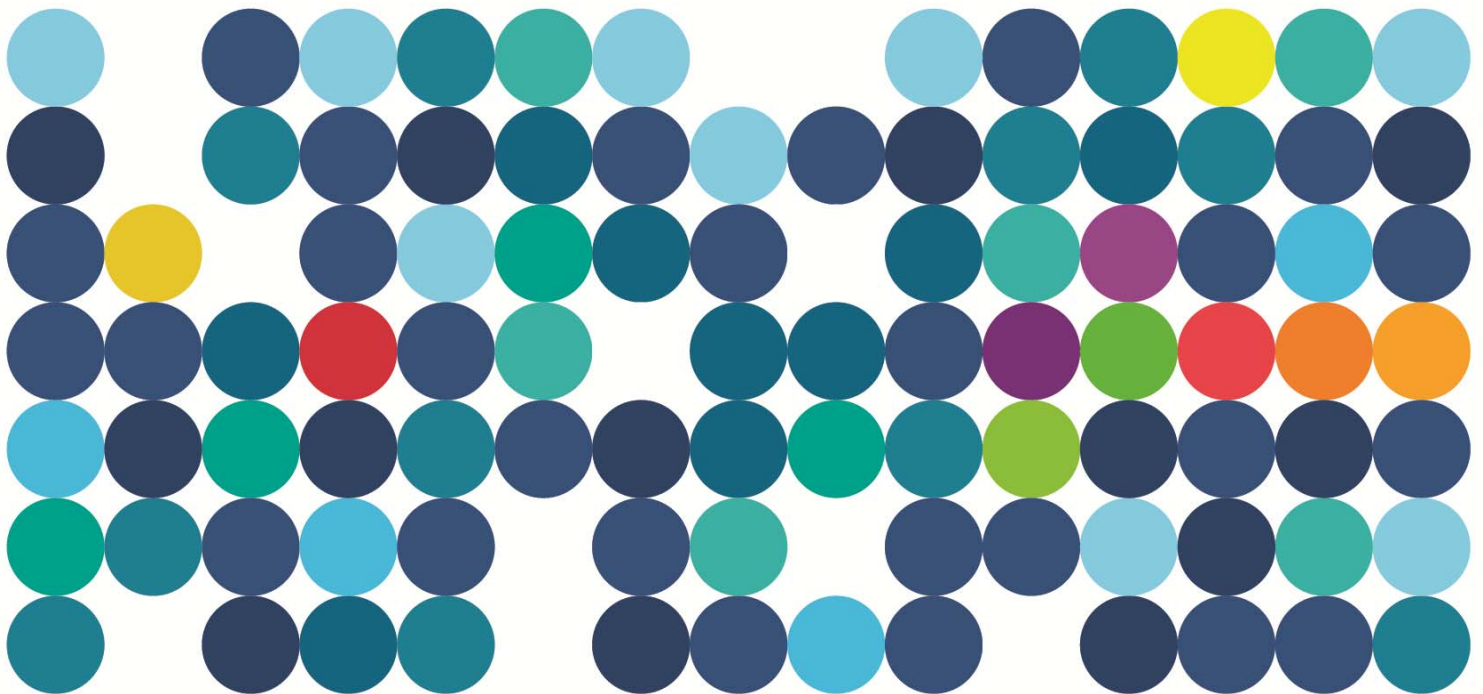


**2017/7932,
CPS 8191/1**

Vasse Diversion Drain Upgrade Variation 2

Supporting Documentation, March 2020 Submission





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1. Project Scope

1.1. Proposal Description

This document has been prepared as supporting information for a new variation (hereon in 'Variation 2') to the Proposed Action 2017/7932 and CPS 8191/1.

The Vasse Diversion Drain ('the drain') is a 100-year-old strategic infrastructure corridor, originally constructed in the 1920s to create more arable land in the catchment, its primary function now, is to prevent flooding of the Busselton township. The drain diverts flows from the catchments of the Vasse and Sabina Rivers, covering a total area of 287 km².

The drain extends approximately 6.3 km from Geographe Bay, to the Busselton Golf Course (**Figure 1**). The existing drain is variable widths along the length of the drain, not exceeding 44 m. Variation 2 covers a distance of 5.3 km, from Queen Elizabeth Avenue to south of the Chapman Hill Road Bridge. The proposal comprises the hydraulic and structural improvement of the drain to meet the 1-in-100 AEP. This will involve:

- Refurbishment of the levee banks from CH800 to CH1300. Temporary coffer dams will be installed and the flow diverted to allow for scouring of the channel, reconstruction of the levees, respraying of the levee walls and repair of the pedestrian bridge footings.
- CH1300 to CH5500 the levees will be deconstructed to ground level and reconstructed between 5 m – 11 m wider. The pedestrian will be jacked up and extended to accommodate the widening in this section.
- From CH5600 – CH6200 the levees will be deconstructed to ground level, the channel will be widened to accommodate a Department of Water and Environment gauging station, and the levees will be reconstructed 5 m – 11 m wider than the existing structures.
- CH6000 – CH6200 will include the reconstruction of the spillway and deepening of the diversion dam, which may involve some dewatering. A dewatering licence will be obtained by the Corporation. This work will include increasing capacity of the culvert connecting the diversion drain to the lower Vasse River.

The total clearing area for the proposal is 2.16 ha, of which 1.57 ha is permanent clearing for the ultimate design if the drain. Further details about the proposed activities is provided in **Section 3.1**.

1.2. Project Justification

Since construction, surrounding land-uses in the catchment have changed. Clearing of farmland has resulted in increased surface water runoff from storm events, and residential areas have been developed adjacent to both sides of the drain downstream of the Busselton Bypass. See **Appendix A** for a comprehensive history of the drain.

The existing drain does not meet the flood mitigation requirements determined by the Busselton Flood Management Steering Committee and State Cabinet. The current infrastructure exposes the community and the state government to high levels of risk in its current form.

On completion of this project, the estimated 1-in-100 AEP flood peak in the drain will be approximately 140 m³/s. Failure to deliver this project may potentially result in loss of life and will result in damage to property in the event of a 1-in-100 AEP storm.



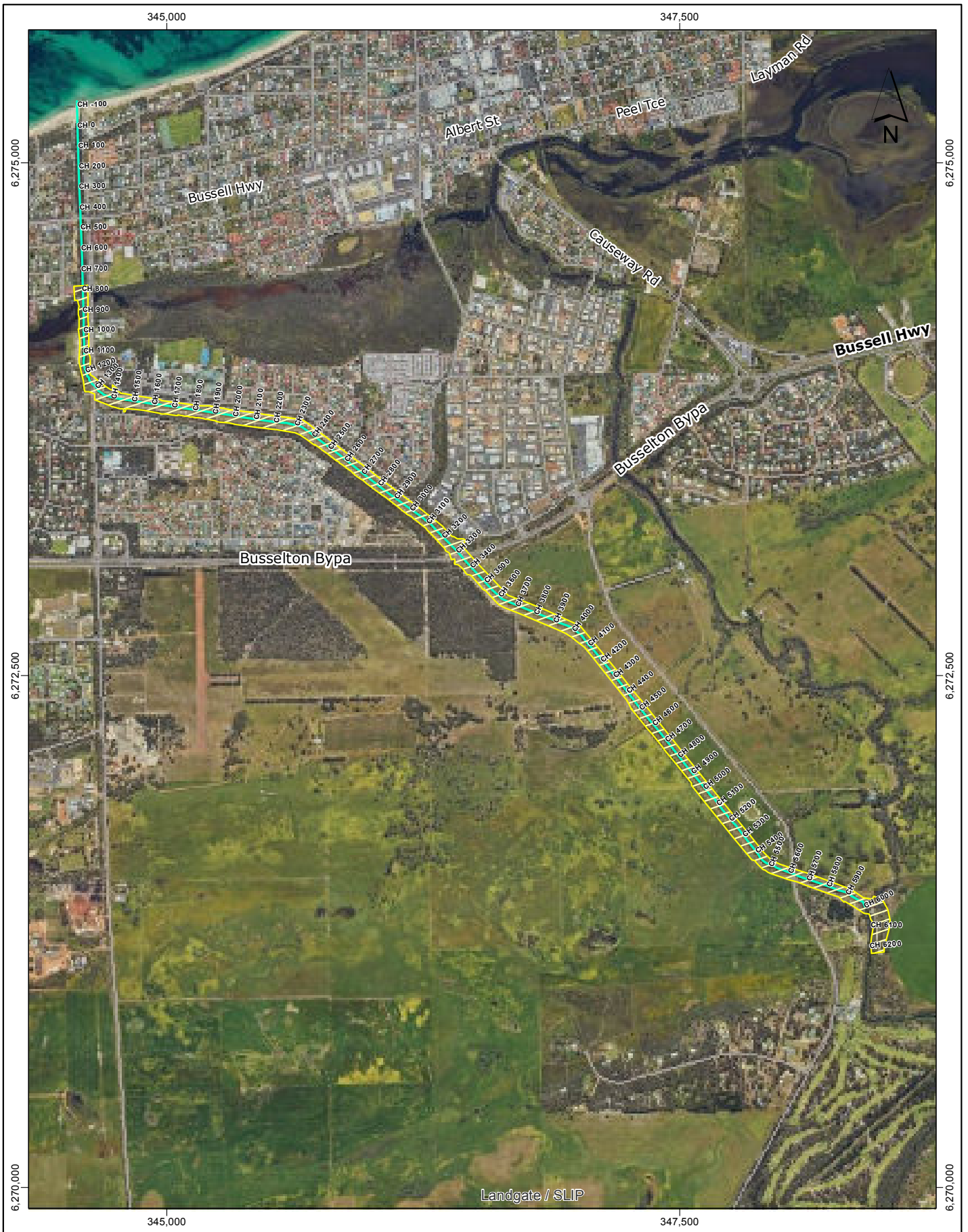
1.3. Alternative Options

Three options were evaluated by Water Corporation, including:



- **Option 1:** To provide standard based piping and slope stability protection and 1% AEP flood capacity with freeboard (estimated costs \$30.1 million);
- **Option 2:** To provide a risk based piping and slope stability upgrade and 1% AEP flood capacity with freeboard (estimated costs \$14.3 million); and
- **Option 3:** A staged risk based upgrade to reduce upfront capital costs by accepting an initially higher level of risk for both overtopping and seepage initiated failure, but ultimately reducing the VDD risk to be within the ANCOLD ALARP region (estimated cost \$17.8 million).

Water Corporation recommended adopting the Risk Based Upgrade (Option 2). The outcome of the recommended option is a reduction of the life safety risk to within the ANCOLD ALARP region and a minimisation of the annualised economic damages associated with failure of the drain.

From an environmental perspective, none of the options considered presented a markedly increased or reduced environmental risk. All options involved widening of the drain in its current location. The negotiations undertaken to obtain three large compensation basins led to the minimisation of the necessary widening of the drain, resulting in the smallest possible clearing footprint for this critical infrastructure project.



LEGEND

-  Vasse Diversion Drain Open Channel
-  Development Area Footprint



1:25,000 at A4
 0 250 500 750
 Metres
 Coordinate System: GDA 1994 MGA Zone 50
 Vertical Datum: AHD

AUTHOR: ALLSOPK0 | DATE: 17/03/2020
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**Vasse Diversion Drain
 Project Location**



2. Approvals context

The drain is located within the South-West region of Western Australia, broadly recognised as a biodiversity hotspot. As such a suite of environmental protection legislation applies to this project (**Table 1**).

Table 1: Legislative context

Title	Jurisdiction
<i>Environment Protection and Biodiversity Conservation Act 1999</i> (EPBC Act 1999)	Federal
<i>Environmental Protection and Biodiversity Conservation Regulations 2000</i>	Federal
<i>Survey Guidelines for Australia's Threatened Orchids: Guidelines for detecting orchids listed as 'Threatened' under the EPBC Act 1999</i> (2013)	Federal
Matters of National Environmental Significance – Significant Impact Guidelines 2013	Federal
<i>Environmental Protection Act 1986</i> (Part V) (EP Act)	State
<i>Environmental Protection Regulations 1987</i>	State
<i>Environmental Protection (Clearing of Native vegetation) Regulations 2004</i>	State
<i>Contaminated Sites Act 2003</i>	State
<i>Biodiversity Conservation Act 2016</i>	State
<i>Biodiversity Conservation Regulations 2018</i>	State
<i>Biosecurity and Agriculture Management Act 2007</i>	State

2.1. Approvals Summary

In 2017 the project was referred under the Federal *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act) with a total clearing area of 4.6 ha. In August 2017 the Corporation was advised that the project is a 'Controlled Action 2017/7932' for the following Matters of National Environmental Significance:

- *Pseudocheirus occidentalis* (Western Ringtail Possum) – Vulnerable
- *Calyptorhynchus baudinii* (Baudin's Cockatoo) - Vulnerable
- *Calyptorhynchus latirostri* (Carnaby's Black Cockatoo) – Endangered
- *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo) – Vulnerable
- *Caladenia procera* (Carbunup King Spider Orchid) – Critically Endangered

A variation to the EPBC Act 1999 referral was submitted in 2018, along with an application to the Department of Water and Environmental Regulation (DWER) for a Part V Clearing Permit (CPS 8191/1) under the Western Australian *Environmental Protection Act 1986*. The variation to the initial proposal included a reduced clearing footprint of 3.6 ha. It was agreed DWER



would conduct the assessment of the project in accordance with the Bilateral assessment process.

DWER advised that under State legislation, in addition to the species listed above, impacts of the proposal on the following Environmental Factors will be considered:

- *Westralunio carteri* (Carter’s Freshwater Mussel) – Vulnerable
- Priority Ecological Community (Priority 1) *Eucalyptus rudis* (flooded gum), *Corymbia calophylla*, *Agonis flexuosa* Closed Low Forest (near Busselton) (not formally protected under any legislation, however it is considered under Clearing Principle (A)), and
- *Conospermum caeruleum* subsp? *Busselton* (Subspecies is not formally recognised under Legislation).

This document has been prepared as supporting information for a new variation to the Proposed Action 2017/7932 and CPS 8191/1. Variation 2 is a result of continued refinement through the detailed design of the project to further reduce the clearing footprint to 1.57 ha of permanent clearing area and 0.6 ha of temporary clearing, discussed further in **Section 3.2**.

2.2. Survey Bibliography

The Corporation has engaged specialist consultants and subject matter experts to create a clear understanding of the potential environmental impacts of this proposal. A comprehensive bibliography of surveys is provided in **Table 2** below.

Table 2: Vasse Diversion Drain Upgrade Survey Bibliography

Survey Title	Survey Type
Western Australian Museum (WAM), 2006, <i>Report on a Survey of the Non-Marine Molluscan fauna of the Vasse Diversion Drain, Busselton, Western Australia</i>	Targeted Fauna Survey
Lymbery et al, 2008, <i>Freshwater mussels (Westralunio carteri) in the catchments of Geographe Bay, South-Western Australia</i>	Targeted Fauna Survey
GHD, 2009. <i>Report for Vasse Diversion Drain Upgrade: Fauna and Flora Study (Level 2 Flora and Vegetation Survey)</i>	Fauna, Flora and Vegetation Survey
GHD, 2017a. <i>Vasse Diversion Drain Upgrade: Flora and Fauna Study (Level 1 Flora and Vegetation Survey)</i> .	Fauna, Flora and Vegetation Survey
GHD, 2017b. <i>Vasse Diversion Drain: Fauna and Vegetation Assessment – Additional Survey Area</i>	Fauna, Flora and Vegetation Survey
GHD, 2017c. <i>Vasse Diversion Drain: Carunup King Spider Orchid, Targeted Survey</i> .	Targeted Orchid Survey
GHD, 2019, <i>Busselton Flood Protection Project: Vasse Diversion Drain Upgrade Mussel Survey (Appendix I)</i> .	Targeted Fauna Survey
Kirkby, 2019. <i>Inspection of possible Black Cockatoo (Calyptorhynchus spp) Breeding Hollows at Vasse Diversion Drain, Busselton</i> .	Targeted Fauna Survey
Bamford Consulting, 2019. <i>Assessment of the Western Ringtail Possum along the Vasse Main Drain, Busselton</i>	Targeted Fauna Survey
Bennett, E, 2019. <i>Distribution of Conospermum caeruleum subsp? Busselton</i>	Targeted Flora Survey
Department of Biodiversity Conservation and Attractions, 2019. <i>Research Report: genetic assessment of the Busselton populations of Conospermum</i>	Targeted Flora Genetic Testing



Survey Title	Survey Type
<i>caeruleum</i> .	
Lymbrey <i>et al</i> , 2019, <i>Vasse Diversion Drain Mussel Survey (Memorandum)</i> . Unpublished.	Targeted Fauna Survey
Dixon. K, <i>Pers comms</i> (2019) advice from Professor Kingsley Dixon, subject matter expert for <i>Caladenia procera</i> .	Subject Matter Expert Advice
EcoEdge Consulting, 2019. <i>Reconnaissance and Targeted Flora and Vegetation Surveys along Vasse Diversion Drain</i>	Targeted Orchid and PEC Survey
EcoEdge Consulting, 2020, Addendum to Detailed and Targeted Flora and Vegetation Survey: Vasse Diversion Drain Upgrade	Targeted PEC and Flora Survey

2.3. Stakeholder Consultation

The Corporation has a community engagement plan in place for the design and construction of the proposal and has invited the community to have an open dialogue with the project team via the following channels:

- Reaching out to the project’s dedicated Community Engagement Advisor, OR
- Visiting our online engagement platform at <https://yoursay.watercorporation.com.au/VasseDrainUpgrade>

Two rounds of letters and emails have been sent to over 350 properties along the drain providing a description of the proposal and inviting comments and feedback. So far, over 100 people have visited the webpage and read or engaged with the content.

In December 2019, we spoke with over 100 Busselton community members, including six representatives of local environmental stakeholder groups. We received valuable feedback. Many people shared their eagerness to see improvements in flood protection for Busselton and told us stories of previous flood events.

People also shared with us their concerns about the project, these included:

- Walking/transport routes over and along the drain during construction.
- Construction impacts like dust, noise and vibration on nearby homes.
- Environmental impacts (disruption to wildlife and loss of trees).
- Aesthetics of the drain when construction is complete.
- Integrated management of drains and rivers.

We listened to this community feedback and incorporated it into the design, surveys and rehabilitation plans. We shared these with the community at pop-up project information booths in Busselton in late February 2020.

Other interested Stakeholders the Corporation has engaged with include:

- City of Busselton
- Department of Water and Environmental Regulation (Native Vegetation Branch)
- Department of Water and Environmental Regulation (Bunbury, Krish Seewraj, Busselton, Kath Lynch)
- Department of Biodiversity Conservation and Attractions (Land Use Planning Branch)



- Department of Biodiversity Conservation and Attractions (Bunbury Regional Office)
- Department of Energy and Environment (now Department of Agriculture, Water and the Environment)
- Main Roads Western Australia
- South West Catchment Council (SWCC)
- Geographe Landcare Nursery
- Dunsborough Wildlife Care
- Geo-Catch
- Conservation Council WA
- Wildflower Society
- Busselton-Dunsborough Environment Centre
- FAWNA
- Busselton Historical Society
- Steps to Friends
- Busselton Senior High School
- Busselton Water Corporation
- State of WA Conservation Commission
- St Mary McKillop College
- Busselton Golf Club Incorporated

The Corporation will continue to liaise closely with all stakeholders throughout the life of the project.



3. Project Location and Scope

The drain (**Figure 1**) is located in the City of Busselton, 220km from Perth, on the shores of Geographe Bay. The drain extends approximately 6.3 km from the ocean at Geographe Bay in the north to the connection with the Vasse River near the Busselton Golf Course in the south.

The drain is situated in the South-West Botanical Province (Beard, 1990), within the Swan Coastal Plain bioregion and Perth subregion as described by the Interim Biogeographic Regionalisation of Australia (IBRA).

3.1. Development Footprint

The development will cover a 5.3 km long section, extending from Bussell Highway, (running parallel to Queen Elizabeth Avenue) in the City of Busselton, to just south of the Chapman Hill Road bridge crossing. The majority of the project is located within degraded to completely degraded landscape. Areas requiring clearing of native vegetation are described in detail below. Average widening is between 5 m – 11 m in these sections.

Figure 2: Chainage 800 – Chainage 1300. The Eastern side of the drain is constrained by overhead powerlines, the existing road easement and a local government swale drain running parallel to the drain. This section of the drain involves refurbishment and bolstering of the existing drain walls, there will be no widening. Contingency clearing area has been provided on the western side to allow for access, however this will only be undertaken if necessary. Reinstatement of the vegetation around the swale drain will occur on the eastern side of the alignment in this section.

