signs of fauna usage.

All trees with large hollows were inspected for any signs of use by cockatoos. These include wear around the hollow, chewing, scarring and scratch marks on the trunks or branches which may be evidence for use by threatened Black Cockatoo species. Old or recent evidence of cockatoo's feeding or roosting sites (feathers, droppings etc.) were also searched for.

The field survey methodology has minimal impact on the fauna within the property and provides sufficient data on the presence and relative abundance and distribution of taxa. During the field surveys, the habitat at the site was assessed to determine its potential suitability to host any of the anticipated threatened, priority or migratory species listed under Commonwealth and State legislation. This approach is consistent with a Level 1 survey under the EPA's Technical Guide: Terrestrial Vertebrate Fauna Surveys for Environmental Impact Assessment (2016) which specifies a minimum requirement of a background research or desktop study to gather information on the five survey areas and a reconnaissance survey to verify the accuracy of the background study and delineate fauna and faunal assemblages for a given survey area.

4.3 Conservation Significant Fauna

The conservation status of fauna within Western Australia is determined by criteria outlined within two acts of legislation: the Environmental Protection and Biodiversity Conservation Act 1999 (Cwth), (EPBC Act) and the State-based Western Australian WC Act (WA) 1950.

Under Section 179 of the EPBC Act, fauna may be listed in one of the following categories (in decreasing degree of threat of extinction):

- Extinct;

- Extinct in the wild;
- Critically Endangered;
- Endangered;
- Vulnerable; and
- Conservation Dependant.

These categories are consistent with the International Union for Conservation of Nature (IUCN) classifications and therefore link into a global ranking system for taxa at risk of extinction.

The WC Act also uses these categories, but uses a set of schedules to define extinction risk (Table 9).

Table 11: Conservation Categories in the Wildlife Conservation Act (WA) 1950.

Category	Code	Description
Schedule 1	S1	Fauna which is rare or likely to become extinct.
Schedule 2	S2	Fauna which is presumed extinct.
Schedule 3	S3	Birds which are subject to an agreement between the governments of Australia and Japan (JAMBA) relating to the protection of migratory birds and birds in danger of extinction.
Schedule 4	S4	Fauna that is otherwise in need of special protection.

The DBCA also produce a supplementary list of possible threatened species that do not meet the criteria for listing in the above categories. These species are not considered threatened under the WC Act, but due to a lack of knowledge or where species are poorly represented in conservation reserves, some concern for their long term survival exists. Table 10 shows the priority classifications.

Table 12: Priority Classifications used in WA.

Category	Code	Description
Priority 1	P1	Taxa with a few, poorly known populations on lands not managed for conservation (e.g. agricultural lands, urban areas etc.).
Priority 2	P2	Taxa with few, poorly known populations on conservation lands (e.g. national parks, nature reserves etc.).
Priority 3	P3	Taxa with several, poorly known populations, some on conservation lands, but where known threats could affect them.
Priority 4	P4	Rare, near threatened and other species in need of monitoring.

The EPBC Act also requires the compilation of a list of migratory species that are recognised under international treaties including the Japan Australia Migratory Bird Agreement (JAMBA), the China Australia Migratory Bird Agreement (CAMBA), and the Bonn Convention (The Convention on the conservation of Migratory Species of Wild Animals). Species listed under JAMBA are also protected under Schedule 3 of the WC Act.

The conservation status of all terrestrial vertebrate species listed as occurring within, near or likely to occur within each of the five survey areas, were assessed using the most recent lists of the relevant legislation and DBCA priority lists. The reconnaissance fauna survey did not include aquatic species, such as Carter's Freshwater Mussel (*Westralunio carteri*). Aquatic survey has separately been undertaken for the Eastern Link and Causeway Bridge areas (Murdoch University, 2017).

4.4 Limitations

Field surveys were confined to four day surveys and two nocturnal spotlight surveys conducted over non-consecutive night at each site. Two pre-dawn and two pre-dusk surveys for Black Cockatoo activity were also conducted. The night surveys were conducted using experienced ecologists utilising individual head torches and a single hand-held spotlight.

Each of the five survey areas was traversed by foot walking the entire length of each site. In the road ways, both sides of the road was inspected. The linear nature of the survey areas allowed ready access and reasonable visibility for any potential fauna within each site.

All large trees of suitable size were examined from the ground for the presence of hollows. Guidelines for the survey techniques for Black Cockatoo species (Dept. of Sustainability, Environment, Water Populations and Communities, 2011) state that all trees with a Diameter at Breast Height (DBH) of over 500m should be inspected. All of these trees were inspected, however only those with observable hollows or potential for hollows, or those with suitable foraging habitat or evidence of feeding activities, were recorded. It should be noted however, that all of the prerequisites that determine the suitability of a hollow for use by cockatoos is difficult to assess. In addition to entrance size, the depth, floor and orientation of the hollow are important factors. The presence of suitable hollows, even in breeding areas, does not make them available for breeding as hollows must be spatially, structurally and temporally correct (Johnstone and Johnston, 2004). The listing of potential nesting hollows is therefore likely to be an over estimation of those actually suitable.

4.5 Expected Fauna

A list of fauna expected to occur within a five kilometre radius of the five survey areas was compiled from conservation significant searches conducted on the WA Museum database and DBCA fauna

database (Nature Maps), Commonwealth's EPBC Act Protected Matters Search Tool and the Birds Australia Atlas project database.

The results of the native fauna database search for rare, threatened or endangered species likely to still be within or utilise the study area (comprising the five survey areas) are shown in Table 13[1]:

Table 13: Rare, Threatened or Endangered Species likely within the five survey areas.

Species	Common Name	Cwth Listing	WA Listing	Habitat	Eastern Link	Causeway Bridge	West-Strelly St	Fairway Dve	Ford Rd- Molloy St
Botaurus poiciloptilus	Australasian Bittern	Endangered	Endangered	Wetlands with tall dense vegetation, favours permanent and seasonal freshwater habitats, dominated by sedges rushes and reeds, growing over a muddy or peaty substrate	Unlikely	Unlikely	Possible	Unlikely	Known
Calyptorhynchus banksii subsp naso	Forest Red Tailed Black Cockatoo	Vulnerable	Vulnerable	Dense Jarrah, Karri and Marri Forests. Species nests in large hollows in these species	Unlikely	known	Unlikely	Unlikely	Unlikely
Calyptorhynchus baudinii	Baudin's White Tailed Black Cockatoo	Vulnerable	Endangered	Dense Jarrah, Karri and Marri Forests. Species nests in large hollows in these species	Possible	Unlikely	Possible	Possible	Possible
Calyptorhynchus latirostris	Carnaby's White Tailed Black Cockatoo	Endangered	Endangered	Dense Jarrah, Karri and Marri Forests. Species nests in large hollows in these species	Known	Unlikely	Possible	Possible	Possible
Dasyurus geoffroii	Chuditch	Vulnerable	Vulnerable	Variety, most dense in riparian jarrah forests. Require large unfragmented habitats	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely
Pseudocheirus occidentalis	Western Ringtail Possum	Vulnerable	Critically Endangered	Coastal Areas of Peppermint woodland and peppermint /tuart associations	Known	Known	Known	Known	Known
Phascogale tapoatafa subsp. wambenger	Southern Brush-Tailed Phascogale	Vulnerable	Conservation Dependant	Highly arboreal, prefers open forest with sparse groundcover.	Unlikely	Unlikely	Possible	Known	Unlikely

[1] Note marine and water based species were excluded due to the terrestrial/inland location of the study area.

Species	Common Name	Cwth Listing	WA Listing	Habitat	Eastern Link	Causeway Bridge	West-Strelly St	Fairway Dve	Ford Rd- Molloy St
Botaurus poiciloptilus	Australasian Bittern	Endangered	Endangered	Wetlands with tall dense vegetation, favours permanent and seasonal freshwater habitats, dominated by sedges rushes and reeds, growing over a muddy or peaty substrate	Unlikely	Unlikely	Possible	Unlikely	Known
Tyto novaehollandiae subsp. *novaehollandiae*	Masked Owl - southern subspecies	N/A	P3	Tall open eucapyt forest and woodlands. Preferred roosts large hollows in standing trees.	Unlikely	Unlikely	Possible	Possible	Unlikely
Isoodon obesulus subsp. *fusciventer*	Southern Brown Bandicoot	N/A	P4	Forest, woodland, shrub and heath, usually in sandy soils with dense healthy vegetation in lower stratum	Known	Possible	Possible	Possible	Possible
Oxyura australis	Blue Billed Duck	N/A	P4	Deep freshwater areas with dense vegetation.	Known	Known	Possible	Possible	Knownr
Hydromys chrysogaster	Water Rat	N/A	P4	Found near permanent fresh or brackish waters.	Possible	Possible	Possible	Possible	Unlikely

The following species are protected under international agreement or are specially protected bird fauna and have been noted within 5 km of the five survey areas. Table 14 shows their status and likelihood of inhabiting or utilising the five survey areas. Note that given the nature of the five survey areas, marine fauna have been excluded.

Table 14 Specially Protected, Migratory or other significant

Species	Common Name	Habitat	Eastern Link	Causeway Bridge	West-Strelly St	Fairway Dve	Ford rd- Molloy St
Falco peregrinus	Peregrine Falcon	Wide variety	Known	Known	Possible	Possible	Possible
Actitis hypoleucos	Common Sandpiper	Coastal wetlands and some inland wetland. Utilises muddy margins. Often associated with mangroves.	Possible	Unlikely	Possible	Possible	Possible
Anous stolidus subsp. pileatus	Common Noddy	Can nest in bushes, saltbush and other low vegetation, on grass or bare rock	Unlikely	Possible	Possible	Possible	Possible
Ardea ibis	Cattle Egret	Moist, low lying poorly drained pastures. Avoids low grass pastures. Roosts in trees or in ground vegetation near lakes.	Unlikely	Possible	Possible	Possible	Possible
Ardea modesta	Eastern Great Egret	Wide range of wetland habitats	Known	Known	Possible	Possible	Known
Calidris acuminata	Sharp-tailed Sandpiper	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergency sedges or other low vegetation.	Unlikely	Possible	Possible	Possible	Known
Calidris ruficollis	Red-necked Stint	Coastal Area, including sheltered inlets, bays and estuaries with intertidal mudflats.	Unlikely	Possible	Possible	Possible	Known
Calidris subminuta	Long-toed Stint	Variety of terrestrial wetlands. Preference is for shallow freshwater or brackish wetlands. Also prefers muddy shorelines.	known	known	Possible	Possible	Possible
Charadrius leschenaultii	Greater Sand Plover	Littoral and estuarine habitats, sheltered sandy, shelly or muddy beaches with intertidal mudflats and sandy estuarine lagoons.	Unlikely	Possible	Possible	Possible	Possible
Macronectes giganteus	Southern Giant Petrel	Marine bird occurs in subtropical waters	Unlikely	Unlikely	Unlikely	Unlikely	Unlikely

Species	Common Name	Habitat	Eastern Link	Causeway Bridge	West-Strelly St	Fairway Dve	Ford rd- Molloy St
Merops ornatus	Rainbow Bee-eater	Open forest, woodland and shrublands, and in various cleared or semi cleared areas	known	known	Possible	Possible	Known
Plegadis falcinellus	Glossy Ibis	Freshwater marshes at the edges of wetland areas. occasionally found in coastal locations such as estuaries	Known	Possible	Possible	Possible	Known
Pluvialis fulva	Pacific Golden Plover	Inhabits coastal habitats and forages on sandy or muddy shores of estuaries and lagoons,.	Possible	Possible	Possible	Possible	Possible
Sterna anaethetus subsp. anaethetus	Bridled Tern	Breeds on islands included vegetated coral cays, and rocks, rarely found inshore. Forager over offshore mid and continental shelf waters.	Possible	Possible	Possible	Possible	Possible
Tringa glareola	Wood Sandpiper	Well vegetated, shallow freshwater wetlands. Typically associated with emergent aquatic plants or grass, dominated by taller fringing vegetation.	Unlikely	Possible	Possible	Possible	Possible
Tringa nebularia	Common Greenshank	Sheltered coastal habitats, typically with large mudflats, and saltmarshes. Forages at the edges of wetlands in soft mud and in shallows around the edges of water along emergent or fringing vegetation	Known	Known	Possible	Possible	Possible
Tringa stagnatilis	Marsh Sandpiper	Permanent or ephemeral wetlands of varying salinity. Forages in shallow water at the edges and probe wet mud or feed among marshy vegetation.	Unlikely	Possible	Possible	Possible	Possible

4.6 Fauna Results and Discussion

4.6.1 Item A – Eastern Link & Item B – Causeway Bridge Duplication

The results of the day and night fauna survey at the Eastern Link and Causeway Bridge survey areas is presented in Map 9.

During the day survey, 6 areas of WRP scats were found, with one drey being observed. The trees in this area are old and have potential gaps or hollows in their lees which would provide WRP habitat.

During the nocturnal surveys , 4 WRP were found in Night 1 and 3 were found in Night 2. Their location is shown in Map 9.

All of these were found in the more dense vegetation around the Eastern Link area, although some scats near the Causeway Bridge site would indicate that the entire area is utilised by population of WRP.

Within both Item A – Eastern Link and Item B – Causeway bridge survey areas, trees known to provide food and roosting sites for black cockatoo species (for example Marri and Flooded Gums) were present, however there were no signs of foraging or feeding within the areas. There were no trees suitable for Black Cockatoo nesting habitat (i.e. there were no hollows) within either of the two sites, nor were any Black Cockatoos seen or heard during either of the dawn or dusk surveys.

Apart from the WRP observations, the field surveys at the Eastern Link and Causeway Bridge survey areas did not record any threatened, priority or migratory terrestrial vertebrate fauna species listed under Commonwealth or State legislation. No listed migratory birds were observed on either the Vasse River or the Vasse River Delta Wetlands within or adjacent to the two survey areas. Note however that the listed migratory bird species would not be expected to be present during August. Surveys between December to March would be more likely to confirm presence.

Historical data from DBCA show some migratory bird observations in this vicinity (e.g. *Ardea modesta*) however the better suited habitat areas are within the Vasse River Delta Wetlands and the Vasse Estuary further to the east, where summer water is present. Historical satellite imagery shows that the wetland area within this site, has the potential to dry out during summer/early autumn, which are key seasons for waterbird activity. This is likely to reduce these wetland areas suitability for habitat for waterbirds.

4.6.2 Items C & D: Strelly-Barlee-West Street Route & Duplication

The results of the day and night fauna surveys at the West-Strelly St survey areas are presented in Map 10.

Only a single drey was observed during the day survey in this site, which was found in a E. rudis in a street tree in Roe St, outside the Community Garden.

3 WRP were observed in Night 1, all in the vegetation off Fredrick St, Two animals were found in Night 2, one near the corner of West and Fredrick St, and one in a clump of Melaleuca behind the industrial area in the Roe St extension area. These data are shown in Map 10.

Trees known to provide food and roosting sites for black cockatoo species (for example Marri and Flooded Gums) were present, however there were no signs of foraging or feeding within the areas. There were no trees suitable for Black Cockatoo nesting habitat (i.e. there were no hollows) within the study area. Black cockatoos were heard at dusk passing over the site on both nights but none were found to roost or shelter within the site.

Apart from the WRP observations and Black Cockatoo calls, the field surveys at the West-Strelly St survey area did not record any threatened, priority or migratory terrestrial vertebrate fauna species listed under Commonwealth or State legislation. No listed migratory birds were observed on the New River within or adjacent to the survey area. Note however that the listed migratory bird species would not be expected to be present during August. Surveys between December to March would be more likely to confirm presence.

4.6.3 Item E – Fairway Drive Duplication

The results of the day and night fauna survey at the Fairway Drive survey area are presented in Map 10.

Within this survey area, 7 trees were found with a potential to have hollows suitable for Black Cockatoos and comply with the Guidelines for Black Cockatoos (Department of Sustainability, Environment, Water, Populations and Communities, 2011). These are shown in Map 11 and summarised in Table 15.

Table 15 Possible Black Cockatoo Habitat Tree Fairway Dve site

No	Easting	Northing	Species	DBH (mm)	Height	Heath	Notes
1	343880	6273404	Marri	690	11	Healthy	No obvious hollows
2	343883	6273375	Marri	760	11	Dead	Chimney Hollow
3	343907	6273406	Marri	760	17	Healthy	No obvious hollows
4	343907	6273438	Marri	1060	16	Healthy	No obvious hollows
5	343904	6273455	Marri	780	12	Healthy	No obvious hollows
6	343908	6273506	Marri	860	12	Healthy	Possible Hollows
7	343928	6273580	Marri	580	14	Healthy	Possible Hollows

Dawn and dusk survey revealed no Black cockatoos were utilising these trees during the survey period.

During the day survey, 7 dreys were observed and a single WRP was found. During Night 1, 7 WRP were seen throughout the site, and 6 were seen during Night 2.This is shown in Map 11.

This indicates there is a healthy population of Western Ringtail possums utilising the entire length of the site.

Apart from the WRP observations, the field surveys at the Fairway Dr survey area did not record any threatened, priority or migratory terrestrial vertebrate fauna species listed under Commonwealth or State legislation. No listed migratory birds were observed on the New River within or adjacent to the survey area.

4.6.4 Item F – Ford Rd Options 1 & 2: Molloy St Option

The field surveys at the Ford Rd-Molloy St survey area did not record any threatened, priority or migratory terrestrial vertebrate fauna species listed under Commonwealth or State legislation. No listed migratory birds were observed on the Vasse Estuary or Vasse River Delta Wetlands within or adjacent to the survey area. Accordingly there is no mapping presented of fauna records for the survey area.

Significant water bird species have been recorded at this survey area as evidenced by the DBCA database records, however during this survey, only common species (Pacific Black Duck (*Anas superciliosa*), Black Swans (*Cygus atratus*), Buff Banded Rail(*Gallirallus philippensis*), Purple Swamp Hen (*Porphyrio porphyrio*) and Australian Shelduck (*Tadorna tadornoides*)) were observed. Note however that the listed migratory bird species would not be expected to be present during August. Surveys between December to March would be more likely to confirm presence.

Black Cockatoos were heard to the south of the study area at dusk of both nights. These calls were from vegetation more than 500 m away (adjoining the Busselton Hockey Stadium) and not connected to the study area.

5 Significance

Under the EPBC Act, an action that has, will have, or is likely to have, a significant impact on a matter of national environmental significance, requires approval from the Minister. A significant impact is defined as an impact which is important or of consequence, having regard for its context or intensity (Commonwealth of Australia, 2009).

Matters of environmental significance are:

- Listed threatened species and ecological communities
- Migratory species protected under international agreements
- Ramsar wetlands of international importance
- The Commonwealth marine environment

- World Heritage properties
- National Heritage places
- Great Barrier Reef Marine Park, and
- Nuclear actions.

Three areas are potentially impacted within the five survey areas:

- Listed threatened species and ecological communities;
- Migratory Species protected under international agreements; and
- Ramsar Wetlands of International Importance.

Significant Impact Guidelines 1.1 (Commonwealth of Australia, 2013) lists significant impact criteria for the assessment for activities which may impact on threatened and migratory species and Ramsar Wetlands.

Table 16 describes these criteria as it relates to the five survey areas and the significant species that may potentially be impacted within their respective survey area.

Table 17 describes these criteria as it relates to the five survey areas and the ecological communities that may potentially be impacted within their respective survey area

Table 18 describes the criteria to define significant impact on listed migratory species as they related to the five survey areas and the species potentially impacted.

Table 19 describes the criteria to define significant impact on wetland of international importance as they relate to the survey areas.

Note that the specific details of what is proposed at each site is not known, and as such the full potential impact of the development cannot be determined. A 40 m clearing for the width of each road expansion is used to base the significant criteria upon.

Table 16: Significant Impact Criteria for Key Listed Species.

