



**Water Corporation**  
Busselton Flood Protection Project  
Vasse Diversion Drain Upgrade  
Mussel Survey

February 2019

# Table of contents

1.	Introduction.....	1
1.1	Background.....	1
1.2	Scope of works.....	1
1.3	Carter’s Freshwater Mussel.....	1
1.4	Scope and limitations.....	2
2.	Methods.....	2
2.1	Survey location.....	2
2.2	Sampling.....	2
2.3	Sampling limitations.....	3
2.4	Data analysis.....	3
3.	Results.....	4
3.1	Mussel occurrence and density.....	4
3.2	Mussel length.....	6
4.	Discussion.....	7
5.	Recommendations.....	8
6.	References.....	8

# Table index

Table 1	Sampling locations.....	3
Table 2	Mussel Occurrence and Density.....	6

# Figure index

Figure 1	Live Mussels within the Vasse Diversion Drain.....	5
Figure 2	Dead mussels within Vasse Diversion Drain.....	5
Figure 3	Length frequency histogram of mussels within the Vasse Diversion Drain.....	7

# Appendices

Appendix A – Site locality and mussel search locations

Appendix B – Mussel search results

# 1. Introduction

## 1.1 Background

The Vasse Diversion Drain (VDD), is located within the City of Busselton, and extends approximately 6.3 km from an outfall at Geographe Bay in the north to Busselton Golf Course in the south. The VDD diverts flow from the catchments of the Vasse River and the upper Sabina River through the town of Busselton to Geographe Bay. The VDD alignment is illustrated in Appendix A.

The Water Corporation is planning to upgrade the VDD, so it passes the 1% AEP (Annual Exceedance Probability) flood event with freeboard and to reduce the societal risk associated with failure of the VDD to within the ALARP (as low as reasonably practicable) zone of the ANCOLD (Australian National Committee on Large Dams) Society Risk Guidelines.

GHD Pty Ltd (GHD) was commissioned by the Water Corporation to undertake a survey of Carter's Freshwater Mussel (*Westralunio carteri*) within the Vasse Diversion Drain from the downstream end near (Ch 1000) upstream to the Vasse River Diversion Dam (VRDD) (Ch 6020) then further upstream in the adjoining 0.5 km section of the Vasse River immediately upstream of the VRDD (the study area).

Carter's Freshwater Mussel is listed as Vulnerable under the Biodiversity Conservation Act 2016 (BC Act), and Vulnerable under the Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act). Due to the conservation status of this species, and the potential for impact caused by the drain upgrade works, there will be a requirement to relocate mussels prior to works commencing, as was recommended by Beatty et.al (2017) for a proposed bridge construction works on the Lower Vasse River. Appendix A shows the location and extent of the study area where the proposed upgrade works will take place.

A previous study by Slack-Smith (2006) recorded the occurrence of the Carter's Freshwater Mussel within the upper portion of the VDD including within the study area, and adjacent Vasse River. A subsequent study by (Lymbery et.al 2008) confirmed the continued presence of the mussel within the drain and other regional waterways and provided estimates of population densities.

## 1.2 Scope of works

The scope of works for this survey are:

- Determine the current occurrence and extent of Carter's Freshwater Mussel for the purpose of Mussel relocation prior to construction of the drain upgrade; and
- Obtain an estimate of current Mussel population density and locations along the VDD for the purpose of potential future monitoring following construction works.

## 1.3 Carter's Freshwater Mussel

Carter's Freshwater Mussel is an elongate-shelled bivalve mollusc that can grow to 100 mm long, but rarely exceeds 90 mm. Larvae are less than 0.5 mm in length and have larval "teeth" used for attaching to host fish, and that aid in upstream dispersion of the juvenile mussels.

This species is endemic to south-western Australia where its current distribution is patchy and extends from around Gingin south to Waychinicup. Formerly its distribution extended into the interior of the south-west, but now it rarely occurs more than 50 km inland. It inhabits



freshwater lakes, river systems, and other waterways having favourable sandy or muddy sediments and often associated with woody debris (Klunzinger et.al 2012).

Following spawning in winter the juvenile mussels attach to the gills of host fish species. This is thought to be an important mechanism for dispersal upstream. After several weeks the juveniles detach from the host fish and move into creek bed sediment or other suitable river bed substrate. The lifespan is potentially 50 years or longer.