Figure 3: Chainage 1300 - Chainage 3400. Between Queen Elizabeth Avenue and the Busselton Bypass, the levee banks will be deconstructed to ground level, and widened. This area is highly constrained by both existing infrastructure and services, particularly along the north of the drain; existing services include vacuum sewer, pressure main, overhead powerlines and a dual use bike path. The southern side of the drain is bordered by regrowth vegetation. To minimise clearing of vegetation, the levees have been shifted as far to the north as possible with the existing services.

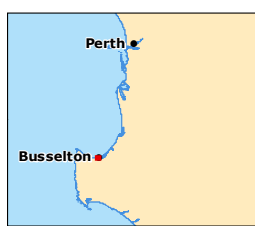
Special care has been taken to constrain areas along the southern boundary of the alignment, allowing no more than two metres of clearing for construction in key areas where priority vegetation and flora has been located. For approximately 400 m (between Chainage 2500 – Chainage 3100) R 52132, a reserve for drainage and conservation, a small retaining structure (no more than 1 m high) will be built to minimise encroachment into the reserve and the existing local government swale drain. As part of our project scope we will repair and reinstate the existing swale drain, currently overrun with *Acaia saligna*, impacting on the efficacy of the asset. The existing fence will be reinstated at completion of the project.

Figure 4: Chainage 5500 – Chainage 6200. South of Chapman Hill Road, reconstruction of the diversion dam and spillway will be undertaken. A number of large trees will require clearing, as the dam will require excavation of soil to allow for containment. Some modifications to the existing culvert and spillway is required, impacting on a section of the lower Vasse River (where it connects to the drain). Advice from DWER confirmed that the works did not require a Bed and Banks permit as the crossing is not located within a proclaimed surface water area under the RIWI Act (**Appendix B**).



LEGEND

Vasse Diversion Drain Open Channel	Sewer Pressure Main
Development Area Footprint	Overhead Powerlines (Distribution)
Native Vegetation Clearing Area	Underground Cables (Distribution)
WaterBody, Nonperennial	Major Waterway
WaterBody, Perennial	Minor Waterway



1:2,500 at A4

0 80
Metres

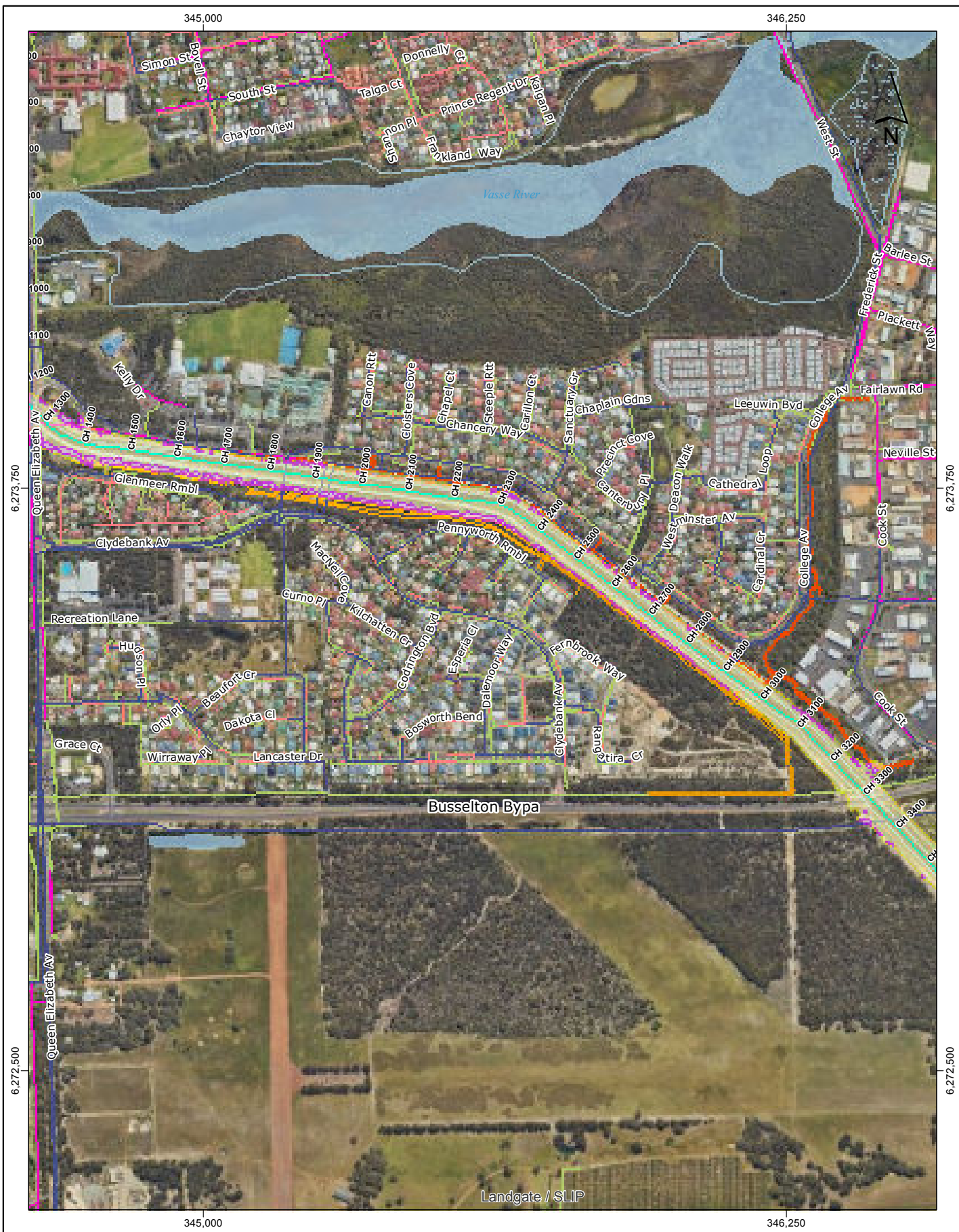
Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

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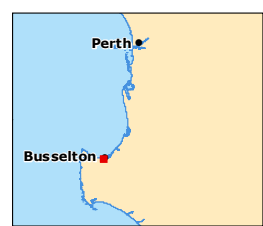
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Water Corporation

Vasse Diversion Drain,
Clearing Footprint
CH 800 - CH 1300




- LEGEND**
- Vasse Diversion Drain Open Channel
 - Native Vegetation Clearing Area
 - Development Area Footprint
 - Sewer Pressure Main
 - Sewer Reticulation
 - Duel Use Bike Path
 - Local Govt. Swale Drain
 - Overhead Powerlines (Distribution)
 - Underground Cables (Distribution)



1:11,000 at A4
 0 125 250
 Metres
 Coordinate System: GDA 1994 MGA Zone 50
 Vertical Datum: AHD

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WATER CORPORATION

Vasse Diversion Drain,
 Clearing Footprint from
 CH 1300 - CH 3400

348,000



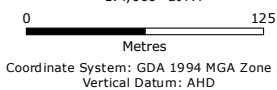
348,000

LEGEND

- Vasse Diversion Drain Open Channel
- WP Transmission Line
- Native Vegetation Clearing Area
- Overhead Powerlines (Distribution)
- Development Area Footprint
- Underground Cables (Distribution)



1:4,000 at A4



Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPK0 DATE: 17/03/2020

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**Vasse Diversion Drain,
Clearing Footprint from
CH 5500 - CH 6200**



3.2. Clearing Mitigation Hierarchy

The Corporation considers the minimisation of clearing as an important step towards achieving the key corporate objective of reducing our net land clearing profile. As such, detailed engineering design has worked first to minimise the footprint of permanent clearing, then sought opportunities to mitigate and rehabilitate areas with the aim of eliminating any residual environmental impacts, as per the *WA Environmental Offsets Guidelines* (EPA, 2014) Clearing Mitigation Hierarchy.

The initial referral under the *EPBC Act 1999* in 2017, had a clearing footprint of 4.6 ha. This was reduced in the Variation submitted in 2018, to 3.6 ha. Detailed engineering design has resulted in the refinement of the final construction footprint to 2.16 ha and the final permanent clearing footprint to 1.57 ha (**Table 3**).

Table 3: Changes in clearing footprint

Design Iteration	Total Clearing Area	Permanent Clearing	Temporary Clearing Reinstatement	Proposed Infill Planting
Referral (2017)	4.6	4.6	-	0
Variation 1 (2018)	3.6	3.6	-	0
Variation 2 (2020)	2.16	1.57 ha	0.59 ha	1.95 ha

Key detailed design factors reducing the clearing extent included:

- Shifting the alignment as far to the north as existing services safely permit.
- Limiting clearing for construction to no greater than 2 m from the levee toe in areas constrained by sensitive receptors.
- Construction of a 400 m retaining structure (maximum height of 1 m) limiting clearing along the southern section of the drain bordering R 52132.
- Construction access locations utilising existing areas of completely degraded vegetation.
- The construction lay-down area was moved upstream to agricultural land-use area. This will utilise existing cleared land, at additional land-access and transportation cost to the project.

In February 2019 the DBCA and DWER requested the Corporation consider the construction of concrete levee walls on each side of the drain, instead of widening the drain, with the assumption that this may reduce the clearing footprint. The Corporation undertook high level design and cost/benefit analysis of this alternative. The Corporation made the determination that concrete levee walls along the drain was not a sustainable design option for the following reasons:

- The levee walls would have to be constructed to 2.8 m tall with additional fencing and barbed wire for safety. Basic designs included deep footings for the structures, likely to result in little reduction in the overall clearing footprint.
- The walls would create a physical barrier to fauna crossing the drain. Fauna surveys conducted for the project noted evidence of fauna traversing the drain.
- There was little, if any, reduction in the clearing footprint due the depth and width of excavations required for footings.



- The walls pose a significant public safety risk leaving Water Corporation and the State Government exposed to high risk.
- The City of Busselton advised this was not their preferred option due to the impact on visual amenity and public safety risks.
- The cost was prohibitive. Cost estimates for the construction of a wall on both sides of the drain were significant. Ongoing maintenance, including refurbishments, safety management and vandalism control, was also considered a significant financial and operation cost.
- Concrete production globally contributes approximately 8% of global carbon emissions. The carbon footprint to construct 2.8 m high walls along the length of the drain would be a significant contributor to corporate emissions, and be contrary to the Corporations objective towards Zero Net Emissions by 2030.
- The wall would be contrary to the efforts towards Waterwise Cities, and does not align with the drainage and liveability goals, aiming to provide people with greater connectivity and access to water.

3.3. High Level Construction Methodology

The construction methodology will not be finalised until the civil contractor is engaged, however indicative methodology proposes two to three construction fronts to expedite project delivery to alleviate flood risk and minimise the period of inconvenience to local residents. An indicative schedule of works is as follows:

- Mobilisation in October 2020, Completion of earthworks in April/May 2021.
- October and November 2020
 - Clearing and topsoil stripping
 - Construction of coffer dams
- Section 1 CH1260 (Queen Elizabeth Avenue) to CH3300 (Busselton Bypass), November 2020 through to January 2021
 - Progressively excavate and construct levees in this section starting from the Queen Elizabeth Avenue bridge
- Section 2 CH3300 to CH5600 (Chapman Hill Road), December 2020 through to February 2020
 - Progressively excavate and reconstruct levees in this area starting from Busselton Bypass.
- Section 3 CH5600 to CH6200
 - Progressively excavate and reconstruct levees in this section: November 2020 to December 2020
 - Vasse River Overflow Structure: December 2020 to March 2021
 - Vasse River Diversion Dam: December 2020 to April 2021
- Concrete lined section CH850 to CH1250, November 2020 to March 2021
- Finishing works



- Scour protection in channel and banks: December 2020 to April 2021
- Fencing: May 2021

3.4. Environmental Management Plans

The civil contractor will be required to prepare a Construction Environmental Management Plan (CEMP). Minimum requirements for environmental impacts during construction will be detailed in a Construction Environmental Management Framework (CEMF) prepared by the Corporation, meeting, or exceeding the AS/NZS ISO 14001 *Australian Standard for Environmental Management*. Management areas will include, but not be limited to:

- Dust
- Erosion and sediment control
- Noise
- Vibration
- Traffic management
- Soil hygiene and weed management
- Clearing
- Water
- Waste
- Hazardous goods storage and spill management
- Communication and community engagement
- Incident response and complaints management.

Targeted management strategies will be incorporated into the CEMF for the management of specific environmental matters with advice from technical specialists. They are listed below, with further details provided in **Section 5**:

- Acid Sulfate Soil and Monosulfidic Black Ooze Management Plan
- *Caladenia procera* management
- Fauna management
- *Westralunio carteri* (Carter's Freshwater Mussel) Translocation and Environmental Management Plan

A specialist revegetation consultant will be engaged separately by the Corporation, and a Revegetation Management Plan will be developed and agreed with the Regulators.



4. Local Context

Table 4: Local context

Setting	Description		Resources
Land Tenure	P ROAD (Queen Elizabeth Ave)	P018644 155	GIS Cadastral Data (WACadCurPoly)
	P009868 56	P ROAD	
	P009868 55	P023318 5336	
	P005399 56	P023318 5337	
	P005399 58	P023318 5339	
	P005399 58	P005399 59	
	P005399 60	P021447 5103	
	P057217 804	P009868 55	
	W Water	P022191 5210	
	P009868 55	P005399 57	
	P061581 11	R 16061	
	P005399 61	P020770 5067	
	V CROWN LAND	R 43250	
	D007431 250	D004170 866	
	P031176 301	R 16061	
	P009868 55	R 45588	
	P009868 56	D042478 5136	
	D009165 100	R 44380	
	P009868 57	P020855 5068	
	P070429 80	P023463 553	
	D039001 1	R 48018	
	D040995 4607	R 45170	
	D042381 22	P018644 4989	
	P020362 5067	P400537 2598	
	P400537 2593	R 52135	
	R 52132	D027395 4348	
	P400537 2594	R 26555	
	P020362 5067	P220139 5190	
R 45171	R 41460		
P417589 501	P417589 505		
	P022630 5209		



Setting	Description		Resources
Site elevation	9.4 – 0.6 m AHD.		Vasse Diversion Drain Upgrade Geotechnical Report (GHD, 2017)
Project Footprint	Total Clearing Area: 2.16 ha (including temporary clearing) Temporary Clearing: 0.6 ha Permanent Clearing: 1.57 ha Total Footprint: 34.75 ha		Development Area Footprint .shp file NVC .shp file
Surrounding land use (Adjacent to the drain)	North	Located within the Busselton township	Local Planning Scheme Shapefile Mosaic aerial photography WMS subscription (Landgate) WACadCurPoly
	North - West	Crossing New River, within residential precincts of the City of Busselton	
	North - East	Passing through residential Busselton, schools are located parallel to the drain on both sides. Industrial area located parallel to the drain on the western side of the Busselton Bypass.	
	South	Broadly Rural	
	South - West	Crossing the Busselton Bypass into agricultural/rural land	
	South - East	Predominantly agricultural/rural land and the Busselton Golf Course at the southern extent of the proposed project area.	
Depth to groundwater	A significant number of test pits did not encounter groundwater due to refusal on iron cemented material or limestone rock. CPT testing in 2016 (southern end) 0.9 m to 4.6 m		Vasse Diversion Drain Upgrade Engineering Summary Report (GHD, 2017)
Groundwater flow direction	Groundwater flow will be heavily influenced by the tide as Busselton is low-lying. Groundwater flows to the North, although this may be seasonally influenced.		Vasse Diversion Drain Upgrade Engineering Summary Report (GHD, 2017)
Nearby contaminated sites	49340 ' <i>Remediated for restricted use</i> ' 278m from the northern end of the development footprint 69951 ' <i>Contaminated - restricted use</i> ' 1.8 km to the west of the project area		ConSitesWCUse Contaminated Sites

4.1. Existing Services

The drain operates as a strategic infrastructure corridor, allowing for multiple services and utilities to run parallel to the drain, with minimal cumulative environmental impact.

There are a number of existing buried and overhead services that run either adjacent (parallel) or cross the drain along the northern levee. The services located adjacent to the drain are generally outside the existing drain reserve. Services include telecommunications, water, sewer, overhead and underground power (**Figure 2** and **Figure 3**).

The footprint has been shifted as far to the north as practicable. Contactors and operators will be advised of the location of services and include appropriate precautions within the CEMP.



4.2. Climate

The Bureau of Meteorology (BOM) weather station located nearest to the study area is Busselton Aero (009603). Recorded climate data is summarised below.

- Mean daily maximum temperature: 22°C (30.2°C in Jan, 16.8°C in July, based on 22 years of data).
- Mean daily minimum temperature: 10.3°C (14.2°C in Jan, 6.9°C in July, based on 22 years of data).
- Mean annual rainfall: 684.8 mm/an (based on 18 years of data)
- Mean annual rain days: 83.7 days (based on 21 years of data)

4.3. Topography, Landforms and Soils

The drain alignment is located on the Swan Coastal Plain. The following geological units have been identified in the project area by a geotechnical investigation (GHD 2017) (**Table 5**).

Table 5: Geological units along the Vasse Diversion Drain (GHD, 2017)

Chainage		Geology				Unit Number
From	To	Embankment	Upper Foundation	Lower Foundation	Base of Channel	
850	1100	Safety Bay Sand	Safety Bay Sand	Estuarine Clay	Estuarine Clay	Unit 1
1100	2500	Tamala Sand	Tamala Sand	Tamala Limestone	Tamala Limestone	Unit 2
2500	3310	Tamala Sand	Tamala Sand / Recent Alluvium	Recent Alluvium/ Tamala Limestone	Tamala Limestone	
3310	4000	Tamala Sand	Tamala Sand	Tamala Limestone	Tamala Limestone	
4000	4250	Sandy Guildford Formation	Sandy Guildford Formation	Clayey Guildford Formation	Ferricrete	Unit 3
4250	4750	Sandy Guildford Formation	Sandy Guildford Formation	Clayey Guildford Formation	Clayey Guildford Formation	
4750	5500	Sandy Guildford Formation with areas of clayey Guildford	Clayey Guildford Formation	Clayey Guildford Formation	Clayey Guildford Formation	Unit 4
5500	6000	Sandy Guildford Formation	Clayey Guildford Formation	Clayey Guildford Formation	Ferricrete	
6000	6300	Sandy Guildford Formation	Sandy Guildford Formation	Clayey Guildford Formation	Ferricrete	Unit 3



4.4. Acid Sulfate Soils

Screening for acid sulfate soils (ASS) was undertaken as part of the geotechnical investigations. Areas of actual ASS (AASS) and potential ASS (PASS) are located within the project footprint (GHD, 2009). The Corporation is currently conducting detailed ASS, waste classification and monosulfidic black ooze (MBO) investigations.