Significant Impact Criterion	Black Cockatoo Species	Western Ringtail Possum	*Caladenia procera*	Meets Criterion
Lead to a long term decrease in the size of an important population[2] of a species.	There was no evidence that any of the trees within the study areas are used as breeding or foraging habitat. Trees may be used opportunistically but higher quality nesting sites would be available within their large range, away from urban development.	WRP populations were found in all four of the five survey areas. DBCA records show a WRP in Molloy St within the Ford Road survey area. This was not found during this survey. Given the definition of "important population" the Fairway Drive site is likely to be considered an important populations and management will be required to ensure no decline in population occurs. All of the survey areas have suitable habitat adjoin the road areas and relocation of any animals into this habitat should not lead to a long term decline with appropriate management of the species during any vegetation modification. The population that exists in the Eastern Link and Causeway Bridge has connectivity along the Vasse River would not be considered important, given the quality of the habitat. However, any modification to these survey areas will need to consider maintaining this connectivity, via alternative techniques, if these were the chosen locations.	This species exists in the Fairway Drive survey area. The species is Critically Endangered. The exact location of the individuals within this survey area need to be determined in a spring flora survey, however it likely the widening of the road would lead to a decrease in the size of the population.	The Fairway Drive survey area contains a population of WRP that may be considered important. There are also populations of *Caladenia procera* within the survey area. The use of this survey area could be considered likely to lead to a decrease in these species and as such a referral should be made, if this site is the preferred option. The other sites have WRP present, however will appropriate management the proposal is unlikely to lead to a decrease in the population size.
Reduce the area of occupancy of an important population.	Will not impact on the area of occupancy of the current population.	Given width of each road expansion (40m), clearing in each survey area is unlikely to reduce the area of occupancy of an important population. However management will be required.	The exact location of the individuals of this population within the Fairway Drive survey area need to be determined to know if the occupancy of this population will be impacted by the development	More detail is needed for the location of Caladenia procera individuals for the Fairway Drive location, however for all the other survey areas, the area of occupancy of an important population is not likely.
Fragment an existing important population into two or more populations.	The species does not appear to utilise any of the sites. There were no evidence of feeding, roosting or nesting therefore the local population will not be fragmented.	The linear nature of most of the sites and the proximity of adjacent suitable habitat would mean that fragmentation will not occur. For the Causeway and Eastern Link populations, the vegetation/habitat along the Vasse River is the best within the population range and it is likely that they will use that vegetation to move through the landscape. The development of these two sites may fragment this population and alternative methods of maintaining connectivity will need to be employed (for example, rope bridges, fauna underpasses).	Unlikely to fragment the existing population.	The Causeway and Eastern Link

[2] *An 'important population' is a population that is necessary for a species' long-term survival and recovery.*

Significant Impact Criterion	Black Cockatoo Species	Western Ringtail Possum	*Caladenia procera*	Meets Criterion
Adversely affect habitat critical to the survival of a species.	None of the trees or vegetation appear to be presently being utilised by Black Cockatoos. Will not affect critical habitat.	While any of the proposals will impact upon habitat, it is unlikely that it will impact to the degree that will affect the survival of the species.	The exact location of the individuals within the Fairway Drive area need to be determined to quantify the potential impact on the species	
Disrupt the breeding cycle of an important population.	No breeding sites identified on site.	Unlikely to impact on the breeding cycle given small area within sites.	Will not disrupt the breeding cycle.	No
Modify, destroy, remove or isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline.	It is unlikely that the species is present on the site No impact is anticipated.	No impact is anticipated provided management of animals is conducted during any clearing.	The exact location of the individuals within the Fairway Drive area need to be determined to quantify the potential impact on the species.	Depending upon the results of a spring survey along Fairway Drive, there is a potential that this proposal may impact on Caladenia procera to the extent that the species may decline. For the other survey areas, the proposals would not impact the species to the point that the species would decline.
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat.	Any introductions highly unlikely to have any impact on species.	Any introductions highly unlikely to have any impact on species.	Any introductions highly unlikely to have any impact on species.	No
Introduce disease that may cause the species to decline.	Highly unlikely to occur.	Highly unlikely to occur.	Highly unlikely to occur.	No
Interfere substantially with the recovery of the species.	Development will not impact on the recovery of the species.	Development will not impact on the recovery of the species.	The exact location of the individuals within the Fairway Drive area need to be determined to quantify the potential impact on the species.	Apart from Fairway Drive area, the development is unlikely to substantially interfere with the recovery of any species. The exact location of individuals with the Fairway drive survey area need to be determined and correlated to the specific extent of disturbance proposed to determine if there will be a substantial impact.

Using these criteria, any proposed development in the Fairway Drive, Causeway Bridge and Eastern Link survey areas would require a referral under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) as the potential actions may be determined significant upon two endangered species, Western Ringtail Possums and *Caladenia procera*.

Table 17: Significant Impact Criteria for Commonwealth listed Ecological Communities.

Significant Impact Criterion	Banksia Woodlands of the SCP	Subtropical & Temperate Coastal Saltmarsh	Meets Criterion
Reduce the extent of an ecological community.	No evidence that the community exists in any of the five study areas.	Three of the five study areas are likely to contain this TEC: Eastern Link, Strelly-West St and Ford Rd/Molloy St. Any development in these areas will likely reduce the current extent of those communities.	The following study areas meet this criterion for Subtropical and Temperate Coastal Saltmarsh Communities; • Item A – Eastern Link; • Items C & D – Strelly-West St; and • Item F – Ford Rd/Molloy St options
Fragment or increase fragmentation of an ecological community	No evidence that the community exists in any of the five study areas.	The Eastern Link and Strelly- West St study areas will impact on the edges of the community and are unlikely to fragment them in these locations. The Ford Rd/Molloy St study area proposal is likely to fragment this community.	Item F – Ford Rd/Molloy St meet this criterion for Subtropical and Temperate Coastal Saltmarsh Communities.
Adversely affect habitat critical to the survival of an ecological community.	No evidence that the community exists in any of the five study areas.	Little is known of the biology and ecology of this community. If the proposed development occurs within the thee study areas that contain this community, it is difficult to determine if the small areas of impact will critically affect the survival of this community.	Uncertain, however using the Precautionary Principle, it would be prudent to assume this criterion is met in the three known study areas.
Modify or destroy abiotic factors (such as water, nutrients or soil) necessary for an ecological communities survival, including reduction of groundwater levels or substantial alteration of surface water drainage patterns.	No evidence that the community exists in any of the five study areas.	Little is known on the full suite of requirements necessary for this community's survival. There is a potential for works in the three likely location may impact on groundwater/surface water or other abiotic factors.	Likely to impact but the degree to which this element meets this criteria is unclear. Using the Precautionary Principle, it would be prudent to assume this criterion is met in the three known study areas.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionally important species.	No evidence that the community exists in any of the five study areas.	Within those study areas where the community exists, the proposal will require the reduction of extent of the community not necessarily a change in the composition of the community.	Unlikely to meet this criterion.
Cause a substantial reduction in the quality or integrity of an occurrence of an ecological community, including: • Assisting invasive species to become established; or • Causing regular mobilisation of fertilisers, herbicide or other chemicals or pollutants into the community.	No evidence that the community exists in any of the five study areas.	Proposal will require the reduction of extent of the community. The addition of roads thought these areas may increase the potential for invasion by grass weed or other introduced plant species. Consequently, herbicide use that would result may potential impact on the community.	Uncertain, however using the Precautionary Principle, it would be prudent to assume this criterion is met in the three known study areas.
Interfere with the recovery of an ecological community.	No evidence that the community exists in any of the five study areas.	Little detail is known on the ecology/biology and interactions within this community. Only a small area (up to 40 m wide) is proposed and the degree to which this would impact on the recovery of the community is unclear	Uncertain, however using the Precautionary Principle, it would be prudent to assume this criterion is met in the three known study areas.

Using these criteria, any proposed development in the Fairway Drive, Causeway Bridge and Eastern Link survey areas would require a referral under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) as the potential actions may be determined significant upon the TEC : Subtropical & Temperate Coastal Saltmarsh

Table 18: Significant Impact Criteria for Migratory or other Protected Species.

Significant Impact Criterion	Discussion	Meets Criterion
Substantially modify (including fragmenting, altering fire regimes, altering nutrient cycles or altering hydrological cycles), destroy or isolate an area of important habitat for a migratory species.	The New River, the Vasse River Delta wetlands and the Vasse Estuary are known areas for migratory waterbird. None of these were observed during the surveys conducted for this project, however it should be assumed that a number of the species still utilises these wetland systems. Items A and B are within the highly modified and degraded riverine habitat areas, it is unlikely that any activities in these two survey areas would significantly impact upon any migratory species. Items E would cross the New River system and there is a potentially for activities to impact on these species, although none were observed during this survey. Item F is directly adjoining the Vasse Wonnerup Estuary and wetland system which is known to provide habitat for these species. The proposed activities int Items E and F, while able to be managed to minimise or mitigate impacts have the potential to modify habitat for these species.	Yes for the following study areas: • Item E – Fairway Drive; and • Item F -Ford Rd/Molloy St sites
Result in an invasive species that is harmful to the migratory species becoming established in an area of important habitat for the migratory species	Non-native plants and issues such as Phytophthora dieback have the potential to be spread during construction activities, however many of the areas are already degraded through grass and other introduced weeds, which do not seem to have a significant impact on the known species Management and Hygiene procedures can be implemented to minimise any impacts.	Unlikely
Seriously disrupt the lifecycle (breeding, feeding, migration or resting behaviour) of an ecologically significant proportion of the population of a migratory species.	Many of the species do not utilise the study areas consistently throughout the year. Works could be planned and times to minimise impact on targeted species to the point where it could not seriously disrupt the lifecycle for a significant proportion of the population of a migratory species	Unlikely, however would depend upon timing and targeted location.

Using these criteria, any proposed development in the Fairway Drive and Ford Road/Molloy St survey areas would require a referral under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) as the potential actions may be determined significant upon the known populations of Migratory or other protected species present in those study areas.

Table 19: Significant Impact Criteria for Wetlands of International Importance.

Significant Impact Criterion	Discussion	Meets Criterion
Areas of the wetland being destroyed or substantially modified.	The Ford Rd/Molly St study area on on the western most edge of the Vasse Wonnerup Estuary system. While the area is degraded with introduced plant species The construction of a road way has the potential to modify the western edge of the wetland	The study area is on the western boundary of the Ramsar site. The establishment of a road will likely have the potential to modify or impact on the wetland, albeit with management and mitigation measures in place. It would be prudent to assume that this criterion will be met.
A substantial and measurable change in the hydrological regime of the wetland.	The construction of any road through the Ford Rd would cause temporary changes in the hydrological regime, however it would not be considered to be substantial or significantly measurable over time	No
The habitat or lifecycle of native species, including vertebrate fauna and fish species, dependent upon the wetland being seriously affected.	The Ecological Character Description for the Vasse- Wonnerup Wetland (Wetland Research & Management, 2007) describes the native species within the wetland. The area is known as an important site for migratory species as well and breeding ground for local bird species. The degree of potential impact on these from any construction in this study area is beyond the scope of this initial report however there is the potential to impact both avifauna and other wetland fauna species, albeit this could be minimised with appropriate management and timing.	Likely to impact but the degree to which this would seriously affect species is unclear. Using the Precautionary Principle, it would be prudent to assume this criterion is met in the Ford Rd/Molly St study area..
A substantial and measurable change in the water quality of the wetland (e.g. salinity , pollutant, nutrients, water temperature) which may adversely impact on biodiversity, ecological integrity, social amenity or human health.	The degree to which any works in the Ford Rd/Molly St study area will impact on the water quality is beyond the scope of this level 1 flora, fauna and vegetation report. Further information and input will be required.	More data is required on water quality and flow on effects before determination on this criterion can be made.
An invasive species that is harmful to the ecological character of the wetland being established (or an existing species being spread).	Non-native plants and issues such as Phytophthora dieback have the potential to be spread during construction activities, however many of the areas are already degraded through grass and other introduced weeds, which do not seem to have a significant impact on the known species Management and Hygiene procedures can be implemented to minimise any impacts.	Unlikely

Using these criteria, any proposed development in the Ford Road/Molloy St survey areas would require a referral under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) as the potential actions may be determined significant upon the Internationally Important Wetland in the Vasse Wonnerup Wetland System, which abuts the Ford Rd study area. Note further speciality information on water quality and hydrological impacts from any development in this study area will be required as part of the referral to ensure all criterion are addressed.

Referral guidelines for three threatened Black Cockatoo species (Dept. of Sustainability, Environment, Water Populations and Communities, 2011) uses a decision tree and a set of criteria to determine whether actions significantly impact on Black Cockatoos. These are set out below based on the details of the development and the data obtained from the surveys. Notes on the flow chart follow.

Question	Answer	High Risk of Significance – Referral Recommended
1. Could the impacts of your action occur within the modelled distribution of the Black Cockatoos?	Yes – Action occurs within the distribution area of all three species.	• Clearing of any known nesting tree • Clearing of any part or degradation of breeding habitat • Clearing more than 1ha of quality foraging habitat • Creating a gap of greater than 4 km between patches of habitat • Clearing or degradation of known roosting site.
2. Could the impacts of your action affect any Black Cockatoo habitat or individuals?	Unlikely. No signs of animal utilisation in the survey areas, or activity in or around the site were found. Trees that met criteria were observed and no activity found.	**Uncertainty – Referral Recommended or contact Department**
3. Have you surveyed for Black Cockatoos using the recommended methods?	Yes	• Degradation of more than 1 ha of foraging habitat. • Clearing or disturbance in areas surrounding habitat that has the potential to degrade through introduction of threats. • Actions that do not directly affect species but have potential to introduce indirect impacts. • Actions with potential to introduce known plant diseases.
4. Could your actions have an impact on Black Cockatoos or their habitats?	No. No signs of animal activity was found within the five survey areas.	**Low risk of significant impacts – referral may not be required.**
5. Is your impact mitigation best practice so that it may reduce the significance of your impacts on Black Cockatoos?	No significant impact is anticipated due to lack of evidence of activity on any of the five survey areas.	• Actions that do not affect Black Cockatoo habitat or individuals • Actions whose impact occurs outside modelled distribution.
6. Could your action require a referral to the federal environmental Minister for significant impact on Black Cockatoos?	No. As there are no signs of any of the three species present within or adjoining the five survey areas, It is unlikely that the species is dependent on any of the five survey areas.	

The summary of these responses are:

1- The development is within the area of modelled distribution of Black Cockatoo species.
2- The type of proposed actions within the Busselton Strategic Network Corridor study area could impact Black Cockatoo individuals or habitat. However, all five survey sites contain less than 1 ha of low quality foraging habitat and no known or observable nesting trees. The narrow width of any proposed development of roads/bridges are unlikely to significantly degrade surrounding habitat values. The animals may utilise survey areas opportunistically rather than habitually.
3- The proposed areas have been surveyed using the recommended methods from the guideline.
4- It is unlikely that any actions for the proposed road or bridge upgrades will impact on any animals or habitat as no evidence of use or visitation by the species were found on any of the five survey sites. Trees with hollows that met the criteria were noted and were observed with no activity. There was no sign of feeding or roosting within any of the site.
5- No evidence within any of the five survey areas of utilisation and the unlikely presence of any of the three species of Black Cockatoos, except opportunistically as part of their range, would mean that no mitigation measures are required.
6- Using the flow chart and criteria it is determined that there is a low risk of actions resulting in an impact upon Black Cockatoos within the five survey areas.

8- Summary and Recommendations

This project is designed to provide a broad overview of the significance values of a number of sites. These are summarised in Table 13

Table 20 Summary of Significance Values

Site	Flora/Vegetation	Fauna
Item A- Eastern Link	Potential to contain Coastal Saltmarsh EPBC listed TEC (WA Listed PEC)	Contains populations of WRP Does not comprise significant Black Cockatoo habit. Potential to impact migratory species habitat.
Item B – Causeway Bridge Duplication	No significant values observed	Area is utilised by WRP, however none observed during survey. Does not comprise significant Black Cockatoo habitat. Potential to impact migratory species habitat
Items C & D – Strelly/West	Potential to contain Coastal Saltmarsh EPBC listed TEC(WA Listed PEC)	Contains populations of WRP Does not comprise significant Black Cockatoo habit. Unlikely to compromise significant migratory species habitat
Item E – Fairway Drive	Contains E. rudis TEC and DRF Caladenia procera (though not found during survey)	Contains significant populations of WRP Does not comprise significant Black Cockatoo habit. Potential to impact migratory species habitat
Item F - Ford Rd Options	Likely to contain Coastal Saltmarsh EPBC listed TEC(WA Listed PEC)	Potential to impact significant migratory species habitat .

Based on the results of the analysis of the five survey areas, the following conclusions and recommendations are made.

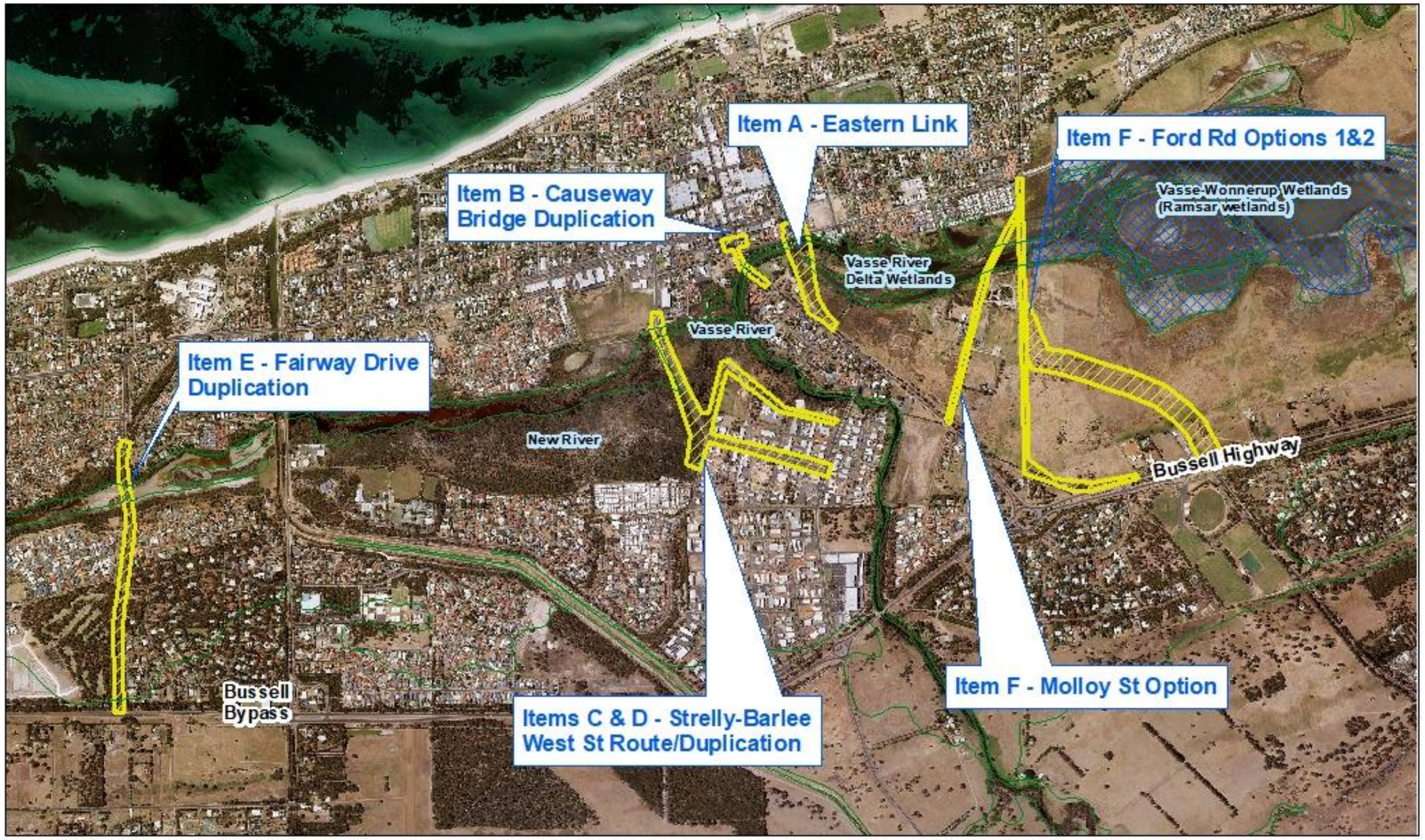
- The vegetation and habitat of the five survey areas vary in condition, however many do contain significant values.
- No threatened or priority flora species listed under Commonwealth or State legislation were observed in any of the five survey areas, however *Caladenia procera* is known from Item E Fairway Drive survey area although it was not in its flowering period and observable during this survey. DBCA records show *Calystegia sepium*, a priority species in the north. This is outside of the footprint of this study area, however the area was searched and this species was not found during the survey.
- All five survey areas contain vegetation classified as Quindalup or Ludlow vegetation, Fairway Drive has Ludlow vegetation which is highly cleared.
- Four of the six areas have populations of WRP, with one other having signs that the species utilises this site. The vegetation within Item A – Eastern Link and Item B – Causeway Bridge Duplication supports connectivity for a population and Item E – Fairway Drive contains a significant population of WRP. Any impacts on these areas should be referred to the Commonwealth under the EPCA Act.
- No Black Cockatoo species were observed in any of the five study areas.
- There are no signs of feeding, nesting or roosting by Black Cockatoos species within any of the five study areas..
- Black cockatoo species are highly mobile and it is highly unlikely they would utilise any of the five survey areas as a feeding, roosting or nesting site.

