pitt&sherry

# Duplication of Midway Point Causeway and Sorell Causeway

## EPBCA Referral Information

Attachment A – Project Description and Significant Impact Assessment

Prepared for

**Department of State Growth**

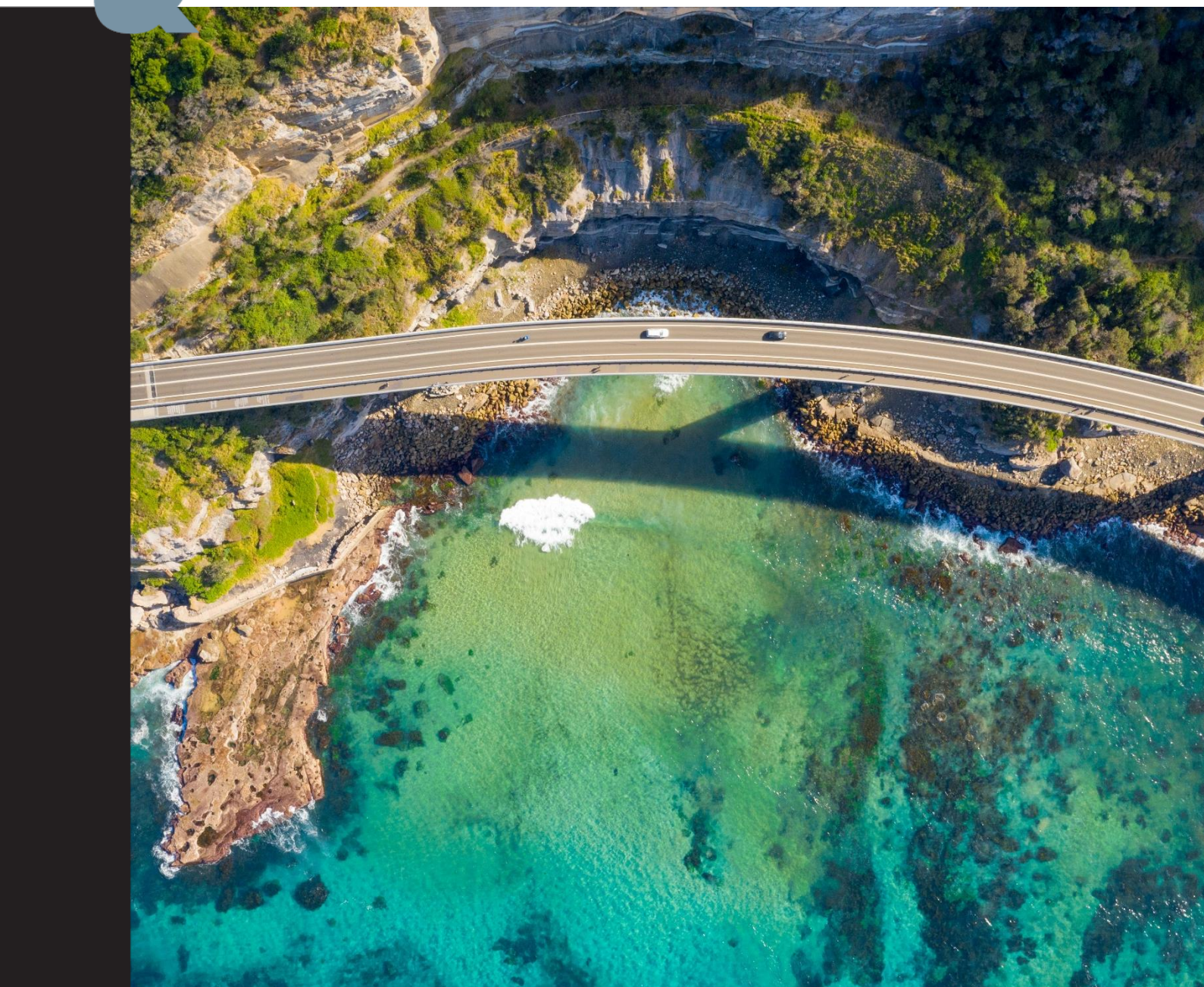
Client representative

**Simon Brown**

Date

**20 November 2024**

Rev02



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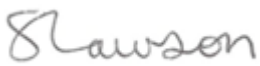
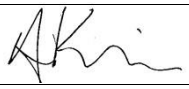
| **Prepared by —** Stephanie Lawson |  | **Date —**20 November 2024 |
| **Reviewed by —** Andrew Knight |  | **Date —**20 November 2024 |
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**Revision History**

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# 1. Introduction

This document provides additional information to support the EPBCA referral of the Duplication of Midway Point and Sorell Causeways project proposed by the Tasmanian Department of State Growth (State Growth).

The project is a key part of the Australian and Tasmanian Government's South East Traffic Solution (SETS) and as result there has been an extensive number of studies undertaken over the past five years to identify the most appropriate option to deliver improved public infrastructure with minimal environmental impact.

This section provides:

- Project location, Figure 1, Figure 3 and Figure 4
- Route option analysis summary; and
- Construction design.

The Tasmanian State Government is keen to see progress on this project and has requested that the project be ready to commence construction in 2025. The timeframes for the proposed action to meet this schedule are outlined below:

- Design of the Midway Point Causeway - July 2024 to May 2025
- Temporary relocation of Tasmanian live-bearing seastars from the Midway Point Causeway to nearby field receiver sites* – February 2025**
- Tendering period for the Midway Point Causeway construction* - May to August 2025
- Construction of the Midway Point Causeway* - October 2025 to August 2027
- Return Tasmanian live-bearing seastars to the upgraded Midway Point Causeway* - February to April 2028
- Design of the Sorell Causeway – July 2025 to May 2026
- Tendering period for the Sorell Causeway construction* – February to April 2027
- Temporary relocation of Tasmanian live-bearing seastars from the Sorell Causeway to nearby field receiver sites* – February to April 2027
- Construction of the Sorell Causeway* - May 2027 to November 2028; and
- Return Tasmanian live-bearing seastars to the upgraded Sorell Causeway* - February to April 2029.

* subject to Australian Government EPBCA approval.

** Access to live-bearing seastars is only possible during the lowest of low tides and in stable weather, which typically occurs in February each year

## 1.1 Proposed Action details - Section 1.2 of referral

### 1.1.1 Project location

Refer to Figure 1 for the general site location. Figure 3 and Figure 4 presents the location of the Midway Point and Sorell Causeways.

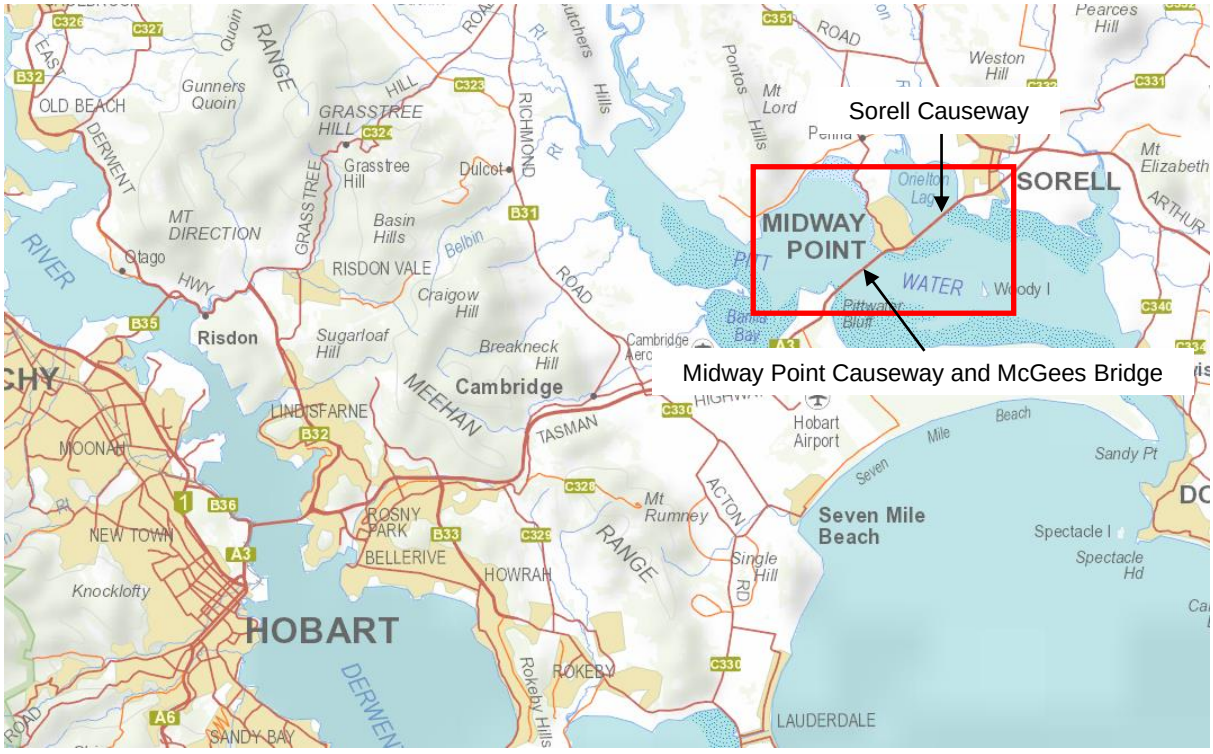


*Figure 1 – General site location – the red box indicates the location of the Midway Point and Sorell Causeways (theLISTmap)*

## 1.2 Options Analysis Summary (EPBCA referral Section 1.2.1)

The Options Analysis Report (pitt&sherry, 2020) describes the route options analysis undertaken for the this project. The five route options identified, as shown in Figure 2, were:

- Option 1 – Maintain existing causeways
- Option 2 – Richmond Road and Brinktop Road
- Option 3 – Shark Point Road route
- Option 4 – Duplication of the causeways; and
- Option 5 – Seven Mile Peninsula and bridge.

A pairwise assessment and multicriteria analysis was used to interrogate the five options according to:

- Road functionality
- Environmental constraints; and
- Socio-economic constraints.

The pairwise assessment and multi criteria analysis identified Option 4 as the preferred route.

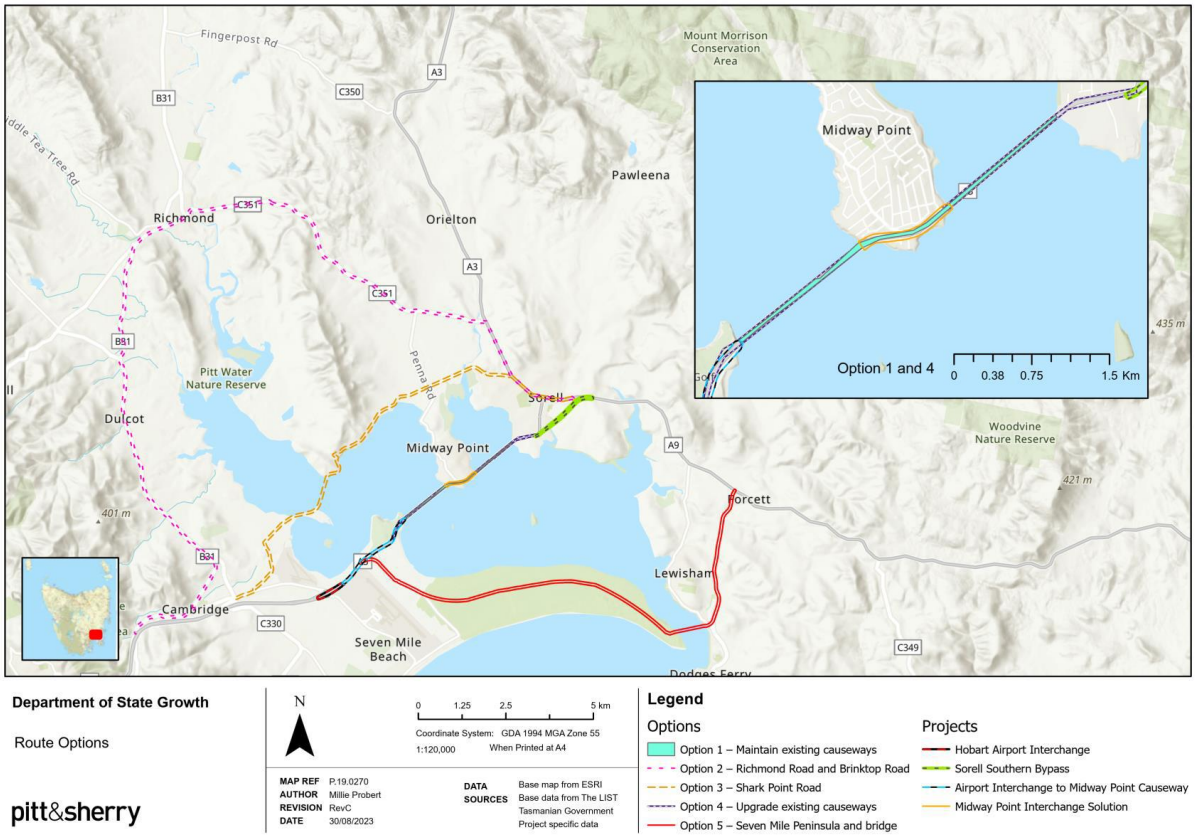


*Figure 2 – Route options analysis*

### 1.2.1 Sorell Causeway

Important and complex environmental values are present on both sides of the Sorell Causeway, including:

- A significant population of threatened Live Bearing Seastar (which inhabit the southern side of the Sorell Causeway. These seastars live in the lower portion of the intertidal zone on the existing armour rock. Modifications to the southern side of the causeway may impact the seastar population
- The northern side of the Sorell causeway is a nature reserve. Any extension of the causeway on its northern side would require the nature reserve boundary to be relocated; and
- The Sorell causeway is surrounded by a Ramsar wetland with seagrass beds. Construction to the south may impact the seagrass beds.

Given complex environment constraints, the pairwise assessment and multicriteria analysis identified a further six sub-options for the Sorell Causeway portion of Option 4 for consideration:

- Option 4A – Widening on both sides of the existing causeway to address the inadequate seawalls
- Option 4B – New causeway to the north of existing causeway
- Option 4C – Bridge for complete causeway length to south of existing causeway
- Option 4D – Bridge for complete causeway length on alignment which does not require nature reserve revocation
- Option 4E – New causeway south of existing causeway, with culverts at similar location, with existing causeway retained to erode naturally; and
- Option 4F - New causeway with culverts similar to existing locations, on alignment which does not require nature reserve revocation, with existing causeway removed.

A pairwise assessment and multicriteria analysis was used to interrogate the six design options according to:

- Cost
- Project delivery duration
- Complexity of environmental assessments; and
- Environmental impacts.

Socio-economic factors were considered to be similar across Options 4A – 4F and therefore not considered a constraint. The pairwise assessment and multi criteria analysis identified that Option 4B is the preferred route and sub-option as it:

- Requires environmental impact assessments of similar complexity to most of the other alternatives
- Has the least environmental impacts
- Can be constructed within the available budget; and
- Has one of the shortest delivery durations.

It is recognised that the environmental approvals required for Option 4B will be complex and lengthy. However, they are less or of similar complexity compared to the other Option 4 sub-options.
It is recommended that:

- Option 4 be adopted as the preferred route for the provision of a dual carriageway road between Cambridge and the Sorell/ Southern Beaches area; and
- Option 4B be adopted as the preferred solution for the Sorell Causeway section of the project.

### 1.2.2 Midway Point Causeway and McGees Bridge

Alignment options were considered for Midway Point Causeway and McGees Bridge as part of the Feasibility Study and Concept Design Report (pitt&sherry, 2020), the Annexure to the Feasibility Study and Concept Design Report (pitt&sherry, 2023b) and the optimum option further refined through recent design activities. Social, environmental and economic factors were considered including environmental impacts, constructability, cost and project delivery duration.

Due to site and environmental constraints, the proposed alignment weaves from the south of the existing Midway Point Causeway to the north of the existing McGees Bridge for the following reasons:

- The alignment to the south of the existing Midway Point Causeway has been designed to avoid, minimise and mitigate impacts to Tasmanian live-bearing seastars and their habitat along the north of the existing causeway.
- The alignment to the north of McGees Bridge has been designed to:
    - tie in with the recent significant upgrade of, and on the approaches to, the Midway Point intersection at Tasman Highway/Penna Road, which also required highway widening to the north of the previous alignment;
    - Reuse the existing, old original road formation on the western side of Midway Point, previously connecting the old original bridge to Midway Point;
    - Avoid property impacts that would result from an alignment to the south of McGees Bridge, including changes to a service station and shopping centre;
    - Separate the second McGees Bridge further north of the existing McGees Bridge to avoid existing pylons that extend into the estuary floor and debris from the old original bridge.

## 1.3 Construction Design

The proposed construction designs are to raise the Reduced Level (RL) of the Midway Point Causeway crest from 2.5 m to 4.2 m AHD and the Sorell Causeway crest from 2.5 m to 3.6 m AHD. Coastal engineering assessments estimate that these raised RLs should avert any flooding of the causeways over the 100-year design life. The design of the artificial rock revetment will have a slope of 2:1 to combat wave overtopping on the causeways. The revetment armouring will include a 1.2 m layer of 350 - 450 kg size rocks on top of a 0.5 m layer of smaller rock (35 - 50 kg) placed over the embankment core. A marine-grade geotextile would be placed over the embankment core, which would compromise general fill material that is largely impermeable. The final crest level and rock size is subject to a more detailed coastal engineering assessment and the need to deliver Tasmanian live-bearing seastar habitat. The amounts of embankment core and rock revetment required for the the causeways have not yet been determined. However, the construction design for the four-lane road at each causeway is 30.6 m wide, and the rock revetment and footings include an additional combined width of approximately 32.5 m and 25.2 m at Midway Point Causeway and Sorell Causeway, respectively. In total, the updated width of the causeways should extend 63.1 m and 55.8 m at Midway Point Causeway and Sorell Causeway, respectively.