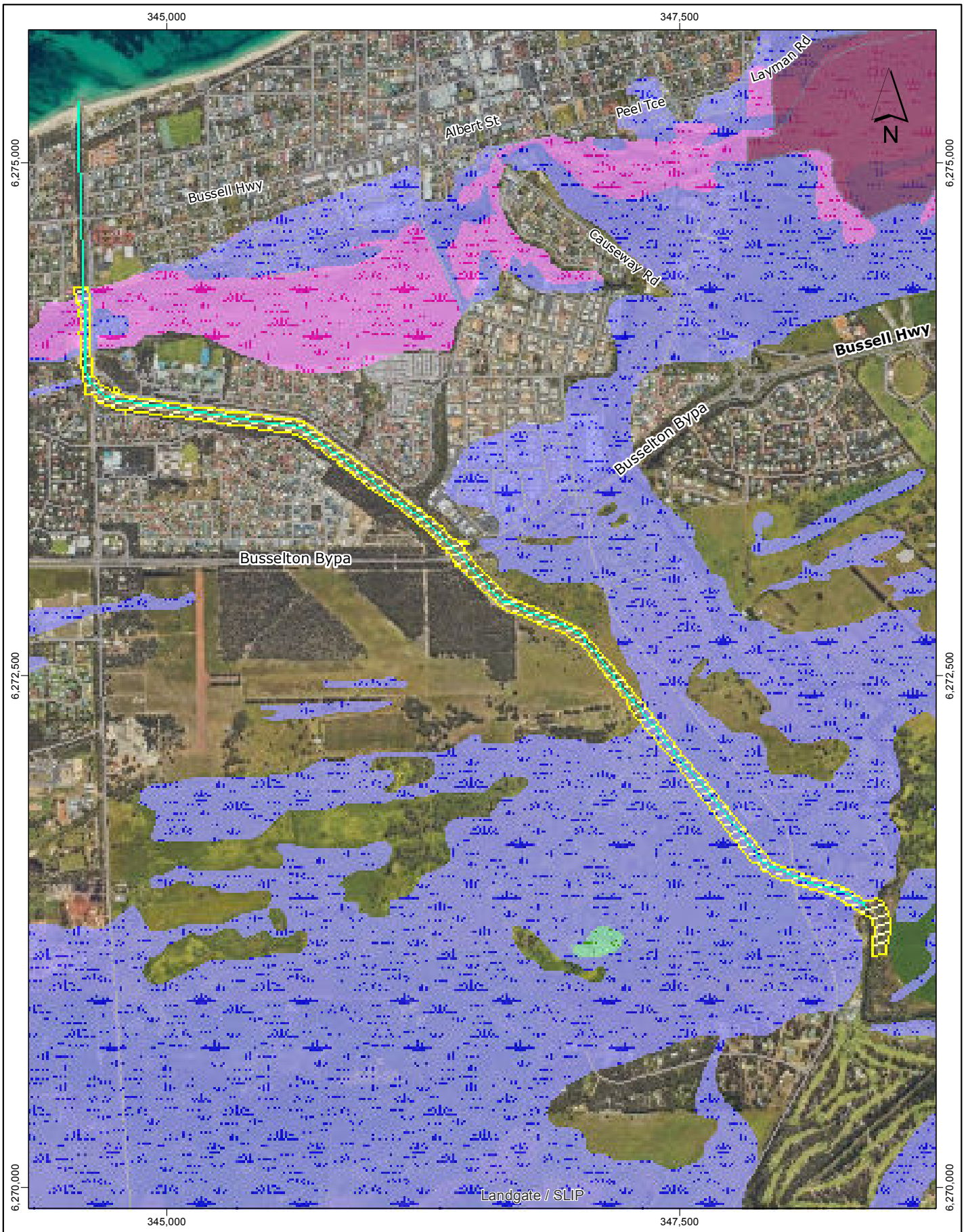
An acid sulfate soil and MBO management plan (ASSMBOMP) will be prepared for the proposed upgrade in line with DWER guidelines. This management plan will be provided to the DWER Contaminated Sites branch for review and approval.

The ASSMP will establish the appropriate treatment and/or management options for the material identified as containing acidity or potential acidity. The ASSMP will incorporate a dewatering management plan that will be implemented in the event that dewatering is required. A dewatering licence will be obtained as contingency. Excavated soil will either be treated, reused where suitable or disposed of to an appropriately classified waste facility.

4.5. Wetlands

The Vasse-Wonnerup RAMSAR wetland boundary is further than 2 km from the development area and will not be impacted by the proposed works.

A Conservation Category wetland is located at the northern end of the drain and is intersected by the project footprint for approximately 300m. A Multiple Use category wetland exists at the southern end of the drain and is intersected by approximately 1.4km of the project footprint (**Figure 5**). An assessment of potential environmental impacts on intersecting wetlands is provided in **Section 5.1**.



LEGEND

- Vasse Diversion Drain Open Channel
- Development Area Footprint
- Geomorphic Wetlands Swan Coastal Plain
- Conservation
- Resource Enhancement
- Multiple Use
- Not Assessed
- Ramsar Wetlands
- Vasse-Wonnerup System



1:25,000 at A4
 0 250 500 750
 Metres
 Coordinate System: GDA 1994 MGA Zone 50
 Vertical Datum: AHD

AUTHOR: ALLSOPK0 DATE: 17/03/2020
 BRANCH: ENVIRONMENTAL APPROVALS

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Geomorphic Wetlands



4.6. Vegetation and Flora

Vegetation

The drain is comprised of predominantly ‘*degraded*’ to ‘*completely degraded*’ vegetation along both sides of the drain reserve between Queen Elizabeth Drive and the Busselton Golf Course. North-west of the Busselton Bypass, the survey area occurs within a suburban context adjacent to generally narrow, linear bush reserves, including the securely fenced drainage and conservation reserve, managed by the City of Busselton for the urban drainage of Peppermint Park, and *Caladenia procera*. South east of the Busselton Bypass the Survey Area occurs within a predominantly agricultural context adjacent to cleared, privately managed land holdings (EcoEdge 2019).

The Corporation has engaged environmental consultants and sought advice from subject matter experts to assess the vegetation and flora within the project area. Some additional targeted surveys were undertaken at the request of the DWER, or to ensure compliance with Survey Guidelines at the State and Federal levels (See **Table 2**)

The Statewide Vegetation Statistics (GoWA, 2016) presented in **Table 6** provide a general overview of the status of ecological communities within the IBRA7 bioregions or sub-regions (DoEE, 2018). This data provides information on the Conservation Reserve System (next update scheduled for 2021) but should be analysed in conjunction with vegetation condition information (

Photos of vegetation at key locations along the drain have been provided in **Plate 1**

Table 8). The following Vegetation Associations intersect with the drain (Beard *et al*, 2013):

- Vegetation Association 27: Low woodland; paperbark (*Melaleuca sp.*)
- Vegetation Association 949: Low woodland; banksia
- Vegetation association 1000 - Mosaic: Medium forest; jarrah-marri / Low woodland; banksia / Low forest; tea tree (*Melaleuca spp.*)
- Vegetation association 1136 – Medium woodland, marri with some jarrah, wandoo, river gum and casuarina.

Table 6: Extent of vegetation associations mapped within the survey area (GoWA 2016).

Vegetation Association (length of drain intersect)	Scale	Pre-European extent (ha)	Current Extent (ha)	Remaining (%)	*% Current extent in all DBCA managed lands
State WA: Swan Coastal Plain Bioregion		1501221.93	578,432.17	38.53	37.85
27 (~1.0 km)	IBRA Bioregion: Association 27	5836.24	1750.12	29.99	41.31
	IBRA Bioregion and System: Bassendean 27	3404.39	1304.41	38.32	40.42
	City of Busselton: Bassendean 27	1119.15	91.24	8.15	N/A
949	IBRA Bioregion: Association 949	209,983.26	120,178.91	57.23	56.43



Vegetation Association (length of drain intersect)	Scale	Pre-European extent (ha)	Current Extent (ha)	Remaining (%)	*% Current extent in all DBCA managed lands
(~0.35 km)	IBRA Bioregion and System: Bassendean 949	115119.15	69896.90	60.72	52.56
	City of Busselton: Bassendean 949	1371.71	117.96	8.6	0.19
1000 (~4.2 km)	IBRA Bioregion: Association 1000	94,175.31	23,669.68	25.13	19.88
	IBRA Bioregion and System: Spearwood 1000	5219.77	987.42	18.92	29.13
	City of Busselton: Spearwood 1000	735.07	242.33	32.97	55.97
1136 (~0.26 km)	IBRA Bioregion: Association 1136	48,118.01	3374.06	7.01	3.82
	IBRA Bioregion and System: Pinjarra 1136	43400.15	2987.86	6.88	3.89
	City of Busselton: Pinjarra 1136	35744.39	2408.35	6.74	2.99

*% Current Extent in All DBCA Managed Lands (proportion of Current Extent)

The Flora and Vegetation surveys undertaken for the project have identified the vegetation assemblages present within the project footprint and the vegetation condition. These are summarised in **Table 7** and **Table 8**:

Table 7: Vegetation assemblages mapped by GHD (2009 and 2017a, Appendix D) and EcoEdge, 2019, Appendix H).

Vegetation Association	Description
<i>GHD, 2009</i>	
Mc*WmLc	Tall open scrub of <i>Melaleuca cuticularis</i> and <i>Agonis flexuosa</i> over herbland of <i>*Watsonia meriana</i> over sedgeland of <i>Lepidosperma carphoides</i>
Espp.Af	Low open woodland of Eucalypt species over tall shrubland of <i>Agonis flexuosa</i> and mixed <i>Acacia</i> species over weed species
AfLe	Tall shrubland of <i>Agonis flexuosa</i> and mixed <i>Acacia</i> species over sedgeland of <i>Lepidosperma effusum</i> , <i>Juncus krausii</i> and <i>Ficinia nodosa</i> over weed species.
AsAf	Tall shrubland of <i>Acacia saligna</i> and <i>Agonis flexuosa</i> over weed species
Heavily Disturbed / Predominantly cleared areas	Heavily disturbed / predominantly cleared areas with introduced grasses, including <i>*Avena fatua</i> , <i>*Cynodon dactylon</i> and <i>*Eragrostis curvula</i> .
<i>GHD, 2017a</i>	



Vegetation Association	Description
Marri and Flooded Gum woodland	<i>Eucalyptus rudis</i> , <i>Corymbia calophylla</i> and <i>Agonis flexuosa</i> open woodland over <i>Melaleuca raphiophylla</i> tall shrubland over * <i>Avena fatua</i> tussock grassland over * <i>Watsonia meriana</i> and * <i>Oxalis pes-caprae</i> herbland
Peppermint woodland	<i>Agonis flexuosa</i> woodland with scattered <i>Corymbia calophylla</i> trees over <i>Acacia saligna</i> and <i>Melaleuca raphiophylla</i> mid to tall shrubland over * <i>Ehrharta longifolia</i> tussock grassland over * <i>Zantedeschia aethiopica</i> , * <i>Watsonia meriana</i> and * <i>Oxalis pes-caprae</i> herbland
Acacia and Peppermint shrubland	<i>Agonis flexuosa</i> , <i>Acacia saligna</i> and <i>Jacksonia furcellata</i> tall shrubland over <i>Poaceae</i> sp. Tussock grassland over <i>Conostylis aculeata</i> subsp. <i>aculeata</i> open sedgeland over * <i>Pelagonium capitatum</i> , * <i>Romulea rosea</i> and * <i>Watsonia meriana</i> open herbland.
Tall Melaleuca shrubland	<i>Melaleuca cuticularis</i> , <i>M. Lanceolata</i> and <i>M raphiophylla</i> tall open shrubland over <i>Lepidosperma carphoides</i> and <i>Gahnia trifida</i> sedgeland
Peppermint woodland over sedgeland	<i>Agonis flexuosa</i> woodland over <i>Acacia littorea</i> , <i>Oleria axillaris</i> and <i>Spyridium globulosum</i> tall open shrubland over <i>Spinifex longifolius</i> and * <i>Bromus diandrus</i> tussock grassland over <i>Lepidosperma effusum</i> sedgeland over <i>Acanthocarpus preissii</i> and * <i>Fumaria capreolata</i> herbland.
Rehabilitated Areas	Consists of areas rehabilitated with local and regional native species
Vasse Drain	Water body
Highly disturbed	Areas that have been cleared and include infrastructure, roads and tracks.
EcoEdge 2019 (Error! Reference source not found.)	
Unit A	<i>Corymbia calophylla</i> and <i>Agonis flexuosa</i> with occasional <i>Banksia littoralis</i> and <i>Melaleuca raphiophylla</i> mid open forest over <i>Acacia cochlearis</i> , <i>A. saligna</i> , <i>Hibbertia cuneiformis</i> <i>Jacksonia furcellata</i> , <i>Kunzea glabrescens</i> and <i>Spyridium globulosum</i> open shrubland over <i>Adenanthos meisneri</i> , <i>Conospermum caeruleum</i> , <i>Daviesia physodes</i> , <i>Hardenbergia comptoniana</i> , <i>Hibbertia hypericoides</i> , <i>Leucopogon propinquus</i> low shrubland over <i>Lepidosperma squamatum</i> and <i>Tetaria octandra</i> sedgeland and <i>Caesia micrantha</i> , <i>Chamaescilla corymbosa</i> , <i>Conostylis aculeata</i> subsp. <i>gracilis</i> , <i>Opercularia hispidula</i> , <i>Sowerbaea laxiflora</i> , * <i>Sparaxis bulbifera</i> , * <i>Watsonia meriana</i> var. <i>bulbillifera</i> and * <i>Zantedeschia aethiopica</i> mid forbland on dark brown sandy loams.
Unit B	<i>Agonis flexuosa</i> low woodland and scattered <i>Acacia saligna</i> or <i>A. cochlearis</i> tall shrubs over * <i>Ehrharta longifolia</i> , * <i>Watsonia meriana</i> and other introduced herbaceous species
Unit C	<i>Eucalyptus rudis</i> and <i>Corymbia calophylla</i> mid open forest or woodland over <i>Agonis flexuosa</i> open low woodland over scattered <i>Acacia saligna</i> over * <i>Oxalis pes-caprae</i> , * <i>Watsonia meriana</i> and other introduced herbaceous species.



Vegetation Association	Description
Unit D	<i>Melaleuca cuticularis</i> , <i>M. lanceolata</i> and <i>M. raphiophylla</i> tall open shrubland over <i>Gahnia trifida</i> and <i>Baumea juncea</i> sedgeland
Unit E	<i>Agonis flexuosa</i> woodland over <i>Acacia littorea</i> , <i>Olearia axillaris</i> and <i>Spyridium globulosum</i> tall open shrubland over <i>Lepidosperma gladiatum</i> sedgeland
Unit F	* <i>Eragrostis curvula</i> , * <i>Cenchrus clandestinus</i> grassland, scattered <i>Acacia saligna</i> shrubs, bare areas and watercourse

Photos of vegetation at key locations along the drain have been provided in **Plate 1**

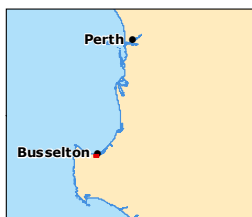
Table 8: Vegetation Condition by type EcoEdge (2019), Figure 7.

Vegetation Unit	Cons Status	Condition	Area (ha)
Unit A	P1	Degraded	0.6
		Good	0.29
Total			0.89
Unit B		Degraded	0.21
		Completely Degraded	0.06
Total			0.27
Unit C		Completely Degraded	0.51
Total			0.51
Unit D		Very Good	0.09
		Good	0.12
		Degraded	0.00
Total			0.21
Unit E		Very Good	0.03
		Good	0.02
Total			0.05
Unit F		Completely Degraded	0.23
Total			0.23
Grand Total			2.16



LEGEND

- Vasse Diversion Drain Open Channel
 - Native Vegetation Clearing Area
 - Development Area Footprint
- | Vegetation Type | |
|------------------------|------|
| | VU-A |
| | VU-B |
| | VU-D |
| | VU-E |
| | VU-F |



1:5,000 at A4

0 125
Metres

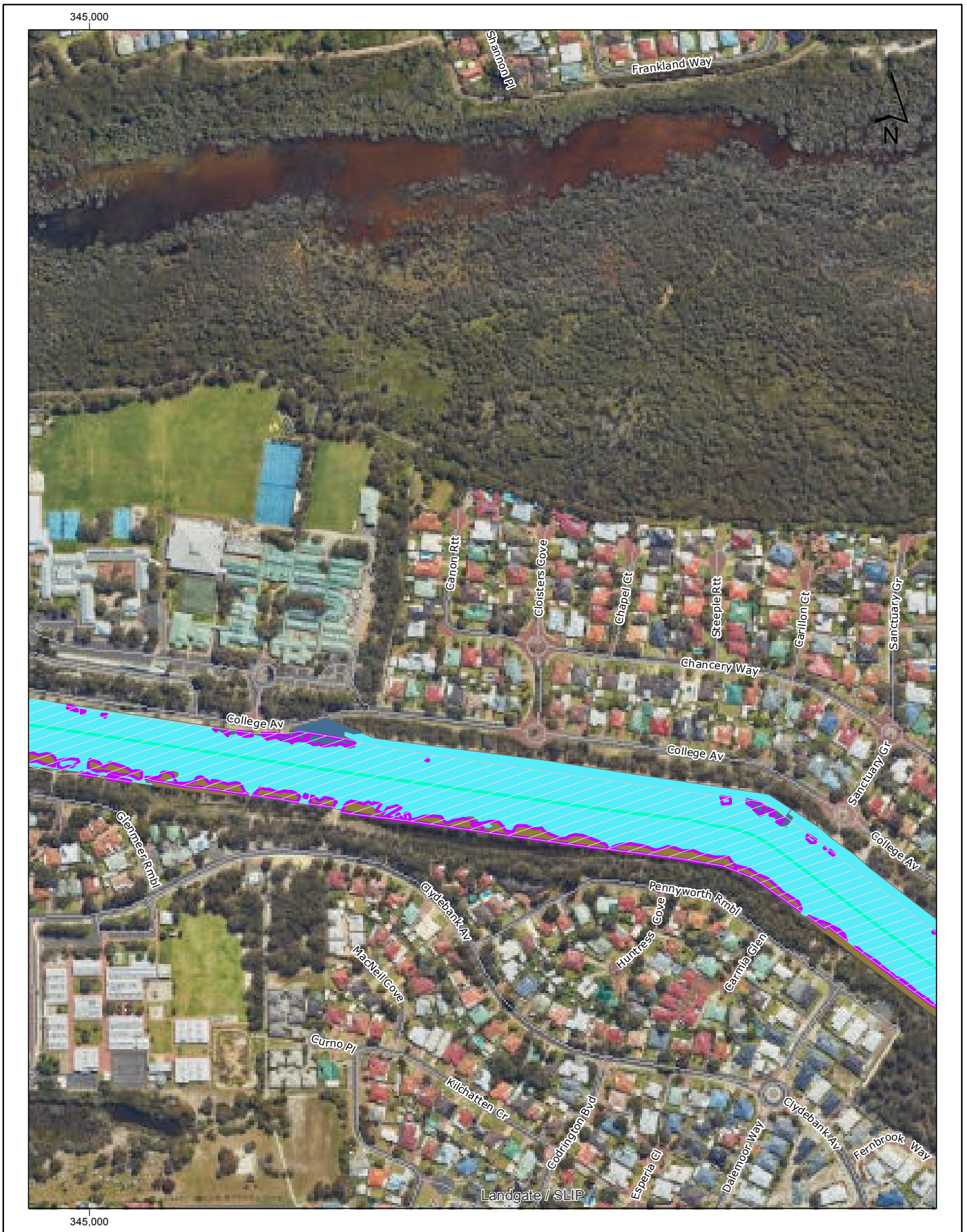
Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPKO	DATE: 17/03/2020
BRANCH: DTG - MAPPING & GEOSPATIAL	

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**Vegetation Type
(EcoEdge 2019)
Map Sheet 1 of 6**



LEGEND

- Vasse Diversion Drain Open Channel
 - Native Vegetation Clearing Area
 - Development Area Footprint
- Vegetation Type**
- VU-A
 - VU-B
 - VU-F



1:5,000 at A4

0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPKO	DATE: 17/03/2020
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Vegetation Type
(EcoEdge 2019)
Map Sheet 2 of 6



LEGEND

- ▬ Vasse Diversion Drain Open Channel
 - ▬ Native Vegetation Clearing Area
 - Development Area Footprint
- Vegetation Type**
- VU-A
 - VU-B
 - VU-F