Given the above information, a referral to under the EPBC Act should occur for any disturbance to the following sites:

- Item A: Eastern Link – Coastal Saltmarsh EPBC listed TEC(WA Listed PEC), Potential impact on migratory species habitat.
- Item B: Causeway Bridge Duplication - Potential impact on migratory species habitat.
- Items C & D West-Strelly St - Coastal Saltmarsh EPBC listed TEC(WA Listed PEC) and WRP impacts
- Item E -Fairway Drive – E rudis WA listed PEC, DRF Caladenia procera and significant population of WRP, Potential impact on migratory species habitat
- Item F - Ford Rd/Molloy Rd sites -Coastal Saltmarsh EPBC listed TEC(WA Listed PEC), Potential impact on migratory species habitat, potential impact on Vasse Wonnerup Ramsar listed wetland system

.

6 Maps



Map 1: Project Sites Project Address: City of Busselton

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:23,000

Meters
0 110 220 440 660 880

Legend

- Study Areas
- Vasse-Wonnerup Ramsar Site

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Map 2: Item A: Eastern Link Vegetation Groups **Project Address: City of Busselton**

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:3,500

0 15 30 60 90 120 Meters

Eastern Link Boundary
Elevation (m)

Vegetation Groups
Vegetation 1
Vegetation 2
Vegetation 3
Vegetation 4

Flora Database
Threatened
Priority 1
Priority 2
Priority 3
Priority 4

TEC/PEC Results
Erudis, Marri & Peppermint Forest (P1)
Subtropical and Temperate Coastal Saltmarsh

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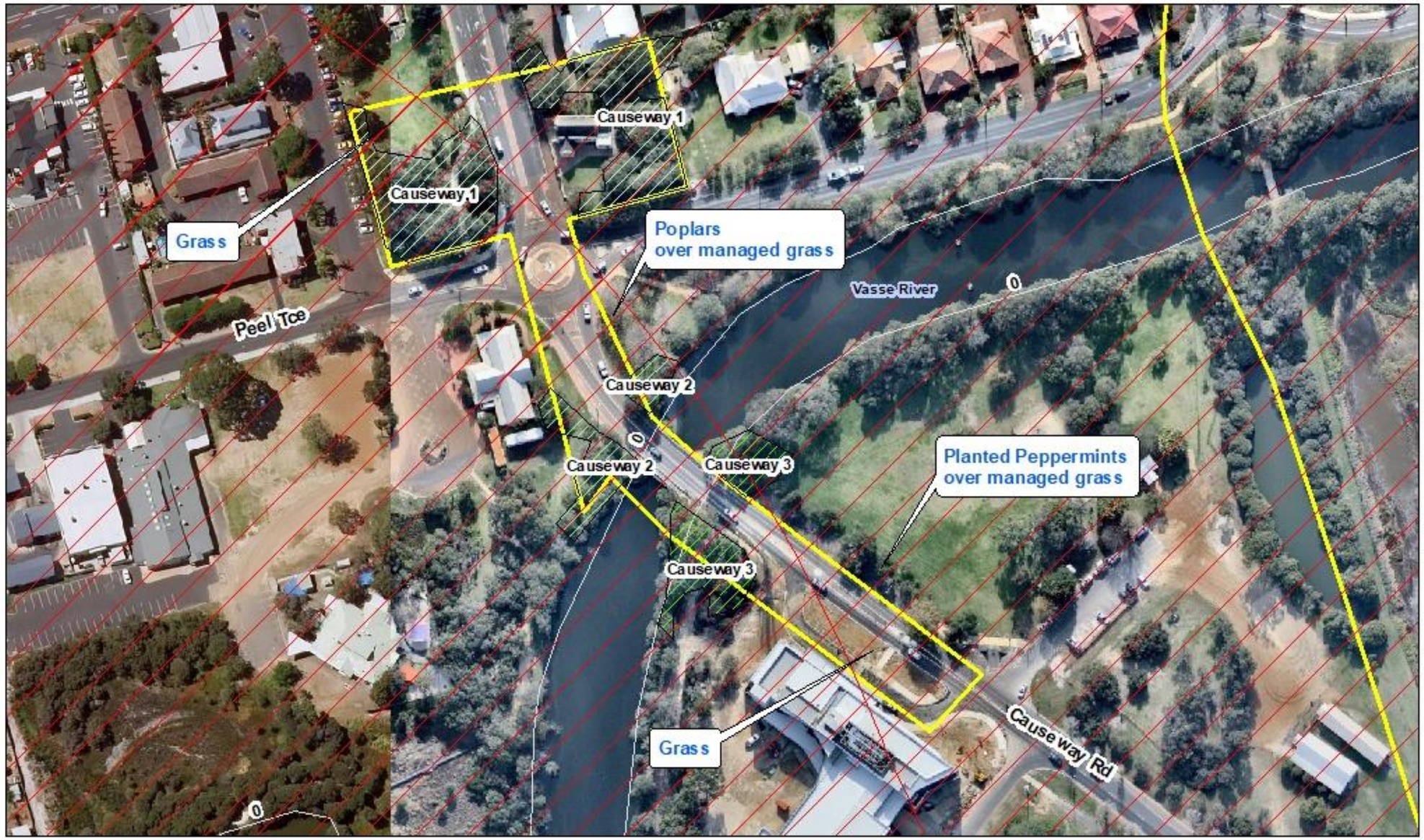

Map 3:Item B: Causeway Duplication Vegetation Groups **Project Address: City of Busselton**

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:3,500

0 5 10 20 30 40 Meters

Study Area
Elevation (m)
Vegetation
Causeway 1
Causeway 2
Causeway 3

Flora Database
Threatened
Priority 1
Priority 2
Priority 3
Priority 4

TEC/PEC Results
E rudis, Marri, Peppermint P1
Subtropical and Temperate Coastal Saltmarsh

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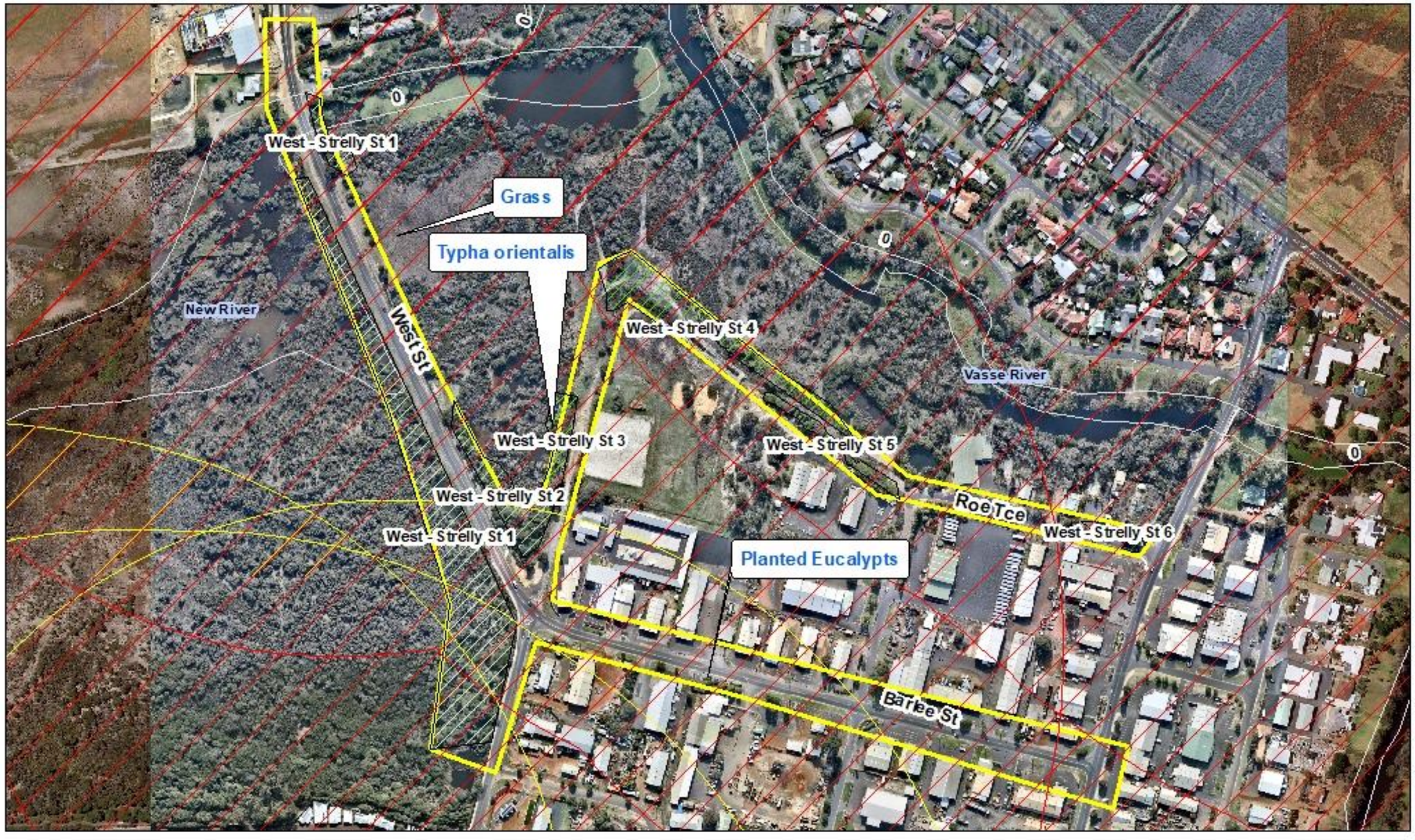

Map 4: Items C & D West-Strelly St Vegetation Groups **Project Address: City of Busselton**

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:4,500

0 20 40 80 120 160 Meters

Vegetation Groups

Fredrick St West St Boundary
Elevation (m)
West - Strelly St 1
West - Strelly St 2
West - Strelly St 3
West - Strelly St 4
West - Strelly St 5
West - Strelly St 6

Flora Database TEC/PEC Results

Threatened
Priority 1
Priority 2
Priority 3
Priority 4
Eruda, Warri, Peppermint Pl
Subtropical and Temperate Coastal Saltmarsh

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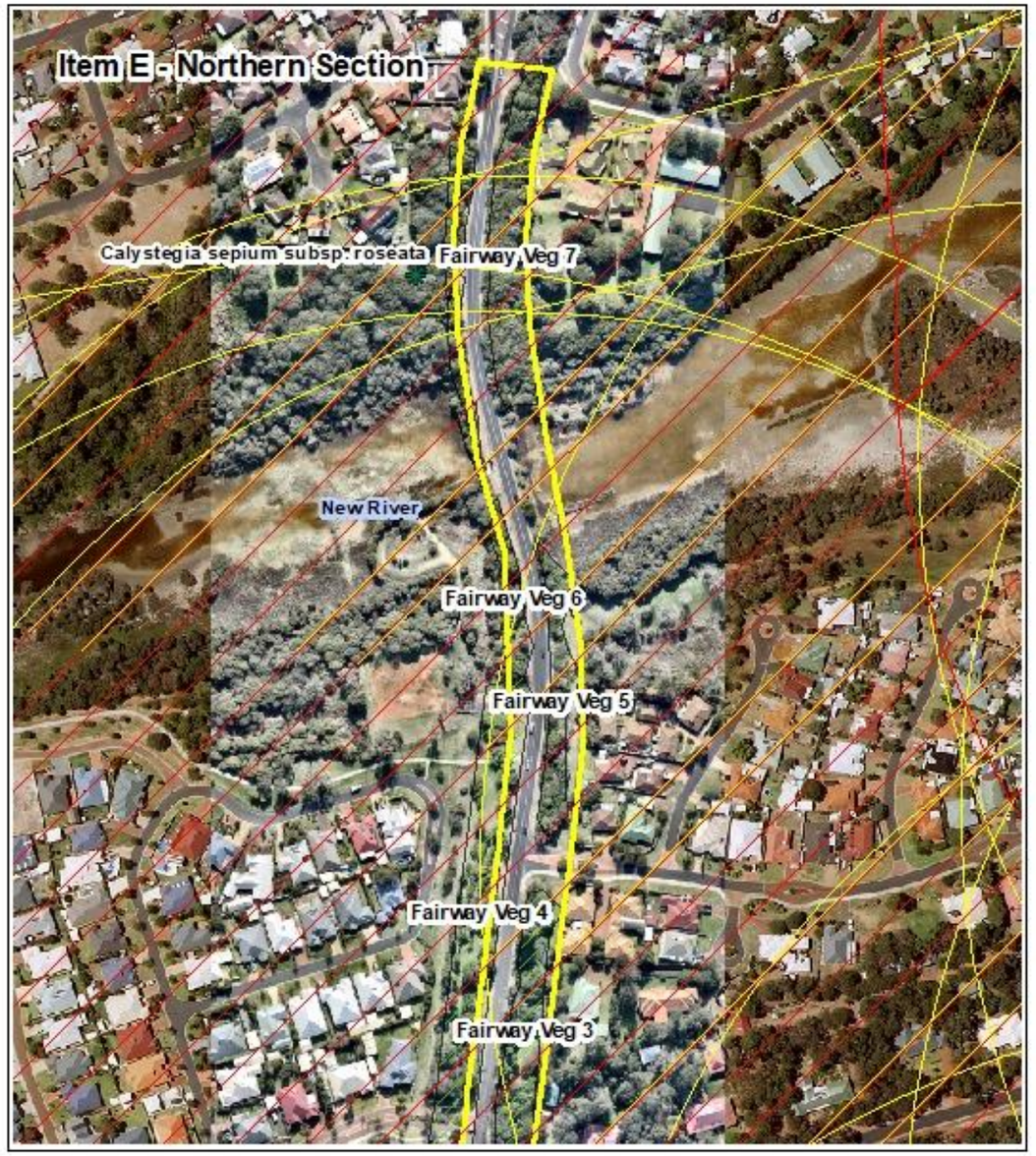

Map 5: Item E Fairway Drive Vegetation Groups **Project Address: City of Busselton**

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:4,000

0 20 40 80 120 160 Meters

Survey Area
Elevation (m)
Fairway Veg 1
Fairway Veg 2
Fairway Veg 3
Fairway Veg 4
Fairway Veg 5
Fairway Veg 6
Fairway Veg 7

Flora Database TEC/PEC Results
Threatened
Priority 1
Priority 2
Priority 3
Priority 4
E rudis, Marri, Peppermint P1
Subtropical and Temperate Coastal Saltmarsh

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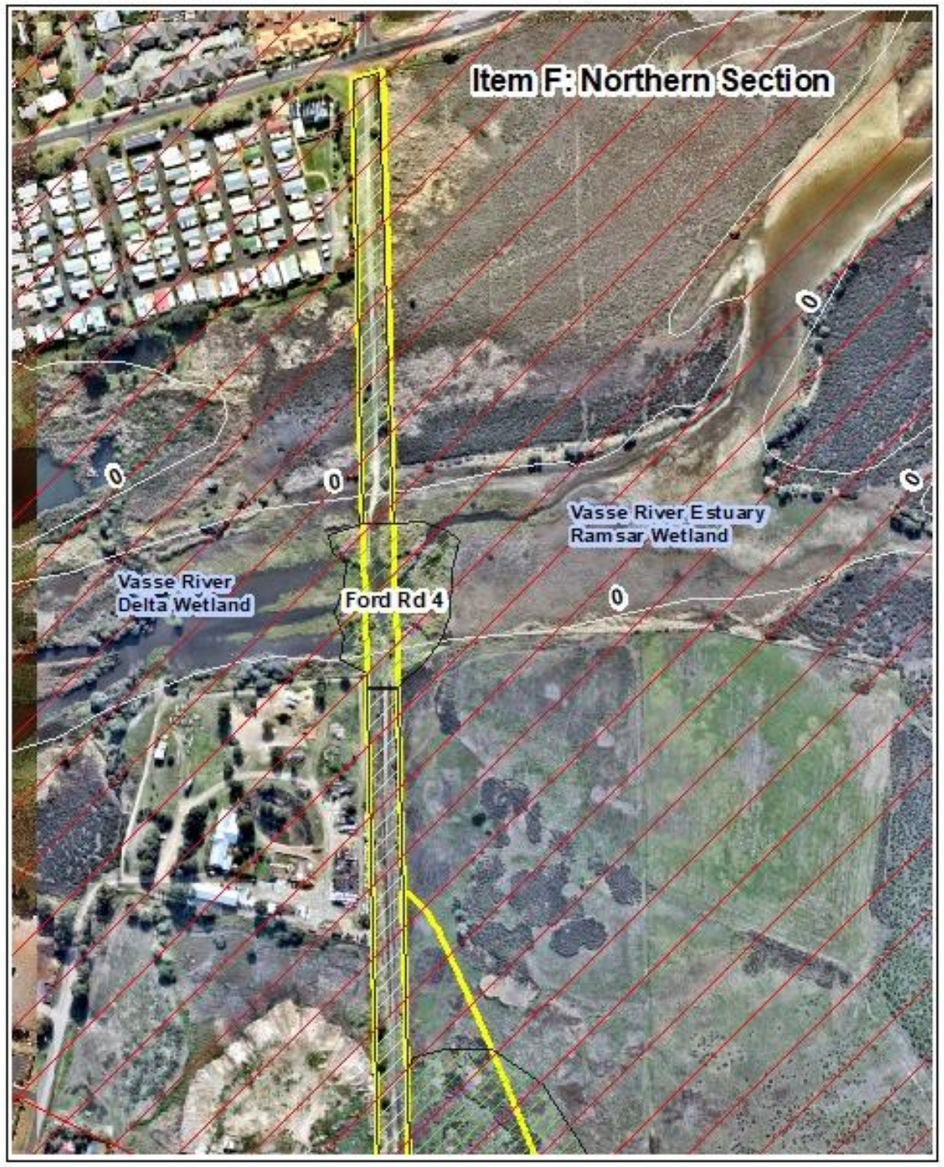

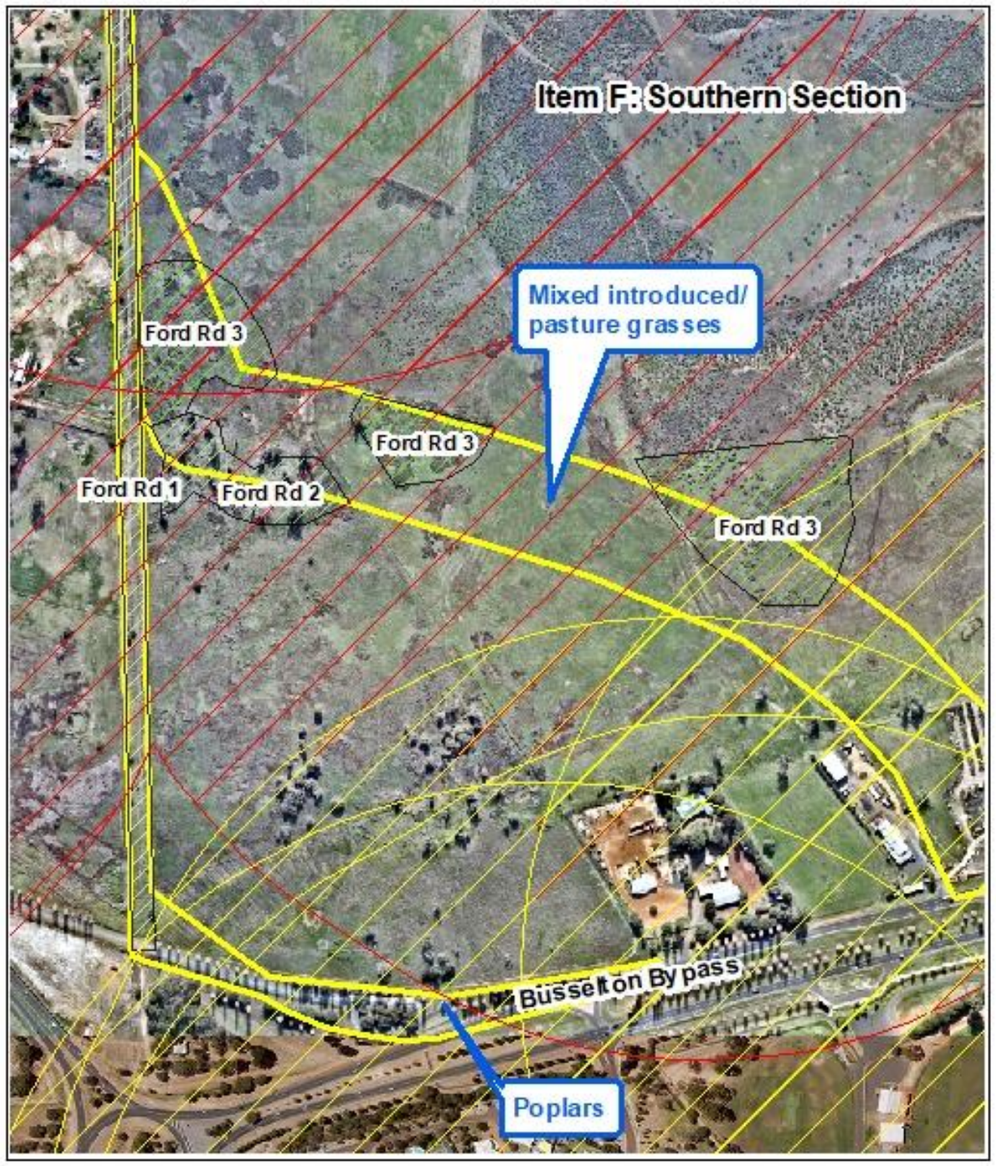

Map 6: Item F - Ford Road Options 1 & 2 Vegetation Groups

Project Address: City of Busselton

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:6,500

0 20 40 80 120 160 Meters

Survey Area
Elevation (m)