Current revetments on both causeways requires repair or replacement as they are generally too steep, and the sizes of rocks are insufficient to withstand impacts from current weather conditions. The causeways are unsuitable to be retained as a structure that would provide an acceptable future design life (100-years). Only the south-eastern revetment of Midway Point Causeway has been deemed stable and has a suitable rock size to withstand future weather events.

A second bridge is proposed to be installed next to the existing bridge to account for the duplication. The nearby footings of a previous, demolished bridge will remain undisturbed. The new bridge will include 17 piers, with two piles at each pier that are driven 25 – 30 m deep into the seabed.

It is proposed that the second McGees Bridge is constructed with a deck level of 4.25 m AHD on the road centreline at the western end rising to 6.5 m AHD at the eastern end. This matches the new causeway height at the eastern end and the gradient on the existing bridge albeit at a level approximately 1.3 m higher than the existing bridge. A cantilevered shared path is proposed for the northern side of the second bridge. The existing bridge has a deck level of 2.98 m at the western end (pitt&sherry, 2020).

The two bridges are approximately 34m apart, as measured from road centreline to centreline. There is approximately 21.5m clear space from the northern outside edge of the existing McGees Bridge to the southern outside edge of the new bridge.


*Figure 3 – Midway Point Causeway Project area*

*Figure 4 – Sorell Causeway Project area*

## 1.4 Land Tenure

The majority of the proposed action occurs on Crown land. A list of land parcels that the project crosses, and their respective tenure, is provided in Table 1. Refer to Figure 5.

Where needed State Growth will acquire all private and local government land under the *Land Acquisitions Act 1993* prior to commencement of the action. Crown land, not currently set aside for road purposes, will be set aside as road under section 8 of the *Crown Lands Act 1976*. For the Project area on the northern side of Sorell Causeway, which falls within the Tasmanian Pitt Water Nature Reserve, the nature reserve status of the land under the *Nature Conservation Act 2002* will be required to be revoked. The Tasmanian Government can compulsory acquire land for the purposes of road if agreement with the landowner cannot be reached.

*Table 1 – Land parcels and land tenure*

| Certificate of Title | PID | Land tenure |
|---|---|---|
| 137586/1 | 5179476 | Private Freehold |
| 37315/2 | | Local Government Act Reserve |
| 75668/53 | 5901019 | Private Freehold |
| 216559/52 | 5901000 | Private Freehold |
| 75668/51 | 5900999 | Private Freehold |
| 75668/50 | 5900980 | Private Freehold |
| 60751/200 | 1818381 | Public Reserve |
| 16/4458 | | Private Freehold |
| 105075/1 | 5933213 | Local Government |
| 105075/2 | 5933213 | Local Government |
| 105075/3 | 5933213 | Local Government |
| 64982/4 | 5933221 | Private Freehold |
| 187106/1000 | 9066476 | Private Freehold |
| 181092/3 | 9465417 | Private Freehold |

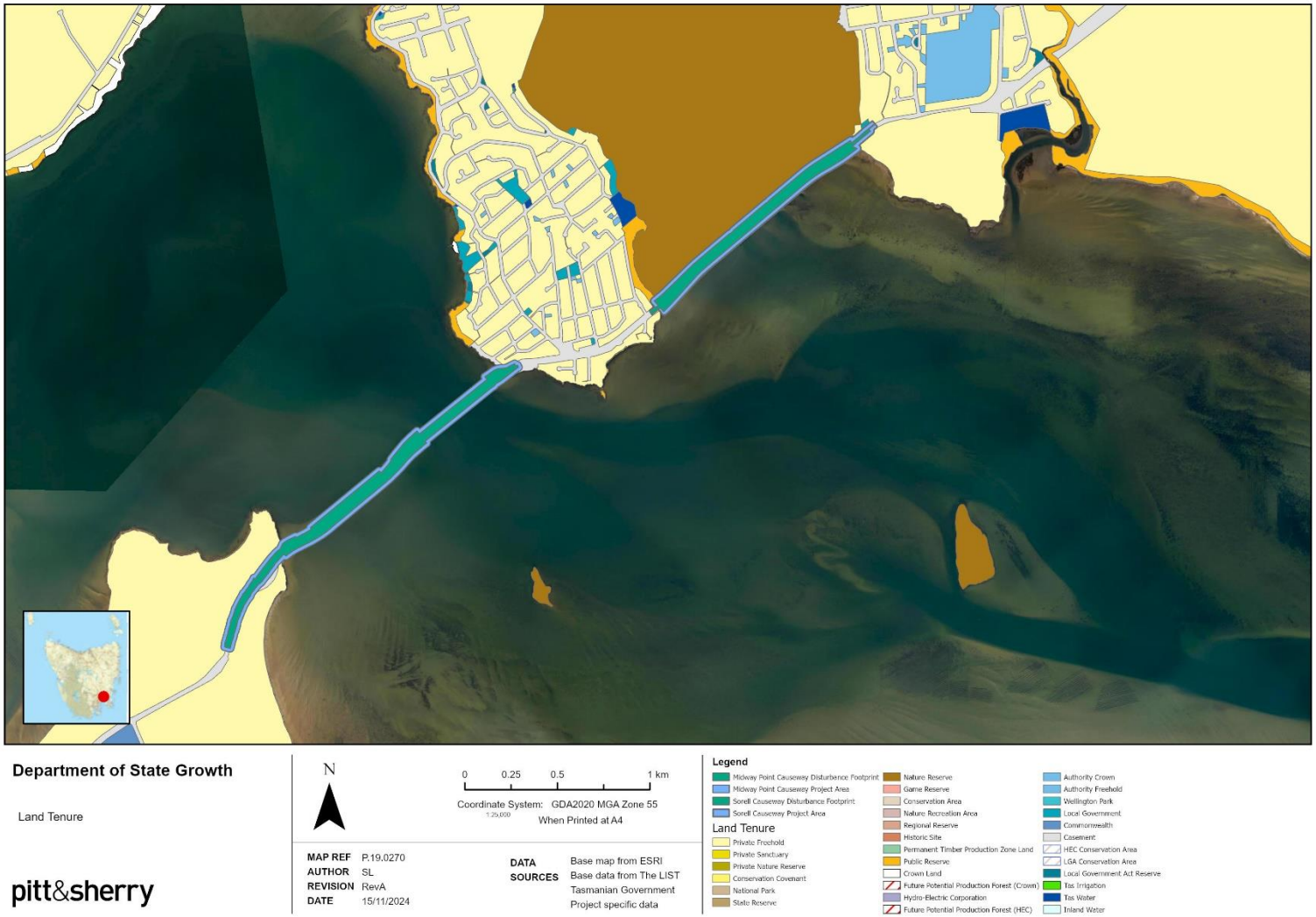


*Figure 5 – Land tenure*

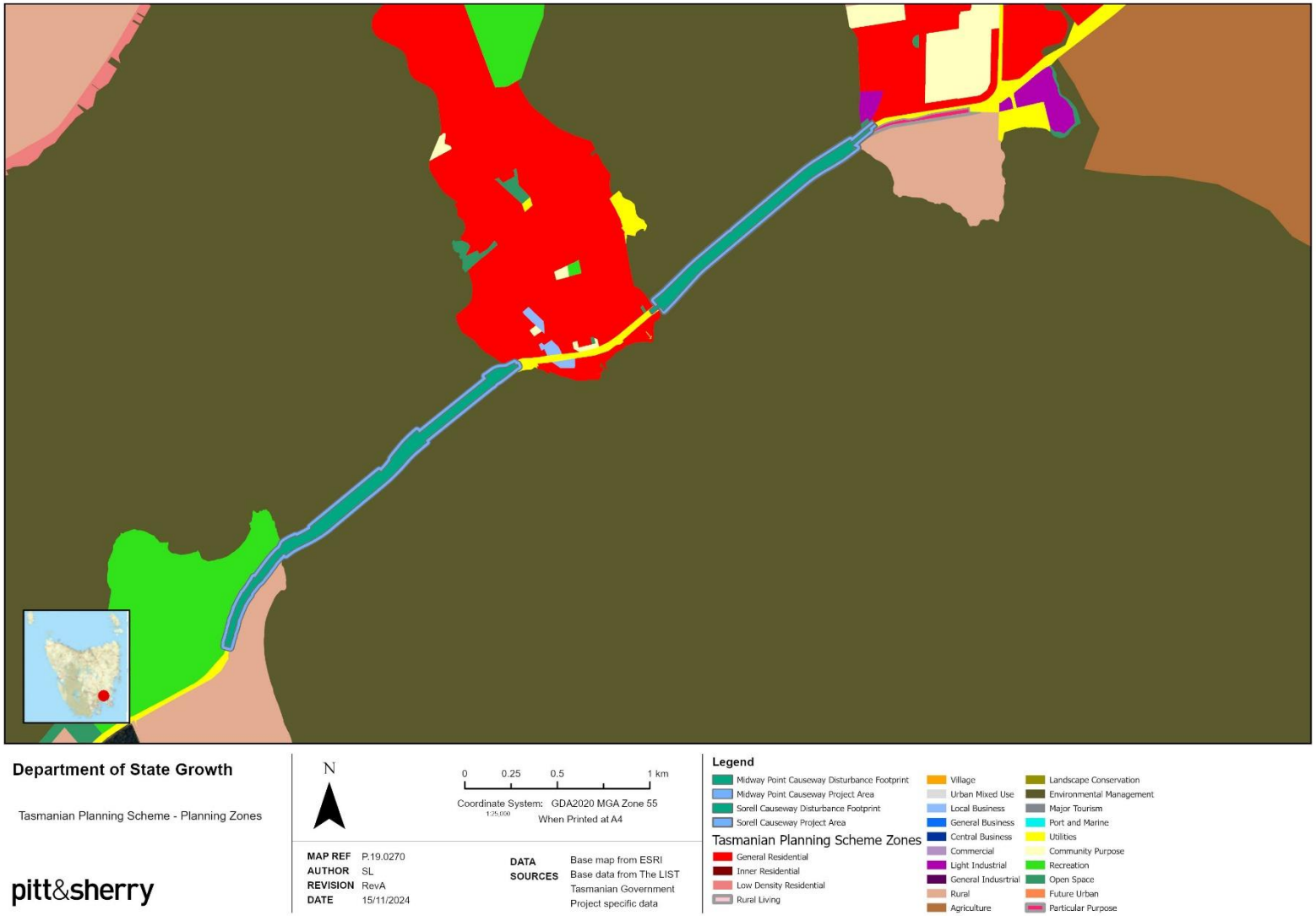


*Figure 6 – Tasmanian Planning Scheme Zoning*

## 1.5 Environmental Assessments

State Growth has commissioned a number of natural values assessments since the project's conception to identify potential impacts that could result from the duplication of the Midway Point and Sorell Causeways. These studies have provided the basis for the concept design, with avoidance of environmental values a key consideration in the development of the duplication options as well as the development of the concept design. The surveys undertaken to date have included the following:

Northbarker Ecosystem Services (NBES), Tasman Highway Duplication of Midway Point and Sorell Causeways, Terrestrial Natural Values Assessment, prepared for Department of State Growth, June 2024

NBES, South East Traffic Solution, Duplication of Sorell and Midway Point Causeways and Sorell Southern Bypass, Matters of National Environmental Significant, Terrestrial Significant Impact Assessment, prepared for Department of State Growth, July 2024

Stantec Australia Pty Ltd (Stantec), Natural Values Assessment for Midway Point Causeway and Sorell Causeway (Option 4B), 4 July 2024

Stantec, Duplication of Midway Point and Sorell Causeways – Option 4B, Matters of National Environmental Significance, Significant Impact Assessment, 29 May 2024

Elgin Associates Pty Ltd (Elgin Associates), South East Traffic Solutions (SETS) Nutrient Sources within the Pitt Water Orielton Lagoon Estuary, Final Report, prepared for pitt&sherry, May 2023

Elgin Associates, South East Traffic Solutions (SETS) Baseline Water Quality Monitoring Program, Final Report, prepared for pitt&sherry, 9 May 2022

Cultural Heritage Management Australia (CHMA), Tasman Highway South East Traffic Solution, Historic Assessment Report, Final Version 1, 29 January 2020

CHMA, Tasman Highway South East Traffic Solution Study, Aboriginal Heritage Assessment Report, Final Version 2, 12 November 2018.

CHMA, Tasman Highway South East Traffic Solution Project, Site AH7904 Sub-surface Test Pitting Program, Final Report, Version 2, 21 February 2024

Ten reports have been undertaken relating to live bearing seastar (*Parvulastra vivipara*):

1. Population Survey and Habitat Mapping Report (Ecomarine, 13th May 2024, V3)
2. Evidence of genetic isolation in populations of Tasmania's threatened sea star, Parvulastra vivipara (UTas, 6th Dec 2021)
3. Nutrient Sources within the Pitt Water Orielton Lagoon Estuary Report (Elgin, 5h May 2023, Final)
4. Habitat Characterisation in Pitt Water and Recommended Impact Avoidance and Mitigation Measures Report (Ecomarine, 13th May 2024, V3)
5. Tidal Data Report, Pitt Water, Hobart (CLS, 28th February 2023, Final)
6. Receiver Sites and Habitat Augmentation Trials in Pitt Water Report (Ecomarine, 13th May 2024, V3)
7. Receiver Sites and Habitat Augmentation Trials Outside Pitt Water Report (Ecomarine, 13th May 2024, V3)
8. Establishing an aquarium "insurance population" for the threatened live-bearing sea star Parvulastra vivipara. Sorell Causeways Duplication Project, South East Traffic Solution (SETS) Aquarium Report (IMAS, July 2023, Final)
9. Live-bearing Seastar Parvulastra vivipara Investigations: Summary Report (Ecomarine, 13th May 2024, V2)
10. Translocation Plan for the Live-bearing Seastar Parvulastra vivipara (Ecomarine, 13th May 2024, V2).

As is the nature with large, complex projects, some information in these reports has been superseded by recent survey. The purpose of this document is to provide a concise summary of up to date information to support the EPBCA referral.

# 2. Existing Environment

## 2.1 Flora and Fauna description (Section 3.2.1 referral document)

### 2.1.1 Terrestrial environment – vegetation communities

Vegetation mapping and the results of field surveys are described in detail in the Terrestrial Natural Values Assessment (NBES, 2024) (Terrestrial NVA). A summary is provided below.

The following native vegetation communities (TASVEG 4) have been recorded within the study area. No EPBCA TECs were recorded within the Project area.

- *Eucalyptus viminalis – E. globulus coastal forest* (DVC)
- *Succulent saline herbland* (ASS)
- *Allocasuarina verticillata forest* (NAV)

DVC corresponds to a listed threatened community under the Tasmanian *Nature Conservation Act 2002* (NCA) and is not listed under the EPBCA. *Eucalyptus viminalis - E. globulus* coastal forest (DVC) occurs towards the western end of the Project area, which is contiguous with larger, higher quality patches located outside of the Project area.

ASS accords to the vulnerable listed threatened ecological community Subtropical and Temperate Saltmarsh under the EPBCA where it meets the condition criteria. Only a small margin of this patch occurs within the Project Area. The total patch size is 0.09ha which is under the 0.1ha patch size threshold for this community. The area is also isolated, being more than 350 m from the nearest patch. It is noted that threatened ecological communities listed as vulnerable are not MNES for the purposes of Part 3 matters under the EPBCA.

NAV is not listed under the NCA or EPBCA. There is a small 0.36 ha patch of this *Allocasuarina verticillata* forest (NAV) on the coastal cliff and cliff top on the western approach to Midway Point Causeway at Pittwater Bluff within the Project area.

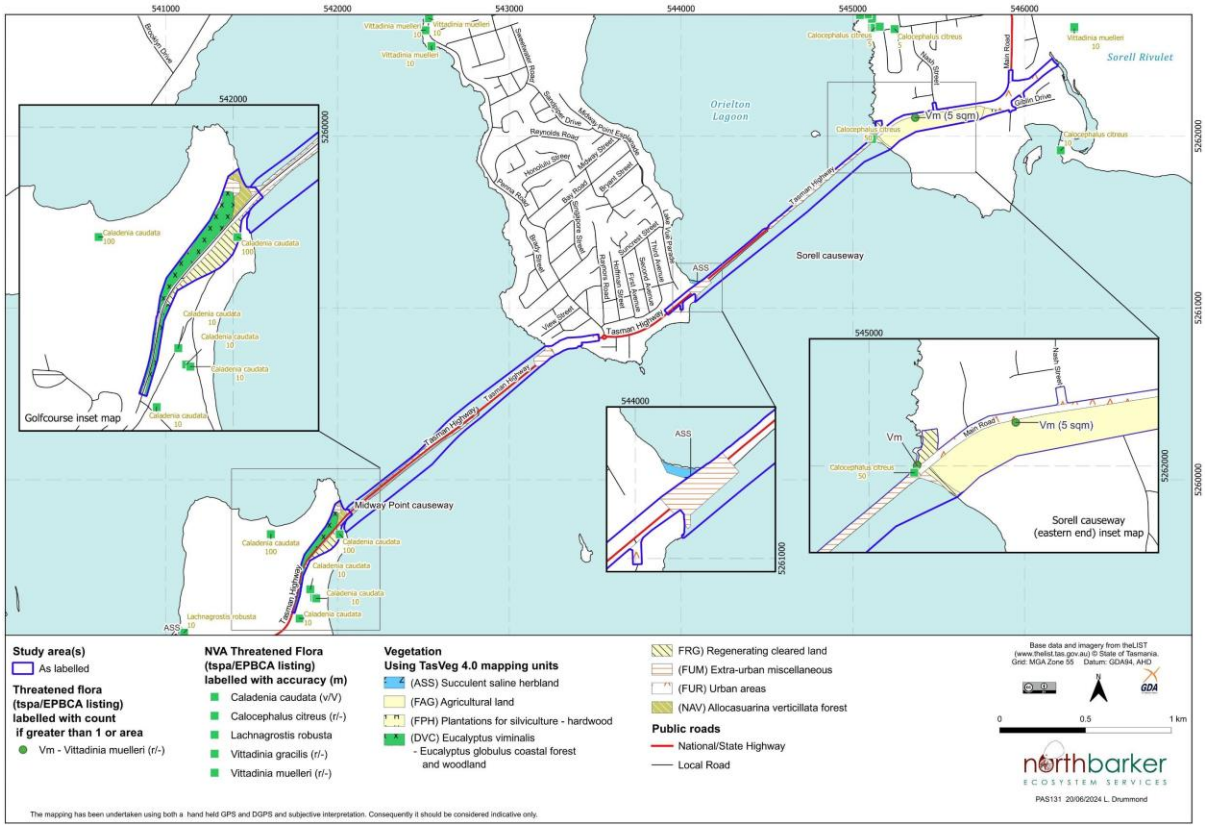


*Figure 7 - Vegetation communities and threatened flora species*

### 2.1.2 Terrestrial environment - flora

A summary from Terrestrial Natural Values Assessment (NBES, 2024) (Terrestrial NVA), is provided below.