A key threatening process for Carter's Freshwater Mussel is the widespread increase in river salinity in the southwest throughout much of their former range which has resulted in a 50 percent reduction in its range (Klunzinger et.al 2015).

## **1.4 Scope and limitations**

This Vasse Diversion Mussel Survey Report has been prepared by GHD for Water Corporation and may only be used and relied on by Water Corporation for the purpose agreed between GHD and Water Corporation, as set out in Section 1 of this Report.

GHD otherwise disclaims responsibility to any person other than Water Corporation arising in connection with this Report. The services undertaken by GHD in connection with preparing this Report were limited to those specifically detailed in the Contract and are subject to the scope limitations set out in the Contract.

The opinions, conclusions and any recommendations in this Report are based on conditions encountered and information reviewed at the date of preparation of the Report. GHD has no responsibility or obligation to update this Report to account for events or changes occurring subsequent to the date that the Report was prepared.

# **2. Methods**

## **2.1 Survey location**

On 24 and 25 January 2019, GHD ecologist Robert Browne-Cooper undertook a field survey of Carter's Freshwater Mussel throughout the study area within the VDD, from the existing Vasse River entry into the VDD towards the coast. The survey extent was approximately 5.3 km from Ch 1000 extending upstream to Ch 6300 and included the entry point of the Vasse River at approximately Ch 6020 (see Appendix A).

## **2.2 Sampling**

Along the length of the study area 10 sites were selected based on water presence and drain access. At each site a 50 m survey transect was established within the river or drain bed catchment. Along each transect, 10 sample quadrats, each measuring 1 m<sup>2</sup> were established. The survey quadrats were set at pre-determined 5 m intervals along each 50 m transect to ensure random placement of search quadrats. In total 100 quadrats were searched within the study area.

Each of the 1 m<sup>2</sup> quadrat was thoroughly searched for Carter's Freshwater Mussel. Where water turbidity was too high for visual detection of mussels, hand searching of the drain and river bed was done to find mussels. The following data were recorded within each quadrat:

- Number of live and dead mussels (mussel shells)
- Length, width, and thickness of each live mussel measured using Vernier callipers to nearest mm;
- Substrate description (sand, gravel, rock etc)

- Approximate water depth range and indication of water quality based on amount of aquatic algae present and water turbidity;
- GPS location at start and end point of each transect

In addition to the required survey transects, further searches were carried out opportunistically along the length of the study area to provide additional data on distribution of live and dead mussels. Transect locations are presented in Table 1 and shown in Appendix A. A summary table of data recorded is presented as Table 2.

### 2.3 Sampling limitations

Many areas along the Vasse Diversion Drain, particularly areas upstream of Chapman Hill Road had limited access for sampling due to prohibitively steep banks and lack of visibly shallow water close to the banks. Sampling was not carried out in these areas due to safety considerations.

Visibility into the water of the Vasse Diversion Drain was generally poor due to high turbidity caused by algal bloom and filamentous algae. This meant that searching for mussels could not be done by visually detection. Mussels were detected by hand searching the drain bed at these locations.

### 2.4 Data analysis

Data recorded were used to determine the distribution, approximate population age structure and approximate density of mussels within the study area. These data will be used to inform on mussel translocation prior to drain upgrade construction, and possible future monitoring of the mussel population distribution within the study area. The results of sampling and data analysis are presented in Section 3.

**Table 1 Sampling locations**

Sample method	Approximate Chainage (m)	Description	Start point	End point
Transect 1	Ch 1250	10 sample quadrats	50 H 344608 6273976	50 H 344594 6274022
Transect 2	Ch 1900	10 sample quadrats	50 H 345265 6273777	50 H 345216 6273785
Transect 3	Ch 2350	10 sample quadrats	50 H 345573 6273734	50 H 345524 6273740
Transect 4	Ch 2800	10 sample quadrats	50 H 346015 6273440	50 H 345976 6273469
Transect 5	Ch 3250	10 sample quadrats	50 H 346360 6273163	50 H 346321 6273195
Transect 6	Ch 4100	10 sample quadrats	50 H 347021 6272697	50 H 346983 6272728
Transect 7	Ch 4250	10 sample quadrats	50 H 347124 6272565	50 H 347158 6272528
Transect 8	Ch 4750	10 sample quadrats	50 H 347465 6272156	50 H 347433 6272188
Transect 9	Ch 5700	10 sample quadrats	50 H 348075 6271516	50 H 348075 6271516
Transect 10	Ch 5900	10 sample quadrats	50 H 348318 6271427	50 H 348280 6271452
Opportunistic 1	Ch 1230	Point sample	50 H 344607 6273977	
Opportunistic 2	Ch 1235	Point sample	50 H 344602 6273993	