Vegetation Groups
- Ford Rd 1
- Ford Rd 2
- Ford Rd 3
- Ford Rd 4

Flora Database
- Threatened
- Priority 1
- Priority 2
- Priority 3
- Priority 4

TEC/PEC Results
- Eruclis, Marri, Peppermint P1
- Subtropical and Temperate Coastal Saltmarsh

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Map 7: Item F- Ford Rd/Molloy St Option **Project Address: City of Busselton**

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:3,500

0 15 30 60 90 120 Meters

Survey Area
Elevation (m)
Ramsar Boundary

Vegetation Groups Flora Database TEC/PEC Results
Molloy St 1
Molloy St 2
Molloy St 3
Molloy St 4
Threatened
Priority 1
Priority 2
Priority 3
Priority 4
E rudis, Marri, Peppermint P1
Subtropical and Temperate Coastal Saltmarsh

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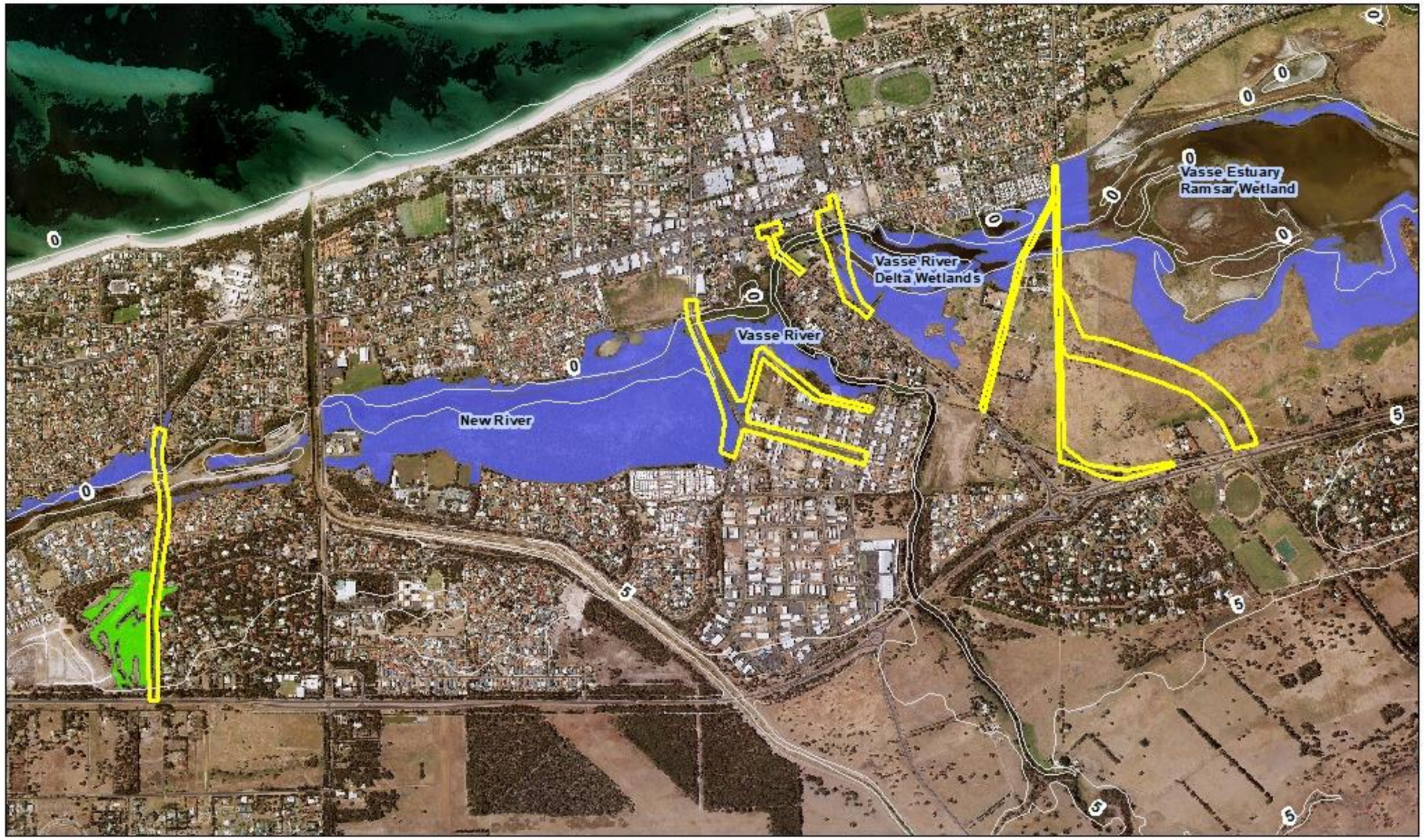

Map 8:Vegetation Complexes (Heddle et al, 1980) **Project Address: City of Busselton**

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:23,000

0 110 220 440 660 880 Meters

Study Areas

Vegetation Association

- Ludlow
- Quindalup

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Map 9: Item A Eastern Link & Item B Causeway Bridge Fauna Survey **Project Address: City of Busselton**

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:3,500

0 15 30 60 90 120 Meters

DBCA Database Records

Survey Areas
Elevation (m)
Fauna Observed
Drey
Soak
WRP Night 1
WRP Night 2
WRP
Critically Endangered
Endangered
Vulnerable
Priority 3
Priority 4
Conservation Dependant
Other Specially Protected
Endangered Migratory Birds
Vulnerable Migratory Birds
Migratory Birds P4
Migratory Birds

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Map 10: Item C & D West- Strelley St Fauna Survey Project Address: City of Busselton

Map 11: Item F Fairway Drive Fauna Survey **Project Address: City of Busselton**

Projection - MGA50
Datum - GDA94
June 2017
Prepared by G McMahon
Our Ref: 17365

N

Scale: 1:4,000

0 37.5 75 150 225 300 Meters

Study Area
Elevation (m)
Hollow Bearing Tree
Drey
WRP Day Survey
WRP Night 1
WRP Night 2

DBCA Database Records

WRP
Critically Endangered
Endangered
Vulnerable
Priority 3
Priority 4
Conservation Dependant
Other Specially Protected
Endangered Migratory Birds
Vulnerable Migratory Birds
Migratory Birds P4
Migratory Birds

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Appendix A Species found in surveys

Family	Species	Item A - Eastern Link	Item B - Causeway Bridge Duplication	Item C&D - Strelly, Barlee, West St	Item E - Fairway Drive Duplication	Item F - Ford Rd Options 1 & 2 & Molloy St.
Anthericaceae	Sowerbaea laxiflora				✓	
Araceae	*Zantedeschia aethiopica	✓	✓	✓	✓	✓
Asparagaceae	Lomandra spp				✓	
Asteraceae	*Arctotheca calendula	✓	✓	✓	✓	✓
Asteraceae	*Hypochaeris radicata	✓	✓		✓	✓
Casuarinaceae	Allocasuarina fraseriana			✓		
Chenopodiaceae	Sarcocornia quinqueflora	✓				✓
Chenopodiaceae	Suaeda australis	✓				✓
Chenopodiaceae	Tecticornia indica	✓				✓
Cupressaceae	Callitris preissii				✓	
Cupressaceae	Callitris spp				✓	
Cyperaceae	*Carex divisa	✓				✓
Cyperaceae	Bolboschoenus caldwellii	✓				✓
Cyperaceae	Ficinia nodosa			✓	✓	
Cyperaceae	Gahnia trifida			✓		
Cyperaceae	Lepidosperma gladiatum		✓		✓	✓
Cyperaceae	Lepidosperma squamatum				✓	
Dilleniaceae	Hibbertia furfuracea				✓	
Fabaceae	*Acacia iteaphylla				✓	
Fabaceae	Acacia cochlearis			✓		
Fabaceae	Acacia divergens	✓		✓	✓	✓
Fabaceae	Acacia littoralis			✓	✓	✓
Fabaceae	Acacia saligna			✓	✓	✓
Haemodoraceae	Conostylis candicans				✓	

Family	Species	Item A - Eastern Link	Item B - Causeway Bridge Duplication	Item C&D - Strelly, Barlee, West St	Item E - Fairway Drive Duplication	Item F - Ford Rd Options 1 & 2 & Molloy St.
Hemerocallidaceae	Dianella revoluta			✓		
Iridaceae	Patersonia umbrosa				✓	
Iridaceae	Sparaxis spp				✓	✓
Juncaceae	Juncus kraussii	✓	✓			✓
Juncaceae	Juncus preissii	✓	✓			✓
Lauraceae	Cassytha racemosa			✓	✓	
Myrtaceae	Agonis flexuosa	✓	✓			✓
Myrtaceae	Callistemon spp.			✓		
Myrtaceae	Corymbia calophylla	✓	✓	✓	✓	
Myrtaceae	Eucalyptus cornuta	✓			✓	
Myrtaceae	Eucalyptus rudis	✓	✓		✓	
Myrtaceae	Hypocalymma angustifolium				✓	
Myrtaceae	Melaleuca cuticularis	✓				
Myrtaceae	Melaleuca preissii	✓				
Myrtaceae	Melaleuca rhaphiophylla	✓	✓		✓	✓
Myrtaceae	Melaleuca viminea	✓			✓	
Orchidaceae	Caladenia latifolia				✓	
Papilionaceae	Hardenbergia comptoniana				✓	
Phyllanthaceae	Phyllanthus calycinus				✓	
Pittosporaceae	*Pittosporum undulatum			✓		✓
Poaceae	*Avena fatua	✓	✓	✓		
Poaceae	*Avena fatua	✓			✓	✓
Poaceae	*Cynodon dactylon	✓	✓			✓
Poaceae	*Lolium multiflorum			✓		✓

Family	Species	Item A - Eastern Link	Item B - Causeway Bridge Duplication	Item C&D - Strelly, Barlee, West St	Item E - Fairway Drive Duplication	Item F - Ford Rd Options 1 & 2 & Molloy St.
Poaceae	*Paspalum vaginatum	✓				✓
Poaceae	*Cenchrus clandestinum	✓				✓
Poaceae	Briza minima	✓	✓	✓	✓	✓
Proteaceae	Banksia littoralis				✓	
Typhaceae	*Typha orientalis			✓		✓
Xanthorrhoeaceae	Xanthorrhoea gracilis				✓	
Xanthorrhoeaceae	Xanthorrhoea preissii				✓	

Appendix B Vegetation Classification Under Muir (1977) & Aplin (1979)

Stratum	Canopy Cover				
	70%-100%	30%-70%	10%-30%	2%-10%	<2%
Trees > 30m	Tall Closed Forest	Tall Open Forest	Tall Woodland	Tall Open Woodland	Scattered Tall Trees
Trees 10-30m	Closed Forest	Open Forest	Woodland	Open Woodland	Scattered Trees
Trees < 10m	Low Closed Forest	Low Open Forest	Low Woodland	Low Open Woodland	Scattered Low Trees
Shrubs >2m	Tall Closed Scrub	Tall Open Scrub	Tall Shrubland	Tall Open Shrubland	Scattered Tall Shrubs
Shrubs 1-2m	Closed Heath	Open Heath	Shrubland	Open Shrubland	Scattered Shrubs
Shrubs <1m	Low Closed Heath	Low Open Heath	Low Shrubland	Low Open Shrubland	Scattered Low Shrubs
Hummock Grasses	Closed Hummock Grassland	Mid-Dense Hummock Grasslands	Hummock Grassland	Open Hummock Grassland	Scattered Hummock Grassland
Grasses, Sedges & Herbs	Closed Tussock Grassland/ Sedgeland/ Herbland	Tussock Grassland/ Sedgeland/ Herbland	Open Tussock Grassland/ Sedgeland/ Herbland	Very Open Tussock Grassland/ Sedgeland/ Herbland	Scattered Tussock Grassland/ Sedgeland/ Herbland

Appendix C Keighery Vegetation Condition Classification

Category	Description
Pristine	Pristine or nearly so, no obvious signs of destruction.
Excellent	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species. For example damage to trees caused by fire, the presence of non-aggressive weeds and occasional vehicle track.
Very Good	Vegetation structure altered, No obvious signs of disturbance. For example disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing.
Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate to it. For example disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration, but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
Completely Degraded	The structure of the vegetation in 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 composing weed or crop species with isolated native trees or shrubs.

Level 1, 50 Subiaco Square Road Subiaco WA 6008 PO Box 243 Subiaco WA 6904
Phone (08) 9380 3100 Fax (08) 9380 4606
177 Spencer Street Bunbury WA 6230 PO Box 287 Bunbury WA 6231
Phone (08) 9792 4797 Fax (08) 9792 4708

To: Daniell Abrahamse

Date: 11 December 2017

Company: City of Busselton

Project No: CIB16605.01

Fax/email: *Daniell.Abrahamse@busselton.wa.gov.au*

Inquiries: Heath Morgan

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.

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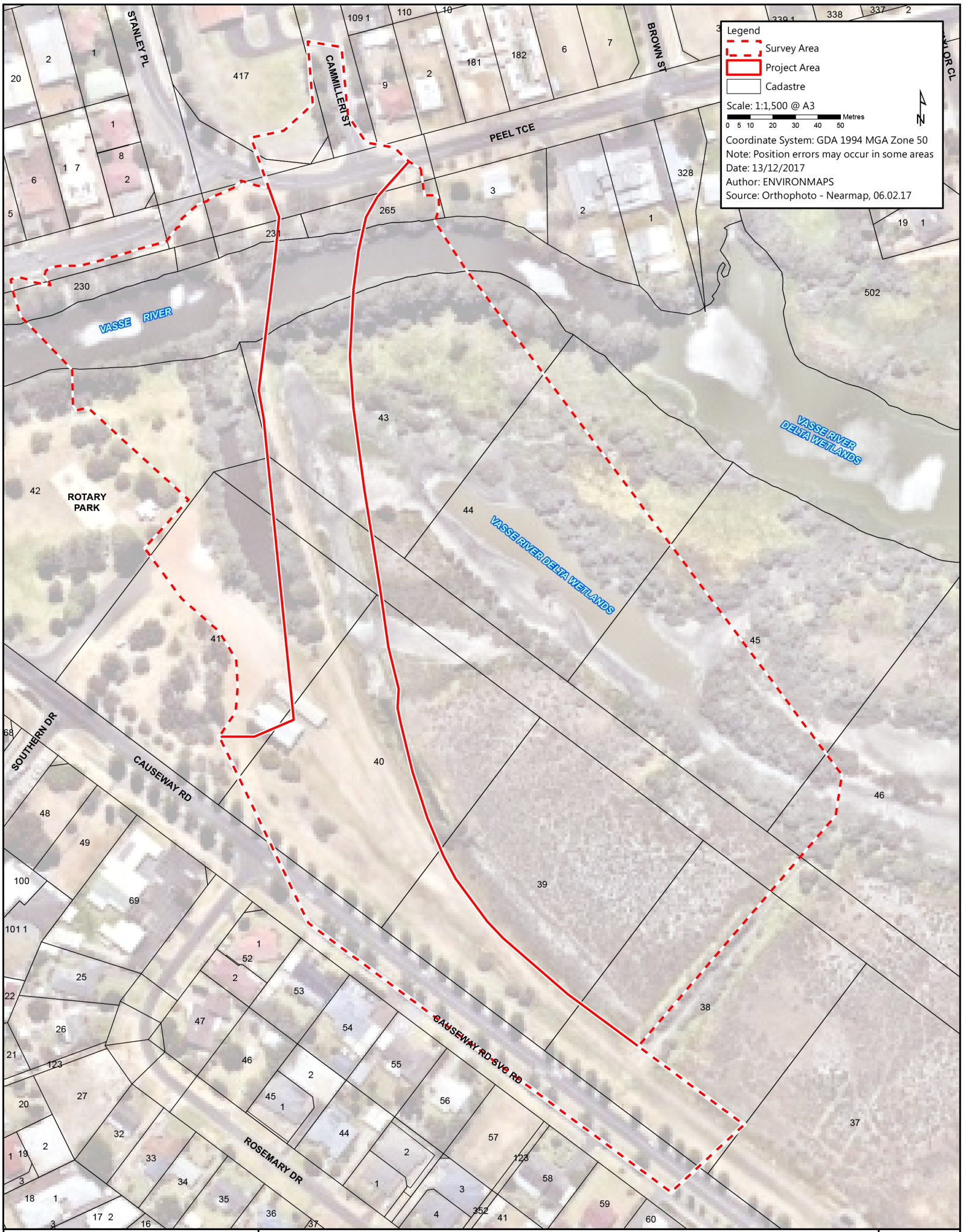