Three flora species listed in the EPBCA were identified as potentially occurring within the Project area, with one flora species listed in the Tasmanian *Threatened Species Protection Act 1995* (TSPA) was identified as occurring within the Project area.

- *Caladenia caudata* (tailed spider-orchid), listed as vulnerable under EPBCA and TSPA. This species is present on the neighbouring southern property known as 'Milford'. Potential habitat includes the area of mapped *Allocasuarina verticillata forest* (NAV) at Pitt Water Bluff and the *Eucalyptus viminalis* - E. globulus coastal forest (DVC) on either side of the road west of the Midway Point Causeway. Refer Figure 8.
    - There is a record of *Caladenia caudata* on the Natural Values Atlas from the Pittwater Bluff area from 1984 which is within the Project area. The record is shown as being in the alignment of the old highway but described as being collected from "Pittwater Bluff", with a recorded accuracy considered to be within 100 m of the location (NBES, 2024a). Although the record is within the Project area, the description provided is suggestive of a location on the bluff itself, which is further south. The nearest observations of known populations are located close to the western end of the study area (NBES, 2024a) approximately 350m from the Pittwater Bluff record. The species was not recorded within the study area during targeted surveys undertaken in October 2018, 2019 or 2023.
- *Caladenia saggicola* (sagg spider-orchid), listed as Critically Endangered (EPBCA) and endangered, (TSPA). The current known extent of this species is entirely restricted to the Milford property, 500 m west of the western end of the Project area. The species has not been observed in the Project area despite targeted surveys. Habitat on the roadside towards the western end of the Project area is degraded and unsuitable for this species.

- *Prasophyllum milfordense* (Milford leek-orchid), listed as Critically Endangered (EPBCA) and endangered (TSPA). *Prasophyllum milfordense* is a terrestrial orchid endemic to southern Tasmania. It is only known from the Milford property, with the species occurring within a prescribed area within DVC habitat more than 500 m west of the study area. The likelihood of the species occurring within the Project area is considered remote based on habitat suitability.
- The Project footprint has been revised since the NBES survey (NBES, 2024a) to include a small portion (approximately 600m$^2$) on the north-eastern extent of Milford and shown in red on Figure 8 below. The likelihood of the threatened orchid species occurring within this additional area is considered remote based on habitat suitability.
- *Vittadinia muellerinarrowleaf* (new-holland-daisy), listed as rare (TSPA). This species was recorded in two locations in 2023 within the road reserve. One patch of approximately 5 m$^2$ was found on the southern side of main road, south of Sorell, the other was a single plant found on the northern side of the Sorell Causeway (NBES, 2024a). This species is not listed under the EPBCA.

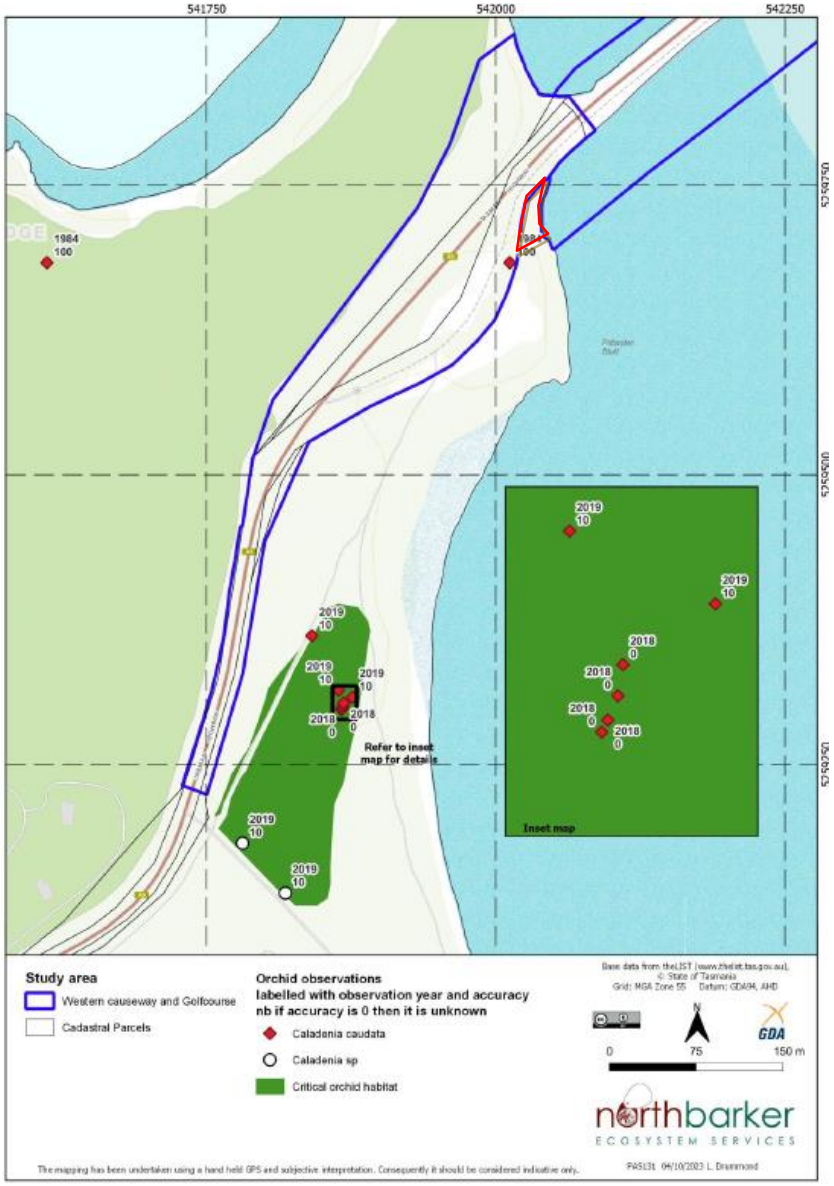


*Figure 8 - Orchid survey results with additional project area shown in red*

### 2.1.3 Terrestrial environment – fauna

According to NBES, 2024 MNES Impact Assessment (NBES, 2024b), 73 listed fauna species have been recorded as occurring or having the potential to occur within 5 km of the proposed development. Of these, 31 fauna species have no likelihood of occurrence, 30 species have the potential to occur but have no likely impacts associated with the proposed action. All species are discussed further in Appendix A of NBES, 2024b. The remaining 12 fauna species potentially impacted by the proposed action are shorebirds associated with PWOL. Refer to avian fauna below for further discussion.

Due to the number of natural values studies undertaken by NBES over the past seven years, and the changes to the proposed Project area over this time, it is noted that the Terrestrial NVA report covers a broader area than the MNES report, as well as including state listed species, hence numbers of species identified do vary between reports. The number of species included in this referral is therefore focused on the MNES report, although some general information on species has also been drawn from the Terrestrial NVA.

Terrestrial fauna that has the potential to occur within or in the vicinity of the Project area includes mammals, shorebirds, including migratory and resident shorebirds as well as woodland birds.

A summary from Terrestrial NVA is provided below with respect to terrestrial mammals.

Four fauna species (mammals) listed in the EPBCA were identified as potentially occurring within the Project area, including:

- *Dasyurus maculatus* (spotted-tail quoll), listed as Vulnerable (EPBCA) and rare (TSPA). Core habitat for this species is in extensive tracts of forest on Milford and Hobart Airport, straddling Pitt Water Road, west of the Project area. No evidence of dens was found in targeted surveys in 2020 on the Milford property and the Tasmanian Golf Club extending from 50 m from the Project area.
- *Dasyurus viverrinus* (eastern quoll), listed as Endangered (EPBCA). A single Natural Values Atlas record from the Milford property was made in 2020. However, as per the spotted-tailed, core habitat is west of the Project area and no evidence of dens was found in targeted surveys.
- *Sarcophilus harrisii* (Tasmanian devil), listed as Endangered (EPBCA and TSPA). Similarly to the quolls, core habitat is west of the Project area. There are two roadkill records from the causeways from 1993 and 2016. Although the species has been known to establish dens close to busy highways, no evidence of dens were found in a targeted survey conducted in 2020 on the Milford property and the Tasmanian Golf Club extending from 50 m from the Project area.
- *Perameles gunnii gunnii* (eastern barred bandicoot), listed as listed as Vulnerable (EPBCA). Potential habitat exists in grassland and woodland at both ends of the project extending well outside the project area and including all of the golf course and woodlands on Milford west of the Midway Point Causeway. East of the Sorell Causeway on the southern side of the road abandoned paddocks also provide habitat. There are numerous reported observation records from Milford and five records of roadkill on the Natural Values Atlas from the adjacent highway and Midway Point Causeway; and
- Given higher quality habitat outside the Project area and in the immediate vicinity, the likelihood of occurrence of threatened carnivorous mammals is considered low (NBES, 2024b - Appendix A).

### 2.1.4 Terrestrial environment –- Avian fauna

Sixty-eight species of woodland birds are known to occur from PWOL (refer NBES 2024b - Appendix C). The only values that woodland birds may rely on within the study area are hollow bearing trees on the Tasmanian Golf Club. Trees with a diameter at breast height of more than 70 cm are likely to contain hollows, and so are considered potential habitat trees for woodland birds including three threatened species:

- *Lathamus discolor* (swift parrot), listed as Critically Endangered (EPBCA) and endangered (TSPA). The nearest known nesting sites for the swift parrot are on the Meehan Range over 8 km away, and the nearest foraging habitat is 6 km away. Breeding habitat for the swift parrot includes mature hollow bearing trees for nesting and forests supporting important foraging trees, notably those supporting *Eucalyptus globulus* or *Eucalyptus ovata.* The Project area is outside any swift parrot important breeding areas (SPIBAs).
- *Neophema chrysostoma* (blue-winged parrot), listed as Vulnerable (EPBCA). The blue-winged parrot breeds in tree hollows, preferably with a vertical opening. DVC bushland across the Tasmania Golf Club property and adjacent Milford property provides potential habitat for the blue-winged parrot, refer Figure 16, NBES, 2024b. During field surveys of the Tasmania Golf Club in September 2023, several parrots (likely musk lorikeets) were observed flying out of a tree hollow of a mature white gum. In total 18 trees with a DBH > 70 cm are located within the study area and are of a sufficient size to contain tree hollows suitable to support blue-winged parrot breeding. However, similarly to swift parrot, suitable, higher quality habitat for the species occurs within the broader area; and
- *Tyto novaehollandiae* (Tasmanian masked owl), listed as Vulnerable (EPBCA) and endangered (TSPA). The survey area is within the core range of the Tasmanian masked owl and contains hollow bearing trees. The Tasmanian masked owl had been previously recorded nesting on the Milford property, although this has been abandoned following tree damage. There are 7 trees within the survey area that may provide potential nesting hollows for Tasmanian masked owls (dbh > 100 cm, Figure 17, NBES 2024b) although no potential hollow bearing trees showed evidence of frequent use by Tasmanian masked owls.

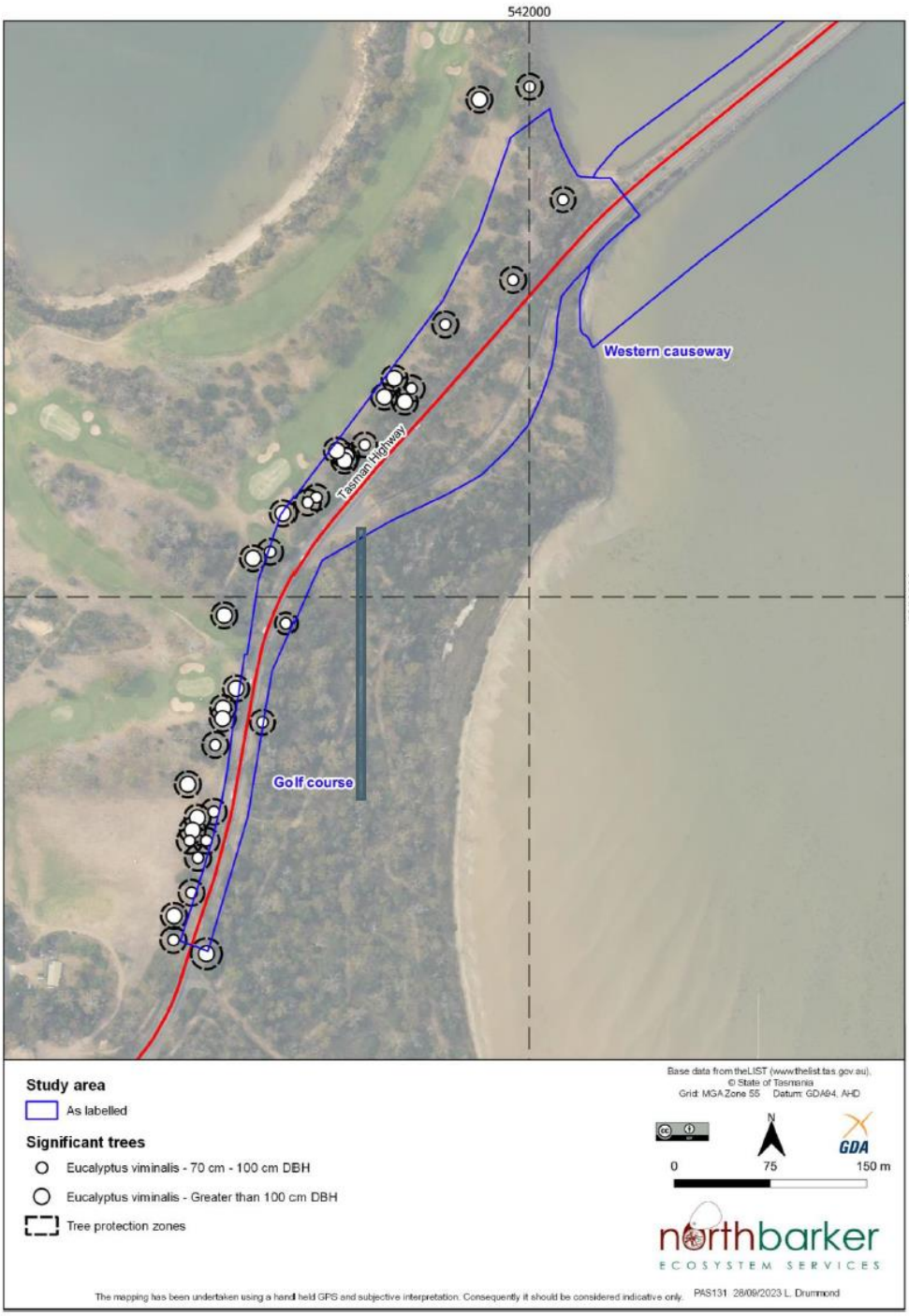


*Figure 9 – Potential hollow bearing trees within and adjacent to the survey area (NBES, 2024a)*

### 2.1.5 Marine environment – Pitt Water Orielton Lagoon Ramsar – Pitt Water Nature Reserve

This project falls within the Pitt Water-Orielton Lagoon (PWOL) Ramsar wetland site (Figure 10).

PWOL was listed under the Ramsar convention largely due to its importance for biological diversity and is listed as Group B – a site of international importance for conserving biological diversity. The site was designated a Ramsar Site in 1982. The PWOL site meets five (5) criteria for listing under the Ramsar convention. Inclusion for each criteria, as described in the Ramsar Sites Information Sheet, is included below:

*Criterion 2: Species and Communities* - PWOL supports nationally and internationally listed threatened species and a threatened ecological communities

*Criterion 3: Species and Communities* – PWOL is important for the conservation of coastal birdlife of the Tasmanian South East Bioregion (IBRA) and Bruny Marine Bioregion (IMCRA). PWOL hosts fringing saltmarshes and is important for maintaining fish and bird biodiversity. Birdlife includes migratory and resident waterbirds. Rocky and sandy shorelines and islands provide roosting and nesting sites. Estuarine waters are a rich food source. The extensive intertidal flats provide feeding areas, and the saltmarshes provide roosting and foraging areas. Estuarine and marine fish species inhabit the site continuously or seasonally. Diverse habitats include sandy shoals and bays, seagrass beds and open water.

*Criterion 4: Species and Communities* - PWOL provides important habitat for non-breeding migratory shorebirds, including 30 species listed under international migratory bird agreements. Orielton Lagoon is one of only two sites in Tasmania included in the East Asian-Australasian Flyway Network. PWOL is the southern-most area in Australia where relatively high numbers of migratory shorebirds occur. Pitt Water has a diversity of estuarine and marine fish species.

*Criterion 8: Fish* - Within the bioregion, PWOL is the most important breeding ground for several species of commercially harvested sharks, with the most significant numbers of juvenile school sharks found in Pitt Water. It is a declared Shark Refuge Area under the Tasmanian *Living Marine Resources Management Act 1995.*

*Criterion 9: Specific criteria based on other taxa* - PWOL is the stronghold for the endemic Live-bearing sea star *Parvulastra vivipara*, hosting the greatest numbers from across 13 sites. It is estimated that 92% of the population occurs in the Pitt Water area, of which around half (45%) are within the PWOL boundary.