1:5,000 at A4

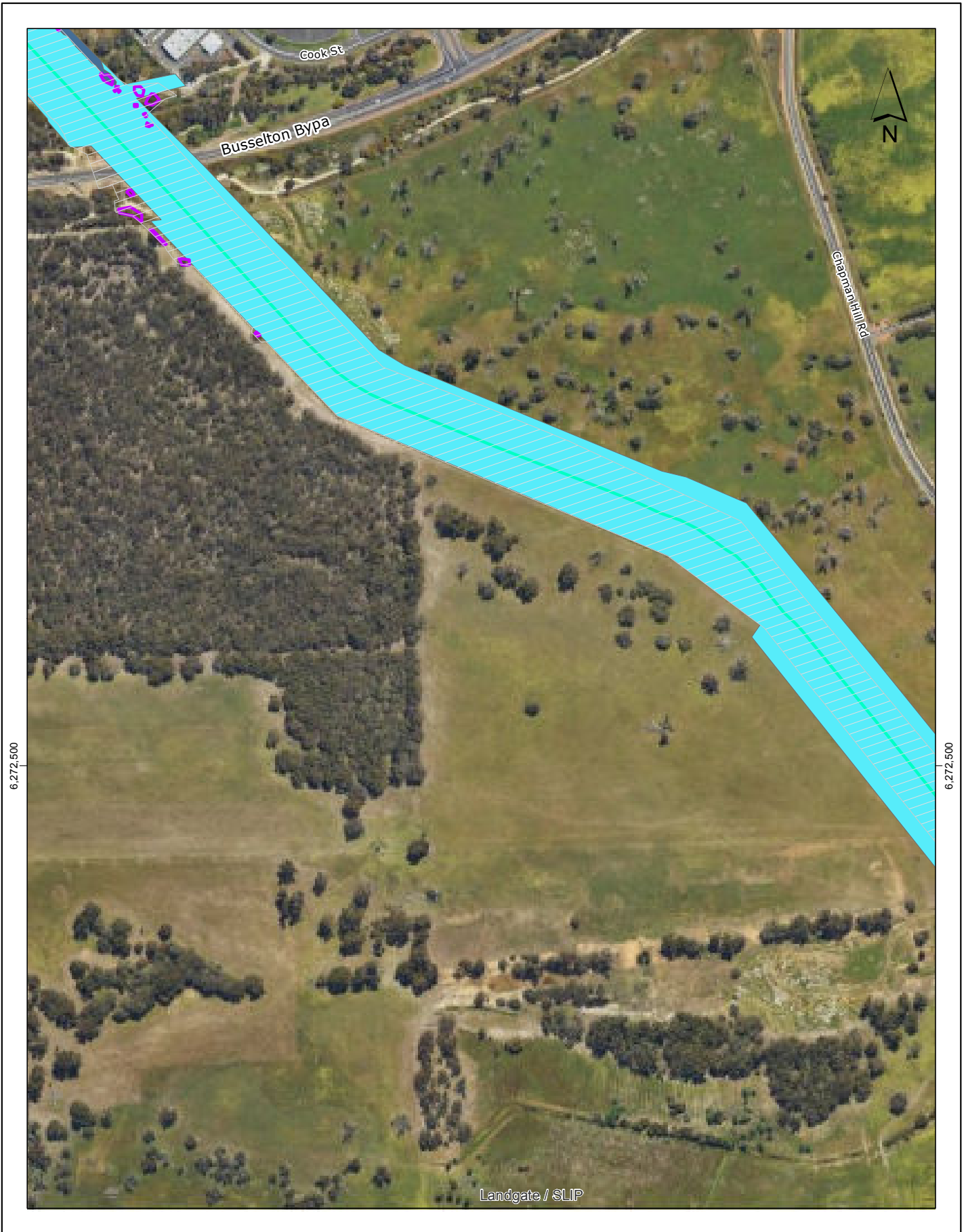
0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPKO | DATE: 17/03/2020
BRANCH: DTG - MAPPING & GEOSPATIAL



Vegetation Type
(EcoEdge 2019)
Map Sheet 3 of 6



LEGEND

- ▬ Vasse Diversion Drain Open Channel
 - ▬ Native Vegetation Clearing Area
 - Development Area Footprint
- Vegetation Type**
- VU-B
 - VU-F



1:5,000 at A4

0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPKO	DATE: 17/03/2020
BRANCH: DTG - MAPPING & GEOSPATIAL	

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Vegetation Type
(EcoEdge 2019)
Map Sheet 4 of 6



LEGEND

- ▬ Vasse Diversion Drain Open Channel
- Development Area Footprint

- Vegetation Type**
- VU-F



1:5,000 at A4

0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPKO	DATE: 17/03/2020
BRANCH: DTG - MAPPING & GEOSPATIAL	

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Vegetation Type
(EcoEdge 2019)
Map Sheet 5 of 6



LEGEND

- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area
- Development Area Footprint

- Vegetation Type**
- VU-C
 - VU-F



1:5,000 at A4

0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPKO	DATE: 17/03/2020
BRANCH: DTG - MAPPING & GEOSPATIAL	







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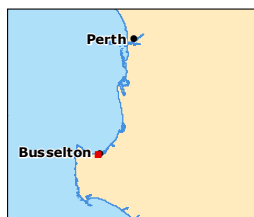


Vegetation Type
(EcoEdge 2019)
Map Sheet 6 of 6



LEGEND

-  Development Area Footprint
-  Native Vegetation Clearing Area
- Vegetation Condition EcoEdge
-  Completely Degraded
-  Degraded
-  Good
-  Very Good



1:5,000 at A4

0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

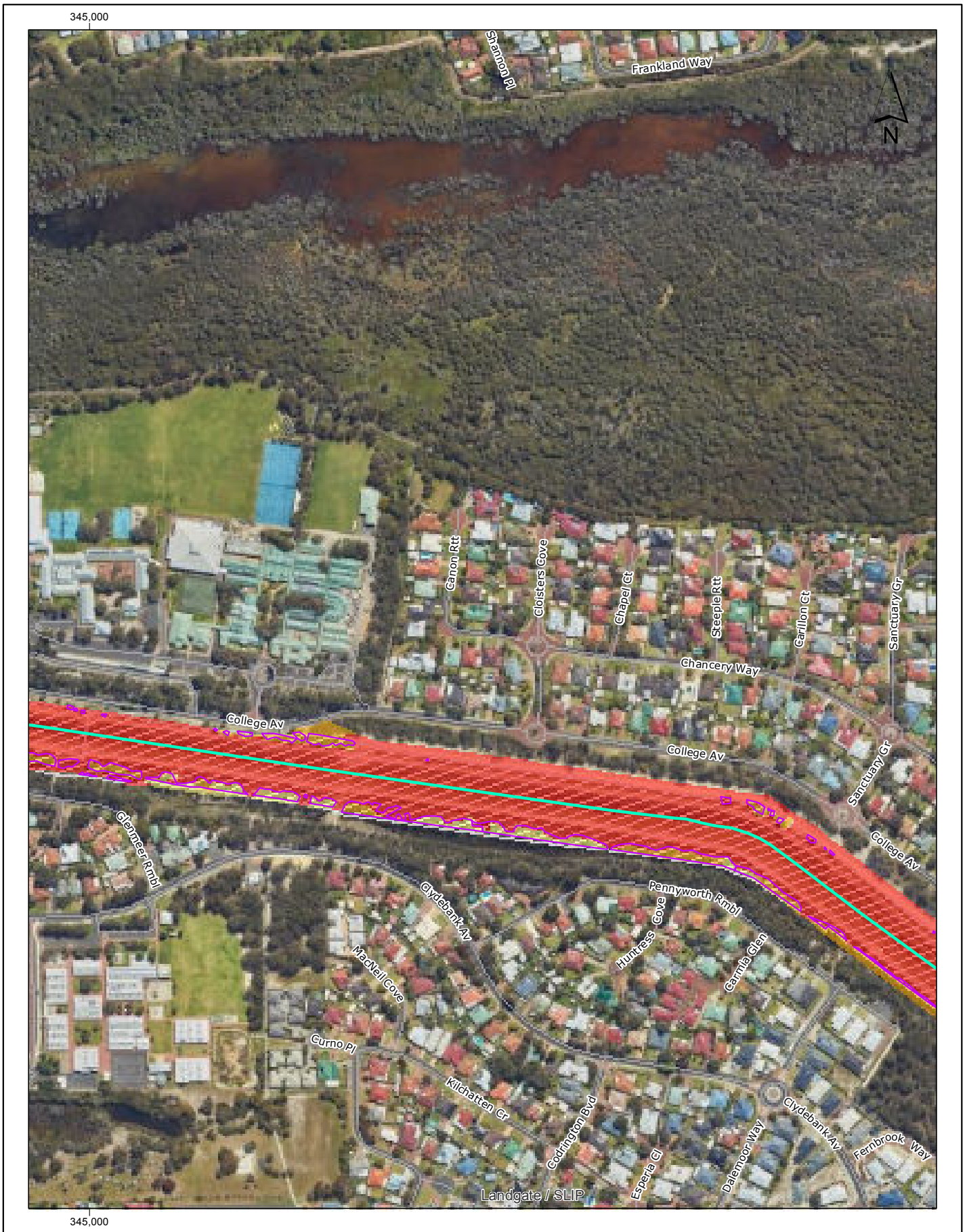
AUTHOR: ALLSOPK0 | DATE: 17/03/2020

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**Vegetation Type
(EcoEdge 2019)
Map Sheet 1 of 6**



LEGEND

- Development Area Footprint
- Native Vegetation Clearing Area
- Vegetation Condition EcoEdge
- Completely Degraded
- Degraded
- Good



1:5,000 at A4

0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPK0	DATE: 17/03/2020
BRANCH: ENVIRONMENTAL APPROVALS	





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**Vegetation Type
(EcoEdge 2019)
Map Sheet 2 of 6**



LEGEND

-  Development Area Footprint
-  Native Vegetation Clearing Area
- Vegetation Condition EcoEdge**
-  Completely Degraded
-  Degraded



1:5,000 at A4

0 125
Metres

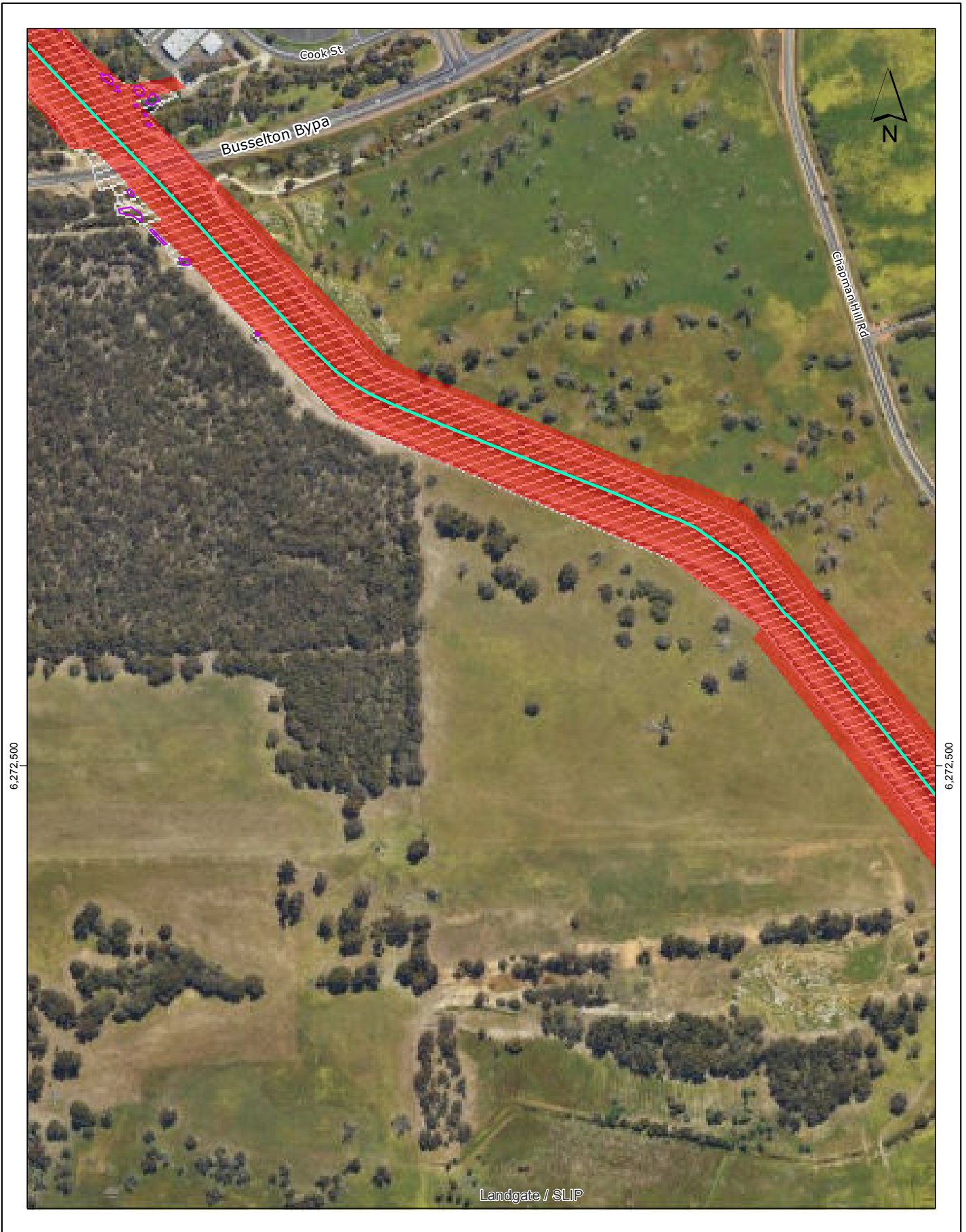
Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPK0	DATE: 17/03/2020
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**Vegetation Type
(EcoEdge 2019)
Map Sheet 3 of 6**



LEGEND

- Development Area Footprint
- Native Vegetation Clearing Area
- Vegetation Condition EcoEdge
- Completely Degraded



1:5,000 at A4

0 125
Metres

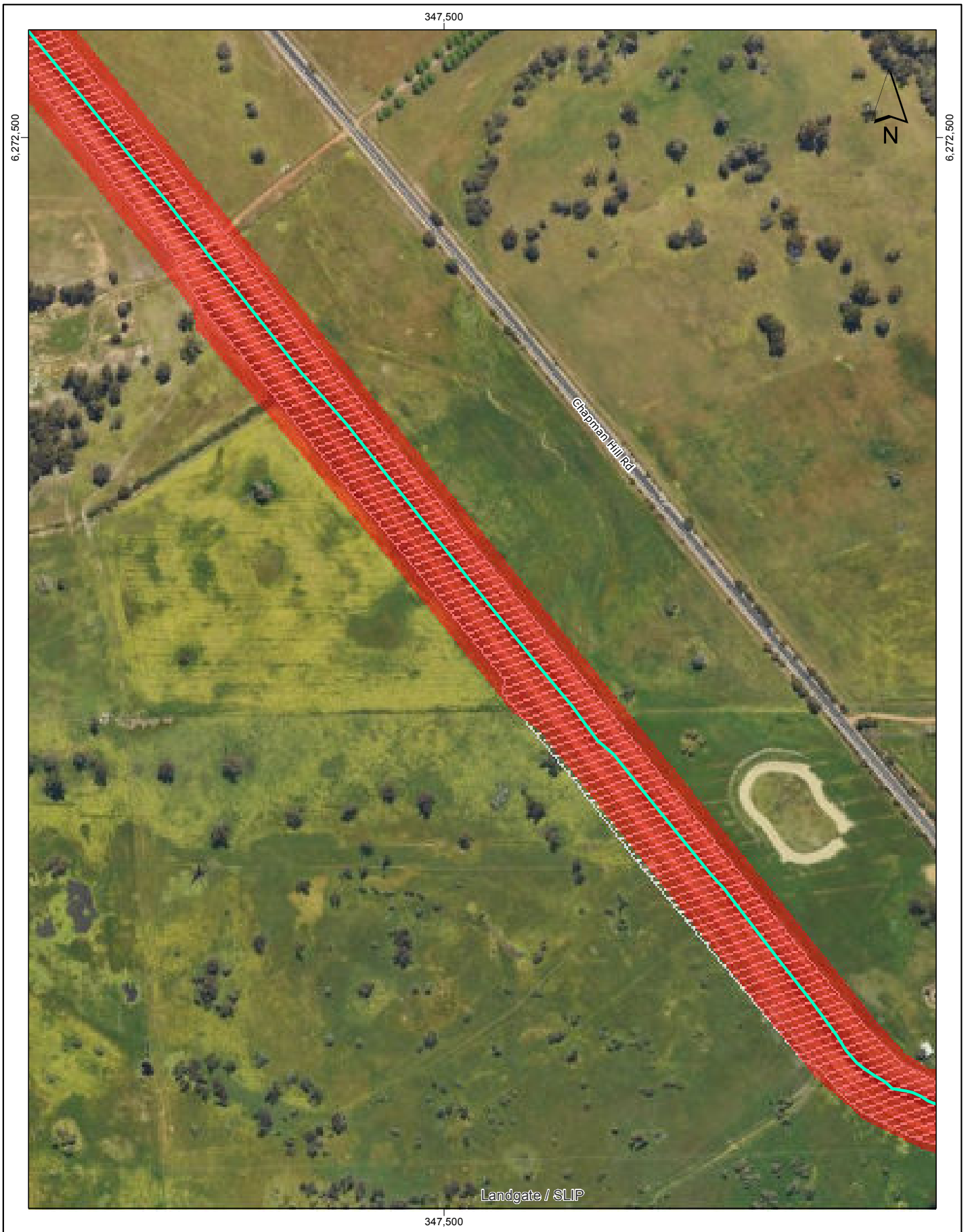
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Vertical Datum: AHD

AUTHOR: ALLSOPK0	DATE: 17/03/2020
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
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**Vegetation Type
(EcoEdge 2019)
Map Sheet 4 of 6**



LEGEND

-  Development Area Footprint
-  Vegetation Condition EcoEdge
-  Completely Degraded



1:5,000 at A4

0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPK0	DATE: 17/03/2020
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

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Vegetation Type
(EcoEdge 2019)
Map Sheet 5 of 6



LEGEND

-  Development Area Footprint
-  Native Vegetation Clearing Area
-  Vegetation Condition EcoEdge
-  Completely Degraded



1:5,000 at A4

0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

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Vegetation Type
(EcoEdge 2019)
Map Sheet 6 of 6

Plate 1: Example vegetation in key sections along the drain. Taken during site visits from 2018-2020

June 2018: Vegetation Unit D along QE Avenue City of Busselton S wale drain. R 41460, looking south



June 2018: Vegetation Unit A within P009868 56 looking sou-sou-west along the drain. Upstream of pedestrian bridge.



June 2019: Vegetation Unit A within P009868 56 looking west along the drain. downstream of pedestrian bridge.

June 2019: City of Busselton swale drain (south-western) P020362 5067 (looking west)



June 2019: Acacia saligna in City of Busselton swale drain (south-eastern) R 52132, Looking south-west along the drain)





Peer Review of Flora and Vegetation Surveys

In February 2019 the DWER advised that vegetation mapping completed by GHD (2009 & 2017) did not correlate with existing DBCA datasets. In order to identify any gaps in the existing vegetation and flora surveys, and to ensure due diligence, the Corporation engaged a consultant to conduct a Peer Review of the existing surveys for the project. Advice from the Peer Review is as follows:

'A peer review of four flora and vegetation assessments conducted at the Vasse Diversion Drain was undertaken for the Water Corporation. All field surveys and resulting reports were found to be thorough and credible. The two insufficiencies noted, which were both identified by the surveying ecologist / botanist, were the lack of access to all of the survey area in GHD 2017a and the March timing of the survey of additional areas in GHD 2017b.' (EcoEdge 2019).

The corporation commissioned an additional targeted survey for spring 2019, ensuring compliance with *Draft Survey Guidelines for Australia's Threatened Orchids: Guidelines for Detecting Orchids Listed as Threatened under the Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth of Australia, 2013), and to better understand the extent and condition of the PEC located within the project footprint. Quadrats installed by the consultant were installed predominantly outside the project impact.

On completion of the Targeted PEC and Orchid survey (EcoEdge 2019) a Threatened grass species, *Austrostipa bronwenae*, was discovered in atypical vegetation that had similarity to VU-D, in a study adjacent to the project area, and in a quadrat outside the impact footprint during the Water Corporation survey. An additional targeted survey was commissioned, and further quadrats for the PEC, located within the project impact area were assessed (EcoEdge 2020).

Historical Clearing Extent

The Vasse Diversion Drain is a nearly 100 year old infrastructure corridor, that has been cleared as part of routine maintenance and surrounding land development numerous times since at least 1954.

In addition to the Vasse Drain there are additional City of Busselton swale drains, pressure mains, gravity sewer, overhead powerlines and pedestrian and cycling infrastructure strategically located in the drain easement to reduce the impact of linear infrastructure development on the local environment.