strategen ENVIRONMENTAL

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**

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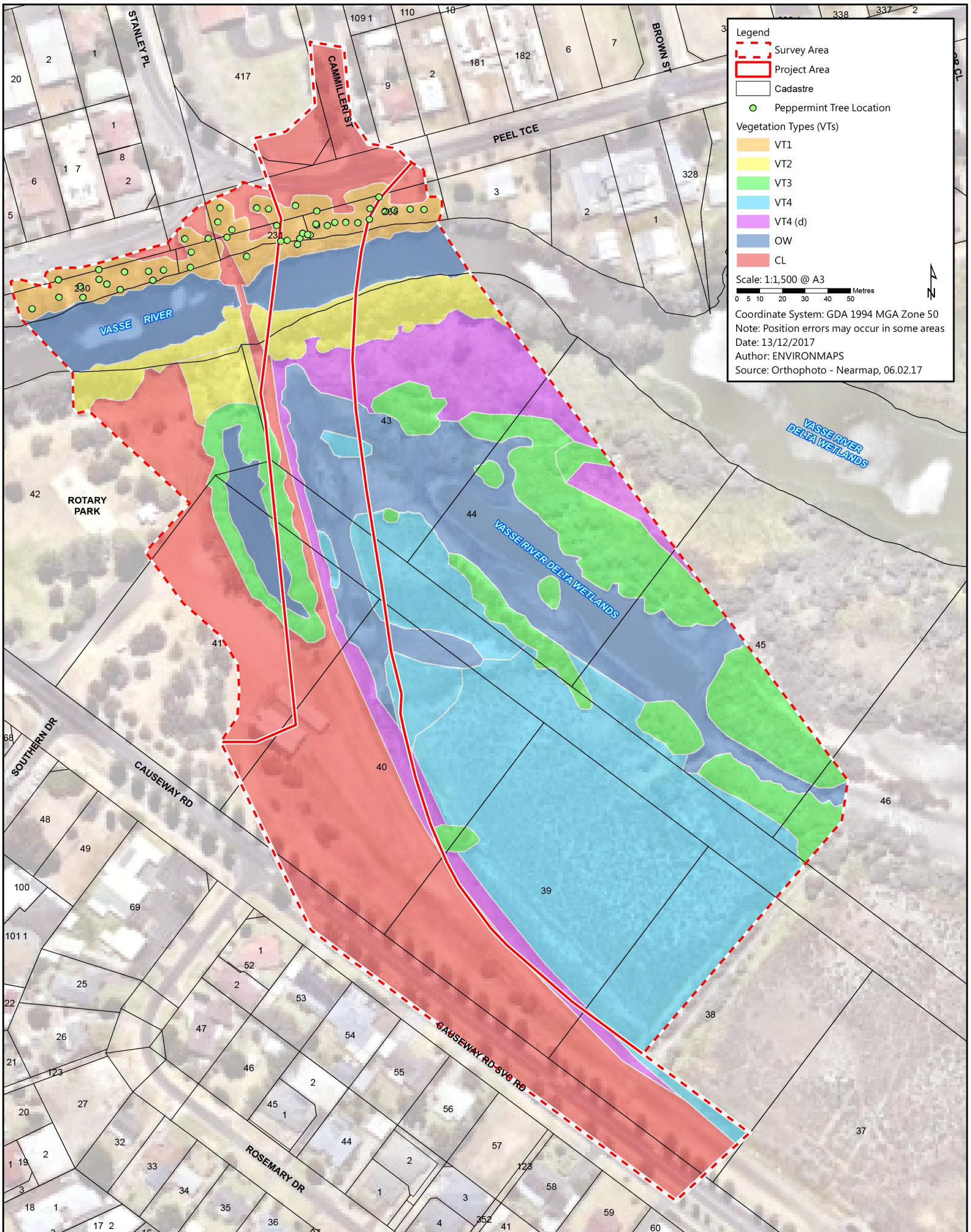
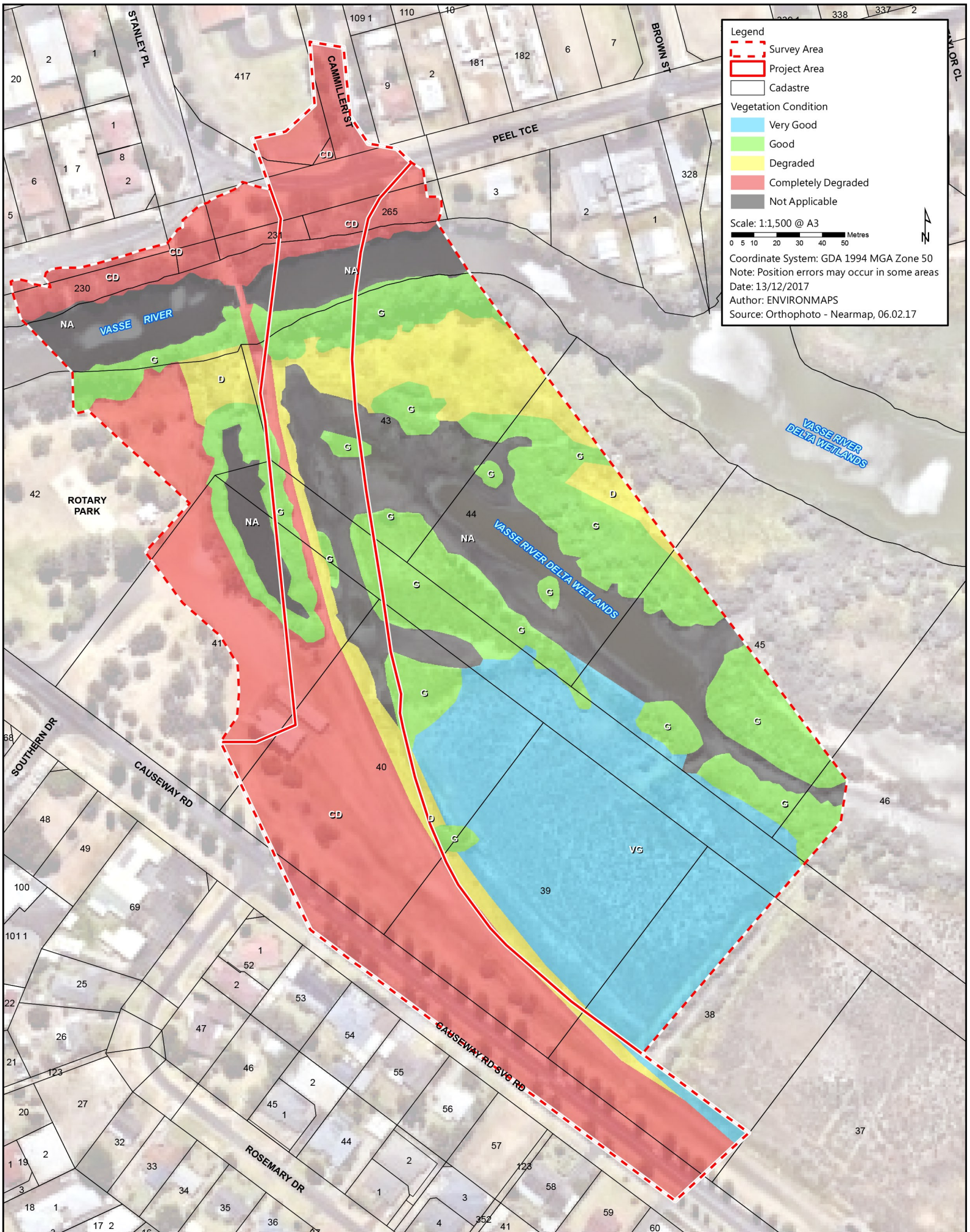


Eastern Link Project – Detailed Flora and Vegetation Survey

Vegetation Types (VTs)

Figure 2



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Vegetation Condition

Figure 3

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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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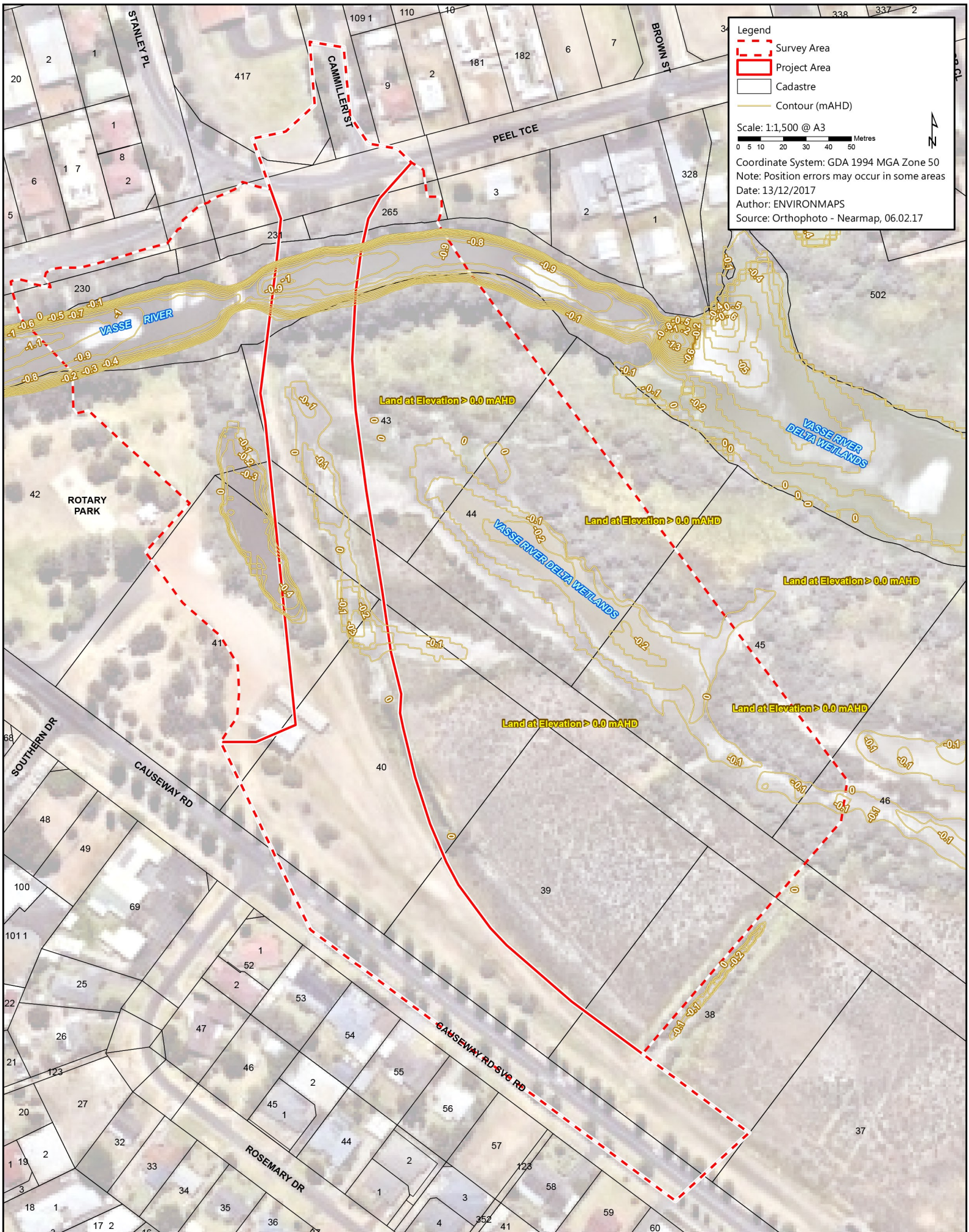

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Eastern Link Project – Detailed Flora and Vegetation Survey

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

Appendix 3
Conservation significant flora identified to potential occur within 5 km of the Project Area

Species	Conservation Status	Habitat requirements	Likelihood of occurrence
Andersonia gracilis — Slender Andersonia	Endangered (EPBCA)	Andersonia gracilis is currently known from the Badgingarra, Dandaragan and Kenwick areas where it is found on seasonally damp, black sandy clay flats near or on the margins of swamps, often on duplex soils supporting low open heath vegetation with species such as Calothamnus hirsutus, Verticordia densiflora and Kunzea recurva over sedges (WAH 1998-).	**Unlikely** Suitable habitat not present
Banksia nivea subsp. *uliginosa*	Endangered (EPBCA)	Banksia nivea subsp. uliginosa occurs in two areas - near Busselton on the Swan Coastal Plain and on the Scott River Plain east of Augusta, growing in red, sandy, shallow loams over ironstone in thick scrub, in winter wet southern and Scott ironstones (DEC 2009). Habitat critical to the survival of the subspecies includes the area of occupancy of important populations; areas of similar habitat surrounding important populations (i.e. clay over laterite in thick scrub, in winter wet southern ironstones – these provide potential habitat for natural range extension and is necessary to allow pollinators to move between populations); the local catchment of the surface and possibly ground waters that maintain the habitat of the subspecies; and additional occurrences of similar habitat that may contain the subspecies or be suitable sites for future translocations (WAH 1998-).	**Unlikely** Suitable habitat not present
Brachyscias verecundus	Critically Endangered (EPBCA)	The Ironstone Brachyscias is endemic to ironstone soils in the Busselton region. It grows in winter-wet clay over ironstone in open to tall shrubland. Local groundwater and/or catchment flows on the surface are important for maintaining the wetland habitat (Luu & English 2004a).	**Possible** Suitable habitat present
Caladenia huegelii — King Spider-orchid, Grand Spider-orchid, Rusty Spider-orchid	Endangered (EPBCA)	The King Spider-orchid grows in well-drained, deep sandy soils in low mixed woodlands of Coast Banksia (Banksia attenuata), Firewood Banksia (B. menziesii), Holly-leaved Banksia (Banksia ilicifolia), Western Sheoak (Allocasuarina fraseriana) and Jarrah (Eucalyptus marginata). It tends to favour areas of lush undergrowth (DotE 2017).	**Unlikely** Associated habitat not present
Caladenia procera — Carbunup King Spider Orchid	Critically Endangered (EPBCA)	The Carbunup King Spider Orchid grows in Jarrah (Eucalyptus marginata), Marri (Corymbia calophylla) and Peppermint (Agonis flexuosa) woodland on alluvial sandy-clay loam flats amongst dense heath and sedges or low dense shrubs. Acacia stenoptera, Red and Green Kangaroo Paw (Anigozanthos manglesii) and Pimelea sylvestris are associated species (Hopper & Brown 2001b; Stack & English 2004).	**Unlikely** Associated habitat not present

Species	Conservation Status	Habitat requirements	Likelihood of occurrence
Darwinia whicherensis — Abba Bell	Endangered (EPBCA)	Abba Bell is known from three locations at the base of the Whicher Range, in a winter-wet area of shrubland over shallow red clay over ironstone (Stack et al. 1999a;(WAH 1998-). The southern ironstone shrublands community type in which this species occurs is found on small areas of ironstone with thin skeletal soil in the Busselton area. Much of this land unit has been cleared. These sites have an endemic flora which includes Laterite Petrophile (Petrophile sp. Whicher Range (G.J.Keighery 11790) WA Herbarium), Andersonia aff. latiflora, Dryandra sp. 30, Hakea aff. varia, Loxocarya magna and Lepyrodia aff. macra. These communities are very diverse with large numbers of annuals and geophytes (Gibson et al. 1994). Abba Bell is located within the 'Busselton Ironstone Community' or 'Shrublands on southern Swan Coastal Plain Ironstones' Threatened Ecological Community (TEC) which is Endangered under the EPBC Act and was ranked as Critically Endangered in Western Australia in 1995 (Gibson et al. 1994). These ironstone soils are highly restricted in distribution.	**Unlikely** Suitable habitat not present
Diuris micrantha — Dwarf Bee-orchid	Vulnerable (EPBCA)	It is found in small populations, on dark, grey to blackish, sandy clay-loam substrates in winter wet depressions or swamps. The bases of the flowering plants are often covered with shallow water (DotE 2016).	**Possible** Suitable habitat present
Drakaea elastica — Glossy-leafed Hammer Orchid, Glossy-leaved Hammer Orchid, Warty Hammer Orchid	Endangered (EPBCA)	The species grows on bare patches of sand within otherwise dense vegetation in low-lying areas alongside winter-wet swamps, typically in banksia (Banksia menziesii, B. attenuata and B. ilicifolia) woodland or spearwood (Kunzea glabrescens) thicket vegetation. D. elastica often occurs with other orchid species such as Drakaea glyptodon (king-in-his-carriage), D. livida (warty hammer orchid) and Paracaleana nigrita (flying duck orchid). The increased rates of survival in sites with relatively little direct sun exposure (Carstairs and Coates 1994) indicate a requirement for shady canopy cover to be present (WAH 1998-).	**Unlikely** Associated habitat not present
Drakaea micrantha — Dwarf Hammer-orchid	Vulnerable (EPBCA)	The Dwarf Hammer-orchid is usually found on cleared firebreaks or open sandy patches that have been disturbed, where competition from other plants has been removed (Brown et al. 1998; Hearn et al. 2006). This suggests that the plants may need a disturbance event at some point, and that plants regenerate from soil stored seed after such an event (WAH 1998-).	**Unlikely** Suitable habitat not present
Gastrolobium papilio — Butterfly-leaved Gastrolobium	Endangered (EPBCA)	Butterfly-leaved Gastrolobium grow in shallow, peaty grey-brown sandy clay (Chandler et al. 2002; Crisp 1995) or very shallow red sandy-clay soil (Brown et al. 1998) over ironstone in winter-wet flats (Brown et al. 1998). Vegetation is a low open, mixed heath (Chandler et al. 2002; Crisp 1995) with *Hakea* aff. *varia*, sedges (*Mesomelaena*), *Melaleuca* and *Stirlingia* (Crisp 1995).	**Unlikely** Suitable habitat not present

Species	Conservation Status	Habitat requirements	Likelihood of occurrence
Grevillea elongata — Ironstone Grevillea	Vulnerable (EPBCA)	This species is found on poorly drained soils ranging from red brown loam sand or gravelly clay over ironstone, through to light brown sandy clay or grey sand. It occurs in scrubby heath often beside creeks, with Corymbia calophylla, Dryandra squarrosa subsp. argillacea, Calothamnus aff. quadrifidus, Viminea juncea and Pericalymma ellipticum. The Ironstone Grevillea is confined to an area of seasonally wet flat, red brown loam sand over ironstone habitat, of which 90% has been cleared (Brown et al. 1998; Olde & Marriott 1995; Phillimore et al. 1999). This habitat was probably originally highly restricted and has been depleted by land clearing (Williams et al. 2001). It is restricted to the Ruabon-Busselton area. The climate for this area is characterised by cold and wet winters, with an annual rainfall of 800-1 000 mm. The summers are cool to warm and dry (Olde & Marriott 1995).	**Possible** Suitable habitat present
Kennedia lateritia — Augusta Kennedia	Endangered (EPBCA)	Confined to coastal dunes on the south coast of Western Australia (Leigh et al. 1984), in the Augusta-Cape Leeuwin area (Brown et al. 1998). The species' geographical range is less than 5 km (Williams et al. 2001).	**Unlikely** Suitable habitat not present
Lambertia echinata subsp. *occidentalis* — Western Prickly Honeysuckle	Endangered (EPBCA)	Western Prickly Honeysuckle is found on shallow soils over sheet ironstone (Brown et al. 1998; Keighery 1997; Obbens & Coates 1997; Stack et al. 1999) and white sandy soils over laterite (WA DEC 2007). It occurs on flats to foothills and grows in winter-wet rich scrub heath/shrubland (Brown et al. 1998; Stack et al. 1999b) with sedges and scattered Banksia (Banksia spp.) and Marri (Corymbia calophylla) (Brown et al. 1998).	**Unlikely** Suitable habitat not present
Lambertia orbifolia - Roundleaf honeysuckle	Endangered (EPBCA)	The roundleaf honeysuckle is endemic to Western Australia where it is found in the Narrikup area (Phillimore & Brown 2003, DEE 2016) and Scott River plains (Luu & English 2004b, DEE 2016). In 2003 the roundleaf honey suckle was known from three populations in the Narrikup area (Phillimore & Brown 2002) the date of these surveys is unknown. The roundleaf honeysuckle in the Narrikup area is found amongst Eucalyptus marginata (Jarrah), Corymbia calophylla (Marri) and Banksia woodland on grey/brown/white gravelly, sandy, loam over ironstone. Associated species include Banksia grandis (bull banksia), Taxandria hypericifolia, Nuytsia floribunda (Western Australian christmas tree), Hakea ferruginea, Taxandria parviceps, Anarthria prolifera, Bossiaea ornata (broad leaved brown pea), Leucopogon verticillatus (tassel flower), Isopogon formosus (rose coneflower), Xanthorrhoea preissii (grass tree), Hakea varia (variable-leave hakea), Adenanthos obovatus (basket flower), Eucalyptus staeri (Albany blackbutt) and Xanthorrhoea platyphylla.	**Unlikely** Associated habitat not present

Species	Conservation Status	Habitat requirements	Likelihood of occurrence
Petrophile latericola — Laterite Petrophile	Endangered (EPBCA)	Laterite Petrophile inhabits tall and low heath on winter-wet flats of red sandy-clay over ironstone (Brown et al. 1998; Gibson et al. 1994) in association with Teatree (Pericalymma ellipticum) and Fringed Regelia (Regelia ciliata) (Brown et al. 1998; Phillimore et al. 2001a). The sites in which this species occurs are two of 13 occurrences of a species-rich plant community located on seasonal wetlands on ironstone and heavy clay soils on the Swan Coastal Plain near Busselton (English 1999c). Associated species include Hakea varia, Loxocarya magna and Royce's Waxflower (Chamelaucium roycei). Much of the species diversity in the community comes from annuals and geophytes. Typical and common native species are the shrubs Kunzea micrantha, Hakea oldfieldii, Hemiandra pungens and Golden Spray (Viminaria juncea), and the herbs Aphelia cyperoides and Pointed Centrolepis (Centrolepis aristata) (Gibson et al. 1994).	**Unlikely** Associated habitat not present
Verticordia densiflora var. *pedunculata* — Long-stalked Featherflower	Endangered (EPBCA)	The Long-stalked Featherflower grows on light yellow or grey sands in low-lying, winter-wet areas. It has been recorded as occurring with Melaleuca viminea, Preiss's Paperbark (Melaleuca preissiana), Redheart (Eucalyptus decipiens), Flooded Gum (Eucalyptus rudis), Jarrah (Eucalyptus marginata), Marri (Corymbia calophylla), Balga Grass (Xanthorrhoea preissii), Western Australian Christmas Tree (Nuytsia floribunda), Hypocalymma angustifolium and Blueboy (Stirlingia latifolia) (WAH 1998-).The variety is associated with the Shrublands on Southern Swan Coastal Plain Ironstones, which is listed as an endangered ecological community under the EPBC Act (Meissner & English 2005).	**Unlikely** Associated habitat not present
Verticordia plumosa var. *vassensis* — Vasse Featherflower	Endangered (EPBCA)	Vasse Featherflower grows on a variety of sands and swampy clay soils in mostly winter-wet flats and depressions on badly degraded, grassy-weed infested road verges. It often grows with Golden Spray (Viminaria juncea), sedge and rushes, or in low heath containing Hypocalymma sp., Grass Tree (Kingia australis), Pericalymma ellipticum and Rose Coneflower (Isopogon formosus) (Brown et al. 1998; Williams et al. 2001). This species sometimes occurs with Long-stalked Feather flower (Verticordia densiflora var. pedunculata) which is listed as Endangered under the EPBC Act.	**Unlikely** Associated habitat not present
Puccinellia vassica	Priority one (WC Act)	Caespitose annual or perennial, grass-like herb, growing 0.41-0.49 m high. Occurring on saline soils, on the outer margins of coastal saltmarshes (WAH 1998-).	**Unlikely** Suitable habitat not present
Stachystemon sp. Keysbrook	Priority one (WC Act)	A description of this species is unavailable (WAH 1998-).	**Unknown**
Amperea micrantha	Priority two (WA Act)	Low, spreading, bushy perennial, herb growing 0.1-0.3 m high. Flowers are brown occurring October to November. This species grows on sandy soils.	**Unlikely** Associated habitat not present
Calystegia sepium subs *roseate*	Priority two (WA Act)	This species grown in damp lands and damp depressions (WAH 1998-).	**Possible** Suitable habitat present
Leucopogon sp. Busselton	Priority two (WC Act)	A species description is currently unavailable (WAH 1998-).	**Unknown**