Sections of the Ramsar site are also classified as a Nature Reserve (Pitt Water Nature Reserve) proclaimed under the Tasmanian *Nature Conservation Act 2002* and managed under the *National Parks and Reserves Management Act* 2002. The reserve has been assigned to the IUCN Category IV and managed under the Pitt Water Management Plan 2013. The Pitt Water Nature Reserve comprises five separate sections and covers approximately 826.3 ha in total. The reserve is managed by the Tasmanian Parks and Wildlife Service as an important estuarine ecosystem, providing for migratory and resident birds, marine life, and vegetation communities.

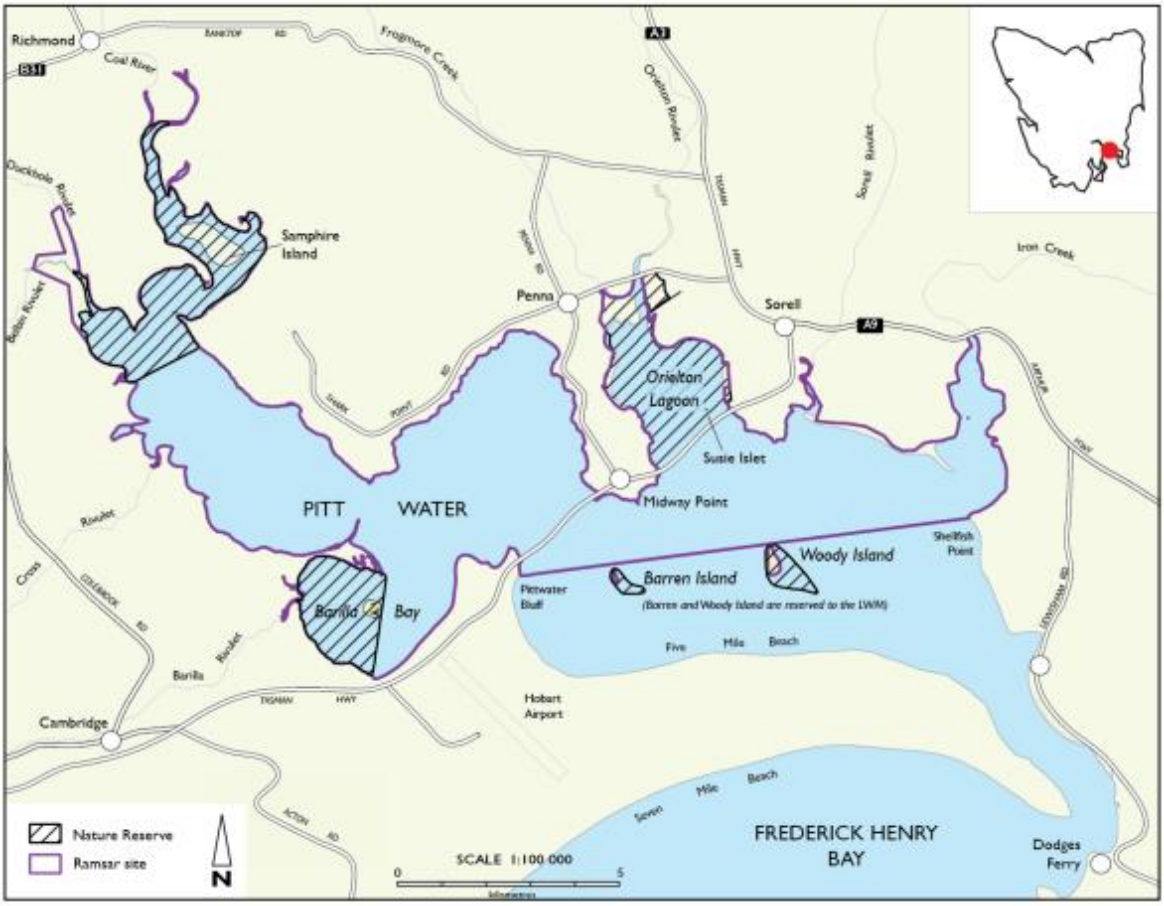


*Figure 10 - Pitt Water Nature Reserve areas and the PWOL Ramsar site*

The Ecological Character Description (2012), listed critical components and processes of the Pitt Water Orielton Lagoon as:

- hydrology – the hydrology of Pitt Water is dominated by marine influence. The estuary has massive tidal flows and high exchange rates. PWOL receives low but variable freshwater inflows from the ephemeral Coal River.
- water quality – at the time of listing, Orielton Lagoon water quality was known to vary depending on climatic conditions. As tidal exchange is limited to the lagoon, it can become fresh under heavy rainfalls. Salinity can vary from fresh to hypersaline. Nitrogen levels may be high, depending on rainfall and temperature.
- seagrass and other aquatic primary producers – seagrass plays an important role in providing habitat and feeding areas for invertebrates, fish, and waterbirds. Seagrasses provide specialised habitats for sygnathids (seahorses and pipefish), and invertebrate fauna associated with seagrasses provide an important food source for other fish species. Phytoplankton plays an important role in the nutrient dynamics of the estuarine systems and is a useful indicator of ecosystem health and nutrient balance.
- fish communities – 40 species of fish have been recorded from within PWOL. The range of species recorded reflects the different habitats within the estuary and the seasonal occurrence of some species. Several shark species migrate to the sandy bays of the upper Pitt Water for breeding and the sheltered nursery habitat for juveniles. Pitt Water is a key breeding area for school shark (*Galeorhinus galeus*) and gummy shark (*Mustelys antarcticus*), the main target species for the southern shark fishery.
- invertebrates – form a food source for fish and birdlife within PWOL. Invertebrates within the intertidal flats rework sediments, releasing organic matter and enabling microbial activity. Within the saltmarsh, the invertebrate community is likely to be comprised of 4 species of crustacean and 5 species of molluscs.

- waterbirds – the wetland provides habitat for a range of birdlife including waterfowl, seabirds, resident, and migratory shorebirds. Migratory shorebirds use PWOL during the (northern) winter. PWOL acts as a refuge for large numbers of waterfowl in times of drought. Orielton Lagoon is considered a priority site in the Bruny Marine Bioregion for beach nesting. PWOL provides a diversity of food sources including open water, shallow bays, intertidal flats, rocky and sandy shorelines, and saltmarshes. Rocky shorelines, saltmarshes, shrubby headlands, and islands provide nesting and roosting areas; and
- saltmarsh – hosts a diverse invertebrate fauna. They provide cover, roosting areas and food for foraging birds and even small mammals. The saltmarshes of PWOL have particular significance for the migratory and resident shorebirds which forage and roost in these areas. Saltmarsh plays a role in sedimentary processes and hydrology of the shoreline. Areas of saltmarsh occur extensively around the shoreline of Pitt Water estuary and Orielton Lagoon. (Dunn 2012).

Key threats to PWOL include:

- agriculture – irrigation practices, stock management and ground water manipulation on adjacent agricultural land impact on saltmarshes, seagrass, hydrology, sediment and water quality.
- stormwater runoff and groundwater seepage can contribute to changes in nutrient balance and water quality, especially in the almost enclosed Orielton Lagoon.
- overfishing could contribute to a loss in abundance and diversity of fish stocks.
- invasive species – including the toxic dinoflagellate (*Gymnodinium catanatum*), the North Pacific seastar (*Asterias amurensis*), and European shore crab (*Carcinus meanus).*
- climate change – Prahalad (2009) suggests that climate change and sea-level rise are the biggest long-term threats to saltmarsh vegetation and bird habitat, with potential for changes to vegetation composition, erosion and salinity (PWS 2013); and
- urban development – increasing numbers of subdivisions on the shores of Orielton Lagoon and Midway Point may contribute to increased run-off and sediments. Some of the stormwater is partially treated. Some treatments allow only for the removal of solid pollutants such as litter, while others also reduce sediment and nutrient loads. Stormwater remains an increasing source of nutrients and a significant threat to the environmental quality of Orielton Lagoon.

### 2.1.6 Marine environment - Avian fauna

Avian fauna was addressed in both the Terrestrial Natural Values Assessment (NBES, 2024) (Terrestrial NVA) and Marine Natural Values Assessment (Stanetc, 2024b) (Marine NVA). A summary is provided below.

Bird species are addressed below in functional groups; shorebirds (migratory and residents), seabirds, waterfowl and woodland birds.

**Shorebirds**
The shorelines around Pitt Water Orielton Lagoon (EPBCA Ramsar) are utilised for roosting and loafing, with birds using rocky and sandy shorelines in addition to saltmarsh flats. PWOL is the southernmost feeding habitat in Australia and is listed as critical habitat within the East Asian-Australasian flyway[1]. The use of PWOL by migratory shorebirds is an important part of the area's listing as a Ramsar site[2].

1 East Asian-Australasian Flyway Partnership 2018; Commonwealth of Australia 2017
2 Pitt Water – Orielton Lagoon Tasmania, Ecological Character Description, Dunn, H., August 2012

Birdlife Tasmania undertook a shorebird utilisation survey[3] which shows that feeding and roosting areas have changed since a PWS assessment of habitat use in 2012[4]. The assessment indicates that feeding and roosting areas have become less closely associated with the causeways since 2012. Feeding and roosting areas of migratory shorebirds found in this assessment are shown in Figure 11. The areas of overlap with the Project area include:

- A roosting area at the western end of the Sorell Causeway, on the southern side of the causeway
- A feeding area to the east of Midway Point, adjoining the roosting area discussed above; and
- A feeding area to the south of the western end of the Midway Point Causeway.

Woehler and Abbot (2022) highlight that 'the changing use of the Pitt Water – Orielton Lagoon Ramsar Site and Nature Reserve for feeding and roosting (and breeding by resident species) reflects a complex interaction of decreasing populations of migratory shorebirds, increasing coastal erosion and the increasing spectrum of human activities on foreshores in PWOL and regionally.'

**Resident shorebirds** are known to breed within the PWOL Ramsar site and the Pitt Water Nature Reserve, with some species residing at PWOL year-round, while others disperse more widely and return to breed over the summer months. Similar to migratory shorebirds, the PWOL Ramsar site contains important feeding, breeding and roosting habitat for 8 resident shorebirds (refer Figure 11).

Eleven EPBCA listed shorebirds are considered resident shorebirds to PWOL (NBES, MNES, 2024):

- *Calidris canutus,* red knot (Endangered, Migratory, Marine)
- *Limosa lapponica baueri,* bar-tailed godwit (western Alaskan) (Vulnerable, Migratory, Marine)
- *Numenius madagascariensis,* eastern curlew (Critically Endangered, Migratory, Marine)
- *Arenaria interpres,* ruddy turnstone (Migratory, Marine)
- *Calidris acuminata,* sharp-tailed sandpiper (Migratory, Marine)
- *Calidris ruficollis*, red-necked stint (Migratory, Marine)
- *Charadrius bicinctus*, double-banded plover (Migratory, Marine)
- *Gallinago hardwickii*, Latham's snipe (Migratory, Marine)
- *Numenius phaeopus*, whimbrel (Migratory, Marine)
- *Pluvialis fulva*, Pacific golden plover (Migratory, Marine)
- *Tringa nebularia*, common greenshank (Migratory, Marine)

Eighteen seabirds are known to utilise PWOL (NBES, 2024a), including gulls, cormorants, terns, shearwaters, pelicans and gannets. Some species are year-round residents (e.g. silver gulls, *Chroicocephalus novaehollandiae*), while others are migratory and spend only a short time at PWOL or pass through.

Seabirds utilise the areas immediately adjacent to the causeways largely for loafing/roosting on the rocky shoreline and feeding near the culverts. Feeding is focused around the culverts under the causeways. Several species breed within PWOL, but only one species breeds immediately adjacent to the causeways; silver gulls, which nest on the rocky shores on the southern side of the Sorell Causeway.

Some species of waterfowl inhabit the area year-round, while other species may disperse more widely depending on seasons and conditions. Twenty-one species of waterfowl are known from PWOL (NBES, 2024a). In general, waterfowl numbers at PWOL have been steadily declining since the 1980s.

3 Roosting and feeding areas for migratory shorebirds, PittWater – Orielton Lagoon Ramsar Site and Nature Reserve, South – east Tasmania, 2021/2022, E J Woehler and D Abbot, May 2022
4 Pitt Water – Orielton Lagoon Tasmania, Ecological Character Description, Dunn, H., 2012

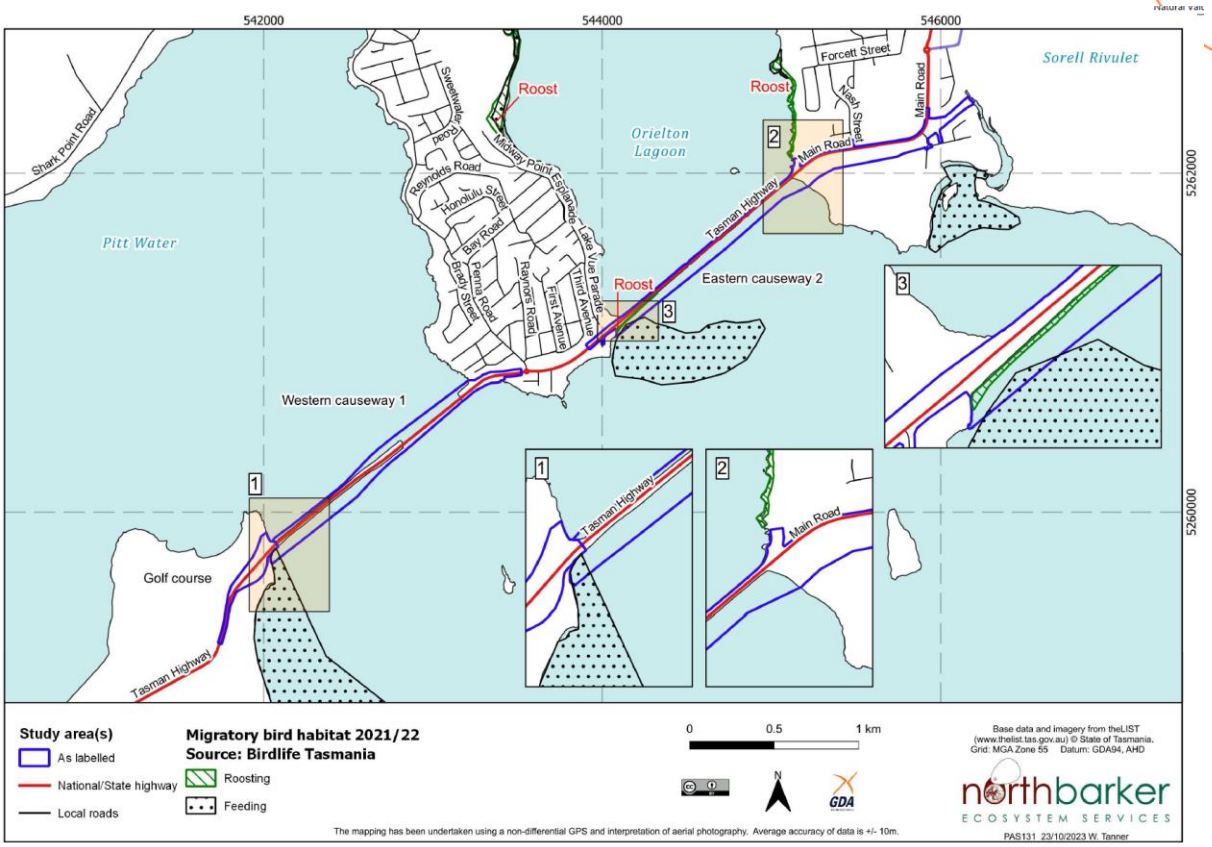


Figure 11: Feeding and roosting areas of migratory shorebirds in 2021/22

*Figure 11 - Feeding and roosting areas of migratory shorebirds in 2021/22 (NBES, 2024b)*

### 2.1.7 Marine – threatened fauna

The latest marine natural values assessment was prepared by Stantec[5].

The Project area is known to include or has the potential to include habitat of the following threatened species.

**Australian grayling**

*Prototroctes maraena* (Australian grayling) is listed as Vulnerable under both the EPBCA and TSPA. The Australian grayling has the potential to be present in the vicinity of the Project area during its larval or juvenile life-phases with an upstream population above Midway Point likely. The Project Area falls within the potential range boundary however there are no records of this species within 20km of the Project area. Any direct impacts to the species are considered highly unlikely, with indirect impacts, such as water quality changes also considered negligible due to the species mobility and ability to avoid areas of disturbance. The species migrates between fresh and marine waters. The waterways surrounding the Project area provides appropriate habitat for some of the life stages of this species.

**Red handfish**

*Thymichthys politus* (red handfish) is listed as Critically Endangered (EPBCA) and endangered (TSPA). They are small demersal fish that inhabit marine benthic environments and are endemic to Tasmania. The red handfish ranges from 6 – 135 mm in length, with two colour varieties: one ranges from red to pale orange and the other almost fully red with variable mottling, spots and black markings on the body and fins.

5 Stantec, 2024, Natural Values Assessment for Midway Point Causeway and Sorell Causeway (Option 4B), The Duplication of the Midway Point and Sorell Causeways Project, July 2024.

Previously widespread, the red handfish is now only known to exist on two, small patches of rocky reef in Frederick Henry Bay, southeastern Tasmania, approximately 12 kms south east of the Project area. At the known locations, critical habitat of healthy seaweed and seagrass has declined dramatically, and the remaining plants are under intense grazing pressure from (native) sea urchins (Stuart-Smith et al., 2021).The Project area falls within the modelled distribution 'may occur'. Key threats to the species include habitat degradation and loss of spawning substrate, pollution and siltation of waterways from diffuse and source-point activities, traditional boat moorings and the spread of invasive Northern Pacific seastars (*Asterias amurensis).*

Advice was sought from the National Handfish Recovery Team and NRE Tas as part of the Project and while red handfish are not known to occur within the vicinity it was recommended that targeted underwater visual consensus surveys (UVCs) be conducted to reliably determine presence. A survey for the red handfish at the Midway Point Causeway, including McGees Bridge, was undertaken by Elgin in July 2024. The area was assessed for potential habitat and where habitat was present, survey for the presence or absence of the red handfish. No suitable habitat for the red handfish was identified within the survey areas, and no handfish were observed on tow video footage or by divers. Therefore, the presence of a red handfish population with the survey areas is considered unlikely.