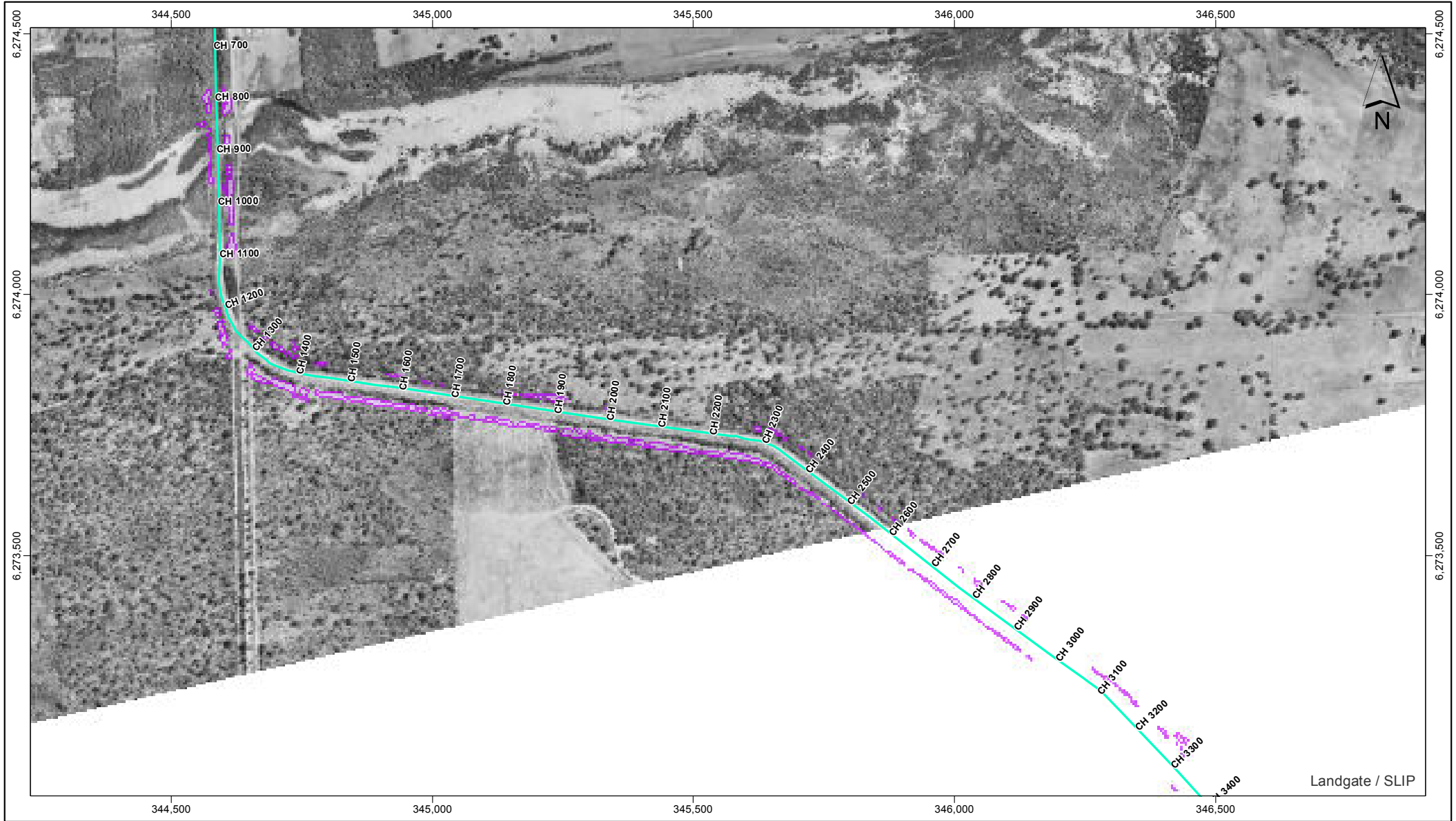
The corporation has provided a number of historical aerial photographs with the current proposal overlaid, to highlight that proposed clearing does not exceed historical clearing extent.

- 1954 (see **Figure 8**) Earliest aerial photo able to be sourced.
- 1970 (see **Figure 9**) Civil upgrade to the drain was conducted in the 1970's.
- 1996 (see **Figure 10**). Greatest clearing extent for a housing development to the south of the drain.
- 2003 (see **Figure 11**) Local Government swale drain to the south of the drain was constructed sometime between 1996 and 2003.
- 2014 (**Figure 12**), most recent extensive maintenance clearing to control *A. saligna*, which was causing pedestrian access issues.



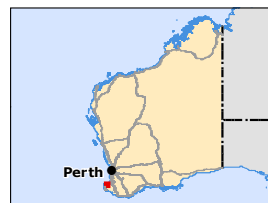
The definition of ‘remnant vegetation’ under Australia’s Native Vegetation Framework (COAG Standing Council on Environment and Water, 2012) is ‘*one or more areas of largely intact (structurally and/or compositionally) native vegetation that remains after the removal (usually by clearing) of parts of a natural area.*’

The proposal will result in the clearing of 2.16 ha, including the temporary clearing of 0.6 ha. 1.61 ha (74.5%) of the vegetation proposed to be cleared is in ‘*degraded*’ to ‘*completely degraded*’ condition, which is not, by definition, remnant vegetation according to COAG Standing Council on Environment and Water (2012).



LEGEND

- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area



1:10,000 at A4

0 100 200 300 400

Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

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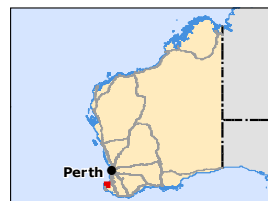


**Vegetation Extent in
1954 Aerial Photography**



LEGEND

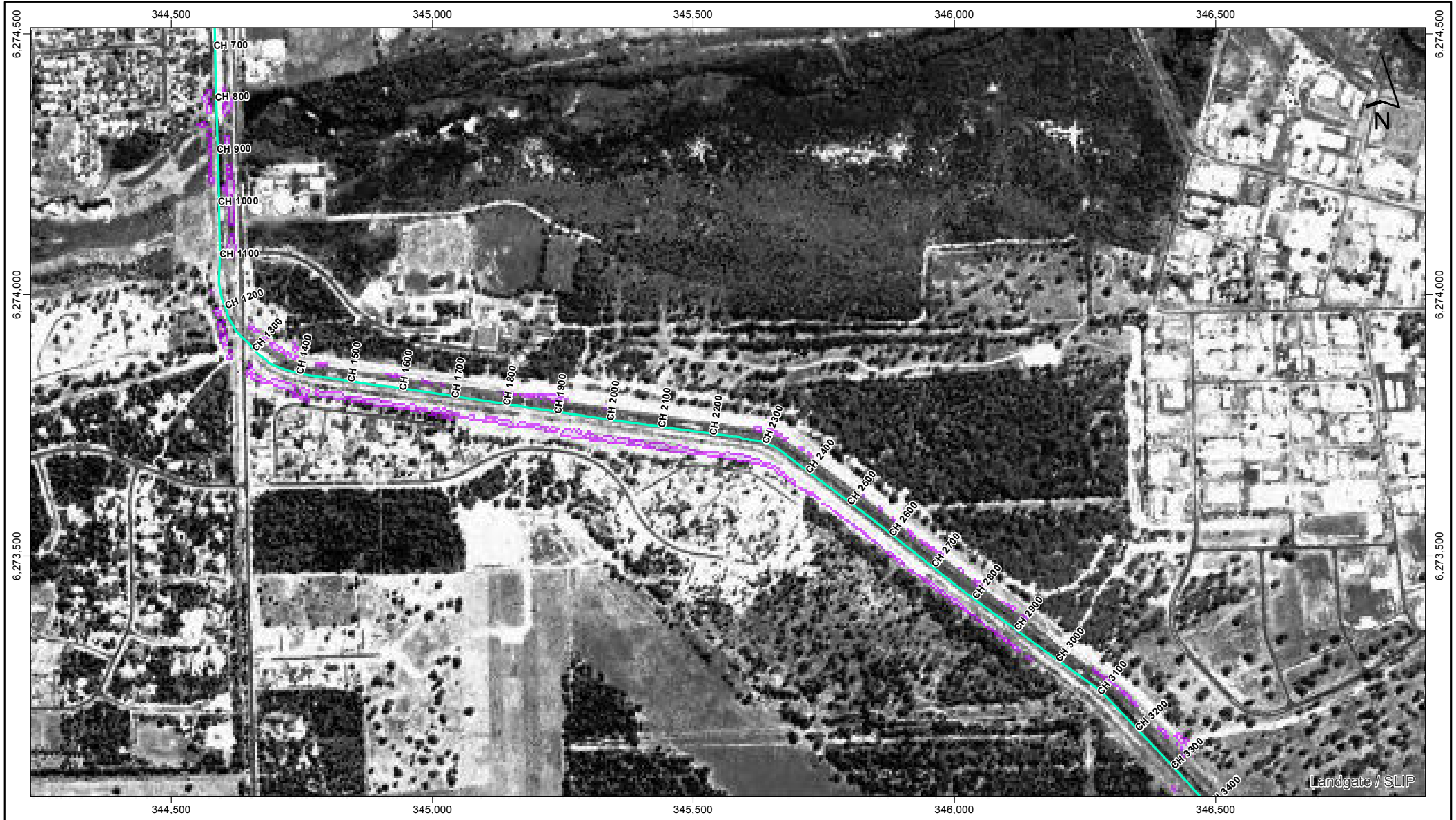
- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area



1:10,000 at A4	
0 100 200 300 400	
Metres	
Coordinate System: GDA 1994 MGA Zone 50	
Vertical Datum: AHD	
AUTHOR: ALLSOPKO	DATE: 17/03/2020
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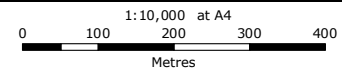
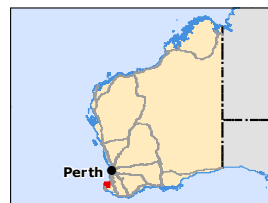


**Vegetation Extent
1970 Aerial Photography**



LEGEND

- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area



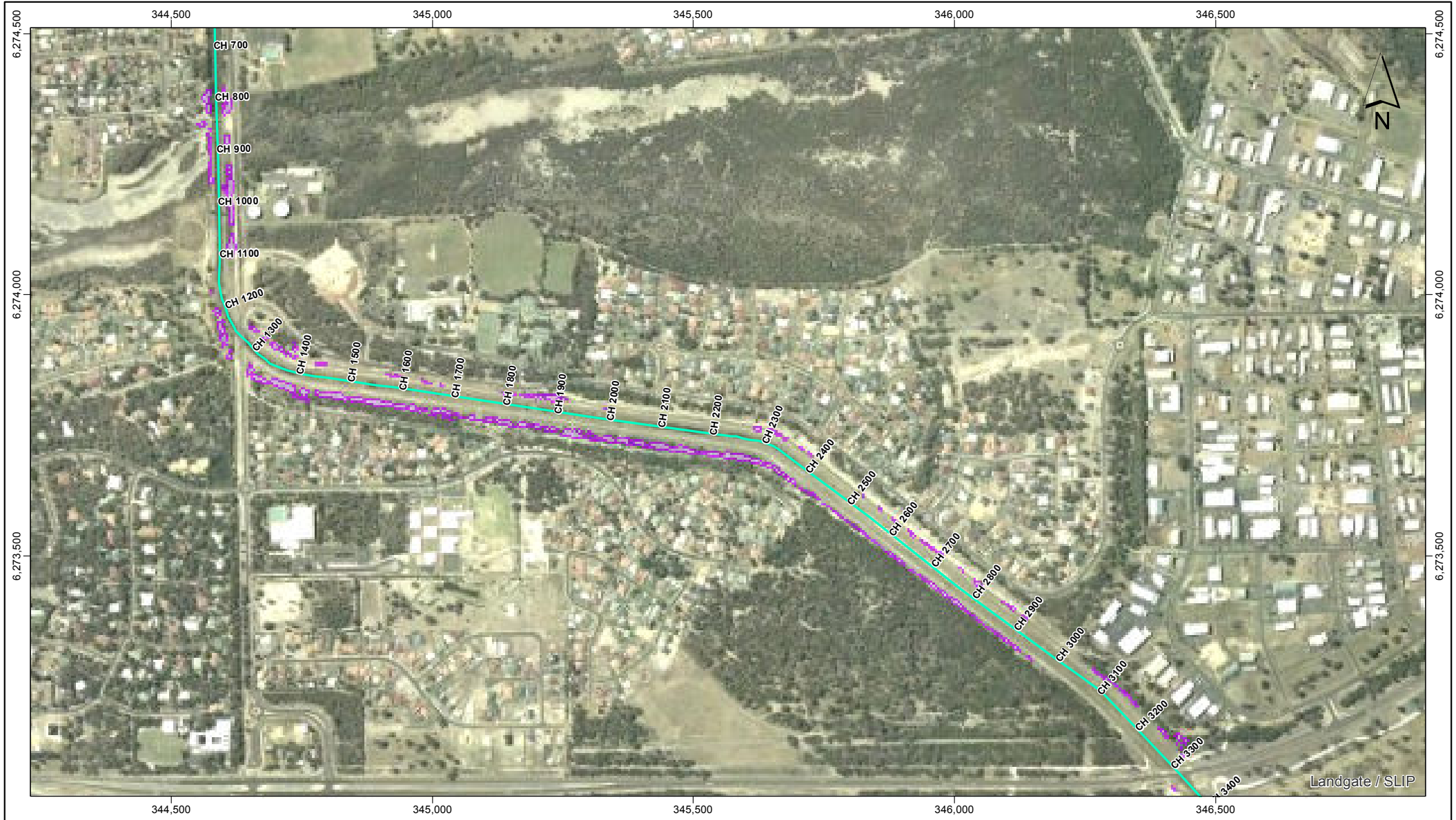
Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

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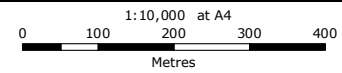
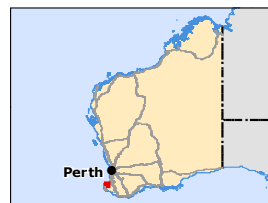


Vegetation Extent in 1996 Aerial Photography



LEGEND

- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area



Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

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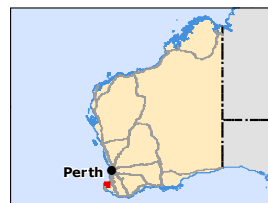


**Vegetation Extent in
2003 Aerial Photography**



LEGEND

- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area



1:10,000 at A4
 0 100 200 300 400
 Metres

Coordinate System: GDA 1994 MGA Zone 50
 Vertical Datum: AHD
 AUTHOR: ALLSOPKO DATE: 17/03/2020
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Vegetation Extent in 2014 Aerial Photography



Flora

One hundred and four vascular flora taxa were identified within and just outside the Survey Area, 22 of these being naturalised non-native or planted species. The high proportion of non-natives is attributed to the highly disturbed nature of the project area and the fact that there have been amenity plantings on previously cleared areas (EcoEdge, 2019, **Appendix H(a)**).

One confirmed individual of the listed orchid, *Caladenia procera*, was identified outside the clearing area, in close proximity to the clearing works, further discussed in **Section 5.4**. Targeted searches of *Drakaea elastica* and *Austrostipa bronwenae* were undertaken and both were absent (EcoEdge 2019, EcoEdge, 2020, **Appendix H(b)**). No other listed or priority species were located within the clearing footprint or the project area in any of the surveys commissioned by the Corporation.

Ecological Communities

Desktop searches identified the presence of one Threatened Ecological Community (TEC) buffer within the survey area:

- *EPBC Act 1999* Listed Vulnerable TEC: Subtropical and Temperate Coastal Saltmarsh

No vegetation associated with a TEC has been recorded within the survey area during any biological surveys undertaken within the project footprint.

The Priority Ecological community ‘*Eucalyptus rudis*, *Corymbia calophylla* and *Agonis flexuosa* Closed Low Forest’ (Webb *et al.*, 2009), occurs within the project area, parallel to the southern boundary of the drain. This is further discussed in **Section 6.2**.

4.7. Fauna and Fauna Habitat

After assessing the information provided in the original 2017 referral under the *EPBC Act 1999*, the DoEE advised the Corporation of the following matters of national environmental significance:

- *Pseudocheirus occidentalis* (Western Ringtail Possum) – Vulnerable
- *Calyptorhynchus baudinii* (Baudin’s Cockatoo) – Vulnerable
- *Calyptorhynchus latirostri* (Carnaby’s Black Cockatoo) – Endangered
- *Calyptorhynchus banksii naso* (Forest Red-tailed Black Cockatoo) – Vulnerable
- *Westralunio carteri* (Carter’s Freshwater Mussel) – Vulnerable

The Corporation engaged specialist consultants to undertake a number of fauna surveys within the project area to address the above listed species, and any additional priority species identified through desktop searches and surveys (See **Table 2**). Level 1 Fauna surveys yielded the following results:

- GHD, 2009 - a total of 39 bird, seven mammal, 11 reptile, five amphibian, two fish and one crustacean species were recorded during the reconnaissance survey within the study area. No additional threatened or priority species were identified as being at risk.
- GHD, 2017a - 37 fauna species, consisting of 22 bird species, three reptiles, eight mammals, three amphibians and one mollusc were recorded within the survey area during the surveys. No additional threatened or priority species were identified as being at risk

Results from the surveys undertaken by GHD, and requests for additional information from the DoEE, DWER and DBCA resulted in the Corporation engaging Subject Matter Experts (SMEs)



to undertake targeted surveys for the Federally and State listed; Western Ringtail Possum, Carnaby's Black Cockatoo and Carter's Freshwater Mussel. Each of these surveys, mitigation strategies and proposed management is discussed in **Sections 5 & 6**.



5. Matters of National Environmental Significance

As part of the Bilateral Assessment, Matters of National Environmental Significance, as defined under the *EPBC Act 1999*, are considered in conjunction with environmental factors considered under Part V of the *WA EP Act 1986*, and Threatened Species listed under the *Biodiversity Protection Act 2016*.

Threatened Species status listed under the *EPBC Act 1999* are considered as at the time of the referral. Under the State legislation, Threatened Species status are considered as at the time of Assessment.

5.1. Vasse-Wonnerup RAMSAR Wetland

The project site is located greater than two kilometres from the Vasse-Wonnerup RAMSAR wetland boundary. The Vasse Wonnerup RAMSAR wetland is joined by the New River.

The Vasse Estuary and the Broadwater were originally connected by New River. The construction of the Drain in the 1920's, near to 100 years ago, formed a barrier between the wetlands. The project is not likely to have any measurable impact on the current hydrological flow regime. Temporary impacts to water quality during the construction phase will be contained within the drain and managed through a CEMP to be prepared by the civil contractor. The outcomes of an assessment of significance of impact to the Vasse-Wonnerup RAMSAR wetland, as a result of the project work is shown below in **Table 9**.

Table 9: Significant Impact Criteria for Wetlands of International Importance (Australian Government Department of the Environment, 2013)

Significance Criteria	Potential Impact (Yes/No)
Areas of wetland being destroyed or significantly altered	No
Substantial and measurable change in the hydrological regime	No
The habitat or lifecycle of native species, including invertebrate fauna and fish species dependant on the wetland being significantly impacted	No
A substantial and measurable change in water quality of the wetland	No
An invasive species that is harmful to the ecological character of the wetland being established.	No

Matters of National Environmental Significance	Residual Impact
Vasse-Wonnerup RAMSAR wetland	No



5.2. Black Cockatoo's (*Calyptorhynchus latirostri*, [Carnaby's Black Cockatoo], *Calyptorhynchus baudinii* [Baudin's Cockatoo], *Calyptorhynchus banksia naso* [Forest Red-tailed Black Cockatoo])

Based on existing site surveys and desktop investigations (GHD 2009, GHD 2017) the initial project referral had potential to impact an estimated 2.41 ha of breeding habitat, and 5.67 ha of foraging habitat, this included 37 Marri and Flooded Gums.

Due to the importance of the Black Cockatoo species, a clearer understanding of the potential impacts was needed. Tony Kirkby, a Black Cockatoo specialist, was engaged by the Corporation in February 2019 to conduct a targeted survey of hollow bearing trees and potential habitat within the project footprint (Kirkby, 2019, **Appendix J**).

Desktop investigations and existing surveys (GHD 2009, GHD 2017) identified foraging and potential breeding habitat for Black Cockatoos and all three species had previously been recorded within 20 km of the development footprint (DPaW 2007).

Utilising existing data, identifying hollows identified by GHD (2009, 2017), the specialist inspected all suitable trees from ground level with binoculars. Hollows with signs of use (chewing or wear at the entrance) were photographed internally using a pole camera. A further photograph was taken of the outside of the hollow using a telephoto lens.

Of the trees inspected, only the one (highlighted*) tree in **Table 10** had a hollow showing signs of use (**Figure 13**). This tree is located outside the proposed clearing area, on the opposite bank from where construction works will be undertaken. Closer inspection of the hollow revealed extensive internal chewing, and is highly likely to be a black cockatoo breeding hollow.