Species	Conservation Status	Habitat requirements	Likelihood of occurrence
Chorizema carinatum	Priority three (WA Act)	An erect or spreading shrub growing 0.1-0.6 m high. Flowers are yellow and occur October to December. This species grows in sand and sandy clay (WAH 1998-).	**Possible** Suitable habitat present
Grevillea bronwenae	Priority three (WC Act)	This species is a slender, erect shrub growing 0.5-1.6 m high. Flowers are red and bloom June to December. The species grown on grey sand over laterite, lateritic loam occurring on Hillslopes (WAH 1998-).	**Unlikely** Suitable habitat not present
Hakea oldfieldii	Priority three (WC Act)	An open, straggling shrub growing up to 2.5 m high. The Flowers are white-cream/yellow and occur August to October. The species grown in red clay or sand over laterite in seasonally wet flats (WAH 1998-).	**Possible** Suitable habitat present
Isopogon formosus subsp. *dasylepis*	Priority three (WC Act)	A low, bushy or slender upright non-lignotuberous shrub, growing 0.2-2 m high. Flowers are pink-purple/red and occur June to December. The species prefers sand, sandy clay or gravelly sandy soils over laterite and often occur in swampy areas (WAH 1998-).	**Unlikely** Suitable habitat not present
Jacksonia gracillima	Priority three (WA Act)	This species grown in sandy soils, sandplains, rises and swampy depressions. (WAH 1998-).	**Unlikely** Suitable habitat not present
Johnsonia inconspicua	Priority three (WA Act)	A rhizomatous, tufted perennial grass-like or herb growing 0.1-0.3 m high, to 0.2 m wide. This species flowers are green-white/pink, occurring October to November. This species grows in white-grey or black sand on low dunes and winter-wet flats (DEC 1994a).	**Possible** Suitable habitat present
Lasiopetalum laxiflorum	Priority three (WA Act)	This species grown on heavy soils in tuart woodlands (WAH 1998-).	**Unlikely** Suitable habitat not present
Loxocarya magna	Priority three (WA Act)	This species grown on sand, loam, clay and ironstone in seasonally inundated or damp habitats.	**Possible** Suitable habitat present
Pimelea ciliata subsp. *longituba*	Priority three (WC Act)	An erect shrub growing 0.3-1 m high. The flowers are pink and bloom from October to December. The species grows on grey sand over clay and loam (WAH 1998-).	**Unlikely** Suitable habitat not present
Pultenaea pinifolia	Priority three (WC Act)	An erect, slender shrub growing 1-3 m high. The flowers are yellow-orange occurring October to November. The species prefers loam or clay on floodplains and swampy areas (WAH 1998-).	**Possible** Suitable habitat present
Synaphea hians	Priority three (WA Act)	A prostrate or decumbent shrub growing 0.15-0.6 m high, to 1 m wide. The flowers are yellow and occur from July or September to November. The species prefers sandy soils on rises (WAH 1998-).	**Unlikely** Suitable habitat not present
Synaphea petiolaris subsp. *simplex*	Priority three (WA Act)	A tufted shrub growing 0.1-0.6 m high. Flowers are yellow and occur from September to October. The species grows on sandy soils on flats and winter-wet areas (WAH 1998-).	**Possible** Suitable habitat present
Acacia flagelliformis	Priority four (WA Act)	A rush-like erect or sprawling shrub, growing 0.3-0.75(-1.6) m high. Its flowers are yellow and occur May to September. The species grows in sandy soils in winter-wet areas (WAH 1998-).	**Possible** Suitable habitat present
Acacia semitrullata	Priority four (WC Act)	A slender, erect, pungent shrub growing 0.2-0.7 m high. The flowers are cream-white occurring May to October. The species grows in white/grey sand, sometimes over laterite clay in sandplains and swampy areas (WAH 1998-).	**Possible** Suitable habitat present

Species	Conservation Status	Habitat requirements	Likelihood of occurrence
Franklandia triaristata	Priority four (WA Act)	An erect, lignotuberous shrub growing 0.2-1 m high. The flowers are white-cream-yellow/brown-purple and occur August to October. The species occurs on white or grey sand (WAH 1998-).	**Unlikely** Suitable habitat not present
Laxmannia jamesii	Priority four (WA Act)	A tufted, stilt-rooted perennial herb growing 0.05-0.2 m high. The flowers are red & white blooming from May to July. The species occurs on grey sand in winter-wet locations (WAH 1998-).	**Possible** Suitable habitat present
Ornduffia submersa	Priority four (WC Act)	The species occurs near freshwater lakes, swamps and claypans (WAH 1998-).	**Possible** Suitable habitat present
Thysanotus glaucus	Priority four (WA Act)	A caespitose, glaucose perennial, herb, growing 0.1-0.2 m high. The flowers are purple occurring from October to December or January to March. The species grown in white, grey or yellow sand or sandy gravel (WAH 1998-).	**Unlikely** Suitable habitat not present

Appendix 4
Conservation significant fauna identified to potential occur within 5 km of the Project Area

Species	Conservation Status	Habitat requirements	Likelihood of occurrence
Botaurus poiciloptilus - Australasian Bittern	Endangered (EPBCA) Endangered (WA Act)	Wetlands with tall dense vegetation, favours permanent and seasonal freshwater habitats, dominated by sedges rushes and reeds, growing over a muddy or peaty substrate	**Unlikely** Suitable habitat not present
Calyptorhynchus banksii subsp. naso - Forest Red Tailed Black Cockatoo	Vulnerable (EPBCA) Vulnerable (WA Act)	Dense Jarrah, Karri and Marri Forests. Species nests in large hollows in these species	**Unlikely** Suitable habitat not present
Calyptorhynchus baudinii - Baudin's White Tailed Black Cockatoo	Vulnerable (EPBCA) Endangered (WA Act)	Dense Jarrah, Karri and Marri Forests. Species nests in large hollows in these species	**Possible** Suitable habitat present
Calyptorhynchus latirostris - Carnaby's White Tailed Black Cockatoo	Endangered (EPBCA) Endangered (WA Act)	Dense Jarrah, Karri and Marri Forests. Species nests in large hollows in these species	**Known** Suitable habitat present and observed on-site
Dasyurus geoffroii - Chuditch	Endangered (EPBCA) Endangered (WA Act)	Variety, most dense in riparian jarrah forests. Require large unfragmented habitats	**Unlikely** Suitable habitat not present
Pseudocheirus occidentalis - Western Ringtail Possum	Vulnerable (EPBCA) Critically Endangered (WA Act)	Coastal Areas of Peppermint woodland and peppermint /tuart associations	**Known** Suitable habitat present and observed on-site
Phascogale tapoatafa subsp. wambenger - Southern Brush-Tailed Phascogale	Vulnerable (EPBCA) Conservation dependant (WA Act)	Highly arboreal, prefers open forest with sparse groundcover	**Unlikely** Suitable habitat not present
Tyto novaehollandiae subsp. *Novaehollandiae* - Masked Owl – southern subspecies	Priority three (WA Act)	Tall open eucalypt forest and woodlands. Preferred roosts large hollows in standing trees	**Unlikely** Suitable habitat not present
Isoodon obesulus subsp. *Fusciventer* - Southern Brown Bandicoot	Priority four (WA Act)	Forest, woodland, shrub and heath, usually in sandy soils with dense healthy vegetation in lower stratum	**Known** Suitable habitat present
Oxyura australis - Blue Billed Duck	Priority four (WA Act)	Deep freshwater areas with dense vegetation	**Known** Suitable habitat present
Hydromys chrysogaster - Water Rat	Priority four (WA Act)	Found near permanent fresh or brackish waters	**Possible** Suitable habitat present
Falco peregrinus - Peregrine Falcon	IA	Wide variety	**Known** Suitable habitat present
Actitis hypoleucos - Common Sandpiper	IA	Coastal wetlands and some inland wetland. Utilises muddy margins. Often associated with mangroves	**Possible** Suitable habitat present

Species	Conservation Status	Habitat requirements	Likelihood of occurrence
Anous stolidus subsp. pileatus - Common Noddy	IA	Can nest in bushes, saltbush and other low vegetation, on grass or bare rock	**Unlikely** Suitable habitat not present
Ardea ibis - Cattle Egret	IA	Moist, low lying poorly drained pastures. Avoids low grass pastures. Roosts in trees or in ground vegetation near lakes	**Unlikely** Suitable habitat not present
Ardea modesta - Eastern Great Egret	IA	Wide range of wetland habitats	**Known** Suitable habitat present
Calidris acuminate - Sharp-tailed Sandpiper	IA	Prefers muddy edges of shallow fresh or brackish wetlands, with inundated or emergency sedges or other low vegetation	**Unlikely** Suitable habitat not present
Calidris acuminata - Red-necked Stint	IA	Coastal Area, including sheltered inlets, bays and estuaries with intertidal mudflats	**Unlikely** Suitable habitat not present
Calidris subminuta - Long-toed Stint	IA	Variety of terrestrial wetlands. Preference is for shallow freshwater or brackish wetlands. Also prefers muddy shorelines	**Known** Suitable habitat present
Charadrius leschenaultii - Greater Sand Plover	IA	Littoral and estuarine habitats, sheltered sandy, shelly or muddy beaches with intertidal mudflats and sandy estuarine lagoons	**Unlikely** Suitable habitat not present
Macronectes giganteus - Southern Giant Petrel	IA	Marine bird occurs in subtropical waters	**Unlikely** Suitable habitat not present
Merops ornatus - Rainbow Bee-eater	IA	Open forest, woodland and shrublands, and in various cleared or semi cleared areas	**Known** Suitable habitat present
Plegadis falcinellus - Glossy Ibis	IA	Freshwater marshes at the edges of wetland areas. occasionally found in coastal locations such as estuaries	**Known** Suitable habitat present
Pluvialis fulva - Pacific Golden Plover	IA	Inhabits coastal habitats and forages on sandy or muddy shores of estuaries and lagoons	**Possible** Suitable habitat present
Sterna anaethetus subsp. anaethetus - Bridled Tern	IA	Breeds on islands included vegetated coral cays, and rocks, rarely found inshore. Forager over offshore mid and continental shelf waters	**Possible** Suitable habitat present
Tringa glareola - Wood Sandpiper	IA	Well vegetated, shallow freshwater wetlands. Typically associated with emergent aquatic plants or grass, dominated by taller fringing vegetation	**Unlikely** Suitable habitat not present
Tringa nebularia - Common Greenshank	IA	Sheltered coastal habitats, typically with large mudflats, and saltmarshes. Forages at the edges of wetlands in soft mud and in shallows around the edges of water along emergent or fringing vegetation	**Known** Suitable habitat present
Tringa stagnatilis - Marsh Sandpiper	IA	Permanent or ephemeral wetlands of varying salinity. Forages in shallow water at the edges and probe wet mud or feed among marshy vegetation	**Unlikely** Suitable habitat not present

Appendix 5
Construction Environmental Management Plan

intelligent outcomes | respected experience

Busselton Eastern Link Project

Construction Environmental Management Plan

Prepared for
City of Busselton
by Strategen

January 2018

strategen
ENVIRONMENTAL

Busselton Eastern Link Project

Construction Environmental Management Plan

Strategen is a trading name of
Strategen Environmental Consultants Pty Ltd
Level 1, 50 Subiaco Square Road Subiaco WA 6008
ACN: 056 190 419

January 2018

Limitations

Scope of services

This report ("the report") has been prepared by Strategen Environmental Consultants Pty Ltd (Strategen) in accordance with the scope of services set out in the contract, or as otherwise agreed, between the Client and Strategen. In some circumstances, a range of factors such as time, budget, access and/or site disturbance constraints may have limited the scope of services. This report is strictly limited to the matters stated in it and is not to be read as extending, by implication, to any other matter in connection with the matters addressed in it.

Reliance on data

In preparing the report, Strategen has relied upon data and other information provided by the Client and other individuals and organisations, most of which are referred to in the report ("the data"). Except as otherwise expressly stated in the report, Strategen has not verified the accuracy or completeness of the data. To the extent that the statements, opinions, facts, information, conclusions and/or recommendations in the report ("conclusions") are based in whole or part on the data, those conclusions are contingent upon the accuracy and completeness of the data. Strategen has also not attempted to determine whether any material matter has been omitted from the data. Strategen will not be liable in relation to incorrect conclusions should any data, information or condition be incorrect or have been concealed, withheld, misrepresented or otherwise not fully disclosed to Strategen. The making of any assumption does not imply that Strategen has made any enquiry to verify the correctness of that assumption.

The report is based on conditions encountered and information received at the time of preparation of this report or the time that site investigations were carried out. Strategen disclaims responsibility for any changes that may have occurred after this time. This report and any legal issues arising from it are governed by and construed in accordance with the law of Western Australia as at the date of this report.

Environmental conclusions

Within the limitations imposed by the scope of services, the preparation of this report has been undertaken and performed in a professional manner, in accordance with generally accepted environmental consulting practices. No other warranty, whether express or implied, is made.

Client: City of Busselton

Report Version	Revision No.	Purpose	Strategen author/reviewer	Submitted to Client	
				Form	Date
Draft Report	A	For client review	D White / H Morgan	Electronic	5 January 2018
Final Report	0	For submission with EPA referral	D White / H Morgan	Electronic	5 January 2018

Filename: CIB16605_01 R006 Rev 0 - 5 January 2018

Executive Summary

This Construction Environmental Management Plan (CEMP) has been prepared to support referral of the Busselton Eastern Link Project (the Proposal) under s 38 of the *Environmental Protection Act 1986* (EP Act). The CEMP demonstrates that appropriate management measures will be in place during construction of the Proposal to ensure that the Environmental Protection Authority's (EPA's) objectives for key environmental factors will be achieved.

Table ES-1 provides a summary of the preliminary key environmental factors, objectives and CEMP provisions for the Proposal.

Table ES-1: Construction environmental management summary

Required information	Response
Title of proposal	Busselton Eastern Link Project
Proponent name	City of Busselton
Purpose of the CEMP	To support referral of the Proposal under s 38 of the EP Act and demonstrate that appropriate management measures will be in place during construction to ensure that the EPA's objectives for key environmental factors will be achieved.
Preliminary key environmental factors and CEMP objectives	**Flora and Vegetation** • Minimise impacts to flora and vegetation outside of Development Envelope as far as practicable. **Terrestrial Environmental Quality** • Minimise impacts from acid sulfate soils, monosulfidic black ooze and site contamination as far as is practicable. **Terrestrial Fauna** • Minimise impacts to terrestrial fauna during construction as far as practicable **Inland Waters Environmental Quality** • Minimise impacts to water quality and aquatic ecology of Lower Vasse River and Vasse River Delta Wetlands as far as is practicable. **Social Surroundings** • Minimise disturbance to nearby residential, commercial and heritage properties and impacts to amenity of Vasse River and wetlands as far as is practicable.
Key provisions in the CEMP	**Management target 1:** • No environmental impacts occur that are attributable to lack of awareness in construction personnel. **Management target 2:** • No native vegetation is cleared outside of designated clearing areas. **Management target 3:** • No construction vehicle or plant access occurs outside of designated access tracks / areas. **Management target 4:** • Revegetation and Rehabilitation Plan targets are met. **Management target 5:** • No weed infestation present within Development Envelope at the completion of construction. **Management target 6:** • Acid Sulfate Soil and Dewatering Management Plan targets are met. **Management target 7:** • Monosulfidic Black Ooze Management Plan (if required) targets are met. **Management target 8:** • All suspected contamination is characterised and appropriately managed. **Management target 9:** • No mortality of threatened, priority or migratory fauna species during clearing works. **Management target 10:** • All fauna identified as injured, abandoned or visibly distressed is handled by a qualified fauna spotter / catcher or in accordance with DBCA wildcare hotline instruction.

Required information	Response
	Management target 11: • No mortality of threatened, priority or migratory fauna species in trenches or excavations. **Management target 12:** • Turbidity of Vasse River outside of silt curtains remains comparable to reference point upstream. **Management target 13:** • No noticeable sediment deposition in wetlands adjacent to Development Envelope. **Management target 14:** • No spills or leaks of hazardous materials or wastes enter the Vasse River, Vasse River Delta Wetlands or groundwater. **Management target 15:** • Translocation management targets for Carters Freshwater Mussel are met. **Management target 16:** • No complaints received due to lack of notification of property owners. **Management target 17:** • All complaints received are documented and responded to within 24 hours for severe impacts and five business days for minor impacts. **Management target 18:** • No repetitive / sustained complaints received due to dust, noise or traffic and parking impacts. **Management target 19:** • Any burials uncovered during excavation works are managed in accordance with directions of Aboriginal cultural monitors.

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1. Context, scope and rationale

This Construction Environmental Management Plan (CEMP) has been prepared to support referral of the Busselton Eastern Link Project under s 38 of the *Environmental Protection Act 1986* (EP Act). The CEMP demonstrates that appropriate management measures will be in place during construction of the Proposal to ensure that the Environmental Protection Authority's (EPA's) objectives for key environmental factors will be achieved.

The CEMP has also been prepared in accordance with *Instructions on how to prepare Environmental Protection Act 1986 Part IV Environmental Management Plans* (EPA 2017).

1.1 Proposal

This CEMP addresses the scope of the Proposal as presented in the Environmental Review Document (Strategen 2018) that supports the s 38 referral. A summary of the Proposal is presented below.

The City of Busselton propose to construct a new two-lane road crossing linking Causeway Road to Cammilleri Street including a new bridge over the Vasse River in Busselton, Western Australia ('the Proposal'). The Proposal is located directly south of the Busselton CBD and approximately 1 km from the coastline of Geographe Bay (Figure 1).

The new bridge will have a width of 12 m and a span of 22 m between abutments. The new road will run approximately 240 m in length to connect Causeway Road to Cammilleri Street. The Proposal involves clearing of approximately 0.56 ha of native vegetation over a total disturbance envelope of approximately 2.64 ha (Figure 2).

The Proposal will be constructed over a period of 12 to 18 months and involve the following key activities:

- establish construction compound south of Rotary Par
- construct road embankment south of the river using imported fill material
- remove soft silt and mud from river banks and bed and construct temporary platforms into the river
- drive pre-cast concrete piles into the river banks then construct reinforced concrete abutments on top of the piles
- construct temporary hard stand near the river's southern bank to provide crane access
- lay large steel girders between abutments using a crane on the river's southern bank
- construct reinforced concrete bridge deck on top of steel girders, and concrete slabs on north and south approaches
- construct asphalt pavements, vehicle / cyclist barriers, kerbing, stormwater drainage and bio-filtration gardens
- install lighting and electrical services
- provide landscaping and erosion protection, including fauna under-passage and planting of Peppermint (*Agonis flexuosa*) trees
- remove temporary hard stand, construction platforms and construction compound.

Construction vehicle access will use Causeway Road as much as possible and minimise use of Causeway Bridge and Peel Terrace. Construction will be limited to between 7:00am to 7:00pm Monday to Friday, with construction on Saturdays by exception and limited to between 7:00am to 7:00pm. No construction works will be undertaken on Sundays or public holidays.