UVC surveys will be undertaken for Sorell Causeway, noting the Marine NVA (Stantec 2024) confirmed patchy seagrass on the southern side of Sorell Causeway only. No works are proposed to the southern side of the Sorell Causeway to protect Live-bearing seastar habitat. It is considered highly unlikely that any downstream impacts will affect handfish due to the large distances to potential handfish habitat.

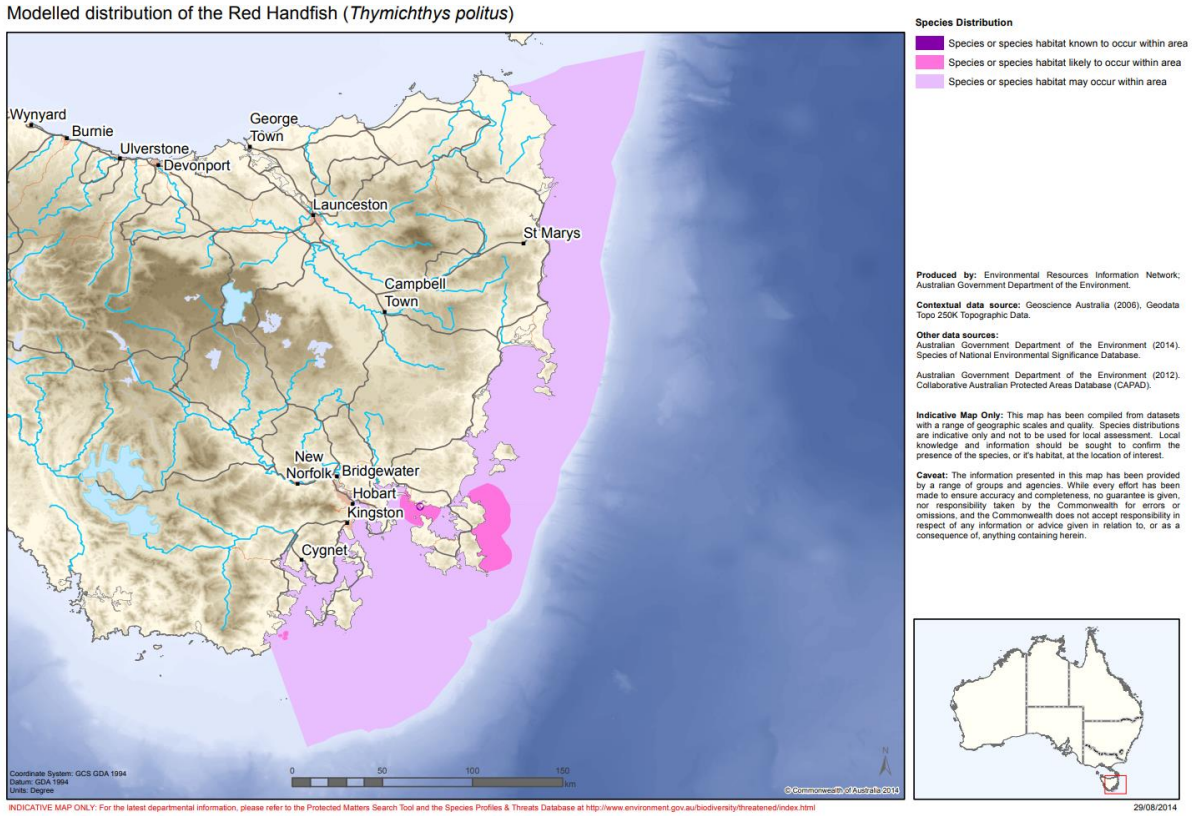


*Figure 12 - Modelled distribution of the red handfish (https://www.environment.gov.au/biodiversity/threatened/species/pubs/83756-map.pdf)*

**Spotted Handfish**

As part of the red handfish survey, Elgin also undertook a survey for the spotted handfish (*Brachionichthys hirsutus*) are listed as Critically Endangered (EPBCA) and endangered (TSPA). Spotted handfish primarily inhabit unconsolidated substrata ranging from well-sorted coarse sand and shell grit, to areas of fine sand and silt. They are often observed in shallow depressions or near rocks of low relief projecting from the substrate. They have been recorded from depths between 2 - 45 m but may occur deeper, potentially up to 60 m. The spotted handfish population decline was first noticed in the 1980s and became the first marine species to be listed as critically endangered on the IUCN Red List. Through extensive surveys across the historic distribution of the species throughout Tasmania, their population was concluded to be limited to only nine sites within the Derwent Estuary (Wong & Lynch, 2017, Powles et al., 2000), with less than 3,000 individuals remaining in the wild (Handfish Conservation Project, 2019).

The Project area falls within modelled distribution 'may occur'. Soft substrate within the project area may contain suitable habitat for spotted handfish. Key threats to spotted handfish are considered the same as those for red handfish. Advice was sought from the National Handfish Recovery Team and NRE Tas \ as part of the Project. While spotted handfish are not known to occur in the Pitt Water area it was recommended that UVCs be undertaken. UVC surveys for spotted handifsh were undertaken by Elgin at the same time as red handfish surveys.

No spotted handfish were recorded during the survey. While UVC surveys are yet to be undertaken at Sorell Causeway, the species is considered unlikely to occur within the Project area, as they are currently only known from the lower Derwent Estuary and D'Entrecateaux Channel, persisting in small fragmented populations[6].No indirect impacts are anticipated from the works, particularly given the distance to known populations of this species.

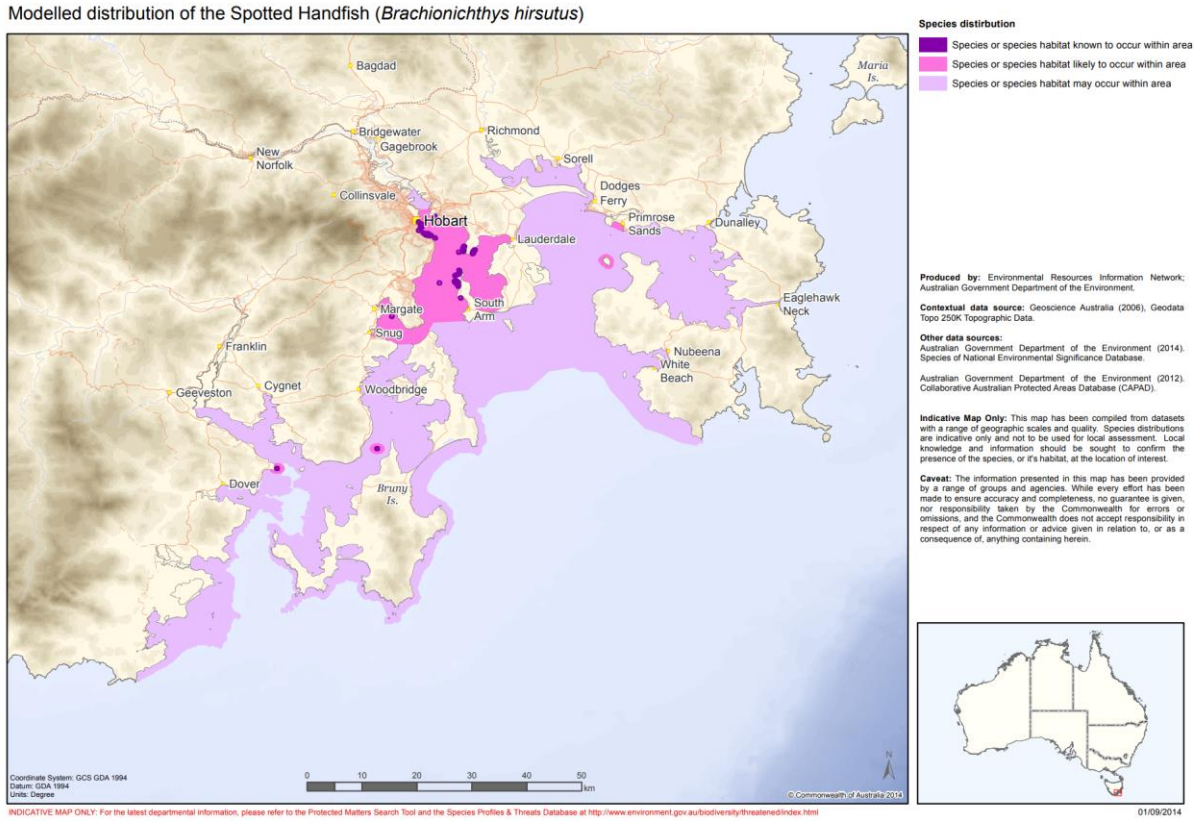


*Figure 13 - Modelled distribution of the spotted handfish (https://www.environment.gov.au/biodiversity/threatened/species/pubs/64418-map.pdf)*

6 Recovery Plan for Three Handfish Species, Commonwealth of Australia 2015

**Live-bearing seastar**

*Parvulastra vivipara* (live-bearing seastar), listed as Vulnerable (EPBCA) and endangered (TSPA), is a small, orange-yellow seastar, up to 30 mm across, with five arms and a rounded pentagonal shape. Endemic to Tasmania. The species is known only to occur in waters between the high and low tide mark (littoral waters) in the state's south-east (Threatened Species Section, 2024[7]). The seastar is unique in being one of very few seastars worldwide that brood their eggs then give birth to live young (viviparous).

The live-bearing seastar is known to occur in the Project area, in rocky intertidal habitat on the Midway Point and Sorell Causeways. The following summary on population and habitat is from Parsons 2024[8].

Within the Project area, the live-bearing seastar inhabit an area of 1,745 $m^2$ (679 m in length) on the northern side of the Midway Point Causeway, and an area of 455 $m^2$ (170 m in length) divided amongst four subpopulation sites on the southern side of the Sorell Causeway (Parsons, 2024). Refer to Figure 14 for population estimates and their location.

The absence of the live-bearing seastar was confirmed on the northern side of the Sorell Causeway in the most recent survey (Parsons, 2024). Former habitat on the southern side of the Midway Point Causeway is no longer occupied within the proposed Project area, with the exception of one small habitat patch contributing to 2% of total animal numbers and <1% of habitat on the Midway Point Causeway (refer Figure 14). By area, the combined causeways support an estimated 24% of habitat for the live-bearing seastar in Pitt Water, and 13% of habitat across the endemic range of the species (Parsons, 2024).

Estimated population sizes of the live-bearing seastar are 2,410 and 2,734 for the Midway Point and Sorell Causeways respectively, representing 37.3% of population numbers in Pitt Water and 12.5% of total numbers for the species (Parsons, 2024). Habitat length and area on the Midway Point Causeway are four times that found on the Sorell Causeway. However live-bearing seastar densities are more than four times higher on the Sorell Causeway (Parsons, 2024).

Population decline for this species in Pitt Water between 2000 and 2023 shows a 96% decline, reflecting environmental degradation and increasing anthropogenic inputs from a range of diffuse and point sources (Parsons, 2024). Large population declines over the past 20 years in other causeway and natural habitats, reflect broader environmental degradation associated with increasing urbanisation and industrial development within the catchment.

Recent data (2019-2023) indicate continued, progressive population declines on the northern side of the Midway Point Causeway (45% from 2019 to 2023), but not on the Sorell Causeway or natural shores. Based on sea level rise predictions, significant habitat loss on the northern side of the Midway Point Causeway is anticipated by 2050, and nearly total loss is predicted by 2100. These findings indicate that the viability of habitat on this causeway is at risk.

Sorell Causeway habitats are not immune to anthropogenic impacts but are likely to experience lower pollutant exposure on average. Rubble and boulders on the Sorell Causeway extend more than 1 m vertically above the live-bearing seastar upper height limit, and habitat viability is predicted to incur a smaller loss (12-19%) under the same sea level rise scenarios assessed.

7 Threatened Species Section (2024). Live-bearing Seastar (Parvulastra vivipara): Species Management Profile for Tasmania's Threatened Species Link. https://www.threatenedspecieslink.tas.gov.au/Pages/Tasmanian-Live-bearing-Seastar.aspx Department of Natural Resources and Environment Tasmania

8 Parsons, K.E. (2024) Live-bearing seastar Parvulastra vivipara investigations: population survey and habitat mapping. Sorell Causeways Duplication Project, South East Traffic Solution (SETS). V3. Report for pitt&sherry and Department of State Growth, Tasmania. Prepared by Ecomarine Consulting.

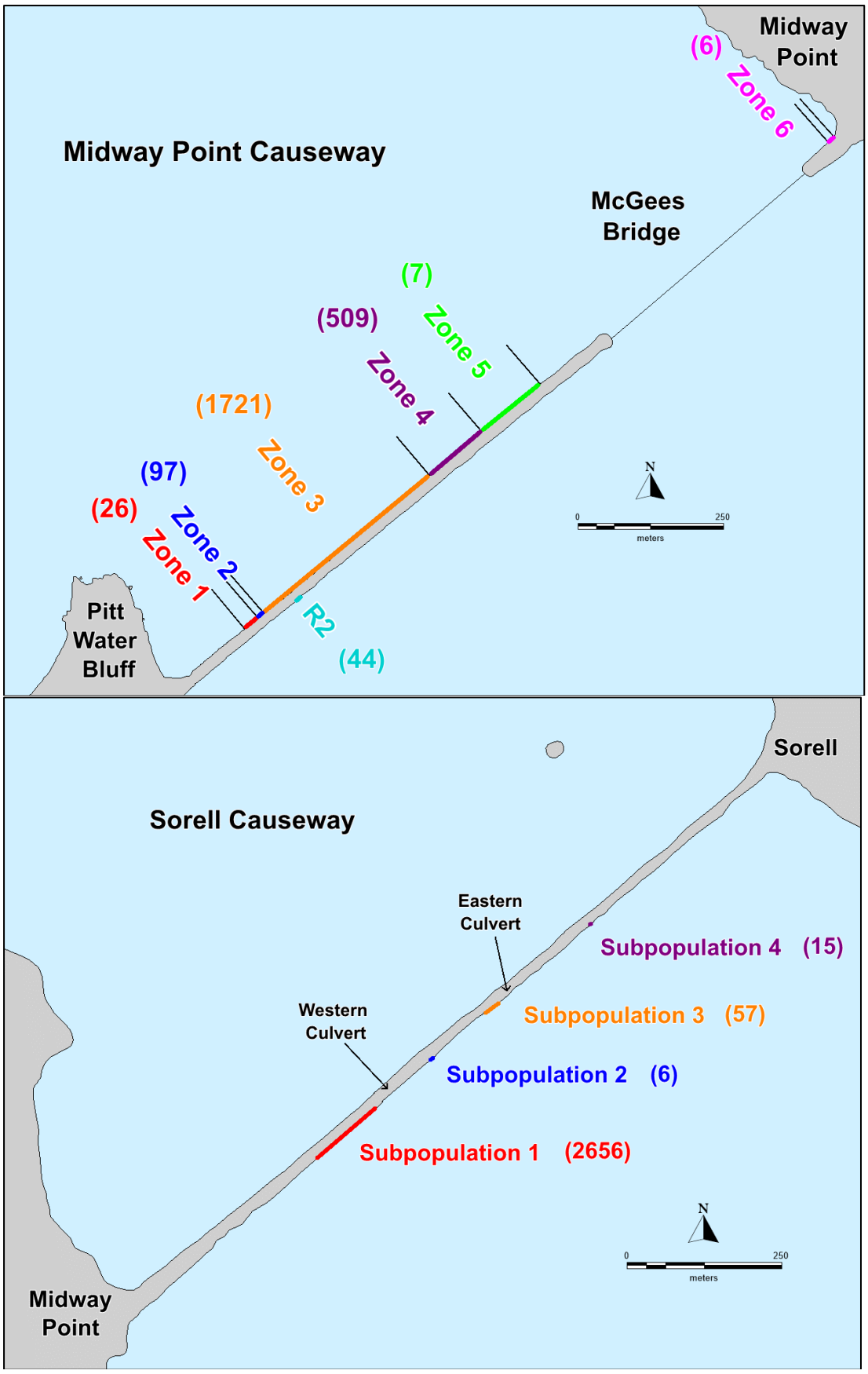


*Figure 14 - Population estimates for live-bearing seastars on Midway Point (top) and Sorell (bottom) Causeways, combined 2023 and 2024 surveys (Parsons, 2024)*

***Translocation and habitat augmentation***

Genetic studies indicate that *Parvulastra vivipara* (live-bearing seastar) is a good candidate for translocations, with transfers amongst sites not expected to result in adverse genetic mixing or impacts on species fitness (Parsons, 2024). Monitoring performed for a previous translocation program 20 years ago found that many natural receiver sites for translocated causeway animals did not sustain higher numbers post-translocation, suggesting that the native habitats were already at carrying capacity. Re-created habitat following causeway widening displayed initial success but did not remain viable over longer timeframes. These findings highlighted the need for new approaches to impact mitigation and translocation planning for *P. vivipara* (Parsons, 2024).

Habitat augmentation on natural shores was investigated as an option to provide receiver capacity for translocated animals (Parsons, 2024). Detailed site screening processes were conducted in Pitt Water Orielton Lagoon and at potential new sites outside PWOL through biological surveys, physical habitat characterisation, habitat augmentation trials and *P. vivipara* translocation trials to augmented habitat patches. Two sites within Pitt Water and one external site at Pipe Clay Lagoon (refer Figure 11) were considered suitable.

*Parvulastra vivipara* translocation trials recorded 95% and 92% survival on augmented patches at Pitt Water and Pipe Clay Lagoon receiver sites, respectively, after one month (Parsons, 2024). Translocated animals successfully bred in augmented habitat, with the total number of animals on receiver quadrats reflecting 138% and 175% population growth at Pitt Water Bluff and Pipe Clay Lagoon sites respectively, one year post-translocation (Parsons, 2024). Findings indicate that the three recommended sites provide suitable temporary receiver options for translocated *P. vivipara*.