Table 10: Location of trees inspected for evidence of cockatoo roosting

Species	DBH (mm)	Easting	Northing
Flooded Gum	1600	348394.3	6271339
*Flooded Gum	900	348397	6271333
Flooded Gum	100	3483970.4	6271326
Flooded Gum	700	3483970.4	6271327
Flooded Gum	600	348417.6	6271123
Flooded Gum	600	348420.9	6271132
Flooded Gum	500	348508.5	6271164
Flooded Gum	120	348509.5	6271161
Flooded Gum	700	344599.4	6273939
Marri	1000	348490.5	6271385

Although all three species of black cockatoo are found in the general area of the survey, it is likely this hollow belongs to Carnaby's Cockatoo. They are known to breed in Tuart Forest in the Busselton area (WA Museum). The nearest known breeding area for Forest Red-tailed Black-Cockatoo is 14 km to the east at the Whicher Range. The nearest confirmed breeding site for Baudin's Cockatoo is 38 km east at Nannup, though these are unconfirmed breeding records from the Whicher Range. The specialist advised, '*the area has very little foraging apart from Marri trees which are few in number. It isn't an important food source*' (pers comms, email 28/03/2019, Tony Kirkby, 2019).



Based on the survey and advice from the Black Cockatoo specialist, assessment against the significant impact criteria for the Carnaby's, Baudin's and Forest Red-tailed Black Cockatoos are provided in **Error! Reference source not found.** and **Table 11**: Significant impact criteria for critically endangered and endangered species Carnaby's Black Cockatoo

Significance Criteria	Potential Impact (Yes/No)
Lead to a long-term decrease in the size of a population	No
Reduce the area of occupancy of the species	No
Fragment an existing population into two or more populations	No
Adversely affect habitat critical to the survival of the species	No
Disrupt the breeding cycle of a population	No
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	No
Introduce disease that may cause the species to decline	No
Interfere with the recovery of the species	No

Table 12.



LEGEND

- ▲ Black Cockatoo Nesting Tree
- ▲ Black Cockatoo Sites
- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area



1:25,000 at A4	
0 250 500 750	
Metres	
Coordinate System: GDA 1994 MGA Zone 50	
Vertical Datum: AHD	
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Black Cockatoo Tree Survey (Kirkby 2019)



Table 11: Significant impact criteria for critically endangered and endangered species Carnaby's Black Cockatoo

Significance Criteria	Potential Impact (Yes/No)
Lead to a long-term decrease in the size of a population	No
Reduce the area of occupancy of the species	No
Fragment an existing population into two or more populations	No
Adversely affect habitat critical to the survival of the species	No
Disrupt the breeding cycle of a population	No
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	No
Introduce disease that may cause the species to decline	No
Interfere with the recovery of the species	No

Table 12: Significant impact criteria for vulnerable species Baudin's and Forest red-tailed Black Cockatoo's

Significance Criteria	Potential Impact (Yes/No)
Lead to a long-term decrease in the size of an important population of a species	No
Reduce the area of occupancy of an important population	No
Fragment an existing important population into two or more populations	No
Adversely affect habitat critical to the survival of the species	No
Disrupt the breeding cycle of an important population	No
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No
Introduce disease that may cause the species to decline	No
Interfere with the recovery of the species	No

Matters of National Environmental Significance	Residual Impact
Threatened Species – Carnaby's, Baudin's and Forrest Red-tailed Black Cockatoos	No



5.3. *Westralunio carteri* (Carter's Freshwater Mussel)

Westralunio carteri is the only freshwater mussel found in south-west WA. They are located in freshwater lakes, streams and rivers within 100 km of the coast bounded by Gingin Brook in the North, to Kent and Waychinicup Rivers in the south (Klunzinger *et.al.* 2015, Ma 2018). The mussel's habitat range has contracted by 49% in less than 50 years, primarily a result of secondary salinity Klunzinger *et al.* (2015).

The issues around the decline in river quality in southwestern WA are understood. There is still a relatively large extent of occupation, even though there has been a decline, therefore it is assumed that the species has some level of tolerance to changing conditions (TSSC, 2018). Low abundance or small distribution does not necessarily indicate imperilment (Ferreira-Rodriguez *et al.*, 2019).

W. carteri has an aggregated distribution; collecting or congregating in areas which may be widely separated spatially (Ma 2018). They generally occur on banks of waterbodies with favourable habitat conditions including shading, riparian vegetation and pools of water that persist through summer. The average density of known populations in waterways and water bodies across south-west WA, is 29.5 individuals/m² (Klunzinger *et al* 2015, Ma 2018).

The following aspects of the project may have a localised impact on *W. carteri* through:

- Direct mortality during construction through the crushing or burying of individuals.
- Indirect mortality of individuals within and outside of the construction footprint associated with a decline in water quality, specifically increases in turbidity and release of monosulfidic black ooze.
- Habitat loss through alteration of the channel profile and the life-span and depth of pools of water for summer refuge.

Westralunio carteri (Carter's Freshwater Mussel) is listed as 'Vulnerable' under Federal and State legislation. Five targeted surveys have been undertaken on the Drain since 2006, see **Table 2**.

Survey Report Summaries

Lymbery *et al.*, 2008

Westralunio carteri, is reasonably widespread in the natural river systems of Geographe Bay. Distribution was confined to a small section of upper reaches of the Vasse Diversion drain, between the junction of the drain and the Vasse River and the Chapman Hill Road bridge.

The species is found in moderate densities (**Table 13**), the highest being 14.5 mussels/m², found in the Vasse River, immediately downstream of the junction with the Diversion Drain, this is lower than the state average of 29/m² (Ma 2018). The population has a truncated size distribution, indicative of a non-sustaining population.

The simplest explanation of the data from the survey is that mussels disperse into the Vasse Diversion Drain from the adjacent Vasse River during periods of increased water flow, but suffer high mortality over summer and are unable to recruit locally. This could be due to:

- The substrate of the drain, which is dominated by hardpan rock, may be unable to support dormant mussels over the dry season, who usually burrow into moist substrate and can survive up to 80 days without water (Ma, 2018), and/or
- the drain may not have suitable fish populations to act as a host for the parasitic larval stage of the mussel's life cycle. (Lymbrey *et al.*, 2008)



Beatty et al. (2017) Busselton Eastern Link and Causeway Bridge Duplication Projects

The study revealed that *W. carteri* is present in the Lower Vasse River. Density was greater at the bridge sites compared with the reference sites, possibly reflecting the species preference for occupying habitats under and adjacent to bridges (Beatty *et al*, 2017). A total of four sites were surveyed in early September 2017 and included the two impact sites and two reference sites upstream and downstream of the impact sites (**Table 13**).

The Project sites had higher densities (mean 1.8 and 2.5 mussels/m² at the Eastern Link and Causeway Bridge sites, respectively) and a greater range of age cohorts than the reference sites (mean 0.6 mussels/m²) and would contribute to the viability of the population in the Lower Vasse River by providing preferred habitat. From a regional perspective, the densities of *W. carteri* recorded at the project sites are lower than the mean density of 4.4 mussels/m² recorded over 17 survey sites in the south-west, and comparable to the density of 2.0 mussels/m² recorded in the Helena River; another system that is subjected to flow regulation (Morgan and Beatty, 2008).

Lymbrey *et al* (2019) estimated, with an impact of 70m x 5m x 2m, the number of mussels to be relocated would be ~1260 (±560) and ~1750 (±840) mussels for the Eastern Link and Causeway Bridge Sites respectively.

It is noted that the calculated density is based on the mussels being distributed evenly on the river banks, whereas research demonstrates the species distribution is patchy.

GHD, 2019 (Appendix I)

Live mussels were recorded at two locations in the drain, between Chapman Hill Road bridge (Ch 5610) and the Vasse River. Mussels were recorded in sandy, shallow substrates, at the edge of the drain and river bed, as well as deeper areas with substrate composed of both rocks and sand.

Where alive, mussel density varied from 0.4 to 15.1 mussels/m². The highest density observed was 40/m² at an opportunistic search point near Transect 10 (**Table 13**).

The range of mussel length (indicating age), including relatively small sized individuals i.e. immature mussels, indicates some degree of recruitment occurring upstream.

The absence of live mussels and presence of numerous dead mussels found between the Chapman Hill Road bridge and the coast, may be an indication of seasonal mortality. High mussel mortality was also observed by Slack-Smith (2006), and Lymbrey *et.al* (2008) who hypothesised the mortality was a result of seasonal downstream dispersal during periods of high-water flow, followed by mortality over summer during periods of reduced water flow and deteriorating water quality.

There is likely to be a range of inter-related factors linked to the downstream mortality observed including:

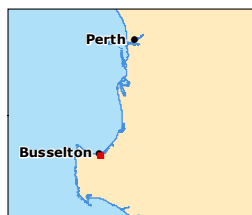
- water volume
- water temperature
- dissolved oxygen
- salinity and nutrient concentration
- lack of water flow, and
- substrate suitability.



LEGEND

Westralunio carteri Survey Sites

- GHD 2019
- ▲ Murdoch 2019
- Vasse Diversion Drain Open Channel



1:5,037 at A4

0 125
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

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Survey Sites for
Westralunio carteri
(GHD 2019,
Murdoch University 2019)



Lymbrey et al, 2019 (Appendix L)

The study by Murdoch University focused on the section of the drain with live specimens identified by GHD (2019). The aim of this survey was to provide a more comprehensive understanding of the abundance and distribution of the mussels. The survey was conducted at 15 sites along the drain upstream of Chapman Hill Road bridge on 30 July 2019.

A total of 192 living and seven dead mussels were recorded, at a mean density of 7.4/m². There was no difference in abundance between the right and left banks. The species was in relatively low density (<0.2/m²) in the first ~200 m upstream of Chapman Hill Road bridge, and the section immediately upstream and downstream of the outlet to the lower Vasse River. Other sections had relatively consistent density of between 10-15 mussels/m².

Lymbrey *et al* (2019) extrapolated the population density within ~680 m of the drain to be approximately 10,043 (± 2429) mussels, under the assumption that the mussels are evenly distributed in an area of 680 m (length) x 2 m (1 m from each bank). Given that the species has an aggregated distribution, this is likely to be an over estimation.

Survey Data Summary

Table 13: Summary of population density in the Vasse River system, including the Vasse Diversion Drain.

Site	Locality	Density (individual/m ²)
Lymbrey <i>et al</i> , 2008 (Spring 2008)		
DD01	Diversion Drain	1.6 ± 0.6
DD02	Diversion Drain	0.10.1 ±
VR01	Vasse River	14.5 ± 5.6
VR02	Vasse River	0.7 ± 0.2
VR06	Vasse River	1.4 ± 0.6
VR08	Vasse River	0.5 ± 0.2
Beatty <i>et al</i> , 2017 (September 2017)		
RE	Lower Vasse River	2.5 ± 1.2
FB	Lower Vasse River	1.8 ± 0.8
ReU	Lower Vasse River	0.6 ± 0.2
ReD	Lower Vasse River	1 ± 0.4
GHD, 2019 (January 2019 Survey)		
Transect 9 (DD01, Lymbrey <i>et al</i> , 2008)	Vasse Diversion Drain	0.4 ± 0.2
Transect 10 (DD02, Lymbrey <i>et al</i> , 2008)	Vasse Diversion Drain	15.1 ± 3.5
Opportunistic 11 (VR6, Lymbrey <i>et al</i> , 2008)	Vasse River	14 individuals
Lymbrey <i>et al</i> , 2019 (July 2019 Survey)		
Site 1	Vasse Diversion Drain	0 individuals



Site	Locality	Density (individual/m ²)
Site 2	Vasse Diversion Drain	0 individuals
Site 3	Vasse Diversion Drain	1 individuals
Site 4	Vasse Diversion Drain	0.5 individuals
Site 5	Vasse Diversion Drain	1.5 individuals
Site 6	Vasse Diversion Drain	9 individuals
Site 7	Vasse Diversion Drain	10.5 individuals
Site 8	Vasse Diversion Drain	12.5 individuals
Site 9	Vasse Diversion Drain	11 individuals
Site 10	Vasse Diversion Drain	1.5 individuals
Site 11	Vasse Diversion Drain	1 individuals
Site 12	Vasse River	14 individuals
Site 13	Vasse River	14.5 individuals
Site 14	Vasse River	8.5 individuals

Targeted Management Plan

W. carteri was listed in 2018, and there are few precedents set within the environmental approval domain to guide management strategies, and limited research available. The Corporation seeks to minimise and mitigate risks where possible. Given that disturbance of the mussels in the drain is unavoidable, and the high number of mussels proposed to be relocated (~10,000), the Corporation commissioned a Peer Review, with the intent to provide technical advice on:

- Translocation methodology
- Collection rates
- Potential alternative approaches, and
- Any other technical advice with regard to the proposed management plan.

Results of the review highlighted the following:

- Population density is likely an over-estimation of individuals present, due to the aggregated distribution of the species and survey effort utilised to determine the population density. The population estimated by Lymbrey *et al.* (2019b) assumed the mussels were present over the entire ~680m length of the drain, which research and similar projects have demonstrated is not the case.
- Best practice should be implemented and some effort should be exerted to collect specimens from the project area prior to construction, to minimise impacts as much as practicable. However, as a significant impact to the population is unlikely, given the natural distribution and abundances that exist across the south-west, it should not be necessary to remove all individuals present, or to target such a high number for relocation.



- Relocation to a suitable site upstream of the project works, but still within the Vasse River system, would mitigate potential risks to resident population health through disease or infection transfer. Additionally, there is likely a lower risk of mortality or stress in the relocated individuals, resulting from relocation and then reintroduction of individuals and differences in water chemistry and environmental quality.

The Corporation has engaged IndoPacific to undertake a scoping study to identify suitable relocation sites upstream of the project area, but still within the Vasse system, including the assessment of key habitat characteristics:

- Salinity
- Presence/absence of perennial water
- Fine sediments
- Woody debris and overhanging riparian vegetation on stream banks,
- Presence/absence of host fish, and/or
- Presence/absence of existing mussels.

In addition, physiochemical parameters (e.g. EC, DO and pH) will be collected and compared to water quality data recorded from the drain. At least two sites will be identified with risk assessments, and a suitable relocation methodology and site will be selected through negotiation with DBCA.

The translocation and environmental management plan will be incorporated into the CEMF for inclusion in the CEMP. The translocation plan will be approved by the DBCA. The plan will be implemented by a suitably qualified specialist consultant. The outcomes of an assessment of significance of impact to the Carter's freshwater Mussel, as a result of the project works, is shown below in **Table 14**.



Table 14: Significant Impact Criteria for vulnerable species Carter’s Freshwater Mussel.

Significance Criteria	Potential Impact (Yes/No)
Lead to a long-term decrease in the size of an important population of a species	No
Reduce the area of occupancy of an important population	No
Fragment an existing important population into two or more populations	No
Adversely affect habitat critical to the survival of the species	No
Disrupt the breeding cycle of an important population	No
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species’ habitat	No
Introduce disease that may cause the species to decline	No
Interfere with the recovery of the species	No

Matters of National Environmental Significance	Residual Impact
Carter’s Freshwater Mussel	No



5.4. *Caladenia procera* (Carbanup King Spider Orchid)

Caladenia procera is listed as critically endangered, and is protected under Federal and State legislation (**Plate 2**). There are more than 535 known mature plants in 7 populations (DEC, 2011) within the South-West region of Western Australia.

Plate 2: *Caladenia procera* (Carbanup King Spider Orchid), Vasse Diversion Drain. Photos (L-R) R. Smith (Sept, 2019), K. Allsopp (25 Sept 2019), K. Allsopp (12 October 2019).



Caladenia procera, Family Orchidaceae, is a herb that dies back to a dormant tuber during the summer months. It grows to 70 cm tall, and has a single, pale green leaf that is 10–30 cm long and 6–10 mm wide. Each plant has 1–3 spider-like flowers. The stiffly-held petals and sepals are greenish lemon yellow with lines and spots of dark maroon to pink. The above ground growing phase of the Carbanup King Spider Orchid extends typically from March to late November with flowering between September and October (*Commonwealth of Australia 2008*).

Approved conservation advice identifies the following key threatening processes:

- Clearing for development, road, firebreak and power utility maintenance.
- Weed invasion.
- Inappropriate fire regimes.
- Grazing by rabbits, kangaroos and cattle.
- Recreational activities including trampling, BMX riders and pet faeces.
- *Caladenia procera* is pollinated by male Thynnid wasps which require largely intact natural habitat.

Advice provided by orchid expert Professor Kingsley Dixon (*Pers Comms*, Dec 2019) highlighted it is 'the fungus that drives distribution of the orchid, which relies on soil conditions and organics that suit the fungus. This is often linked to, but is probably not dependent upon the exact vegetation community. We can 'force' an orchid into a site by inoculating the fungus and the research is underway to ensure that there is longevity to the fungus.'

Water Corporation has undertaken numerous flora and vegetation surveys along the Drain over the past ten years. Until this year, no previous sightings of *Caladenia procera* occurred.



To comply with *Survey Guidelines for Australia's Threatened Orchids: Guidelines for detecting orchids listed as 'Threatened' under the Environmental Protection and Biodiversity Conservation Act 1999*, targeted surveys were undertaken in September 2017 (GHD, 2017c) and September 2019 (EcoEdge, 2019),

EcoEdge (2019) positively identified *Caladenia procera* (confirmed through flowering) and a second potential specimen was noted, but not able to be confirmed through flowering. In addition to the EcoEdge survey, Water Corporation personnel completed two additional confirmation visits on 25 September 2019 and 12 October 2019 with Botanist, Vanessa Clarke reviewing and identifying species from photos (Water Corporation, 2019, **Appendix M**). Specimens were found to be predominantly *C. attigens*.

The single flowering confirmed, and additional unconfirmed orchid specimens are located between 2.5 m - 5 m from the edge of the proposed temporary clearing footprint (**Figure 15**).

Impact Management

Clearing is occurring on the northern flank of the specimens, which is not likely to be suitable habitat in its current condition. The vegetation where the specimens are located is damp, with seasonal inundation and well shaded from the canopies of peppermint trees. This habitat continues south, east and west of the known specimens.

The Corporation obtained advice from SME Professor Kingsley Dixon regarding *in situ* management of the specimens. Advice is as follows:

"Since the orchids exist in a pre-existing disturbed matrix where the surface hydrology has been altered for some time, it is highly unlikely that the proposed works will have any direct hydrological impact upon [CP] C. procera.

I would strongly recommend clearly demarked temporary fencing is installed prior to and for a period after the works. This is to prevent accidental ingress by contractors." (Pers Comms, K. Dixon, Email, 08 Jan 2020).

Professor Dixon has been engaged to complete a custodial collection of up to 50 plants for the project, to be stored for three years post construction, sufficient to assess no negative impact on the remaining plants. At the end of that three-year period, the Corporation, in collaboration with Professor Dixon and DBCA will explore potential translocation opportunities.

C. procera has been successfully propagated in the past, as the symbiotic fungus has been isolated, and plant tissue culture has proven effective (DBCA 2004 & 2011).

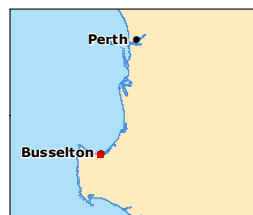
The Corporation recognises the importance of the preservation of biodiversity in the Busselton region, as such the Corporation has endeavoured to minimise and mitigate impacts on *C. procera*:

- Construction site access areas have been carefully selected to avoid the known orchid habitat to prevent further fragmentation or deterioration in vegetation condition.
- Grazing is considered a key threatening process for the species. Rabbit control along the drain, to maintain the integrity of the levees, may have additional positive impacts on the orchid population through reduction in grazing.
- The work being undertaken for this project is considered to be the 'ultimate design' for the asset. It is unlikely that future clearing will occur within the remaining vegetation. This land parcel remains vested with the Crown with a 'Drainage and Conservation' encumbrance.



LEGEND

- Reported Orchids (EcoEdge2019)
- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area



1:1,000 at A4

0 30
Metres

Coordinate System: GDA 1994 MGA Zone 50
Vertical Datum: AHD

AUTHOR: ALLSOPK0	DATE: 17/03/2020
BRANCH: ENVIRONMENTAL APPROVALS	

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Caladenia procera locations



Targeted Environmental Management Plan

Targeted environmental management strategies for the species will be developed with Professor Kingsley Dixon, and be incorporated into the CEMF for inclusion in the CEMP. Measures will include, but not be limited to:

- Construction will be undertaken between November 2020 to April 2021 during the time of the year when the orchid tubers are dormant.
- Prof. Kingsley Dixon will undertake a Spring reconnaissance survey to note the location and extent of the population in 2020. This information will inform the position and extent of fencing to be installed.
- Prof. Kingsley Dixon will undertake a custodial collection (approximately October 2020), noting that the plants do not necessarily flower or successfully go to seed every year.
- The protection zone will be clearly delineated on the ground with fencing and fine mesh to be installed, and approved by Prof. Kingsley Dixon. Fencing will remain in place for the duration of the project, and will not be removed until all works have been completed and ceased.
- During construction the location of the protected area will be indicated on plans. This zone will be highlighted in daily tool box meetings when clearing is actively being undertaken in close proximity.
- Water Corporation personnel will be present on site to monitor clearing works in the immediate vicinity of the protection zone.
- Water Corporation Environmental Officers will regularly inspect the exclusion zone during construction to ensure it is visible, intact and in the correct location.