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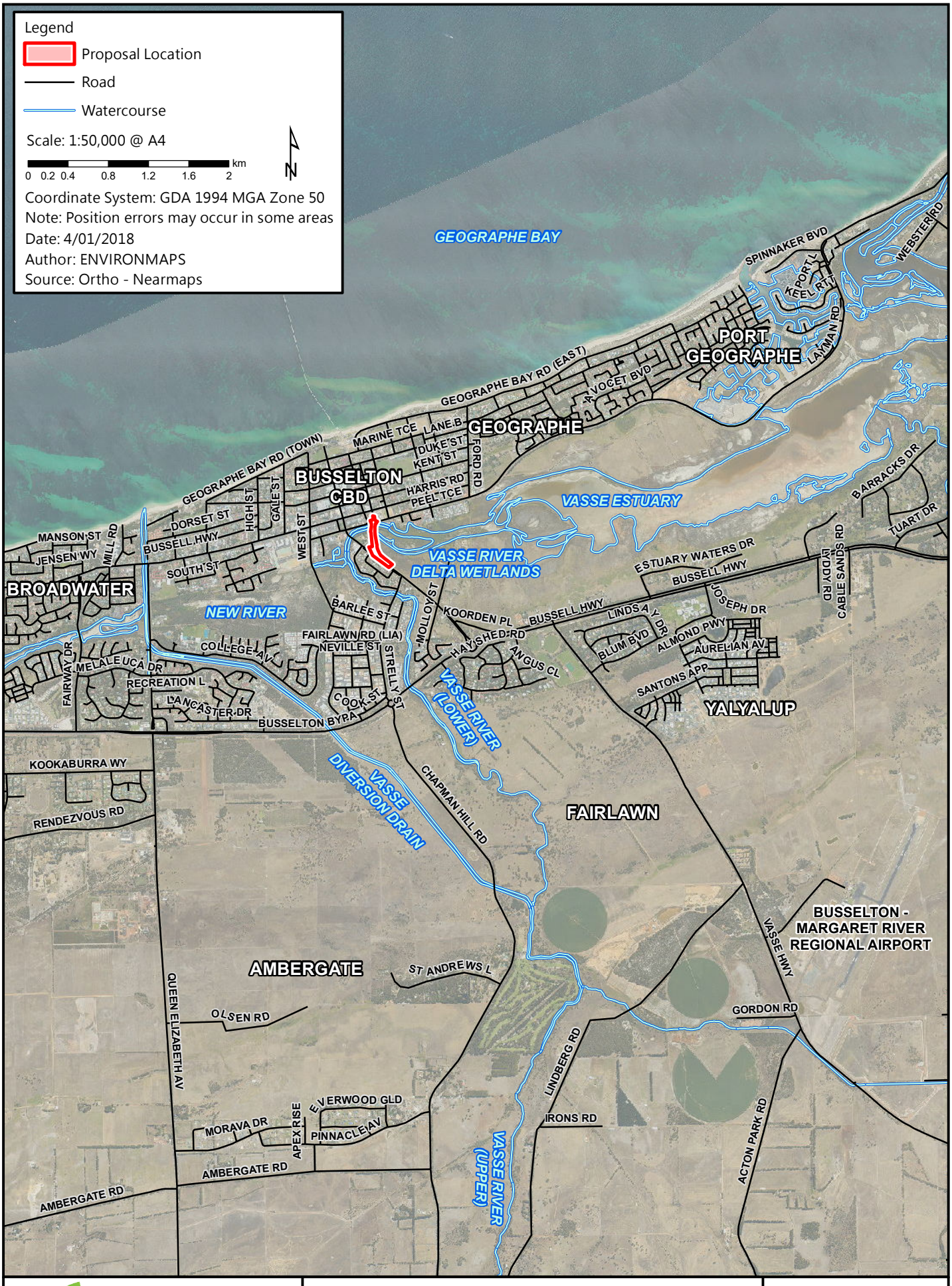

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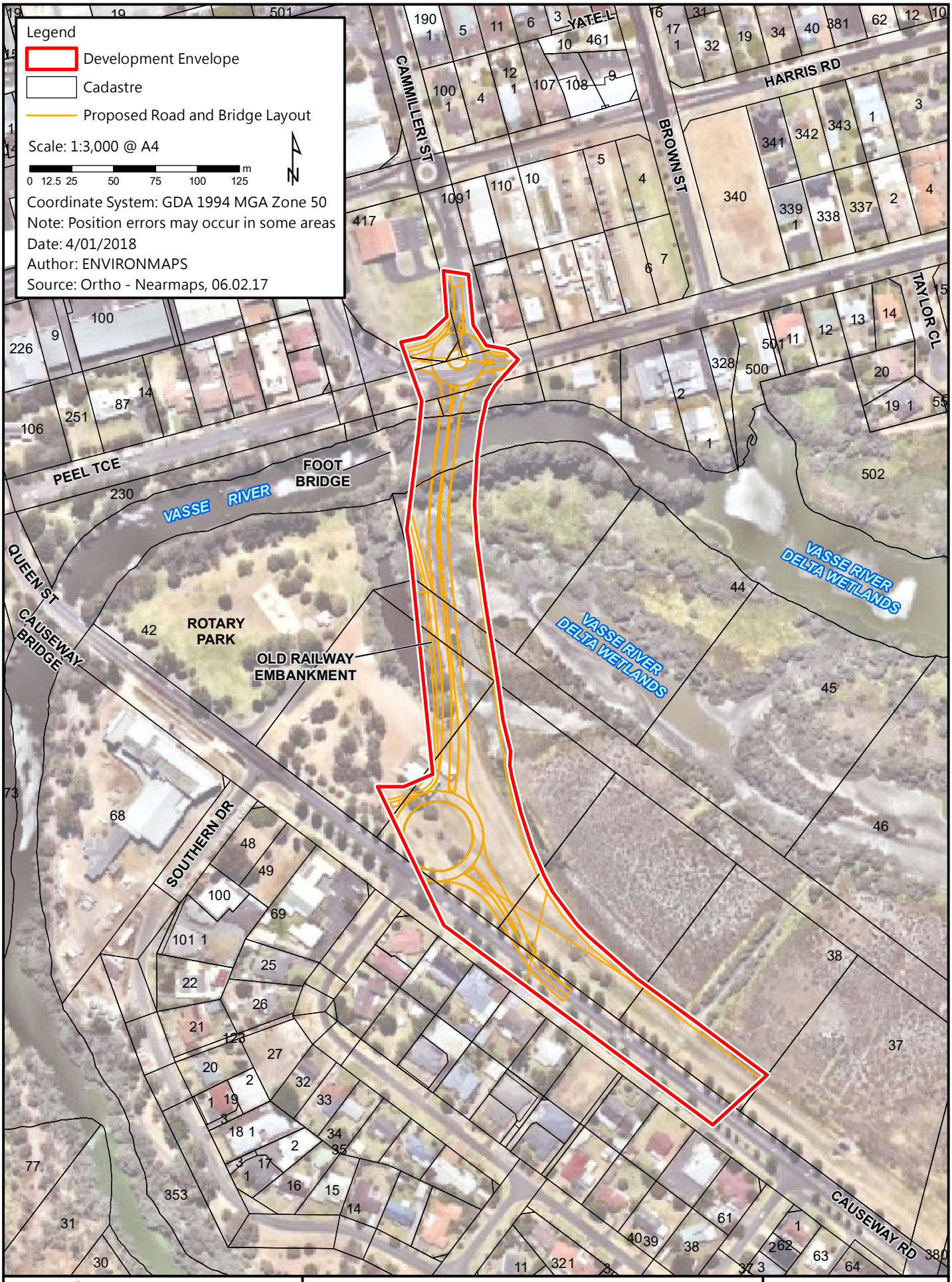

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Busselton Eastern Link Project
Construction Environmental Management Plan
Proposal Development Envelope and Layout

Figure 2

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1.2 Key environmental factors

Six preliminary key environmental factors are identified in the referral for the Proposal, as follows:

1. Flora and Vegetation.
2. Terrestrial Environmental Quality.
3. Terrestrial Fauna.
4. Hydrological Processes.
5. Inland Waters Environmental Quality.
6. Social Surroundings.

Of these factors, Hydrological Processes is identified with respect to potential impacts during operations, with impacts during construction expected to be insignificant (Strategen 2018). Accordingly, this CEMP does not include provisions for Hydrological Processes.

Table 1 presents the five preliminary key environmental factors relevant to construction, the Proposal activities that would affect the factors and the site-specific environmental values, uses and sensitive components that will be affected.

Table 1: Key environmental factors, construction activities and site characteristics

Preliminary key environmental factor	Proposal construction activities that would affect the factor	Site specific environment values, uses and sensitive components
Flora and Vegetation	• Clearing of up to 0.56 ha of native vegetation. • Soil erosion and sediment. • Storage and handling of hazardous materials and wastes.	• Vegetation comprises planted and remnant vegetation varying in condition from completely degraded to very good, representing 0.01% of estimated remaining extent of Vasse vegetation complex. • No threatened or priority ecological communities or flora species will be impacted.
Terrestrial Environmental Quality	• Excavation, dewatering and dredging of riverine sediments. • Soil erosion and sediment. • Storage and handling of hazardous materials and wastes.	• Presence of acid sulfate soils (ASS) on land and potential presence of monosulfidic black ooze (MBO) in river sediments.
Terrestrial Fauna	• Clearing of up to 0.56 ha of native vegetation including up to 17 Peppermint trees (0.1 ha). • Construction vehicle movements. • Construction plant operation. • Soil erosion and sediment. • Storage and handling of hazardous materials and wastes.	• Peppermint trees comprise habitat for threatened species Western Ringtail Possum. • Western Ringtail Possums identified during fauna survey. • No significant habitat for Black Cockatoos, with no roosting or breeding trees. • Potential waterbird habitat in Vasse River and Vasse River Delta Wetlands adjacent / downstream to Proposal.
Inland Waters Environmental Quality	• Excavation, dewatering and dredging of riverine sediments. • Soil erosion and sediment. • Storage and handling of hazardous materials and wastes.	• Threatened species Carters Freshwater Mussel located in Vasse River within bridge footprint. • Vasse River has poor water quality and low fish species diversity. No threatened fish species recorded in surveys. • Vasse River mapped as a conservation category wetland. Adjacent Vasse River Delta Wetlands mapped as multiple use wetlands. • Potential presence of MBO in river sediments.

Preliminary key environmental factor	Proposal construction activities that would affect the factor	Site specific environment values, uses and sensitive components
Social Surroundings	• Construction vehicle movements. • Construction plant operation including pile driving. • Soil erosion and sediment. • Storage and handling of hazardous materials and wastes.	• Residential and commercial properties in the vicinity. • Vasse River foreshore comprises public open space and connections to walk trails. • State heritage listed buildings (St Mary's Anglican Church and Old Butter Factory) in the vicinity. • No Aboriginal heritage sites present. • Potential for burials on northern bank of river.

1.3 Rationale and approach

The CEMP provisions have been developed with consideration of the key environmental factor objectives, the findings of surveys and studies, and the environmental risks posed by the Proposal construction activities.

1.3.1 Survey and study findings

This CEMP has been prepared with consideration of the following site specific environmental investigations:

- *Reconnaissance Flora, Vegetation and Fauna Survey* (Ecosystem Solutions 2017)
- *Detailed Flora and Vegetation Survey (*Strategen 2017a)
- *Acid Sulfate Soil Investigation Report* (Strategen 2017a)
- *Baseline assessment of Carter's Freshwater Mussel* (Beatty et al. 2017)
- *Report of an Aboriginal Heritage Survey* (Brad Goode & Associates 2017).

The reports and findings from these environmental investigations are provided in the Environmental Review Document (Strategen 2018) supporting the Proposal referral. The key findings are summarised in Table 1.

1.3.2 Key assumptions and uncertainties

Key uncertainties include the following:

- seasonal usage of wetlands by migratory waterbirds
- potential horizontal and vertical variation in ASS properties and specific properties in excavation and dewatering areas may potentially vary from those in investigation bores
- presence and characteristics of MBO within the Development Envelope remain uncertain
- presence of subsurface burials along the Vasse River banks remain uncertain.

To address these uncertainties the CEMP adopts a conservative approach to protecting wetlands, managing ASS and MBO, and monitoring for subsurface burials.

1.3.3 Management approach

This CEMP adopts a risk based approach to identify and prioritise actions, which addresses the key environmental values, uses and sensitive components summarised in Table 1.

1.3.4 Rationale for choice of provisions

This CEMP adopts provisions based on industry standard practices for minimisation and rehabilitation of environmental impacts during construction. The provisions reflect the potential for intermittent, episodic and acute impacts posed by construction activities, such as un-authorised clearing, dust emissions during high winds, or accidental spills of hazardous materials or wastes.

2. CEMP provisions

This section of the CEMP presents the proposed provisions for environmental management during construction of the Proposal. The CEMP provisions represent the Proponent's commitments for environmental management and demonstrate that construction activities will be appropriately managed to achieve the EPA's objectives for the key environmental factors identified for the Proposal.

This CEMP utilises management-based provisions. The selection of management based provisions rather than outcome based provisions is due to the Proposal construction activities posing environmental risks that are generally intermittent, episodic or acute impact events that are less applicable to objective measurement and reporting.

Table 2: CEMP provisions – Flora and Vegetation

EPA factor objective:	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.
CEMP objective:	Minimise impacts to flora and vegetation outside of Development Envelope as far as practicable.
Key environmental values:	Riparian vegetation and samphire surrounding Proposal is representative of Vasse vegetation complex and provides habitat for threatened and migratory species.
Key impacts and risks:	• clearing beyond the defined clearing areas of Development Envelope • introducing and/or spreading weeds and dieback • soil erosion and sediment discharge • accidental spills or leaks of hazardous materials or wastes

Management actions	Management targets	Monitoring	Reporting
Induct all construction personnel in: • avoiding clearing and access outside designated areas, particularly clearing of Peppermint trees • reporting all un-authorised clearing and access. Risk priority: High Timing: Prior to construction commencing	No environmental impacts occur that are attributable to lack of awareness in construction personnel.	Induction records.	Post-construction report.
Clearly mark all clearing areas on construction drawings and on the ground (e.g. pegging) and ensure areas of vegetation nominated to be excluded from clearing (e.g. mature trees where practicable) are visually identifiable to construction personnel. Risk priority: High Timing: Prior to clearing	No native vegetation is cleared outside of designated clearing areas.	Visual inspection of boundaries of clearing areas for evidence of un-authorised clearing. Daily inspection during clearing works. Weekly inspection once clearing is completed.	Post-construction report. Report of all un-authorised clearing.
Restrict all construction vehicle and plant access to designated access tracks / areas. Risk priority: High Timing: At all times	No construction vehicle or plant access occurs outside of designated access tracks / areas.	Visual inspection of boundaries of designated access tracks / areas for evidence of un-authorised access.	Post-construction report. Report of all un-authorised access.
Undertake re-planting and rehabilitation of vegetation in accordance with a Revegetation and Rehabilitation Plan approved by Department of Biodiversity, Conservation and Attractions. Risk priority: Moderate Timing: to be specified in Revelation and Rehabilitation Plan	Revegetation and Rehabilitation Plan success criteria are met.	As specified in Revegetation and Rehabilitation Plan	As specified in Revegetation and Rehabilitation Plan
Ensure all imported fill, soil, mulch, plants and seedlings used on site are certified weed and dieback free. Risk priority: High Timing: At all times	No weed infestation present within Development Envelope at the completion of construction.	Reconciliation of earthworks and landscaping against delivery certification.	Post-construction report.

EPA factor objective:	To protect flora and vegetation so that biological diversity and ecological integrity are maintained.
CEMP objective:	Minimise impacts to flora and vegetation outside of Development Envelope as far as practicable.
Key environmental values:	Riparian vegetation and samphire surrounding Proposal is representative of Vasse vegetation complex and provides habitat for threatened and migratory species.
Key impacts and risks:	• clearing beyond the defined clearing areas of Development Envelope • introducing and/or spreading weeds and dieback • soil erosion and sediment discharge • accidental spills or leaks of hazardous materials or wastes

Management actions	Management targets	Monitoring	Reporting
Control all weed outbreaks within construction area using mechanical or chemical means. All use of herbicides to be approved by the City Representative. Risk priority: Moderate Timing: throughout construction.	No weed infestation present within Development Envelope at the completion of construction.	Weekly inspection of construction area for weed infestation.	Post-construction report.
All construction plant and vehicles entering the construction compound and construction work areas to be free of soil, plant and organic material. All plant and vehicles found to contain soil, plant or organic material to be turned away for washing off-site or else washed down at the construction compound with washwater draining into a sump. Sump contents to be regularly cleaned out and disposed of at a licenced landfill. Risk priority: High Timing: At all times	No weed infestation present within Development Envelope at the completion of construction.	Inspection of all construction plant and vehicles upon entry to the construction compound or construction works areas. Inspection to include tyres, underside and earthmoving components.	Report all incoming plant and vehicles washed to remove soil, plant or organic material.
Soil erosion and sediment controls as specified in Table 5: CEMP provisions – Inland Waters Environmental Quality	See Table 5	See Table 5	See Table 5
Hazardous materials and waste management as specified in Table 5: CEMP provisions – Inland Waters Environmental Quality	See Table 5	See Table 5	See Table 5

Table 3: CEMP provisions – Terrestrial Environmental Quality

EPA factor objective:	To maintain the quality of land and soils so that environmental values are protected.		
CEMP objective:	Minimise impacts from acid sulfate soils, monosulfidic black ooze and site contamination as far as is practicable.		
Key environmental values:	Development Envelope lies in proximity to wetlands that support threatened Carters Freshwater Mussel and migratory waterbird habitat.		
Key impacts and risks:	• excavation and dewatering of acid sulfate soils or contaminated material • dredging of riverine sediments potentially containing monosulfidic black ooze • soil erosion and sediment discharge • excavation of unexpected contamination • accidental spills or leaks of hazardous materials or wastes		
Management actions	Management targets	Monitoring	Reporting
Induct all construction personnel in: • reporting all suspected contamination encountered during earthworks. Risk priority: Moderate Timing: Prior to construction commencing	All staff inducted.	Induction records.	Post-construction report.
Undertake excavation and dewatering in accordance with an Acid Sulfate Soil and Dewatering Management Plan (ASSDMP) approved by Department of Water and Environmental Regulation (DWER). Risk priority: High Timing: ASSDMP approved prior to commencement of excavation.	As specified in ASSDMP	As specified in ASSDMP	Approved ASSDMP. ASSDMP implementation reporting as specified in ASSDMP
Riverine sediments to be removed for abutment construction will be subject to sampling and management in accordance with advice of DWER. This will include • sampling of sediments over the proposed footprint and depth of construction platforms • laboratory analysis of samples to determine MBO characteristics • assessment of hazard posed by MBO characteristics and proposed volume/method of removal Prepare MBO Management Plan (MBOMP) to address the hazard, incorporating advice from DWER and guidance from the Commonwealth Department of Agriculture and Water Resources. MBOMP to be reviewed and approved by DWER. Risk priority: High Timing: MBOMP approved prior to commencement of dredging.	As specified in MBOMP	As specified in MBOMP	MBO investigation report. Approved MBOMP (if required). MBOMP implementation reporting as specified in MBOMP
In the event of excavation encountering suspected contaminated materials, the excavation works are to be stopped and advice sought from a qualified environmental professional. If required, the suspected contamination will be sampled and analysed to determine the appropriate remediation and disposal. Risk priority: Moderate Timing: throughout excavation works.	All suspected contamination is characterised and appropriately managed.	Visual monitoring during excavation.	Reporting of all suspected contamination. Contamination report from environmental professional.
Soil erosion and sediment controls as specified in Table 5: CEMP provisions – Inland Waters Environmental Quality	See Table 5	See Table 5	See Table 5

EPA factor objective:	To maintain the quality of land and soils so that environmental values are protected.		
CEMP objective:	Minimise impacts from acid sulfate soils, monosulfidic black ooze and site contamination as far as is practicable.		
Key environmental values:	Development Envelope lies in proximity to wetlands that support threatened Carters Freshwater Mussel and migratory waterbird habitat.		
Key impacts and risks:	• excavation and dewatering of acid sulfate soils or contaminated material • dredging of riverine sediments potentially containing monosulfidic black ooze • soil erosion and sediment discharge • excavation of unexpected contamination • accidental spills or leaks of hazardous materials or wastes		
Management actions	Management targets	Monitoring	Reporting
Hazardous materials and waste management as specified in Table 5: CEMP provisions – Inland Waters Environmental Quality	See Table 5	See Table 5	See Table 5

Table 4: CEMP provisions – Terrestrial Fauna

EPA factor objective:	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.		
CEMP objective:	Minimise impacts to terrestrial fauna during construction as far as practicable.		
Key environmental values:	Development Envelope contains habitat for Western Ringtail Possum and migratory waterbirds.		
Key impacts and risks:	• clearing of native vegetation comprising fauna habitat • construction vehicle movements • construction plant operation • excavation of trenches • soil erosion and sediment discharge • accidental spills or leaks of hazardous materials or wastes		
Management actions	Management targets	Monitoring	Reporting
Vegetation clearing controls as specified in Table 2: CEMP provisions – Flora and Vegetation	See Table 2	See Table 2	See Table 2
Weed and dieback controls as specified in Table 2: CEMP provisions – Flora and Vegetation	See Table 2	See Table 2	See Table 2
Re-vegetation and rehabilitation as specified in Table 2: CEMP provisions – Flora and Vegetation	See Table 2	See Table 2	See Table 2

EPA factor objective:	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.
CEMP objective:	Minimise impacts to terrestrial fauna during construction as far as practicable.
Key environmental values:	Development Envelope contains habitat for Western Ringtail Possum and migratory waterbirds.
Key impacts and risks:	• clearing of native vegetation comprising fauna habitat • construction vehicle movements • construction plant operation • excavation of trenches • soil erosion and sediment discharge • accidental spills or leaks of hazardous materials or wastes

Management actions	Management targets	Monitoring	Reporting
Induct all construction personnel in: • avoiding injury or harassment of native fauna during operation of vehicles or equipment • reporting all injured, abandoned or otherwise visibly distressed fauna • prohibition on feeding fauna, hunting or keeping of firearms or pets on site. Risk priority: High Timing: Prior to construction commencing	No environmental impacts occur that are attributable to lack of awareness in construction personnel.	Induction records.	Post-construction report.
Engage qualified fauna spotter / catcher prior to and during clearing works to inspect vegetation and remove all threatened fauna species. Risk priority: High Timing: Prior to and during clearing	No mortality of threatened, priority or migratory fauna species during clearing works.	Visual monitoring of clearing areas.	Post-clearing report. Reporting of all threatened fauna species mortality.
Conduct clearing in a sequential manner and in a way that encourages escaping wildlife away from the activity into adjacent natural areas and not onto roads, trenches or other areas of threat. Risk priority: Moderate Timing: During clearing	No mortality of threatened, priority or migratory fauna species during clearing works.	Visual monitoring of construction work areas.	Post-clearing report. Reporting of all threatened fauna species mortality.
Ensure a qualified fauna spotter / catcher is on call during clearing works to handle any injured, abandoned or otherwise visibly distressed fauna. If any injured, abandoned or otherwise visibly distressed fauna are observed when a wildlife handler/fauna spotter is not available, contact the Department of Biodiversity and Conservation (DBCA) wildcare hotline on 08 9474 9055. Risk priority: High Timing: At all times	All fauna identified as injured, abandoned or visibly distressed is handled by a qualified fauna spotter / catcher or in accordance with DBCA wildcare hotline instruction.	Visual monitoring of construction work areas.	Post-construction report. Reporting of all fauna handling.
Check open excavations and trenches for fauna and remove any trapped animals by authorised fauna handlers Risk priority: High Timing: immediately prior to backfill and twice daily when trenching present.	No mortality of threatened, priority or migratory fauna species in trenches or excavations.	Visual monitoring of excavations and trenches.	Reporting of all threatened fauna species mortality.