Aquaria provides a third, viable option for receiving translocated animals, although captive trials identified a high risk associated with disease outbreaks, and aquaria provides a temporary receiver option only that cannot contribute to environmental offsets or longer-term habitat expansion. The feasible size of an aquarium population is also limited to due to the small tank sizes and stocking densities required for effective disease management (Parsons, 2024).

Advice from Parsons (2024) is that a receiver/offset strategy based solely on the above shore-based options, consisting of three sites spread across two locations with demonstrated *P. vivipara* survival, recruitment and population growth from trial translocations, is sufficiently robust to support translocated animals and not only avoid net population loss but also contribute to a nature positive benefit by supporting population growth, availability and future proofing of habitat to support species conservation and biodiversity outcomes for PWOL.

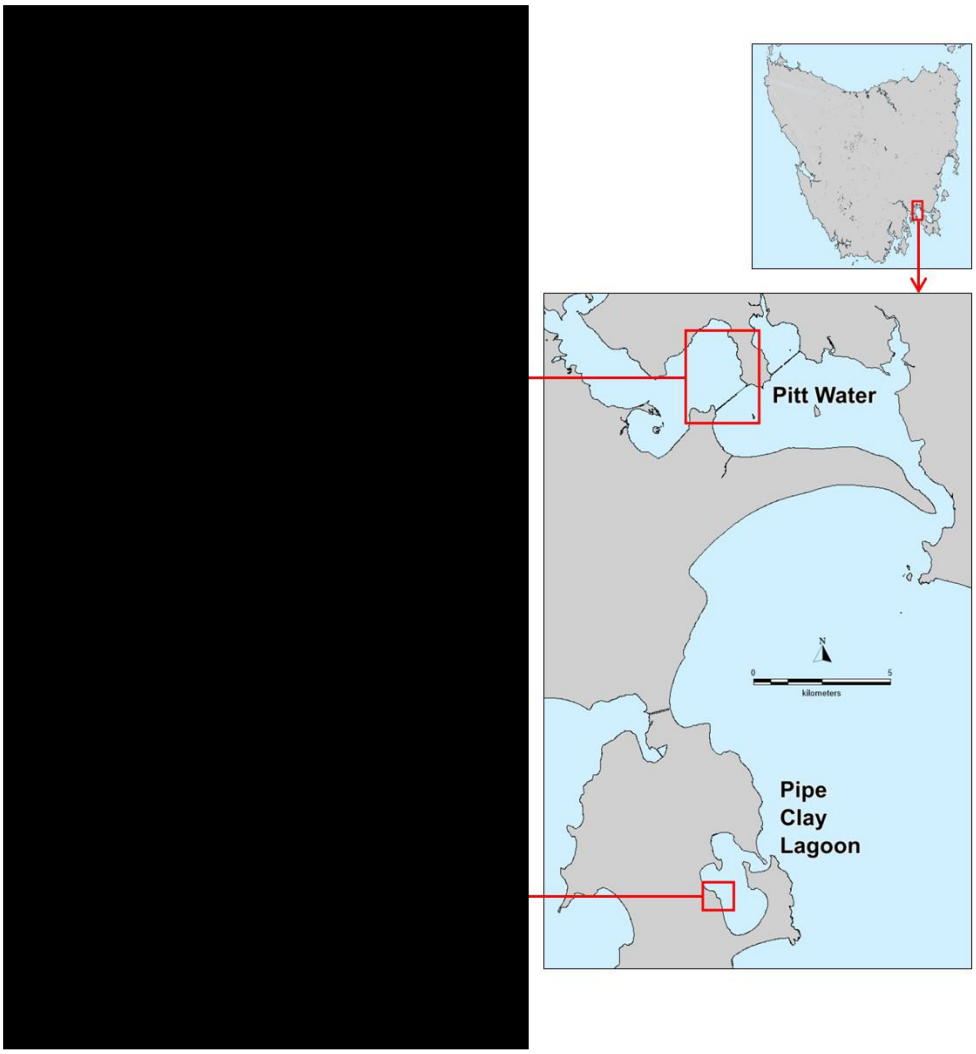


*Figure 15 - Habitat Augmentation Sites*

# 3. Impacts and Mitigation

This section provides additional information from Section 4 of referral for two MNES with the potential to trigger a significant impact; Pitt Water Orielton Lagoon Ramsar wetlands and *Puarvulstra vivipara* (live-bearing seastar). The heading numbers of the referral have been provided to assist in identifying the relevant sections.

## 3.1 Impact details (Ramsar Wetland) – section 4.1.3 referral

**4.1.3.2 If Yes: Briefly describe why your action has a direct and/or indirect impact on these protected matters.**

Potential impacts to Ramsar, at this stage of the project, are general in nature as they are based on a concept design with a large area of disturbance of 20 m, surrounding the concept design. Further assessment of potential impacts will be required following the preliminary and detailed designs, which will allow scrutiny of potential impacts at a finer detail relating to the actual design and construction methodologies proposed.

### 3.1.1 Construction Impacts

**Habitat disturbance**

The duplication of the Midway Point Causeway and Sorell Causeways will result in the direct loss of approximately 10.5 ha of intertidal and sub-tidal habitat within the Project area. This habitat is comprised mostly of soft-sediments and artificial rock revetments. Small areas of macroalgae on revetments will be lost on either side of Midway Point Causeway and the northern side of Sorell Causeway. An area (0.03ha) of saltmarsh in the north-western corner of Sorell Causeway will also be lost due to Causeway duplication.

A number of threatened and migratory species have the potential to occur in these habitats including the live-bearing seastar. Refer to section 4.1.4 Threatened species and ecological communities of the referral, for further details on impacts to these threatened species.

Approximately 5.76 ha of PWOL Ramsar site the sits within the Pitt Water Nature Reserve, managed by PWS. The Project will therefore result in the loss of approximately 10.5 ha of habitat from the PWOL Ramsar site which includes 5.76 ha of habitat from the Pitt Water Nature Reserve.

An increase in marine vessels as a result of construction has the potential for indirect habitat disturbance. These potential impacts include shading, wash of sensitive intertidal habitats such as saltmarsh, scour of benthic habitats such as seagrass, and fauna strike. Barges moored for extended periods can shade marine vegetation and reduce light availability for photosynthesis (Sagerman et al., 2020). Manoeuvring of vessels can scour intertidal and subtidal habitats through direct disturbance from anchors and propellors as well as indirect disturbance from vessel wash (Sagerman et al., 2020).

Increased vessel operations are also associated with increased risk of fauna strike, with collisions with vessels one of the primary threats to marine mammals (Schoeman et al., 2020). Scouring of rocky shores and soft-sediments could lead to relocation and/or mortality of epi- and in-fauna associated with these habitats. However, benthic assemblages can reestablish following disturbance if habitat is still available, disturbances cease, and nearby source populations remain intact (Stantec, 2024).

**Water quality degradation**

Construction activities in and around waterways has the potential to impact water quality through sediment disturbance and mobilisation. Mobilised sediment can smother marine vegetation and other subtidal habitat depending on the particle size and volume of sediment mobilised. Sediment disturbance can also result in the resuspension of potentially contaminated material such as Potential Acid Sulfate Soils (PASS). Impacts to marine habitats and associated biota as a result of poor water quality from sediment mobilisation is likely to be temporary depending on the volume and size of sediments, along with wave, tide and current actions (Stantec, 2024).

Given the highly disturbed nature of PWOL, it is considered that changes in water quality, as a result of construction works, will be temporary and remain within local levels of natural variability (Stantec, 2024).

### Hydrological alterations

Potential impacts to existing hydrological conditions are likely as a result of construction activities, particularly in relation to the Sorell Causeway where the installation of more culverts is being considered as part of the detailed design. The installation of the bridge duplication is expected to cause a negligible impact to the hydrological flows in Pitt Water. Hydrology and flood modelling will be undertaken to support the detailed design of both the Midway Point and Sorell Causeways.

The installation of more culverts at the Sorell Causeway would impact flows throughout the Orielton Lagoon system by increasing the drainage and infiltration of the lagoon via diurnal tidal fluctuations and periodic rainfall events. These fluctuations are considered likely to improve ambient habitat quality within the lagoon by improved water quality via increased mixing as well as promoting fish passage.

The increased movement of water in and out of Orielton Lagoon may also alter habitat and species compositions, particularly those adjacent to the causeway. Hydrological modelling of these potential changes will be undertaken following more detailed design.

### Fish passage alterations

Structures such as bridges, pylons and causeways have the potential to alter and limit fish passage. Fish passage can be directly impacted by the creation of a physical barrier between upstream and downstream areas, as well as indirect impacts through change in flow velocities and increase turbulence, which may be untraversable by some species, create shade which some species avoid, and alter estuary morphology by causing erosion and/or deposition which changes habitat availability (Fairfull and Witheridge, 2003; Forest Practices Authority, 2013).

The new bridge adjacent to the McGees Bridge is unlikely to alter fish passage, as bridges pose less of a risk to fish passage than other in-water structures (Fairfull and Witheridge, 2003).

The overall level of fish passage between Orielton Lagoon and Pitt Water at Sorell Causeway is unlikely to significantly change as the design, location and number of culverts is proposed to remain the same under the existing construction design.

There is potential for the inclusion of additional culverts at the Sorell Causeway, which is being considered as part of the Causeway design. This is considered likely to increase fish passage, however, further assessment of fish passage will be required once the final construction design is confirmed.

Maintaining and/or improving fish passage is an important consideration for the overall ecological health of the PWOL Ramsar site and PWNR, by preserving species connectivity between upstream and downstream areas of the ecosystem. For example, allowing the juvenile school shark (*Galeorhinus galeus*) passage between the ocean and waters upstream of Midway Point Causeway. The duplication of McGees Bridge is not expected to limit movement of school sharks or other elasmobranchs, such as southern eagle rays (*Myliobatis australis*) or smooth rays (*Dasyatis brevicaudata*), which were observed in the Project Area.

Alterations to fish passage may pose a threat to the Australian grayling (*Prototroctes maraena*), refer section 4.1.4 of the referral, however as there are no significant changes to fish passage anticipated as part of the Project. Impacts to Australian grayling from altered fish passage are considered minimal. Less mobile species with strong site fidelity such as big-belly seahorses (*Hippocampus abdominalis*) are also unlikely to be affected by changes to fish passage due to their restricted home range.

### Introduction and spread of pests and diseases

The use of equipment and movement of vessels associated with maritime construction has the potential to introduce and spread marine pests and diseases by acting as vectors. Marine pests and diseases can impact marine environments as well as recreational and commercial fisheries by competing with and infecting native species if not managed appropriately.

The introduction of marine pests and diseases is considered a key threat to PWOL, which is common for sites within close proximity of human activity (Dunn, 2012). It is understood that the Project area is relatively free of marine pests and diseases with the exception of the Pacific oyster (*Crassostrea gigas*) and Pacific Oyster Mortality Syndrome (POMS) (Department of Natural Resources and Environment Tasmania, 2023). It is unlikely that the proposed works would contribute to the spread of existing pests and diseases provided that standard mitigation measures are implemented. There is nevertheless a risk of the introduction of pests and diseases to the Project area through the use of equipment and movement of vessels that have the potential to act as vectors from other areas (Stantec, 2024).

### Increased noise

Noise arising from construction in and around waterways can impact marine mammals, fish, elasmobranchs, marine reptiles and birds, along with many invertebrates such as cephalopods and crustaceans. Tolerance to changes in noise varies among species, however, the response is generally similar with marine fauna moving away from noise sources. Increased noise above water is likely to disturb susceptible marine fauna such as shorebirds. Underwater, noise travels four times faster and can cause physical harm from higher energy transfer than in air.

Construction associated with the proposed duplication works will generate underwater noise within and adjacent to the Project area, with peak and chronic noise levels depending on methodology. Piling activities are the primary generator of underwater noise in maritime construction and are expected to be required for duplication of the McGees bridge.

Marine mammals are particularly prone to the impacts of underwater noise, however, they are not considered likely to occur in the Project area. Other mobile fauna in the Project area such as fish, elasmobranchs and marine reptiles are likely to be temporarily displaced as they move away from the noise source (Gomez et al., 2016) but tend to eventually return once noise levels subside (Bryant et al., 1984; Morton and Symonds, 2002).

Less mobile species such as big-belly seahorse have the potential to be impacted by increases in noise levels resultant from the proposed duplication works. No information is available on the sensitivity of these species to underwater noise, however, death and injury of fish including syngnathids can result from barotrauma associated with exposure to very high amplitude, impulsive sounds (Anderson et al., 2011; Stephenson et al., 2010).

## 3.1.2 Operational Impacts

Once operational the project is not expected to have a significant increase in impacts from current activities. The project however is expected to include a number of potential benefits to PWOL including:

- Hydrological alterations, including addition of or modification to culverts to increase tidal flushing of Orielton Lagoon where considered compatible with live-bearing seastars;
- Modification of causeway revetments and subsequent increase in availability of intertidal habitat suitable for important species including the threated live bearing seastar and migratory birds;
- Creation of additional offsite habitat for live-bearing seastar within PWOL; and
- Implementation of water sensitive urban design and best practice erosion and sediment control measures to improve stormwater treatment and water quality run off into PWOL.

### 3.1.3 Significant Impact Assessment – Ramsar wetlands

**4.1.3.6 If No: Describe why you do not consider this to be a Significant Impact**

An action is likely to have a significant impact on the ecological character of a declared Ramsar wetland if there is a real chance or possibility that it will result in:

**1. Areas of the wetland being destroyed or substantially modified**

Duplication works will result in the loss of intertidal and sub-tidal habitat immediately surrounding the causeways (10.5 ha of a total 3,334 ha, or 0.3%), within PWOL Ramsar site. The wetlands and marshes in the northern parts of Orielton Lagoon and Pitt Water will not be affected.

Artificial intertidal and subtidal habitats provided by the existing causeways infrastructure constitute part of the PWOL ecosystem that will be modified by the duplication works. These structures are known to support a portion of the PWOL population of live-bearing seastars (Stantec, 2024). The potential impacts to this species area discussed in detail in section 4.1.4 of the referral but are also considered against this criterion.

Construction activities will result in increased vessel and barge movements in PWOL, which could cause loss or modification of habitat additional to what would occur in the direct construction footprint. This could include shading of marine vegetation by barges, which can lead to death and loss of vegetation when prolonged, wash and scouring of subtidal and intertidal habitats, and damage to benthic habitats from anchors. Vessel impacts can be prevented through methods such as demarcation of sensitive habitats (e.g., buoys outlining seagrass habitat) and stringent operational plans and procedures to avoid interference with habitats wherever possible (Stantec, 2024).

The duplication works will result in a loss of 10.5 ha of PWOL, the majority of which (approximately 80%) consists of soft sediment and artificial seawall habitats. The loss of artificial structures that constitute important habitats will be rectified as new structures develop into habitat over time. New artificial structures are likely to provide ecologically valuable subtidal and intertidal habitat in the future as they gradually attract sessile marine animals and macroalgae, which in turn provide habitat structure and food for mobile species such as invertebrates and fish. It is, therefore, anticipated that impact to habitat will dissipate over time and will be further minimised through the retention of the existing McGees Bridge pylons.

In addition, habitat enhancement works on Midway Point Causeway, to extend live-bearing seastar habitat to upper, drier areas, is expected to increase availability of intertidal habitat and ‘future proof’ habitat from predicted 2100 sea level rise (SLR). The southern revetment of Sorell Causeway will also be retained which provides important habitat for the seastar. It is acknowledged, that the causeways are in poor condition, eroding and susceptible to sea level rise and therefore existing environments are susceptible under the status quo. In the do ‘nothing’ scenario, habitat for *P. vivipara*, and other intertidal species using the causeways, is predicted to be unviable by 2100. Through physical modification, the Project presents an opportunity to establish viability of habitat over a longer timeframe, with this viability unlikely in the absence of the development.

There will be a direct loss of shorebird habitat within the PWOL wetland of 0.04 % of feeding and 0.4 % of roosting habitat. The scale of impacts to these areas are discussed in more detail in relation to threatened species in section 4.1.4. There is not likely to be any reduction in the capacity of the extensive habitat within PWOL to support migratory shorebirds. Migratory shorebirds are highly mobile, moving between and among sites in response to disturbance, weather conditions and tide heights. The numbers of migratory shorebirds have declined substantially over the years indicating feeding and roosting habitat availability is not a limiting factor for these species in PWOL (Birdlife Tasmania, 2022).

Although a net loss of natural habitat is expected to occur as a consequence of the proposed action, similar natural habitats to those in the construction footprint are available throughout PWOL, and the area of impact is small (0.3% of PWOL) in relation to the size of the Ramsar site, the impact is therefore not considered significant.

2. **A substantial and measurable change in the hydrological regime of the wetland, for example, a substantial change to the volume, timing, duration and frequency of ground and surface water flows to and within the wetland**

According to Dunn, 2012, the major threats to PWOL hydrology are climate change and the altered freshwater inputs into the estuary system. Freshwater inputs into PWOL have been historically modified, especially from Coal River due to upstream damming (Parks and Wildlife Service, 2013). Freshwater hydrology will not be further impacted by the proposed duplication works.

The Midway Point and Sorell Causeways have historically modified the tidal hydrology of PWOL, with the impacts of this most noticeable in Orielton Lagoon.

A second bridge is proposed to be installed next to the existing McGees Bridge, with the footings of the existing McGees Bridge to remain. The McGees Bridge area is already an area of higher water velocity due to the presence of Midway Point Causeway and the bridge being the only path for tidal water movement in the area. Bridges pose a less considerable risk to fish passage than other in-water structures (Fairfull and Witheridge, 2003), and additional pylons are not likely to significantly change the current hydrodynamics or other aspects of fish passage. The new bridge is unlikely to substantially impact current tidal flow through this area.