Sample method	Approximate Chainage (m)	Description	Start point	End point
Opportunistic 3	Ch 1240	Point sample	50 H 344605	6273996
Opportunistic 4	Ch 1245	Point sample	50 H 344594	6274048
Opportunistic 5	Ch 1250	Point sample	50 H 344595	6274060
Opportunistic 6	Ch 1300	Point sample	50 H 344596	6274017
Opportunistic 7	Ch 2150	Point sample	50 H 345417	6273749
Opportunistic 8	Ch 4050	Point sample	50 H 346978	6272723
Opportunistic 9	Ch 5150	Point sample	50 H 347681	6271890
Opportunistic 10	Ch 5300	Point sample	50 H 347808	6271718
Opportunistic 11	Ch 6250	Point sample	50 H 348436	6271214

## 3. Results

### 3.1 Mussel occurrence and density

Carter's Freshwater Mussel was recorded alive at two locations within the VDD between Chapman Hill Road bridge (Ch 5610) and the Vasse River in the vicinity of the Vasse River Diversion Dam (Appendix B). Live mussels were also recorded at a further location immediately upstream of the VDD within the Vasse River (Ch 6250). Mussels were recorded within sandy shallow substrates at the edge of the drain and river beds, and also in deeper areas with substrate composed of both rocks and sand (Figure 1). Very few dead mussels were recorded upstream of the Chapman Hill Road bridge.

No live mussels were recorded downstream of the Chapman Hill Road bridge (downstream of Ch 5650). Dead mussels (shell remains) were recorded at several locations in this lower section of the study area. These shell remains were recorded in shallow residual pools and scattered on dry areas of drain bed (Figure 2). Some dead mussels were noted to be partially imbedded within substrate. Shell remains were noted to be generally intact and appeared to have died in-situ rather than predated by other animals.

Where live mussels were recorded, mussel density varied between transects from 0.4 to 15.1 mussels per m<sup>2</sup> along Transect 10. The highest density observed was 40 mussels per m<sup>2</sup>. This was recorded at an opportunistic search point near Transect 10.