EPA factor objective:	To protect terrestrial fauna so that biological diversity and ecological integrity are maintained.		
CEMP objective:	Minimise impacts to terrestrial fauna during construction as far as practicable.		
Key environmental values:	Development Envelope contains habitat for Western Ringtail Possum and migratory waterbirds.		
Key impacts and risks:	• clearing of native vegetation comprising fauna habitat • construction vehicle movements • construction plant operation • excavation of trenches • soil erosion and sediment discharge • accidental spills or leaks of hazardous materials or wastes		
Management actions	Management targets	Monitoring	Reporting
Ensure trenches remain open only for the time required for construction purposes and be backfilled as soon as the trenches are no longer required. Risk priority: Moderate Timing: Throughout construction.	No mortality of threatened, priority or migratory fauna species in trenches or excavations.	Visual monitoring of excavations and trenches.	Reporting of all threatened fauna species mortality.
Soil erosion and sediment controls as specified in Table 5: CEMP provisions – Inland Waters Environmental Quality	See Table 5	See Table 5	See Table 5
Hazardous materials and waste management as specified in Table 5: CEMP provisions – Inland Waters Environmental Quality	See Table 5	See Table 5	See Table 5

Table 5: CEMP provisions – Inland Waters Environmental Quality

EPA factor objective:	To maintain the quality of groundwater and surface water so that environmental values are protected.		
CEMP objective:	Minimise impacts to water quality and aquatic ecology of Lower Vasse River and Vasse River Delta Wetlands as far as is practicable.		
Key environmental values:	Development Envelope lies in proximity to wetlands that support threatened Carters Freshwater Mussel and migratory waterbird habitat.		
Key impacts and risks:	• excavation and dewatering of acid sulfate soils or contaminated material • dredging of riverine sediments potentially containing monosulfidic black ooze • dredging of riverine sediments containing Carters Freshwater Mussel • soil erosion and sediment discharge • accidental spills or leaks of hazardous materials or wastes		
Management actions	Management targets	Monitoring	Reporting
Induct all construction personnel in: • maintaining soil erosion and sediment controls • hazardous materials and waste management, including reporting and responding to spills and leaks. Risk priority: High Timing: Prior to construction commencing	No environmental impacts occur that are attributable to lack of awareness in construction personnel.	Induction records.	Post-construction report.

EPA factor objective:	To maintain the quality of groundwater and surface water so that environmental values are protected.
CEMP objective:	Minimise impacts to water quality and aquatic ecology of Lower Vasse River and Vasse River Delta Wetlands as far as is practicable.
Key environmental values:	Development Envelope lies in proximity to wetlands that support threatened Carters Freshwater Mussel and migratory waterbird habitat.
Key impacts and risks:	• excavation and dewatering of acid sulfate soils or contaminated material • dredging of riverine sediments potentially containing monosulfidic black ooze • dredging of riverine sediments containing Carters Freshwater Mussel • soil erosion and sediment discharge • accidental spills or leaks of hazardous materials or wastes

Management actions	Management targets	Monitoring	Reporting
Soil erosion and sediment controls • Maintain silt curtains either side of bridge abutments for the duration of bridge construction works and until turbidity levels are visually observed as equivalent to background levels upstream of silt fence. • Maintain silt fences at the base of all embankments adjacent to waterways and wetlands. • Stabilise embankments and earth worked areas as soon as practicable to minimise soil erosion. • Provide temporary stormwater drainage to direct surface runoff to sumps for sediment retention and infiltration. Risk priority: High Timing: throughout construction	Turbidity of Vasse River outside of silt curtains remains comparable to reference point upstream. No noticeable sediment deposition in wetlands adjacent to Development Envelope.	Visual inspection of turbidity in Vasse River within and adjacent to silt curtains and at a reference point upstream. Daily inspection during abutment construction period and weekly inspection thereafter. Visual inspection of wetlands adjacent to Development Envelope. Daily inspection during road embankment construction and weekly inspection thereafter. Weekly inspection of erosion and sediment controls during construction and following rainfall events exceeding 10 mm in one day.	Post-construction report.

EPA factor objective:	To maintain the quality of groundwater and surface water so that environmental values are protected.
CEMP objective:	Minimise impacts to water quality and aquatic ecology of Lower Vasse River and Vasse River Delta Wetlands as far as is practicable.
Key environmental values:	Development Envelope lies in proximity to wetlands that support threatened Carters Freshwater Mussel and migratory waterbird habitat.
Key impacts and risks:	• excavation and dewatering of acid sulfate soils or contaminated material • dredging of riverine sediments potentially containing monosulfidic black ooze • dredging of riverine sediments containing Carters Freshwater Mussel • soil erosion and sediment discharge • accidental spills or leaks of hazardous materials or wastes

Management actions	Management targets	Monitoring	Reporting
Hazardous materials and waste management • All refuelling of construction vehicles and plant to be via mobile tankers – no fuel storage on site. • All scheduled / major maintenance of construction vehicles and plant to be undertaken off-site. • Minimise on-site storage and handling of hazardous materials. • Maintain an inventory and materials safety data sheets (MSDS) for all hazardous materials on site. • Clearly label and placard all hazardous materials. • Hazardous materials to be stored in bunded facilities within construction compound. No storage to occur within 10 m of waterways or wetlands. • Putrescible wastes to be stored in covered containers and collected at least weekly to prevent odours, insect breeding and animal scavenging. • Waste storage areas to be located within construction compound and kept in a clean and tidy condition. No storage to occur within 10 m of waterways or wetlands. • Wind-blown litter to be managed through daily collection and provision of wind fencing, if required. • Portable toilets maintained at construction compound. • Maintain spill response procedure. • Maintain spill response equipment on site to response to small spills. • Immediately respond to all spills within construction site to prevent discharge into Vasse River, wetlands or groundwater. All contaminated soils, spill response materials and equipment to be disposed of at a licensed waste facility. • Provide floating absorbent booms (at least 30 m long) to Busselton Fire & Rescue prior to construction commencing. • Conduct a spill response drill in the Vasse River prior to construction commencing, in collaboration with Busselton Fire & Rescue. Risk priority: High Timing: prior to and throughout construction	No spills or leaks of hazardous materials or wastes enter the Vasse River, Vasse River Delta Wetlands or groundwater.	Daily inspection of hazardous material and waste storage areas for evidence of spills, leaks and litter. Visual monitoring of construction work areas for evidence of spills and litter.	Post-construction report. Reporting of all spill / leak incidents into waterways, wetlands or groundwater. Contamination reporting as required under the *Contaminated Sites Act 2003*.

EPA factor objective:	To maintain the quality of groundwater and surface water so that environmental values are protected.
CEMP objective:	Minimise impacts to water quality and aquatic ecology of Lower Vasse River and Vasse River Delta Wetlands as far as is practicable.
Key environmental values:	Development Envelope lies in proximity to wetlands that support threatened Carters Freshwater Mussel and migratory waterbird habitat.
Key impacts and risks:	• excavation and dewatering of acid sulfate soils or contaminated material • dredging of riverine sediments potentially containing monosulfidic black ooze • dredging of riverine sediments containing Carters Freshwater Mussel • soil erosion and sediment discharge • accidental spills or leaks of hazardous materials or wastes

Management actions	Management targets	Monitoring	Reporting
Undertake translocation of Carters Freshwater Mussel in accordance with a Regulation 17 licence and approved translocation proposal. Risk priority: High Timing: as specified in translation proposal.	As specified in translocation proposal	As specified in translocation proposal	As specified in translocation proposal
ASS and dewatering management as specified in Table 3: CEMP provisions – Terrestrial Environmental Quality.	See Table 3	See Table 3	See Table 3
MBO management as specified in Table 3: CEMP provisions – Terrestrial Environmental Quality.	See Table 3	See Table 3	See Table 3
Contamination management as specified in Table 3: CEMP provisions – Terrestrial Environmental Quality.	See Table 3	See Table 3	See Table 3

Table 6: CEMP provisions – Social Surroundings

EPA factor objective:	To protect social surroundings from significant harm.
CEMP objective:	Minimise disturbance to nearby residential, commercial and heritage properties and impacts to amenity of Vasse River and wetlands as far as is practicable.
Key environmental values:	Development Envelope lies in proximity to residential and commercial properties, State heritage listed buildings. Vasse River foreshore comprises public open space and linkage to walk trails.
Key impacts and risks:	• dust emissions from cleared and earthworked areas and stockpiles • noise from construction vehicles and equipment • impacts to Vasse River amenity through excavation, dewatering, dredging, sediment discharge, accidental spills or leaks of hazardous materials or wastes.

Management actions	Management targets	Monitoring	Reporting
Induct all construction personnel in: • restrictions in vehicle and plant movements and operations to minimise noise and traffic impacts to nearby properties and roads Risk priority: High Timing: Prior to construction commencing	No environmental impacts occur that are attributable to lack of awareness in construction personnel.	Induction records.	Post-construction report.
Inform the public and nearby properties of construction activities, timing and query / complaints hotline. Nearby properties informed via letter drops. Public informed via City newsletter / facebook page. Risk priority: High Timing: Prior to construction commencing	No complaints received due to lack of notification of property owners.	Not applicable.	Not applicable.
Maintain complaints hotline throughout construction. For all complaints received, determine the impact (if any) associated with construction works, any corrective and/or remedial action required, and provide a response to the complainant within 24 hours for severe impacts and within five business days for minor impacts. Risk priority: High Timing: throughout construction.	All complaints received are documented and responded to within 24 hours for severe impacts and five business days for minor impacts.	Not applicable	Post-construction report.

EPA factor objective:	To protect social surroundings from significant harm.
CEMP objective:	Minimise disturbance to nearby residential, commercial and heritage properties and impacts to amenity of Vasse River and wetlands as far as is practicable.
Key environmental values:	Development Envelope lies in proximity to residential and commercial properties, State heritage listed buildings. Vasse River foreshore comprises public open space and linkage to walk trails.
Key impacts and risks:	• dust emissions from cleared and earthworked areas and stockpiles • noise from construction vehicles and equipment • impacts to Vasse River amenity through excavation, dewatering, dredging, sediment discharge, accidental spills or leaks of hazardous materials or wastes.

Management actions	Management targets	Monitoring	Reporting
Dust management • Minimise area of clearing and earthworks to that required for construction activities. • Schedule vegetation clearing to occur immediately before planned earthworks to minimise duration of exposure of cleared ground, as far as practicable. • Avoid dust generating activities during unfavourable weather conditions (e.g. high wind speed) and unfavourable wind directions, where practicable. • Stabilise cleared areas and any dry, dust-prone areas or stockpiles to prevent dust lift off. Stabilisation methods may include wetting, application of hydromulch or other sealing material. • Restrict site access to designated access and construction areas. • Enforce maximum speed limit in construction areas to reduce dust lift off. • Implement dust suppression (e.g. water spray/wet down of unsealed tracks\stockpiles) if high levels of dust are observed or considered likely to occur. • Dust suppression equipment maintained on site. • Ensure haul truck loads are covered to prevent dust emissions. Risk priority: Moderate Timing: throughout construction.	No repetitive / sustained complaints received due to dust impacts.	Ongoing visual inspection of dust levels in construction areas. Daily check of weather conditions that may affect dust emissions.	Post-construction report.
Noise management • Construction limited to 7 am and 7 pm Monday to Friday. Any works for Saturday to be authorised in writing by City Representative. • Operation of construction plant restricted to within Development Envelope. • Construction vehicles and plant maintained in accordance with manufacturers specification. • Trucks not left idling and construction traffic minimised along Peel Terrace and local roads north of Development Envelope. Risk priority: Moderate Timing: throughout construction.	No repetitive / sustained complaints received due to noise impacts.	Daily check of noise levels in construction areas.	Post-construction report.

EPA factor objective:	To protect social surroundings from significant harm.
CEMP objective:	Minimise disturbance to nearby residential, commercial and heritage properties and impacts to amenity of Vasse River and wetlands as far as is practicable.
Key environmental values:	Development Envelope lies in proximity to residential and commercial properties, State heritage listed buildings. Vasse River foreshore comprises public open space and linkage to walk trails.
Key impacts and risks:	• dust emissions from cleared and earthworked areas and stockpiles • noise from construction vehicles and equipment • impacts to Vasse River amenity through excavation, dewatering, dredging, sediment discharge, accidental spills or leaks of hazardous materials or wastes.

Management actions	Management targets	Monitoring	Reporting
Traffic management • Construction vehicles to use Causeway Road to access construction compound from the south rather than use Peel Terrace from the north, as far as is practicable. • Stage construction works to minimise the duration of traffic impacts at any particular location along Causeway Road, Peel Terrace and Camilleri Street. • Provide traffic controllers during all works on Causeway Road, Peel Terrace and Camilleri Street. • Develop and implement a strategy for maintaining access to the Old Butter Factory Museum during construction works, in consultation with the Busselton Historical Society. • Prohibit parking, standing or access by construction vehicles to verges alongside the Old Butter Factory and St Mary's Church. • Prohibit parking of construction vehicles in public carparks including Rotary Park or Peel Street outside of construction hours. Construction vehicle parking to be provided at construction compound. Risk priority: High Timing: throughout construction.	No repetitive / sustained complaints received due traffic and parking impacts.	Not applicable.	Post-construction report.
Engage Aboriginal cultural monitors during excavation works on the northern banks/foreshore of the Vasse River. Risk priority: Moderate Timing: during excavation works on north side of river	Any burials uncovered during excavation works are managed in accordance with directions of Aboriginal cultural monitors.	Aboriginal cultural monitoring.	Post-construction report.
ASS and dewatering management as specified in Table 3: CEMP provisions – Terrestrial Environmental Quality.	See Table 3	See Table 3	See Table 3
MBO management as specified in Table 3: CEMP provisions – Terrestrial Environmental Quality.	See Table 3	See Table 3	See Table 3
Contamination management as specified in Table 3: CEMP provisions – Terrestrial Environmental Quality.	See Table 3	See Table 3	See Table 3
Soil erosion and sediment controls as specified in Table 5: CEMP provisions – Inland Waters Environmental Quality	See Table 5	See Table 5	See Table 5
Hazardous materials and waste management as specified in Table 5: CEMP provisions – Inland Waters Environmental Quality	See Table 5	See Table 5	See Table 5

3. Adaptive management and review of the CEMP

The Proponent will apply an adaptive management approach to implementation of the CEMP as follows:

- response actions in the event of failure to achieve key management targets, as presented in Table 7
- review of CEMP provisions at three months and nine months from commencement of construction works.

Table 7: Adaptive management for CEMP provisions

Trigger	Indicators	Response actions
Clearing or access outside of designated areas.	• Cleared vegetation outside of demarcated boundary • Damage of clearing boundary fencing / demarcations. • Access tracks outside of demarcated boundary.	1. Investigate cause. 2. Report and investigate as an incident. 3. Stop construction activities. 4. Re-establish approved boundary with temporary fencing. 5. Rehabilitate impacted area. 6. Implement corrective action (e.g. induction, CEMP revision) based on cause findings.
New weeds, declared pests of high priority weed species observed within construction area.	Visual inspection of construction area during construction.	1. Investigate cause. 2. Report and investigate as an incident. 3. Arrange for weed control by a suitably qualified contractor, ensuring no spray drift into adjacent native vegetation or wetland areas. 4. Undertake inspection of treated areas after an expected re-growth period (considering species and season) and apply further weed control (if required) to knock back any re-growth. 5. Implement corrective action (e.g. plant washing, supplier warning, CEMP revision) based on cause findings.
Weeds present within Development Envelope at completion of construction.	Visual inspection of construction area at completion of construction.	1. Arrange for weed control by a suitably qualified contractor, ensuring no spray drift into adjacent native vegetation or wetland areas. 2. Undertake inspection of treated areas after an expected re-growth period (considering species and season) and apply further weed control (if required) to knock back any re-growth.
Threatened, priority or migratory fauna species mortality during clearing works or within trenches or excavations. Native fauna present onsite during construction.	Visual identification of dead fauna during construction.	1. Engage fauna spotter / catcher to confirm species. 2. Investigate cause. 3. Report and investigate as an incident. 4. Stop construction works associated with the mortality. 5. Fauna spotter / catcher to inspect vicinity of mortality to identify and relocate any fauna deemed to be at risk from the construction works. 6. Implement corrective action (e.g. induction, trench fencing, CEMP revision) based on cause findings.

Trigger	Indicators	Response actions
Turbidity of Vasse River outside of silt curtains is noticeably greater than reference point upstream. Noticeable sediment deposition in wetlands adjacent to Development Envelope.	• Visual observation of turbidity. • Visual observation of sediment deposition.	1. Investigate cause. 2. Report and investigate as an incident. 3. Stop construction activities. 4. Repair / reinstate all affected sediment and erosion controls. 5. Establish additional sediment and erosion controls (if required) to prevent ongoing impacts. 6. Conduct daily inspections of turbidity / deposition for one month to verify effectiveness of sediment and erosion controls.
Spill or hazardous material or waste entering Vasse River, wetlands or waterways	• Visual observation of spill contents in standing water. • Visual observation of contamination in groundwater upon excavation of contaminated soil during on-site spill / leak response.	1. Immediately contact Busselton Fire & Rescue to recover any spill contents within waterways or wetlands, using floating booms provided for the purpose. 2. Identify cause of the spill/leak and implement corrective action to prevent re-occurrence. 3. Implement remedial works to repair any damage from the spill (e.g. contaminated soils, groundwater, vegetation or deposition) under direction of a qualified environmental professional. 4. Any site contamination to be managed and reported in accordance with the *Contaminated Sites Act 2003*.
Sustained / repetitive complaints received due to dust, noise, traffic or parking impacts.	• Sustained / repetitive complaints received with verified impacts from construction.	1. Stop construction works associated with the specific impacts. 2. Review construction activities and replan as required to reduce impacts such as route selection, staging, parking restrictions, timing of works, and application of site controls (e.g. dust suppression / stabilisation). 3. Provide inductions to personnel (if required) on the replanned construction works / controls. 4. Undertake monitoring to verify the effectiveness of the replanned works / controls. 5. Update CEMP if required.

4. Stakeholder consultation

Consultation has been undertaken with relevant government agencies and key stakeholders to identify potential environmental impacts and mitigation strategies for the Proposal. The consultation is presented in Section 3 of the Environmental Review Document (Strategen 2018).

5. References

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