The current construction design of the Sorell Causeway includes the extension of existing culverts at approximately the same locations. Longer culverts at Sorell Causeway may reduce fish passage for some species by increasing the length of the dark area and higher velocity water that fish need to traverse (Fairfull and Witheridge, 2003). However, the overall level of fish passage between Orielton Lagoon and Pitt Water is unlikely to significantly change as the design, location and number of culverts is proposed to remain the same under the current design (Stantec, 2024).

An additional design option has been considered (pitt&sherry, 2023a) which suggests the inclusion of between 5 and 13 additional box culvert cells to account for 2120 storm tide and coincident 1% AEP flood event. This is likely to increase tidal flow and the availability of fish passage, and potentially improve water quality. However, further assessment will be required once the design is sufficiently advanced.

Based on the current concept design, with no additional culverts proposed, tidal hydrology of PWOL would be expected to remain stable. It is therefore highly unlikely that the proposed works will cause a substantial or measurable change in the hydrological regime of PWOL.

3. **The habitat or lifecycle of native species, including invertebrate fauna and fish species, dependent upon the wetland being seriously affected**

PWOL is home to a diverse range of habitats that are critical to the survival of many native species at some point in their lifecycles (Stantec, 2024). Some habitat areas such as soft sediments, seagrass and artificial structures will be lost as a result of the proposed duplication of the causeways. However, these areas represent a small portion (0.3%) of total available similar habitat in PWOL and hence these impacts are unlikely to seriously affect the overall habitat or lifecycle of the majority of native species in PWOL (Stantec, 2024).

Species with high site fidelity to habitats in the Project Area, such as the live-bearing seastar, are the most at risk of being impacted by the proposed duplication works. This has, however, been considered in the Concept Design Report (pitt&sherry, 2020) and, if appropriate steps are taken to conserve habitat and populations, the impact of the proposed works on the habitat and lifecycle of these species would be limited (Stantec, 2024).

Changes to water quality through sediment mobilisation has the potential to affect marine species and habitats. Given that PWOL is a highly disturbed waterway, periodic changes in turbidity and suspended solids due to construction activities are expected to be within local levels of existing variability and could be appropriately managed through the implementation of erosion and sediment controls. Marine fauna with high site fidelity or low mobility (e.g., live-bearing seastars) would be the most susceptible to any changes in local water quality (Stantec, 2024).

The potential for underwater noise to impact on the lifecycle of native species will depend on construction methodology. Piling activities are the main generator of underwater noise during maritime construction and are anticipated to be required for the duplication of McGees Bridge. Provided mitigation measures are implemented, such as soft-start procedures and marine mammal observation, it is unlikely that short-term underwater noise resulting from piling activities will seriously affect the lifecycle of native species (Stantec, 2024).

Fish passage through waterways is crucial to the survival of many native species. The proposed duplication of the causeways is not expected to include any additional barriers to fish passage, with existing culverts at the Sorell Causeway planned to be maintained and extended. Impact to fish passage from the causeway duplication within the Project area is therefore considered to be negligible.

Construction activities will require an increase in vessel and barge movements within PWOL, which have the potential to impact native species and their habitats, by creating underwater noise, disturbing sediments or shading macrophytes. There is also potential for vessel strike to marine fauna such as marine mammals. Vessel impacts can be minimised through methods such as demarcation of sensitive habitats and development of detailed operational plans and procedures, to ensure impacts are minimised. The increase in vessel traffic is expected to be very small in proportion to current vessel movement in the area.

Impacts to habitats and lifecycles of native species in PWOL are expected to be isolated to a small geographical area and small portion of overall available habitat in PWOL (Stantec, 2024). If appropriate mitigation measures are implemented, it is considered highly unlikely adverse impacts to native biodiversity within PWOL will occur.

Impacts to threatened species are addressed in section 4.1.4 of the referral.

4. **A substantial and measurable change in the water quality of the wetland – for example, a substantial change in the level of salinity, pollutants, or nutrients in the wetland, or water temperature which may adversely impact on biodiversity, ecological integrity, social amenity or human health**

PWOL is a highly disturbed environment, with historical impact to water quality and tidal flow. These impacts have been most noticeable in Orielton Lagoon, which has gone through periods of isolation from tidal influence leading to issues such as harmful algal blooms connected to sewage and agricultural pollution and exacerbated by limited flushing (Dunn, 2012; Parks and Wildlife Service, 2013).

The proposed action will not alter any external influences on water quality or input from freshwater flows. Temporary changes in water quality in PWOL as a result of duplication works are likely from temporary changes from sediment mobilisation. However, no permanent changes to water quality are anticipated, with no permanent changes to tidal flows proposed.

Sediment mobilisation from marine construction activities, when not managed by appropriate mitigation measures, have the potential to smother marine vegetation such as seagrasses and macroalgae, and other subtidal habitats. Sediment mobilisation can also result in the resuspension of contaminated material, such as potential acid sulfate soils (PASS) (Stantec, 2024). There is high potential for ASS to occur in the Project area, which, if exposed to air, can oxidise to produce sulphuric acid which can be harm to aquatic life. The duplication works are not expected to raise any PASS above the water table and, therefore, no impacts to water quality from PASS are anticipated.

Sampling conducted in 2021 recorded elevated nutrient levels in PWOL sediments, reflective of the various nutrient inputs into the estuary (Elgin Associates, 2022a). Concentrations of toxicants including metals, ammonia and PFAS were all below guideline values where available (Elgin Associates, 2022). The sediments in the Project area are therefore considered a low risk of impact to water quality.

Considering the highly disturbed nature of PWOL, temporary changes in water quality from construction activities are anticipated to be within local levels of variability already present in PWOL, with potential impacts on water quality mitigated through implementation of industry standard erosion and sediment controls. Therefore, impacts on biodiversity, ecological integrity, social amenity or human health resulting from changes in water quality are not expected as a result of the proposed action (Stantec, 2024).

**5. An invasive species that is harmful to the ecological character of the wetland being established (or an existing invasive species being spread) in the wetland**

Construction of this project has the potential of introducing or spreading weed species into the area, with a number of invasive species recorded both within and in the vicinity of PWOL as a result of historical disturbance in the area. The use of construction equipment and the movement of marine vessels will also have the potential to act as vectors for introduced species.

The possibility of triggering this criterion can be significantly reduced through the implementation of management measures to avoid the introduction and spread of invasive species, including the implementation of a project specific Weed and Hygiene Management Plan.

**Conclusion**

Stantec, 2024 concluded that, significant impacts in relation to hydrology, native species habitats and lifecycles, water quality or invasive species are not anticipated to occur as a result of the proposed duplication works provided mitigation measures are implemented. Although considered unlikely to affect the ecological character of the PWOL Ramsar site, the loss of 10.5 ha of habitat within PWOL (0.3% of the available habitat) will result in areas of the wetland being directly impacted and substantially modified, which, under the Guidelines, constitutes a significant impact occurring from the proposed works.

Potential benefits from the project including maintaining or improving the hydrological regime between Orielton Lagoon and Pitt Water, improved stormwater management and futureproofing of intertidal habitat for live bearing seastar seek to deliver nature positive outcomes for PWOL and as such the project is not expected to have a significant residual impact.

## 3.2 Impact details (Threatened Species and Ecological Communities) – section 4.1.4 referral

#### 4.1.4.5 If Yes: Describe why you consider this to be a Significant Impact.

Potential impacts to the live-bearing seastar are summarised in section 4.1.8.2 of the referral and in further detail by Parsons (2024a - e).

***Live-bearing Seastar, Parvulastra vivipara***

The live-bearing seastar, *Parvulastra vivipara* is limited to intertidal waters in south-east Tasmania and has reliably been recorded from 13 locations, however is suspected to now be extinct at four of these (Threatened Species Section, 2023). As a result of its live-bearing reproductive biology, *P. vivipara* lacks a planktonic dispersive stage and has very poor dispersal capabilities, making it vulnerable to localised extinctions through altered environmental conditions. This species exhibits high site fidelity and has a distribution that is particularly restricted within the context of marine organisms (O'Hara and Byrne, 2017; Liversage and Byrne, 2018). The different populations vary in size from less than 20 animals to more than ten thousand individuals. The largest population is located at Pitt Water (>13,000 animals), while an overall population estimate for the species across its endemic range is approximately 41,000 (Threatened Species Section, 2023). Pitt Water is estimated to provide 9,125 $m^2$ (0.9 ha) of habitat for *P. vivipara*, while the total area occupied by the species across its geographic range has been reported as 16,940 m (1.7 ha) (Strain et al. 2024).

The live-bearing seastar is listed as vulnerable under the EPBCA, although it is currently being re-assessed under the Act and is likely to be uplisted in the future to critically endangered status. This follows a large, recorded decline in numbers of the species over the past 20 years, primarily in the Pitt Water population (Parsons, 2024a). The Pitt Water population occurs partially within the Project area, and meets the criteria of an 'important population', as described below.

The Pitt Water population of *P. vivipara* is identified as an 'important population' on the basis of the following attributes:

- It is the largest known population of *P. vivipara* within its endemic south-east Tasmanian range, contributing an estimated 34% of total species numbers and 54% of habitat area (Parsons, 2024a);
- It occurs at the geographical limit of the species range, representing the most northern site where *P. vivipara* has been identified, and is also the location of the holotype specimen (i.e. type location) used to describe the species for the first time (Dartnall 1969); and
- It has been identified as having a particularly high reproductive output in a comparative site assessment (Byrne, 1996).

For all subsections below, the population affected by the Project in Pitt Water is considered to be an 'important population'. An action is likely to have a significant impact on a vulnerable species if there is a real chance or possibility that it will:

**a) Lead to a long-term decrease in the size of an important population of the species**

The live-bearing seastar subpopulations on the combined Midway Point and Sorell Causeways contribute 37% of animal numbers (combined causeway population size estimate: 5,144) in the important Pitt Water population, and 13% of total estimated numbers across the species' broader geographical range (Parsons, 2024a). On the Midway Point Causeway (estimated population size: 2,410), all animals are located on the northern side of the causeway, with the exception of one small identified colony estimated to contain 44 animals and located within poor quality habitat. Other areas on the southern side of this causeway have become unsuitable for *P. vivipara* over time and do not provide habitat for the species. On the Sorell Causeway (estimated population size: 2,734), all animals are located on the southern side of the causeway, and environmental conditions on the northern side are considered unsuitable for *P. vivipara* (Parsons, 2024a).

Total loss of the causeway subpopulations would lead to a substantial long-term decrease in the size of the important Pitt Water population, highlighting the need for avoidance and mitigation measures to prevent this from occurring. The primary measure proposed for the Project is avoidance through focusing development of new causeway structures primarily on the sides lacking or supporting very little suitable habitat. Based on the proposed concept engineering designs, there will still be a small extent of unavoidable direct habitat loss on the Midway Point Causeway in the vicinity of the new bridge site located at the eastern end of the causeway, and at the small colony site indicated above occurring on the southern side. It is estimated that habitat to be lost supports 2% of population numbers (estimated at 340 animals) and 4% of the area occupied within the important Pitt Water population (corresponding to 1% of total species numbers and 2% of the total area occupied by the species more broadly) (Parsons, 2024b). Areas of unavoidable habitat loss are characterised by low-quality environments which are occupied by lower densities of *P. vivipara* than found in other higher quality causeway habitats and healthy natural shorelines. Dependent on the final detailed design, the area of direct habitat loss and associated population capacity could be marginally higher than indicated above (3% of animals and 5% of habitat area in Pitt Water) but remain low (<2% of animal numbers, <3% of habitat area) within the context of total habitat area occupied by the seastar across its endemic range. Anticipated loss of habitat nevertheless has the potential to lead to a small long-term decrease in the size of the important population.

While the concept engineering design for the Sorell Causeway is aimed at minimising direct habitat loss for *P. vivipara* indirect loss of habitat and population numbers could potentially occur through modification of culverts and associated altered hydrodynamics and sediment processes. In addition, the species is known to be sensitive to water pollution and sediment deposition, and there is potential for indirect impacts from degraded water quality, elevated turbidity and modified sediment transport processes to occur in the long-term as a result of duplication works on both causeways. These could occur as a result of construction works; for example, from sediment plumes impacting adjacent areas of habitat, noting that re-colonisation of impacted areas may require long timeframes due to the inherent poor dispersal capabilities of the species. Impacts could also occur as a result of ongoing causeway operation; for example, due to changes to 'morphology' of structures or revised management and positioning of constructed stormwater outlets.

The above direct and potential indirect impacts may cumulatively lead to a long-term decrease in the size of the live-bearing seastar population if appropriate mitigation measures are not applied. Parsons (2024b) has identified a range of measures for the Project to minimise the risk of a decrease in the size of the Pitt Water population including on-site extension of habitat at Midway Point Causeway to future proof *P.vivipara* habitat at risk of inevitable sea level rise and off-site habitat augmentation in natural receiver sites within Pitt Water. Creation of supplementary habitat is expected to facilitate increased capacity and population size beyond the Project, providing long-term habitat of higher quality to support a potential net gain in the important Pitt Water population (Parsons 2024b).

**b) Reduce the area of occupancy of an important population**

The two causeways together provide an estimated 2,213 $m^2$ of habitat for *P. vivipara*, representing 24% of habitat by area in the important Pitt Water population, and 13% of habitat area across the species' broader geographic range. Loss of all causeway habitat would result in a substantial reduction in the area occupied by P. vivipara within the important Pitt Water population. On the basis of concept causeway engineering design, direct loss of habitat is expected to be avoided across most areas. However, there will be unavoidable direct loss of small areas of *P. vivipara* habitat to the east and west of the proposed new bridge site on the northern side of the Midway Point Causeway (324 $m^2$), and at the site of a small colony on the southern side of this causeway (14 $m^2$). The total area of unavoidable direct habitat loss is estimated at 338 $m^2$, representing 4% of habitat area within the important Pitt Water population and 2% of total habitat for the species across its endemic range (Parsons, 2024b). Dependent on the final detailed design for the Midway Point Causeway, it is possible that habitat loss could be marginally higher than this, but expected to remain <500 m2 (5% of area in the important Pitt Water population; 3% of total species habitat) and be confined to areas with low population numbers and animal densities.

On the basis of the Sorell Causeway concept design, no direct habitat loss is predicted for this causeway, however indirect habitat loss could occur as a result of culvert modifications, while degraded water quality or altered sediment transport processes during construction or operation could potentially result in a reduction of the habitat area occupied by *P. vivipara* as described above.

The Project works will be located on the two causeways which are each of 1-1.5 km length, but separated by the Midway Point peninsula which provides additional habitat for *P. vivipara* beyond the Project area. On the basis of the 2 km grid cell approach to estimating area of occupancy (AOO) (IUCN, 2022), potential direct and indirect habitat loss resulting from the Project is not expected to result in a reduction of the AOO. However, the Project is expected to result in a reduction of the precise area of occupied habitat as measured in $m^2$ if measures are not applied to replace lost habitat. The area impacted is estimated to be small on the basis of direct habitat loss but could be larger as a result of indirect impacts.

Parsons (2024b) has identified a range of measures needed to minimise the risk of a reduction in the area occupied by *P. vivipara* within its important Pitt Water population. These include measures for habitat augmentation to replace lost habitat: an on-site habitat creation mitigation option, the feasibility of which requires further investigation for Midway Point Causeway; and off-site habitat augmentation which has been investigated using detailed trials and provides viable options for receiving animals requiring temporary translocation away from areas of short-term construction disturbance (i.e. with the intention to return animals to temporarily disturbed causeway habitats post-construction), as well as providing long-term habitat to support translocated individuals and compensate for lost causeway habitat if on-site habitat creation is deemed infeasible. It is notable that review of data from a former *P. vivipara* translocation program indicated that existing sites for the species should be considered to be at population capacity and unable to receive and support additional translocated individuals. This necessitates the creation of additional habitat to provide receiver capacity for animals requiring translocation away from areas of potential disturbance or habitat loss prior to initiation of works, based on use of suitable rubble material, sites, and methodologies. Habitat augmentation is therefore a key measure proposed to increase the area of, and future proof, available habitat for *P. vivipara*

**c) Fragment an existing important population into two or more populations**

The Tasmanian distribution of the live-bearing seastar is severely fragmented and all known populations are separated by distances that exceed the presumed dispersal capacity of the species (Threatened Species Section, 2023). The important Pitt Water population is itself fragmented, with *P. vivipara* occurring in a number of subpopulations within Pitt Water which are expected to be isolated from each other on the basis of the primary dispersive mechanism (crawling) of the species, and known obstacles to dispersion. These subpopulations occur on the north-west side of the Midway Point Causeway, the north-east side of the Midway Point Causeway, the south-west side of the Midway Point Causeway, four areas on the southern side of the Sorell Causeway which are separated by culverts or potentially unsuitable environments, the southern shore of Midway Point, western shore of Midway Point, the western shore of upper Pitt Water, Barren Island, Woody Island and Lewisham near the Pitt Water estuary mouth. Laboratory analyses found that geographically separated subpopulations from the western shore of Pitt Water and western shore of Midway Point were genetically homogenous. While very occasional rafting between sites could occur over long timeframes (Parsons, 2024a), the paucity of genetic diversity recorded was attributed to the evolution of self-fertilisation and brood protection of low-dispersing benthic offspring, resulting in a high level of inbreeding and extreme genetic poverty, rather than evidence of existing gene flow between the subpopulations (Gunn et al. 2021).

Total loss of *P. vivipara* from the causeways would result in a reduction in the number of subpopulation sites; this would not result in fragmentation of the already-fragmented subpopulations, but would result in increased distances between remaining subpopulations. This could further reduce the potential for any genetic mixing such as through rafting or other stochastic processes.