**Figure 1 Live Mussels within the Vasse Diversion Drain**



**Figure 2 Dead mussels within Vasse Diversion Drain**



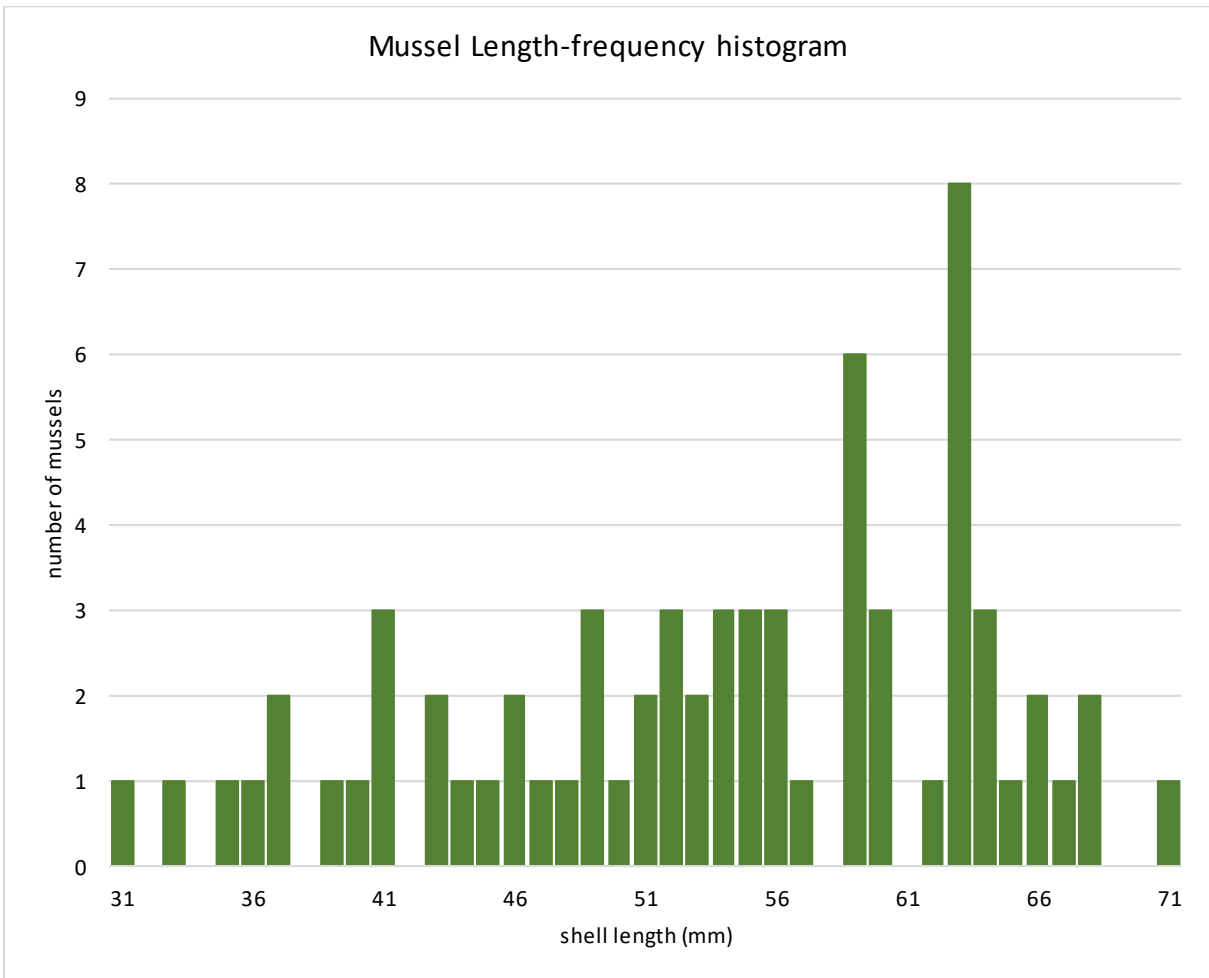
**Table 2 Mussel Occurrence and Density**

Sample method	Approximate Chainage (m)	Mussels recorded (absent / live / dead)	Mean density (live mussels / m <sup>2</sup> ) ± standard error	Mean density (live mussels / m <sup>2</sup> ) ± standard error (Lydney et.al 2008)
Transect 1	Ch 1250	dead	0	-
Transect 2	Ch 1900	absent	0	-
Transect 3	Ch 2350	absent	0	-
Transect 4	Ch 2800	absent	0	-
Transect 5	Ch 3250	absent	0	-
Transect 6	Ch 4100	absent	0	-
Transect 7	Ch 4250	dead	0	-
Transect 8	Ch 4750	dead	0	-
Transect 9	Ch 5700	live and dead	0.4±0.2	0.1 ±0.1 (DD02)
Transect 10	Ch 5900	live	15.1±3.5	1.6 ±0.6 (DD01)
Opportunistic 1	Ch 1230	dead	0	
Opportunistic 2	Ch 1235	dead	0	
Opportunistic 3	Ch 1240	dead	0	
Opportunistic 4	Ch 1245	dead	0	
Opportunistic 5	Ch 1250	dead	0	
Opportunistic 6	Ch 1300	dead	0	
Opportunistic 7	Ch 2150	dead	0	
Opportunistic 8	Ch 4050	dead	0	
Opportunistic 9	Ch 5150	dead	0	
Opportunistic 10	Ch 5300	dead	0	
Opportunistic 11	Ch 6250	live	14 (approx.)	1.4 ±0.6 (VR6)

### 3.2 Mussel length

Based on a sample of 68 mussels recorded at Transect 10 within the upstream portion of the VDD, mussel length was found to vary widely from juvenile to adult size, ranging from 31 mm to 71 mm respectively. Within the Vasse Diversion Drain there was broad and moderately even distribution of mussel length or age class, and with a slight dominance of mussels ranging from 53 mm to 63 mm. Figure 3 shows the length frequency of mussels recorded at Transect 10.