The outcomes of an assessment of significance of impact to the Carbanup King Spider Orchid, as a result of the project works, is shown below in **Table 15**.

Table 15: Significant Impact Criteria for Critically endangered and endangered species (Caladenia procera).

Significance Criteria	Potential Impact (Yes/No)
Lead to a long-term decrease in the size of a population	No
Reduce the area of occupancy of the species	No
Fragment an existing population into two or more populations	No
Adversely affect habitat critical to the survival of the species	No
Disrupt the breeding cycle of a population	No
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No
Result in invasive species that are harmful to a critically endangered or endangered species becoming established in the endangered or critically endangered species' habitat	No
Introduce disease that may cause the species to decline	No
Interfere with the recovery of the species	No



Matters of National Environmental Significance	Residual Impact
Carbunup King Spider Orchid	No

5.5. *Pseudocheirus occidentalis* (Western Ringtail Possum)

Western Ringtail Possum is listed as ‘*Critically Endangered*’ under the *WA BC Act 2016*, and ‘*Vulnerable*’ at the time of referral under the *EPBC Act 1999*. The status and listing of the species was based on an estimated remaining population of less than 8,000 mature individuals (DPAW, 2017). Recent extensive studies have been undertaken on the South-west Swan Coastal Plain (Error! Reference source not found.), to better understand the population levels and distribution of the species.

Plate 3: Excerpt, Bunbury Outer Ring Southern Section Fauna Assessment (Biota, 2019).

Table 7.2: Population estimates of the Western Ringtail Possum derived from IUCN expert elicitation in 2014 (Burbidge and Zichy-Woinarski 2017) and a 2019 regional population assessment using line transect distance sampling (Biota in prep.).

IUCN Assessment Sub-population	2014 IUCN Population Estimate (adults)	2019 Distance Sampling Estimate (95% confidence interval) (all individuals)
Swan Coastal Plain	2,000	6,445 ± 311 (5,864 – 7,088)
Cape to Cape	500	2,263 ± 186 (1924 – 2661)
Upper Warren	100	7,680 ± 1,774 (4,891 – 12,059)
Other Manjimup Sites	Not assessed	Approx. 250
Around Albany	500	3,045 ± 208 (2,663 – 3,482)
Other Forest Rivers	300	Not assessed
Crooked Brook	Not assessed	721 ± 130 (506 – 1,028)
Total	Approx. 3,400 (40,000 km²) *	Approx 20,000 (1,050 km²)**

* 2014 population estimate (adult population) obtained by expert elicitation for the entire Expected Extent of Occupation, equal to 40,000 km².

** 2019 population estimate (all individuals) for the surveyed area of 1,050 km² and derived from a robust distance sampling program.

The ‘*Precautionary Principle*’ was applied to conserve the species, and as the pool of scientific data increases, better understanding of the actual state of the species is obtained. The significant impact guidelines for the species (DEWHA, 2009) acknowledges that:

‘In the case of Busselton, the existing planning scheme has allowed for significant change in urban form and density. This policy does not intend to stop development within the areas, but aims to minimise the loss of habitat.’

The development area footprint was surveyed by Bamford Consulting in March 2019. The entire area was searched in daylight for dreys, and spotlighting was carried out in five locations across three nights, targeting areas that were biased towards ‘better’ areas for possums (Figure 16).

Survey Limitations

Night time survey locations targeted areas that were biased towards ‘better’ areas for possums to be found. This preferential sampling method likely over estimates the actual population of possums present (Bamford, 2019).



Results

- A total of 66 possums were located across the entire project area (42 ha) during daytime surveys. Four of the 66 possums were not in dreys.
- Spotlighting located 25 possums in the northern area and 9 possums in the southern area – across a total of 5 locations.
- Estimated density for the northern area is approximately 5.8/ha.

Advice from the fauna specialist is as follows:

The proposed drain widening will result in some habitat loss, with population decline potentially proportional to the proportion of connected vegetation lost. The drain likely functions as a corridor linking the vegetated blocks south of the Busselton Bypass to the vegetation fringing the Broadwater and some of the older-style gardens in the inner suburbs of Busselton, supporting the species. Where ever the drain is being widened, there will be retained habitat.

The proposed clearing may cause the displacement of 10-15 possums, into the remaining, adjoining vegetation. This estimate has been reduced since the original report due to the decrease in clearing area through detailed design. Regardless *'this figure needs to be treated with caution, as the survey was biased towards 'better' areas for possums'* (Bamford 2019).

The Corporation has liaised with the neighbouring schools with areas of bushland running parallel to the project area. In Principle agreement for the installation of nest-boxes, rope bridges and targeted infill planting has been obtained (**Figure 17**). These works will be undertaken in conjunction with the proposed extension of the existing GeoCatch infill planting and restoration works on the Queen Elizabeth Avenue sections of the drain (**Section 7**).

Mitigation Strategies

The following actions will be undertaken to minimise impacts:

- Engage a qualified fauna handler to facilitate the displacement of animals immediately prior to clearing.
- Displacement will be complimented with nest-box installation in the neighbouring primary school bushland, in the months prior to clearing, to provide increased shelter availability where possum density is increased due to displacement.
- Rope bridges in the neighbouring primary school bushland, connecting with the vegetation remaining along College Avenue, in the months prior to clearing. This will improve access and egress in the remaining vegetation canopy. Areas of more sparse canopy will be targeted.
- Replant sections along the drain where vegetation is currently sparse; improving connectivity and offsetting habitat loss.
- While peppermint is an important tree for the species, planting Marri, Spearwood and Coojong is also considered helpful, these species will be included in the infill planting and rehabilitation works were appropriate.



LEGEND

- Day Sighting No Drey
- Empty Drey
- Night Sighting
- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area



1:25,000 at A4
 0 250 500 750
 Metres
 Coordinate System: GDA 1994 MGA Zone 50
 Vertical Datum: AHD

AUTHOR: ALLSOPK0	DATE: 17/03/2020
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Bamford 2019,
 Possum survey data



LEGEND

- Proposed Possum Infill, Bridges and Boxes
- Vasse Diversion Drain Open Channel
- Native Vegetation Clearing Area



1:8,000 at A4	
0 125 250	
Metres	
Coordinate System: GDA 1994 MGA Zone 50	
Vertical Datum: AHD	
AUTHOR: ALLSOPK0	DATE: 18/03/2020
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**Bamford 2019,
Possum survey data**



Construction Management Strategies

Targeted Fauna management strategies will be included in the CEMF, in collaboration with Bamford Consulting. The fauna management requirements will be incorporated into the CEMP to be prepared by the civil contractor.

Management strategies will include, but not be limited to:

- Immediately prior to clearing, trees must be checked for possums and any identified will be relocated to an area of native vegetation outside the construction corridor by a qualified fauna handler.
- To prevent possums from entering stockpiles of cleared vegetation, debris will be moved offsite or mulched on the day of clearing.
- Removal of unoccupied dreys a week before clearing will be undertaken by a qualified fauna handler, to encourage resident animals to move out.
- Nest-boxes will be installed in areas of native vegetation adjacent to the construction corridor to reduce the pressure associated with the potential increase in the population density in remaining habitat.
- Replanting adjacent sections of the drain post-construction and where possible, prior to commencement of construction (See **Section 7**).
- Installation of basic rope bridges in adjacent vegetation will be under the advice of a fauna specialist.

Fauna management strategies will also include additional management for Quenda, Rakali and migratory bird species, in the event they are sighted during construction.



The outcomes of an assessment of significance of impact to the Western Ringtail Possum, as a result of the project works, is shown below in **Table 16**.

Table 16: Significant Impact Criteria for vulnerable species, Western Ringtail Possum (as at time of referral in 2017).

Significance Criteria	Potential Impact (Yes/No)
Lead to a long-term decrease in the size of an important population of a species	No
Reduce the area of occupancy of an important population	No
Fragment an existing important population into two or more populations	No
Adversely affect habitat critical to the survival of the species	No
Disrupt the breeding cycle of an important population	No
Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline	No
Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat	No
Introduce disease that may cause the species to decline	No
Interfere with the recovery of the species	No

Matters of National Environmental Significance	Residual Impact
Western Ringtail Possum	No



6. Matters of State Environmental Significance

6.1. Conservation Category Wetland

New River, a Conservation Category wetland, recognised as an Environmentally Sensitive Area, is located at the northern end (0.3km CH 800 – CH 1000) of the drain on the western bank (**Figure 5**).

The northern section of the drain is characterised by a deeply incised channel with sprayed-concrete levee walls up to the Queen Elizabeth Road bridge. The drain walls in this section are deteriorated and the existing structure will be removed, the foundations deepened and the walls refurbished.

The ultimate design of this section does not involve further widening, however temporary clearing will be necessary to ensure the foundation reaches the desired depth. The proposed clearing does not exceed the extent of historical clearing as discussed in **Section 4.5**.

As there is no permanent increase in the width of the drain in this section, and clearing is no greater than the historical extent, it is unlikely these works will significantly alter the existing environmental attributes surrounding this section of the drain. Temporary impacts during construction will be detailed in the Construction Environmental Management Plan. This will include, but is not limited to:

- Construction will be conducted through late Spring, Summer and early Autumn of 2020/2021.
- Up to three construction fronts will be utilised, expediting the delivery of the project, minimising inconvenience to residents and ensuring the project is delivered at or close to surface and ground water level minimum.
- Water quality management requirements will be defined by the Corporation and managed through the civil contactors CEMP.

As discussed in **Section 4.4**, the Corporation is currently undertaking detailed ASS and waste classification assessments. An ASSMP will be developed and sent to the DWER Contaminated Sites Branch for review and approval.

6.2. Priority Ecological Community

Context

The Corporation commissioned eight flora and vegetation surveys, between 2008 and 2020, detailed in **Section 4.6**, to confirm the location and extent of the P1 Priority Ecological Community (PEC), “*Eucalyptus rudis* (flooded gum), *Corymbia calophylla*, *Agonis flexuosa* Closed Low Forest.” The vegetation community has been historically highly cleared, however there are several small remnants known to occur on public land. Webb *et. al* (2009), the first published recognition of this PEC, recommends that ‘*larger, most intact representative areas of this community should be protected*’ (Webb *et. al*. 2009).

Survey Results

VU- A occurs within the historical extent of the PEC, which totals 0.89 ha (**Table 17**) of the total clearing footprint of the project (2.16 ha). The VU-A proposed for clearing (Error! Reference source not found.), is predominantly degraded, with non-contiguous sections of ‘*Good*’ condition vegetation, and patchy, non-continuous canopy coverage, separated from the



broader, recognised PEC bushland by the City of Busselton swale drain and the Busselton Bypass.

Table 17: PEC area within clearing footprint

Vegetation Unit	Cons Status	Condition	Area (ha)
Unit A	P1	Good	0.29
		Degraded	0.6
Total			0.89

VU-A shares six of the 14 species listed in the DBCA (Version 28, 2019) description for the community. VU-A also contains 20 species not recognised within the PEC, three of which are weeds (Table 18).

Table 18: Comparison of PEC species DBCA (Version 28, 2019) list and species list of VU-A (EcoEdge 2019).

PEC Description (DBCA, 2019)	Vegetation Unit A
<i>Eucalyptus rudis</i>	-
<i>Corymbia calophylla</i>	<i>Corymbia calophylla</i>
<i>Agonis flexuosa</i>	<i>Agonis flexuosa</i>
<i>Hibbertia hypericoides</i>	<i>Hibbertia hypericoides</i>
<i>Logania vaginalis</i>	-
<i>Conspermum caeruleum</i>	<i>Conspermum caeruleum</i>
<i>Agrotocrinum hirsutum</i>	-
<i>Lomandra micrantha</i>	-
<i>Eucalyptus decipens</i>	-
<i>Melaleuca raphiophylla</i>	<i>Melaleuca raphiophylla</i>
<i>Banksia littoralis</i>	<i>Banksia littoralis</i>
<i>Hakea avria</i>	-
<i>Baumea juncea</i>	-
<i>Gahnia trifida</i>	-
	<i>Acacia cochlearis</i>
	<i>Acacia saligna</i>
	<i>Hibbertia cuneiformis</i>
	<i>Jacksonia furcellata</i>
	<i>Kunzea glabrescens</i>
	<i>Spyridium globulosum</i>
	<i>Adenanthos meisneri</i>
	<i>Daviesia physodes</i>
	<i>Hardenbergia comptoniana</i>
	<i>Leucopogon propinquus</i>



PEC Description (DBCA, 2019)	Vegetation Unit A
	<i>Lepidosperma squamatum</i>
	<i>Tetraria octandra</i>
	<i>Caesia micrantha</i>
	<i>Chamaescilla corymbosa</i>
	<i>Conostylis aculeata subsp gracilis</i>
	<i>Opercularia hispidula</i>
	<i>Sowerbaea laxiflora</i>
	<i>Sparaxis bulbifera*</i>
	<i>Watsonia merianavar bulbiflora*</i>
	<i>Zantedeschida aethiopica*</i>
14 Species	23 Species (plus 3 Naturalised)

Impact Assessment

By definition, vegetation classed as ‘degraded’ to ‘completely degraded’ would not be considered part of the PEC ‘extent’ under Federal or State Legislation¹ (DBCA, 2014). The drain is a highly modified, artificial ecosystem, evident from the number of contra-indicative species present in the vegetation present. The proposed works will not increase the historic extent of modification.

The proposed clearing includes only 0.29 ha of discontinuous ‘Good’ condition PEC aligned vegetation. At best, the vegetation mapped shares approximately 50% of species in alignment with the PEC definition, although many of these species are found widely distributed throughout the Swan Coastal Plain, making them difficult to utilise as indicator species.

In the absence of a formal policy, the Corporation has considered criteria assessed for ecological communities recognised under the *EPBC Act 1999*, although it should be acknowledged that this is technically used for the assessment of recognised *Critically Endangered* and *Endangered* Threatened Ecological Communities.

Table 19: Significant impact criteria for critically endangered and endangered ecological communities (DoE, 2013). This criteria has been utilised in the absence of formal guidance from the State Regulator. Consideration of the lower level of protection granted to a Priority community should be taken.

Impact criteria for Federal Threatened Ecological Community’s	Potential Impact
Reduce the extent of an ecological community	The drain is a highly modified environment originally cleared in the 1920’s, with aerial photography evidence of clear-felling four times since 1954 (Figure 8 - Figure 12). The clearing being undertaken as part of this project is less

¹ Based on information from the 2014 drafted nomination form (Unpublished Department of Environment and Conservation Nomination of a Western Australian ecological community for listing as a threatened, priority, change of status or delisting): “Only vegetation that is ‘good’ or better is considered ‘extent’.”



Impact criteria for Federal Threatened Ecological Community's	Potential Impact
	than the historical extent of clearing.
Fragment or increase fragmentation of an ecological community, for example by clearing vegetation for roads or transmission lines	The vegetation along the drain is highly modified from historical clearing. The condition is largely degraded with patchy canopy, and would not create further fragmentation than what currently exists, or has existed in the past.
Adversely affect habitat critical to the survival of an ecological community	The drain is a highly modified, artificial ecosystem, evident from the number of contra-indicative species present (Table 18). The proposed works will not increase the historic extent of modification.
Modify or destroy abiotic (non-living) factors (such as water, nutrients or soil) necessary for an ecological community's survival, including reduction of groundwater levels, or substantial alteration of surface water drainage patterns	The drain is a highly modified, artificial ecosystem, evident from the number of contra-indicative species present in the vegetation present. The proposed works will not increase the historic extent of modification or destroy abiotic factors required for the survival of the PEC.
Cause a substantial change in the species composition of an occurrence of an ecological community, including causing a decline or loss of functionality of important species, for example through regular burning or flora or fauna harvesting.	As evident in Table 18, the existing structure of the vegetation is already highly modified. The proposed works will not cause any further decline or loss of functionality. Proposed infill vegetation works will potentially improve ecological function, including for the use of Western Ringtail Possums.
Cause substantial reduction in the quality or integrity of an occurrence of an ecological community, including but not limited to: <ul style="list-style-type: none"> • Assisting invasive species, that are harmful to the listed ecological community, to become established, or • Causing regular mobilisation of fertilisers, herbicides or other chemicals or pollutants into the ecological community which kill or inhibit the growth of species in the ecological community 	The drain has existed for near to 100 years. Its original function was to increase the amount of arable land. The current purpose of the drain is flood mitigation for the City of Busselton, capturing flood waters of a predominantly agricultural catchment that is greater than 200 km ² . Modifications made to the drain have been modelled extensively and reviewed by the Department of Water (now DWER). The proposed works will not increase the impacts of abiotic factors on the environment, and will cause not further deterioration in the quality of vegetation or vegetation communities locally. The Corporation has a maintenance strategy for declared species. Weed control will continue to be undertaken in compliance with existing Acts and Regulations.
Interfere with the recovery of an ecological community	There is no recovery plan for this community, as it is not recognised as a TEC. Regardless, revegetation and infill vegetation works will incorporate species found within the PEC, under the guidance and advice from revegetation experts to ensure survivability.

Mitigation and Management of Clearing Impacts

The Corporation will include clearing management in the CEMF, to be incorporated into the contractor CEMP. Management will include, but not be limited to:

- The clearing boundary will be delineated on plans and on ground by a qualified surveyor.



- The clearing boundary will be clearly delineated on the ground with flagging. Flagging will remain in place for the duration of the project, and will not be removed until all earth works have ceased.
- Prior to clearing works, the Geographe Landcare Nursery will undertake a salvage operation within the clearing footprint.
- During construction the clearing boundary will be highlighted in daily tool box meetings when clearing is actively being undertaken.
- Water Corporation personnel will be present on site to monitor clearing works.
- Water Corporation Environmental Officers and contractor personnel will regularly inspect flagging during construction to ensure it is visible, intact and in the correct locations.
- Proposed infill and reinstatement works will include species aligned with the PEC where suitable. This is further discussed in **Section 7**.

6.3. *Conospermum caeruleum*

Under advice from the DWER in February 2019, Water Corporation engaged SME Dr Eleanor Bennett to conduct a targeted survey for *Conospermum caeruleum* subsp? *Busselton*. This subspecies was first mentioned in Webb *et al* 2009, and had yet to be formally defined. *C. caeruleum* subsp? *Busselton* is not recognised as a priority species under State or Federal environmental protection legislation. A search of Florabase (Online 2019) does not yield a result.

On 1st to 5th April 2019, Dr Eleanor Bennett undertook a survey to determine the location of the subspecies unofficially identified as *Conospermum caeruleum* subsp? *Busselton* (**Appendix G**). The plants are morphologically distinct from other *Conospermum caeruleum* as they are a bright green compared to the dark green of most native taxa, they grow in a prostrate form in damp sand, but not seasonally inundated areas. This taxon is currently filed under *Conospermum caeruleum* subsp. *marginatum* at the Western Australian Herbarium.

The consultant conducted surveys on potential sites within close proximity to the project area, however it is noted that information in the genetic testing report indicates a second known population near Cape Naturalist. During the survey the Consultant recorded 489 GPS coordinates of which four were *Conospermum caeruleum* subsp. *marginatum*. The individual plants are difficult to survey because it can form dense carpets (**Plate 4**). Initial survey methodology was to record individual specimens of each plant, however the plant(s) grow in large, sometimes dense, delicate carpets and, and difficult to distinguish individual specimens. After liaison with the Corporation, the methodology was altered and a carpet area was recorded where individual plants were difficult to distinguish. As a result of this change in methodology Survey Areas 1, 4 and 15 have more intensive estimates recorded. The remaining sites are much more conservative estimates, as a carpet was counted as 'one' plant, likely under-representing the number of plants.

Table 20 details the survey site number (**Figure 18**) and number of locations (individual GPS points, sometimes reflecting one or more plants, and sometimes representing a carpet), the conservative estimate based on 1 Carpet = 1 plant (the greyed out sites were a more intensive survey methodology more accurately reflecting the number of plants present) and the survey extent (ha).