On the basis of the concept design, total population loss is not expected, but the Project will result in loss of very small subpopulation sites on the north-east side of the Midway Point Causeway (estimated population size: 6) and south west side of the Midway Point Causeway (estimated population size: 44), and result in small reductions in habitat area and animal numbers on the north west side of the Midway Point Causeway. This will result in greater geographic separation between subpopulations on Midway Point/Sorell Causeway from the subpopulations on the north Midway Point Causeway/western shore of Upper Pitt Water, although noting that these subpopulations are already separated by the deep water channel beneath the existing bridge - which could not be traversed by crawling *P. vivipara*. These subpopulations are therefore expected to already be isolated from each other; there will be no change to this situation as a result of the Project, although increased distances between remaining subpopulations could reduce the likelihood of genetic mixing through stochastic processes as described above.

There is also potential for the Project to cause reductions in habitat area and population numbers on the north side of the Midway Point Causeway or south side of the Sorell Causeway through degraded water quality during construction or operation. On the southern side of the Sorell Causeway, where populations are already highly fragmented as a result of culverts and variation in intertidal attributes, further fragmentation could occur through changes to numbers or positions of culverts.

Overall, direct impacts from the Project are not expected to result in fragmentation of the important Pitt Water population, which is already fragmented into a number of isolated subpopulations. The Project will result in increased distances between subpopulations, which could further reduce the potential for genetic exchange through stochastic processes, but these subpopulations are already expected to be isolated on the basis of the highly restricted dispersive capabilities of *P. vivipara*. Changes to water flows and quality, such as associated with culvert and stormwater structures, could result in further population fragmentation at localised scales if suitable mitigation measures are not applied. Parsons (2024b) has recommended measures to minimise the risk of impacts from these structures and of population fragmentation.

**d) Adversely affect habitat critical to the survival of a species**

Considerations relating to identification of critical habitat are diverse but include use of habitat: during periods of stress; to meet essential life cycle requirements; by important populations; to maintain genetic diversity and long-term evolutionary development; as corridors for movement between sites used to meet essential life cycle requirements; for reintroduction or re-colonisation to ensure the long-term future of the species; and in any other way which may be critical to the survival of a listed threatened species.

It is relevant to note that *P. vivipara* performs all processes relevant to its life cycle and survival at each site that it occupies; it does not utilise different sites for different purposes, such as during stress or for different parts of its life cycle or behaviours.

The Project has the potential to adversely affect habitat within the important Pitt Water population. The population is estimated to support 13,803 animals (Parsons, 2024a) across 9,125 $m^2$ of habitat (Strain et al. 2024), with 37% of these animals and 24% of this habitat by area found on the two causeways (Parsons, 2024a). The causeway habitat supports 13% of both total animal numbers and habitat by area for *P. vivipara* across its endemic range. Total loss of habitat on the causeways would adversely impact on a substantial portion of the important population; as a result of its extent and status, this habitat could be interpreted as being 'critical to the survival' of *P. vivipara*.

However, on the basis of the proposed concept design, direct impacts of the project are not expected to result in total loss of causeway habitats, but are expected to result in direct loss of 4% of low quality habitat supporting 2% of animal numbers within the important Pitt Water population (Parsons, 2024b). Depending on the final detailed design, this could increase to 5% of habitat by area, supporting 3% of animal numbers. Loss of habitat and associated population capacity at this level is not expected to critically affect the survival of the important population or species more broadly.

Indirect impacts through degraded water quality and altered culverts, hydrodynamics and sediment transport processes could adversely affect larger areas of habitat within the important population if effective design and mitigation measures are not applied. Investigations have shown that the Pitt Water system is impacted by a broad range of anthropogenic inputs, and many areas of both causeway and natural shorelines have become highly degraded over the past 20 years (Parsons, 2024b). Causeway habitats which still support relatively high animal numbers and densities, namely the central area of habitat on the north western side of the Midway Point Causeway, and the western subpopulation site on the Sorell Causeway, are therefore considered very important for the survival of the important Pitt Water population. Based on the proposed concept design, these higher quality causeway habitats will not be directly impacted by the project, but any indirect impacts on them may have more critical consequences for survival of the important population.

Within the Pitt Water important population, the direct effects of the Project will adversely impact on habitat that is used for essential life cycle processes, such as breeding, feeding and sheltering, although noting that there are adjacent areas of habitat outside the Project area in Pitt Water that are used for the same processes. The directly impacted habitats are not considered critical in terms of being used in times of stress, because they are lower quality habitats which are more likely to be affected by stress than adjacent higher quality sites. On account of their low quality, they would not be considered for re-introduction or re-colonisation activities aimed at species recovery. Similarly, they are not considered critical for maintaining genetic diversity, since *P. vivipara* suffers from extreme genetic poverty and analyses have demonstrated genetic homogeneity across the broader Pitt Water population and over even larger spatial scales (Gunn et al. 2021). As noted above, indirect impacts that extend to other habitats which are of higher quality have more critical consequences, since these areas are likely to have greater resilience to stress and could contribute to recovery activities. This is particularly true of the Sorell Causeway western sup-population, which has greater resilience to sea level rise than subpopulations on the Midway Point Causeway (Parsons, 2024a).

Because *P. vivipara* habitat on the Pitt Water causeways is used by this species for essential life cycle requirements and occurs in an important population, all areas of habitat collectively comprise critical habitat. However, based on proposed concept design, habitat anticipated to be directly impacted by the project is of low quality, and not considered critical to the survival of the important population or the species more broadly. There is potential for indirect impacts to extend to higher quality habitat which is more critical for the survival of the population and species. Parsons (2024b) has identified mitigation measures to minimise risks of indirect impacts and adverse impacts that could have critical implications for the population and species.

**e) Disrupt the breeding cycle of an important population**

The unique live-bearing reproductive biology of the species means that advanced juveniles emerge from the surface of the adults to crawl away as independent individuals (Byrne, 1996). The live-bearing seastar is a simultaneous hermaphrodite, meaning that it has both male and female gonads and can self-fertilise. Young are incubated in the gonads after a gestation period of up to one year and reach a relatively large size before birth (on average 38% of adult size) by cannibalising their smaller siblings within the gonad (Byrne, 1996). Sexual maturity (and a radius of 5 mm) is attained at around 12 months of age, and while lifespan is not known, the species has been described as the longest lived of the viviparous sea stars investigated, with evidence of animals living for at least 8 to 10 years. An enhanced period of reproduction has been reported from October to January, however high numbers of juveniles have also been recorded during June-July, and there is evidence of this species giving birth to juveniles throughout the year (Prestedge, 1998).

All habitat occupied by *P. vivipara* is utilised for breeding; there is no particular location, or site within Pitt Water which is used specifically for breeding at the omission of other sites. However, it can be expected that higher quality sites characterised by higher population densities also have higher birth and/or juvenile survival rates than poorer quality habitats characterised by low animal densities. Activities which directly or indirectly impact on the health or survival of individuals will impact on the ability of the individuals to reproduce. 'Stress-birth' is also a recognised phenomenon in *P. vivipara,* whereby a stressed animal will eject juveniles held in the gonads, with the first 3-4 born generally large enough to survive (Prestedge, 1998).

The live-bearing seastar subpopulations on the combined Midway Point and Sorell Causeways contribute 37% of animal numbers in the important Pitt Water population. Total loss of these subpopulations would have a substantial impact on the reproductive capacity of the important Pitt Water population. However, based on the proposed concept design and allowing for further detailed design, direct impacts and habitat loss will be limited to areas supporting 2-3% of population numbers. Areas of unavoidable habitat loss are characterised by low-quality environments which are occupied by lower densities of *P. vivipara* than adjacent higher quality causeway habitats, and may also be characterised by lower reproductive rates. Hence, direct impacts of the Project may cause a small reduction in the reproductive output of the population, but are not expected to have significant implications for breeding capacity of the broader population. Degraded water quality and modified hydrodynamics and sediment processes could have indirect affects over larger areas of habitat, and hence greater impacts on reproductive output, if not effectively mitigated.

There is evidence of continued reproduction in *P. vivipara* animals disturbed through translocation activities and altered conditions such as in aquaria (Prestedge, 1998; Trotter et al. 2023; Parsons, 2024c,d), while evidence of reproduction year-round also indicates high environmental tolerances for breeding activities.

Project activities are not expected to disrupt the breeding cycle of *P. vivipara* in Pitt Water habitats beyond the causeways and immediately adjacent environs. Impacts relate more to loss or degradation of habitat, and therefore loss of breeding capacity and reproductive output as a result of reduced number of individuals, in areas of direct or indirect impact. Parsons (2024b) has recommended measures to minimise the risks of reductions in population size, habitat area and therefore breeding capacity.

**f) Modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline**

The live-bearing seastar is usually found under or among loose intertidal rocks, but moves to the upper surfaces of rocks to feed when immersed at night or in dull weather. Key needs for the species relate to microalgal food, shelter from water movement, and unimpeded pathways to facilitate diurnal movement patterns between feeding and sheltering niches (Prestedge, 1998). The intertidal habitat preferences of *P. vivipara* have recently been investigated in more detail by Parsons (2024b), and relate to shore height and perpendicular length, rock size and level of cover, substrate condition (i.e. rocks need to be 'clean', lacking thick deposits of sediment or biological fouling), exposure to nutrient and sediment inputs, and nearshore and within-habitat shore gradients and hydrodynamic processes.

Habitats for *P. vivipara* on the causeways and adjacent natural shorelines in Pitt Water are of variable quality, as reflected by variation in shore heights and gradients, rubble sizes and availability, sediment deposition and biological growth on rocks, proximity to anthropogenic inputs, and observed densities of *P. vivipara* (Parsons 2024b).

On the Midway Point Causeway, 71% of animals occur within a north-west area of the causeway that is adjacent to a sandstone wall and occupies 54% of the length of the occupied habitat (i.e. alongshore length = 371 m, while total occupied length on this causeway is 688 m). This particular area of habitat is superior to other habitat on the Midway Point Causeway in terms of rock structure, shore height and nearshore and within-habitat gradient. On the Sorell Causeway, where only 170 m of the length of the structure is occupied by *P. vivipara*, 97% of animals have been recorded in the most western subpopulation, which occupies 74% (125 m) of the length of occupied habitat. Suitability appears to be related to availability of rubble by depth, position in relation to culvert flows and nearshore and within-habitat shore gradients and hydrodynamics. Beyond the above areas of habitat on the two respective causeways, densities of *P. vivipara* and habitat quality are generally lower.

Together the causeways provide 2,213 $m^2$ of habitat supporting an estimated 5,144 animals; representing 24% of habitat by area in the important Pitt Water population, and 13% of habitat area across the species' broader geographic range, and 37% of animals in Pitt Water and 13% of animals for the species. Loss of all causeway habitats would mean destruction and loss of habitat to the extent that the species is likely to decline. On the basis of the proposed concept design, and allowing for further design refinement, direct loss of habitat will be <500 $m^2$, and represent 4-5% of habitat in Pitt Water and 2-3% of habitat for the species. Design has focussed in particular on avoiding direct loss of the above two higher quality areas of habitat on the causeways that support the majority of the animals on the causeway structures. Without measures to replace lost habitat, the Project is nevertheless expected to result in a small decline in the species. Indirect impacts through degraded water quality, and altered culverts, hydrodynamics and sediment transport processes, could lead to a larger decline through additional loss, modification, isolation or reduced quality of habitat. Parsons (2024b) has identified a range of measures that will minimise risks of destroying, modifying, isolating or reducing quality of habitat for the species. As noted above, these incorporate potential options for on-site and off-site habitat augmentation to compensate for habitat loss, facilitated by animal translocations away from impacted areas. Habitat augmentation has been identified as a viable option for replacing lost causeway habitat where supported by a detailed understanding of the species' habitat requirements and targeted site-based investigations of habitat augmentation methodologies. Creation of supplementary habitat is expected to facilitate increased capacity and population size beyond the Project, providing long-term habitat of higher quality to support a potential net gain in the important Pitt Water population

**g) Result in invasive species that are harmful to a vulnerable species becoming established in the vulnerable species' habitat**

A number of invasive species already occur in Pitt Water, with the European green crab (*Carcinus maenas*), New Zealand seastar (*Patiriella regularis*), Asian date mussel (*Arcuatula senhousia*), New Zealand porcelain crab (*Petrolisthes elongatus*), feral Pacific oyster (*Magallana gigas*), and New Zealand green chiton (*Chiton glaucus*) all recorded in *P. vivipara* habitat (Parsons, 2024e). The northern Pacific seastar *Asterias amurensis* also occurs in Pitt Water and, together with *P. regularis*, has been identified as a potential predation threat to *P. vivipara* (Threatened Species Section, 2023), although Parsons (2024e) suggests that niche overlap and threat to *P. vivipara* from these species is in fact minimal. Several other invasive species have been recorded in Pitt Water, including a virus [Ostreid Herpesvirus-1 (OsHV-1)] associated with Pacific Oyster Mortality Syndrome (POMS) which has impacted on the commercial oyster aquaculture industry in Pitt Water. All invasive species recorded in the waterway have planktonic life stages or occur as water-born species, and hence have existing opportunity for wide dispersal and colonisation in Pitt Water.

While a number of invasive species are already established in Pitt Water, it is nevertheless important to prevent the introduction of any further organisms which could impact on *P. vivipara*. Use of equipment and movement of vessels and barges have the potential to act as vectors for introduction and spread of invasive species. Appropriate hygiene protocols and other biosecurity measures will be implemented to minimise the risk of invasive species being introduced as a result of the Project. Upon implementation of industry standardmeasures, it is unlikely that the proposed works will result in harmful invasive species becoming established in the habitat of the live-bearing seastar.

**h) Introduce disease that may cause the species to decline**

Disease symptoms have previously been reported in wild *P. vivipara* animals at Pitt Water by Prestedge (1998), who identified the presence of 'brown spot' disease. The disease is characterised by the development of brown spots or areas, which may clear without leaving a scar, or which may cause necrosis of tissue and scarring, and in severe cases may lead to animal mortality. Prestedge (1998) noted that this disease occurred in animals located near stormwater drain outlets, suggesting that disease was associated with substances in discharges, or stress caused by fluctuating environmental conditions at these outlets. Similar observations of disease have been made in captive aquaria animals (Trotter et al. 2023), with recent trials recording brown spots and necrosis in animals which lacked symptoms when they were collected from the wild. Environmental measures relating to temperature control, aquaria hygiene, and management of biological load and feeding regimes helped to reduce the risk of disease outbreak in aquaria.

No other disease type has been described for *P. vivipara* populations, and field investigations in Pitt Water during 2019-2023 did not identify evidence of brown-spot or other disease in this species (Parsons, 2024e). It seems likely that the cause of previous observations of disease in wild animals was related to environmental stressors which are pre-existing in the Pitt Water environment. While there are no other known diseases which could impact on *P. vivipara* if introduced to Pitt Water, use of equipment and movement of vessels have the potential to act as vectors for the spread of diseases. Through implementation of standard hygiene protocols and other biosecurity measures, it is unlikely that diseases could be introduced as a consequence of the proposed works that may cause the live-bearing seastar to decline.

**i) Interfere substantially with the recovery of the species**

There is currently no recovery plan or recommendations for a recovery plan for the live-bearing seastar. However, the main management objectives for the recovery of the species have been outlined by Threatened Species Section (2023) and include:

- Prevent the loss or degradation of habitat supporting known subpopulations
- Identify new subpopulations of the species
- Increase the information and data available on the location, size and condition of known subpopulations; and
- Improve the understanding of the ecological requirements of the species.

As described in earlier sections above, the Project will result in the direct loss of small areas of low quality habitat for a known subpopulation of *P. vivipara* in Pitt Water. Indirect impacts could result in more widespread habitat loss and habitat degradation if appropriate mitigation measures are not implemented.

Investigations conducted for the Project have contributed to improved understanding of the ecological requirements of the species (Parsons, 2024b), have increased information and data available on the location, size and condition of known subpopulations (Parsons, 2024a,b) and have also identified a new subpopulation of the species (Parsons, 2024d).

Parsons (2024b) has identified a range of mitigation measures to minimise the risk of habitat loss and degradation as a result of the Project. These incorporate several options for habitat augmentation, which have the potential to create areas of new habitat which are of an areal extent exceeding the predicted area of habitat loss resulting from construction works that could effectivity contribute to increased habitat area and long-term conservation of the species. Successful implementation of identified measures, combined with a significant improvement in knowledge of the species as facilitated by the Project, has the potential to benefit species recovery more broadly.

**Conclusion**

The Project site consisting of the two causeways in Pitt Water supports a significant portion of the important Pitt Water population of the vulnerable live-bearing seastar. Detailed investigations of the causeway subpopulations, as well as subpopulations on neighbouring natural shorelines, has helped to identify key habitat requirements for the species as well as high quality habitats that are particularly important for conservation of the species. The proposed concept design has been developed which aims to avoid direct impacts on key habitats supporting high densities of *P. vivipara*.

Unavoidable habitat loss will occur in small areas of the Midway Point Causeway, while indirect impacts across larger areas of habitat could occur on either causeway as a result of water quality degradation, or modified sediment transport and hydrodynamic processes, if appropriate mitigation measures are not applied.

There is the potential for the Project to impact significantly on the vulnerable live-bearing seastar through a long term decrease in the size of an important population, reduction in the area of occupancy of an important population, fragmentation of an important population, adversely affecting habitat critical to the survival of the species, and modifying, destroying, removing, isolating or decreasing the availability or quality of habitat to the extent that the species is likely to decline. Parsons (2024b) has identified a range of mitigation measures to minimise the risk of these sources of significant impact. This includes measures to address potential indirect impacts, and also detailed approaches to replace habitat that will be unavoidably lost. Several options for habitat replacement have been identified, with detailed habitat augmentation trials indicating that receiver habitat for seastars, including those requiring translocation either as a result of temporary disturbance or anticipated longer-term habitat loss, can viably be created on the basis of an understanding of the species' habitat needs and detailed site-based investigations. Habitat augmentation is considered an essential measure for impact minimisation, due to existing habitats being at population capacity and unable to support individuals requiring translocation away from causeway habitats. Avoidance of a significant residual impact as a result of the Project is considered feasible upon implementation of the full range of measures identified.

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# Duplication of Midway Point and Sorell Causeways

## EPBCA Referral Information

Attachment A – Project Description and Significant Impact Assessment

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