**Figure 3 Length frequency histogram of mussels within the Vasse Diversion Drain**

## 4. Discussion

The absence of live mussels and presence of numerous dead mussels found extensively in the VDD between the Chapman Hill Road bridge and the coast may be an indication of seasonal mortality. High mussel mortality in the VDD was also observed by Slack-Smith (2006), and by Lumbery et.al (2008) who explain the high mortality being a result of season downstream dispersal during periods of high water flow and water quality, followed by mortality over summer during periods of reduced water flow and deteriorating water quality. Algal bloom indicated by highly turbid green water was noted downstream of the Chapman Hill Road bridge during the January 2019 survey. There is likely to be a range of inter-related factors linked to downstream mortality observed such as water volume, water temperature, dissolved oxygen, salinity, nutrient concentration, lack of water flow, and substrate suitability.

Live mussels were recorded from Chapman Hill Road bridge to Vasse River. The broad range of mussel length (age) including relatively small sized individuals i.e. immature mussels observed (Figure 3) indicates a degree of recruitment occurring within the upstream section of the Vasse Diversion Drain. This size range observed within the study area was wider and included more immature mussels than the size range observed by Lumbery et.al (2008) within the same area.

Mussel sampling was not carried out in the Lower Vasse River immediately downstream of the Vasse River Diversion Dam during the current (2019) survey, however it is likely that Carter's

Freshwater Mussel also occurs in this area given the previously recorded occurrence of the mussel in the Lower Vasse River by Lumbrey et.al (2008).

Mussel density within the upper reaches of the Vasse Diversion Drain appears to be higher in the current survey of January 2019 compared to density found during the 2008 survey. For example, Lumbrey (2008) recorded a mean density of 1.6 mussels per m<sup>2</sup> at site DD1, compared to 15.1 mussels per m<sup>2</sup> recorded at Transect 10 during the current survey, noting that these two sites are in close proximity. Temporal changes observed in mussel density could be caused by a variety of factors such as difference in sampling season, water quality, water level (habitat availability) or mussel detectability.

The decline of Carter's Freshwater Mussel in the southwest region has been likely due to increased salinity within the river systems (Klunzinger et.al (2015). In 2014, this species was listed as Vulnerable under the WA former Wildlife Conservation Act 1950, and listed in 2018 as Vulnerable under the Commonwealth EPBC Act 1999. The present occurrence and apparent recruitment of Carter's Freshwater Mussel within the upper reaches of the Vasse Diversion Drain is an indication of a moderately high level of aquatic ecosystem function and general health of this waterway. The continued occurrence of the mussel is important because of the likely bio-filtration benefit to the water quality, and the important role this species has as a food source within the freshwater ecosystem.

## 5. Recommendations

The following recommendations are provided for consideration:

- To avoid mortality of mussels during the VDD upgrade works, consideration should be given to translocation of mussels from the section of the VDD located upstream of the Chapman Hill Road bridge and from the lower Vasse River in the vicinity of the Vasse River Diversion Dam just prior to the Drain upgrade works. A potential translocation site for consideration is the adjacent upper Vasse River.
- Monitoring of mussels within the upper reaches of the Vasse Diversion Drain following the Drain upgrade works.