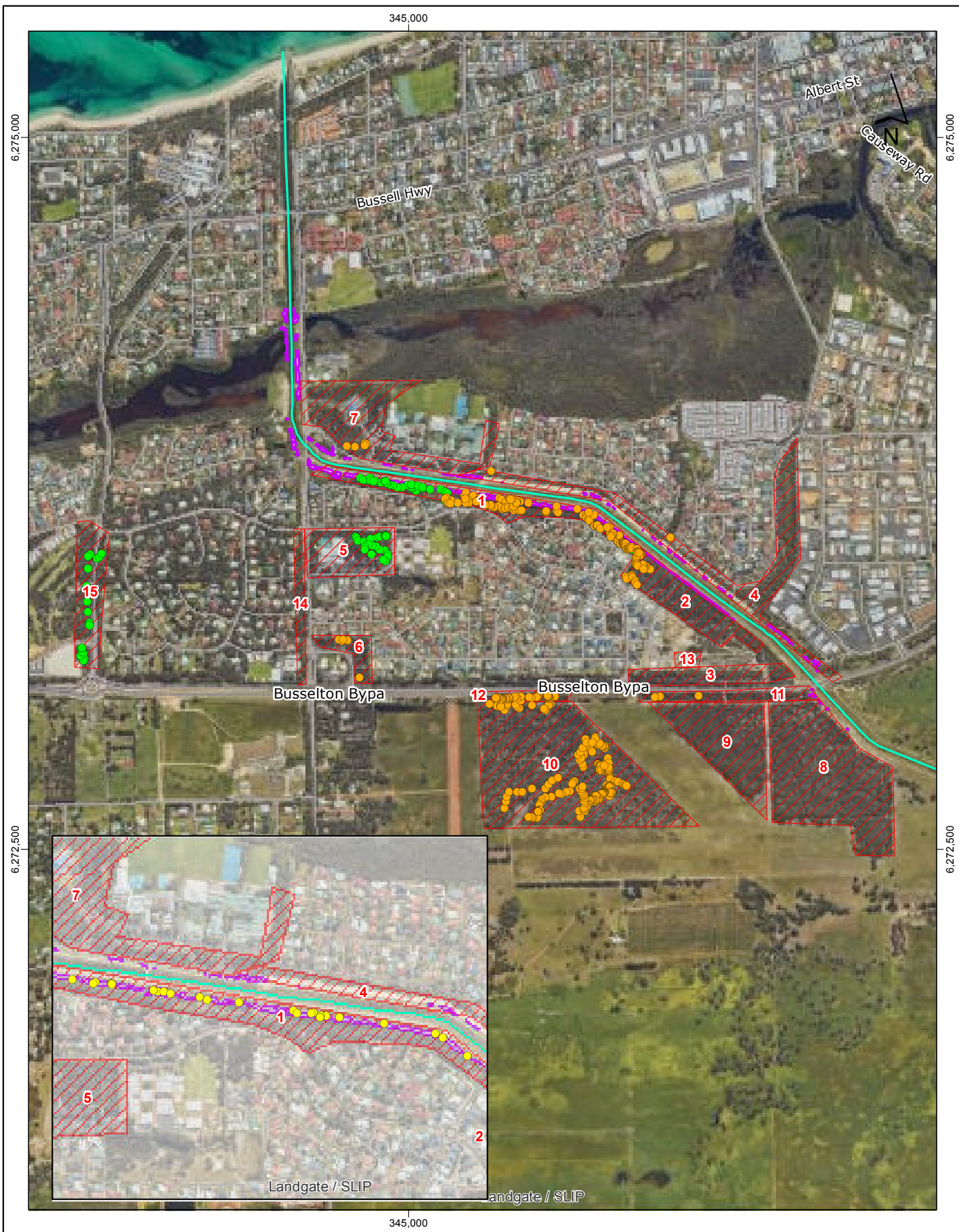
Survey Site 1 is the only area where clearing for the project will occur, and result in the removal of some *C. caeruleum* plants. Personal communications with Dr Bennett (Dec 2019) indicated that the abundance of plants in Survey sites 1 and 10 were in fact similar, but the



variation in survey methodology between the two sites under-represents the potential number of plants in Survey Site 10.

Plate 4: *Conospermum ceruleum* subsp? *Busselton* carpet photo taken 03 September 2019 (Klara Allsopp), located within R 52132, Survey Site 2





LEGEND

Conospermum Survey Locations (Bennett)

- 1 April 2019
- 2 thru 5 April 2019
- 29 Conospermum Survey Locations within Clearing Area
- Vasse Diversion Drain Open Channel
- ▨ Conospermum Survey Areas (Bennett)
- ▨ Native Vegetation Clearing Area



1:18,000 at A4
 0 125 250 375
 Metres

Coordinate System: GDA 1994 MGA Zone 50
 Vertical Datum: AHD

AUTHOR: ALLSOPK0 DATE: 18/03/2020
 BRANCH: ENVIRONMENTAL APPROVALS

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Conospermum caeruleum subsp(?)
Busselton Survey
and extent
(Bennett 2019)



Table 20: Bennett (2019) survey results

Survey Site	Number of Locations	*Conservative Number of Plants	Survey Area (ha)	Estimated number of plants being cleared
1	144	653	5.2	105
2	41	175	5.4	Nil
3	0	0	3.5	N/A
4	2	2	10.2	Nil
5	28	308	5.2	N/A
6	5	9	1.7	Nil
7	5	19	9.4	Nil
8	0	0	16.8	N/A
9	0	0	8.4	N/A
10	194	206	24.1	Nil
11	3	8	2.5	Nil
12	44	124	1.3	Nil
13	0	0	0.5	N/A
14	0	0	1.9	N/A
15	10	135	5.0	Nil

*Survey methodology for Areas 1, 4 and 15 was significantly more thorough. A nominal count of '1' has been given to Carpets in all other areas.

Genetic Testing Results

Water Corporation, in collaboration with Department of Main Roads commissioned genetic testing of the *Conospermum caeruleum* species. Diversity Arrays Technology sequencing (DArTseq) was used to assess genome-wide Single Nucleotide Polymorphism (SNP) (DBCA 2019) variation within the species.

C. caeruleum subsp(?) *Busselton* was first identified in the literature in Webb *et al* (2009), within the *C. caeruleum* species group, growing in coastal limestone-associated sands, primarily within the City of Busselton. Most known populations are subject to impending disturbance activity and/or are without formal conservation protection. The species has a highly 'plastic' morphology, requiring genetic data to clarify relations.

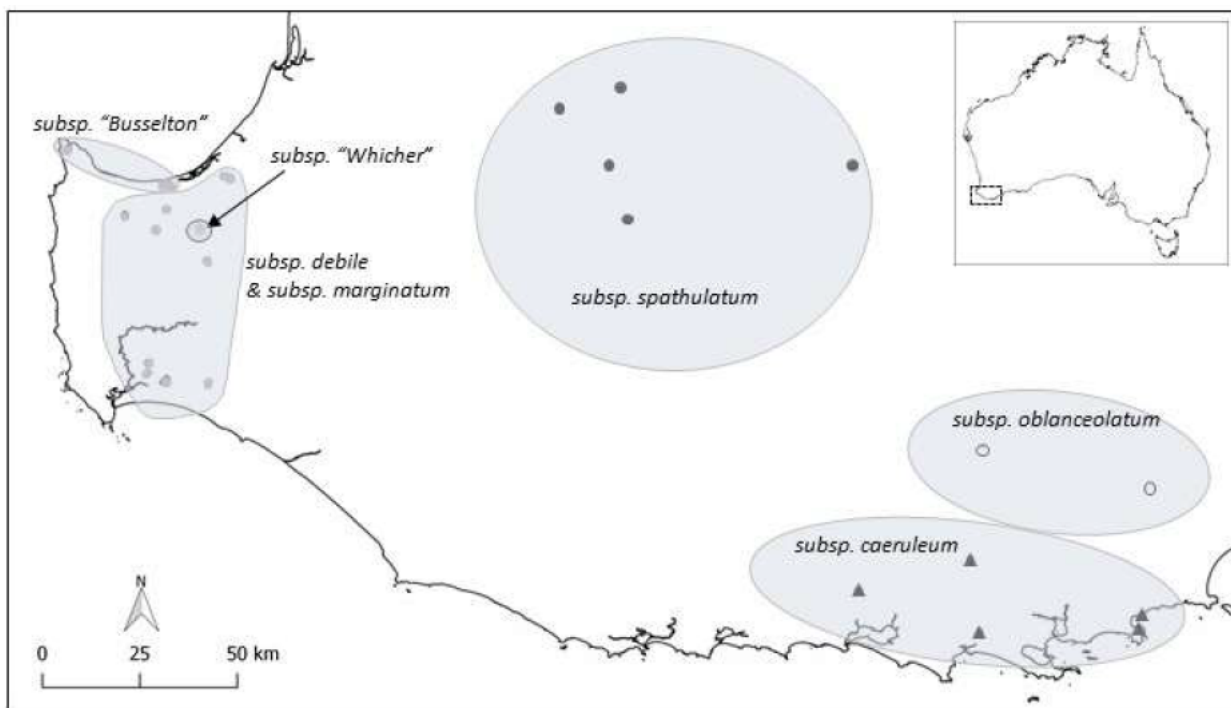
The following specimens were collected as part of the study, approximate sampling locations are presented in **Plate 5**:

- *C. caeruleum* subsp(?) 'Busselton'
- *C. caeruleum* subsp *caeruleum*
- *C. caeruleum* subsp *oblanceolatum*
- *C. caeruleum* subsp *spathulatum*
- *C. caeruleum* subsp *debile*
- *C. caeruleum* subsp *marginatum*



- *C. caeruleum* subsp(?) *marginatum* (intermediate)
- *C. caeruleum* subsp 'Whicher'
- *C. glumaceum*
- *C. polycephalum*

Plate 5: Approximate geographic distribution of currently described and proposed subspecies of *C. caeruleum* overlaid on populations sampled for the present study (DBCA 2019, Pg 24).



Results of the genetic testing indicate at the larger scale, variation is generally explained by geography, rather than by the current taxonomy. The data represents the presence of at least three closely-related but distinct *Conospermum* species, however based on the genetic analysis undertaken the conservative conclusion is that there is a single, highly morphologically variable *Conospermum* species occupying the south-west between Busselton and Scott River, and is comprised of three distinct Management Units (Mus) for conservation:

- All populations currently recognised as subsp 'Busselton'
- All other SW North populations, and
- All SW south populations.

With the current information it is not recommended that *C. caeruleum* be recognised as a distinct subspecies, but its unique morphology warrants management (DBCA 2019).

Further detail about the scope, method and results is located in **Appendix N**.

Conservative estimates indicate 105 plants will be removed as part of the clearing works. However as indicated in the results of the genetic testing, the species is not a recognised subspecies, but a hybrid, and permit to take is not required.



In recognition of the morphologically distinct nature of this hybrid, and the importance of the plant to the local wildflower groups, the Corporation has engaged the Geographe Landcare Nursery to propagate 300 seedlings for use during revegetation post-construction.



7. Revegetation and Infill Planting

'Lowest Environmental Impact' is one of the Water Corporation's corporate objectives. The Corporation provided an Offset Proposal with the 2018 Variation. However, considering the reduction of environmental impact achieved through engineering design, greater scientific understanding of the local ecosystem, including a clear understanding of the linear, degraded nature of the vegetation being cleared, and proposed infill planting and revegetation works, the Corporation considers offsets are not required.

The Corporation proposes to undertake infill planting and revegetation in and around the drain to mitigate the minor potential clearing impacts the project. This will result in better environmental outcomes for the local environment, whilst improving the amenity of the strategic infrastructure corridor.

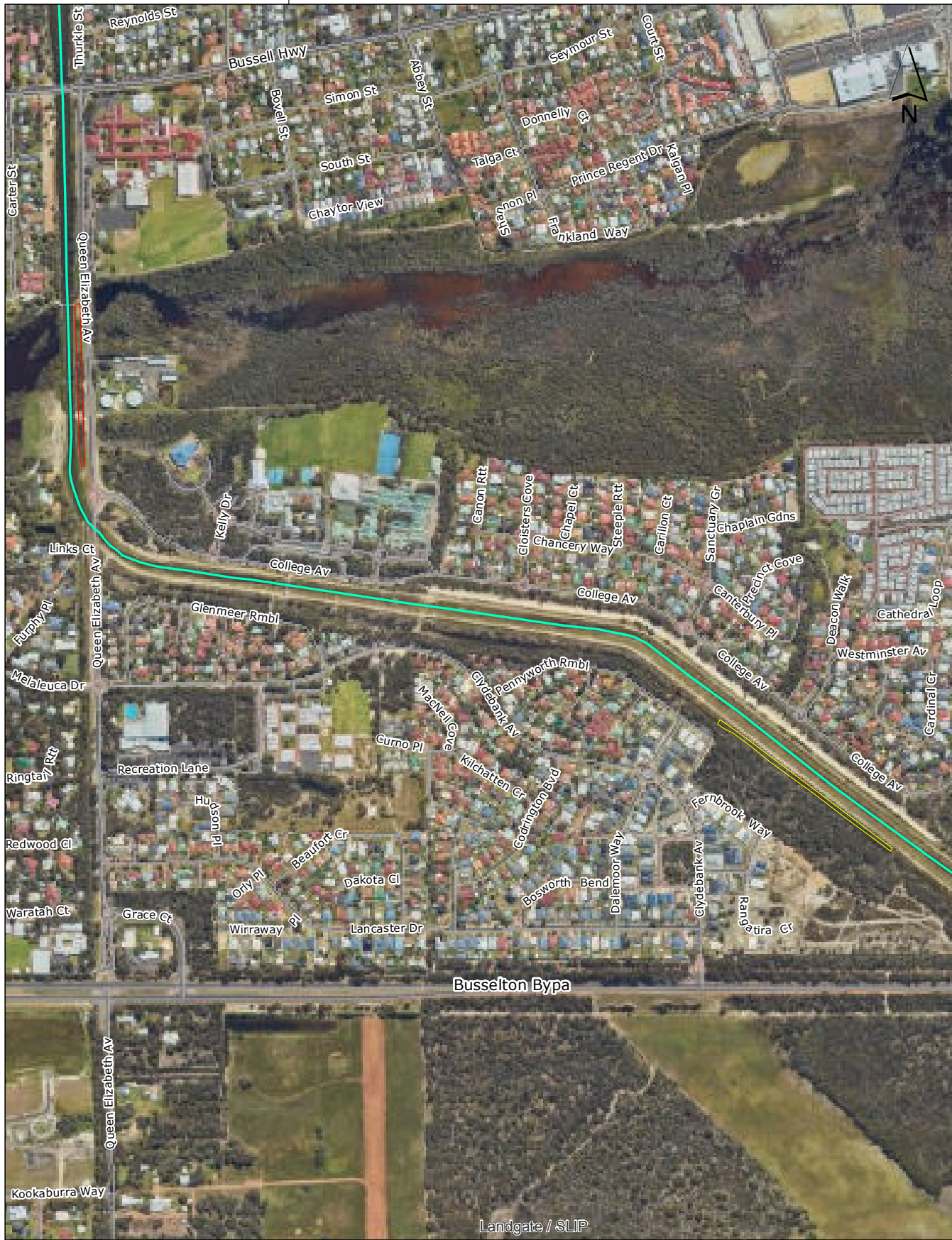
Through our initial community engagement events, the Busselton community expressed to the Corporation the importance of the drain for egress and exercise, as well as creating a green corridor in the middle of town, with screening vegetation being considered very important for both the health and wellbeing of residents. From an environmental perspective, the vegetation along the corridor provides linkage to the Vasse-Wonnerup wetland area. Enhancing the existing vegetation and extending existing revegetation works locally will result in the most sustainable outcomes benefitting both the local residents and the local flora and fauna.

7.1. Vegetation Reinstatement

The Corporation is required to clear two City of Busselton swale drains (**Figure 2 and 3**); the first running parallel to Queen Elizabeth Avenue, the second running parallel to the drain in R 52132. The Corporation intends to reinstate the vegetation around these drains (including reinstating the fencing and reconstruction of the swale drain running parallel to the drain in R 52132).

Vegetation assemblages in these areas are different to other sections of the drain, and advice from both revegetation consultants and the Local Geographe Landcare Nursery will be obtained, to ensure the best outcomes and most appropriate species are planted. The reinstated vegetation will be maintained and monitored for four years post-construction, and a specific revegetation plan will be prepared and agreed with the Regulator. The total amount of vegetation being reinstated is 0.6 ha (**Figure 19**).

345,000



345,000

LEGEND

- Vasse Diversion Drain Open Channel
- City Swale Drain Reinstatement
- QE Ave Swale Drain Reinstatement



1:10,000 at A4	
Metres	
Coordinate System: GDA 1994 MGA Zone 50	
Vertical Datum: AHD	
AUTHOR: ALLSOPK0	DATE: 18/03/2020
BRANCH: ENVIRONMENTAL APPROVALS	

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Proposed vegetation reinstatement sites



7.2. Additional Infill and Revegetation Works

The Corporation has liaised closely with the Busselton DWER and GeoCatch Officers, as well as revegetation specialists to ensure that the vision for improving the ecosystem and vegetation condition around the drain is viable. In particular, the opportunity to extend the existing GeoCatch revegetation works from Bussell Highway to the northern extent of the project area (**Figure 20**) was identified as desirable for both visual amenity, improvement to the existing habitat for flora and fauna, and an improvement to the corridor linkage. This area covers 1.95 ha. Similar revegetation efforts have been undertaken locally with the following completion criteria:

- Weed cover % (all sites) - <15%
- No significant weed species (all sites) – No significant weeds
- Total native vegetation cover % (all sites) – 50%
- Species richness representation (% of initial richness [no. of species]) (all sites)– 70%
- Native stem density in first 2 years (all sites) – 1.5 plants / m²

Table 21: Proposed vegetation reinstatement and infill planting areas

Revegetation/Infill planting	Area
Queen Elizabeth Avenue Swale Drain	0.29 ha
City Swale Drain R 52132	0.3 ha
GeoCatch Rehabilitation Extension	1.95 ha
Total	2.54 ha

As discussed in **Section 0**, and in addition to the areas detailed in **Table 21**, the Corporation has obtained In Principle support to undertake infill planting and the installation of rope bridges and nest-boxes in vegetated land adjacent to the drain, to improve the neighbouring habitat, and aid displaced possums. These works will be completed with the advice and support of local Western Ringtail Possum specialists in Busselton.

The Corporation will continue to work with the Local Community, interested Stakeholders and the Regulatory Authorities to negotiate the most sustainable outcome of the project, and the lowest environmental impact achievable, whilst acknowledging that this is a critical, and unavoidable infrastructure upgrade.



LEGEND

- Vasse Diversion Drain Open Channel
- Vegetation Rehabilitation and Infill
- QE Ave Swale Drain Reinstatement



1:4,791 at A4	
0	125
Metres	
Coordinate System: GDA 1994 MGA Zone 50	
Vertical Datum: AHD	
AUTHOR: ALLSOPK0	DATE: 18/03/2020
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**Proposed vegetation
Rehabilitation and
infill sites**



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Appendix A: History of the Vasse Diversion Drain



Appendix B: Advice from DWER for Bed and Banks



Appendix C: GHD, 2009, Report for Vasse Diversion Drain Upgrade: Fauna and Flora Study



Appendix D: GHD, 2017a Vasse Diversion Drain Upgrade: Flora and Fauna Study



Appendix E: GHD 2017b Vasse Diversion Drain: Fauna and Vegetation Assessment – Additional Survey Area



Appendix F: GHD 2017c Vasse Diversion Drain: Carburnup King Spider Orchid



Appendix G: Bennett, E, 2019. Distribution of *Conospermum caeruleum* subsp? *Busselton*



Appendix H(a) EcoEdge Consulting, 2019. Reconnaissance and Targeted Flora and Vegetation Surveys along Vasse Diversion Drain



Appendix H(b) EcoEdge Consulting, 2020. Addendum to Detailed Targeted Flora Survey Vasse Diversion Drain Upgrade



Appendix I: GHD, 2019, Busselton Flood Protection Project: Vasse Diversion Drain Upgrade Mussel Survey



Appendix J: Kirkby, 2019. Inspection of possible Black Cockatoo (*Calyptorhynchus spp*) Breeding Hollows at Vasse Diversion Drain, Busselton



Appendix K: Bamford Consulting, 2019. Assessment of the Western Ringtail Possum along the Vasse Main Drain, Busselton



**Appendix L: Murdoch University, Harry Butler Institute, 2019,
Vasse Diversion Drain Mussel Survey (Memorandum).
Unpublished**



Appendix M: Site Inspection for potential *Caladenia procera* locations (Water Corporation 2019)



Appendix N: Department of Biodiversity Conservation and Attractions, 2019. Research Report: genetic assessment of the Busselton populations of *Conospermum caeruleum*.