## 6. References

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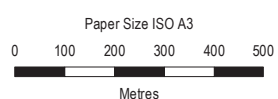
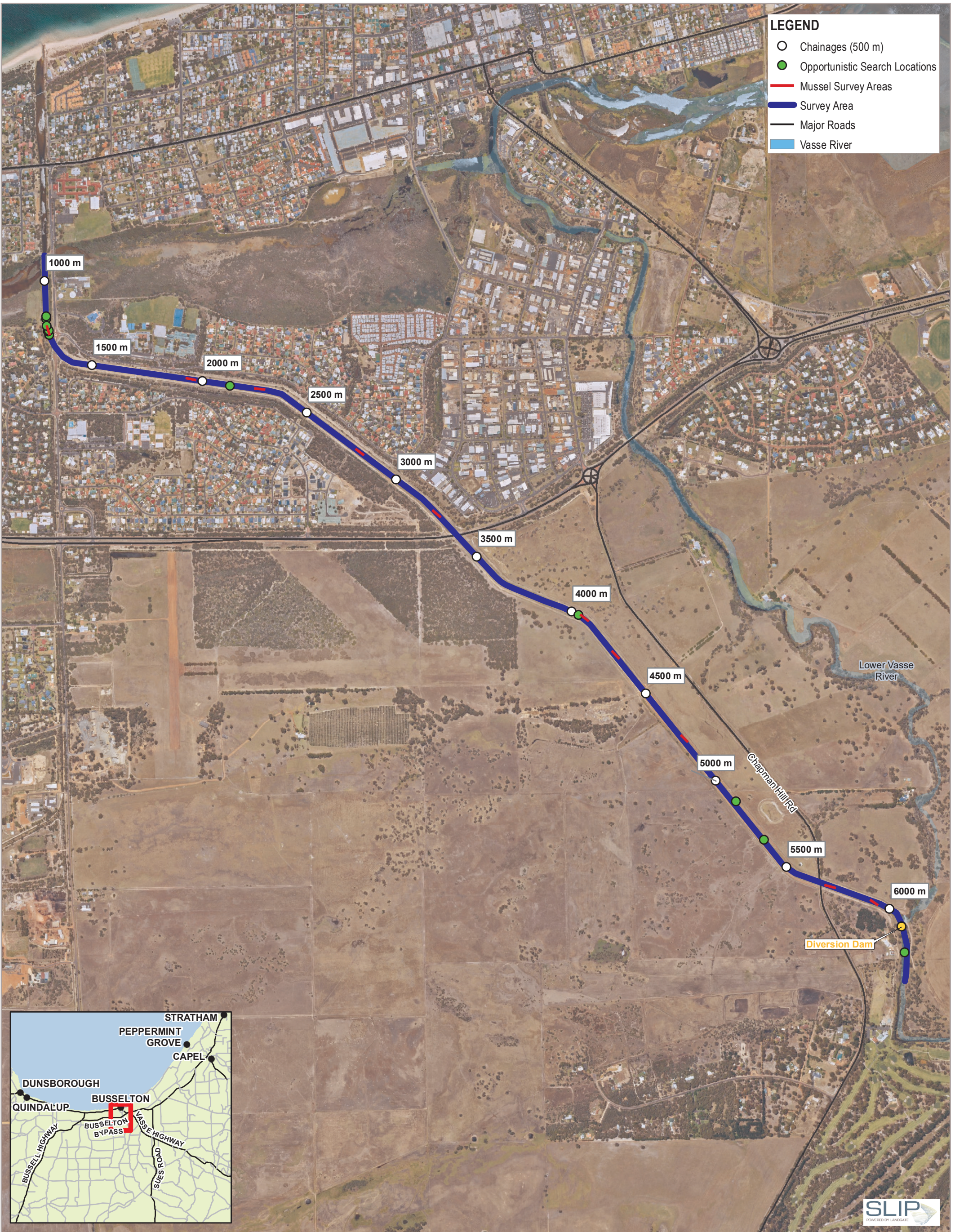
Slack-Smith, S.M. (2006) *Report on a survey of the non-marine molluscan fauna of the Vasse Diversion Drain, Busselton, Western Australia*. Western Australian Museum, Perth.

# Appendices



# **Appendix A** – Site locality and mussel search locations





Water Corporation  
Vasse Diversion Drain

Project No. 61-3687233  
Revision No. A  
Date 14/02/2019

Map Projection: Transverse Mercator  
Horizontal Datum: GDA 1994  
Grid: GDA 1994 MGA Zone 50

Mussel search locations

FIGURE 1

Data source: GHD: Survey Area, Chainages - 20190204, Mussel Survey Areas, Opportunistic Search Locations - 20190206; Landgate: Imagery - January 2018, Roads - 20190114; NatMap Geodata Topo 250K Series 3 GA. Created by: kaadams



# **Appendix B** – Mussel search results



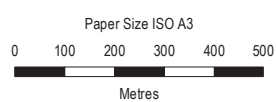


**LEGEND**

- Chainages (500 m)
- Survey Area
- Vasse River
- Major Roads

**Mussels**

- Absent
- Dead
- Live



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA 1994  
 Grid: GDA 1994 MGA Zone 50



Water Corporation  
 Vasse Diversion Drain

Project No. 61-3687233  
 Revision No. A  
 Date 14/02/2019

Mussel search results

FIGURE 2

Data source: GHD: Survey Area, Chainages - 20190204, Mussel Types - 20190206; Landgate: Imagery - January 2018, Roads - 20190114; NatMap Geodata Topo 250K Series3 GA. Created by: kaadams



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Document Status

Revision	Author	Reviewer		Approved for Issue		
		Name	Signature	Name	Signature	Date
Rev 0	R Browne-Cooper	G Gaikhorst		G Mann		

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