



# Syngnathid Management Plan

SRF-West Priority Infrastructure  
Works Project

(EPBC Act approval 2024/10031)

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## Abbreviations, acronyms and definitions

Abbreviation / acronym	Definition
AUKUS	Australia, the United Kingdom and the United States
° C	Degrees Celsius
CEMP	Construction Environmental Management Plan
CIF	Controlled Industrial Facility
dB	Decibels
DBCA	Department of Biodiversity, Conservation and Attractions
DCCEEW	Department of Climate Change, Energy, Environment and Water
DPIRD	Department of Primary Industries and Regional Development
DWER	Department of Water and Environmental Regulation
EPBC Act	<i>Environment Protection and Biodiversity Conservation Act 1999</i>
GPS	Global positioning system
h	Hour
km	Kilometre
m	Metre
mm	Millimetres
mg/L	Milligrams per litre
NTU	Nephelometric turbidity units
PSU	Practical salinity units
SMART	Specific, measurable, achievable, relevant and time-bound
SRF-W	Submarine Rotational Force – West
SSN	Ship submersible, nuclear
WA	Western Australia

Words and terms	Definition in the Conditions Approval (EPBC 2024/10031)
<b>Action area</b>	Means the combined area encompassed by the <b>Armament Wharf Action area</b> and the <b>Careening Bay Action area</b> .
<b>Approved Action area</b>	Approval under the <i>Environment Protection and Biodiversity Act 1999</i> (EPBC Act), to undertake the Action outlined in EPBC 2024/10031, with effect until 31 May 2085, subject to the Conditions under the EPBC Act as set out in annexure A of the approval for EPBC 2024/10031.
<b>Armament Wharf Action area</b>	Means the area represented in Appendix A Map 1 and Map 2 by the zone designated in the legend as ' <b>Armament Wharf Action area</b> '. For maps, see EPBC Conditions of Approval 2024/10031.
<b>Asian Green Mussel</b>	Means the species Asian Green Mussel ( <i>Perna viridis</i> )
<b>Avoidance area</b>	Means the areas within the <b>Action area</b> represented in: Appendix A Map 2, Map 3 and Map 5 by the zones designated in the legend 'Seagrass avoidance area'. For maps, see EPBC Conditions of Approval 2024/10031.
<b>Biodiversity data</b>	Means ' <b>biodiversity data</b> ' as described in the Policy on Accessing and Sharing Biodiversity Data, Commonwealth of Australia 2024.
<b>Careening Bay Action Area</b>	Means the location represented in Appendix A Map 1 and Map 3 by the zone designated in the legend 'Careening Bay Action Area'. See EPBC Conditions of Approval 2024/10031.
<b>Carpet Sea Squirt</b>	Means the species Carpet Sea Squirt ( <i>Didemnum vexillum</i> ).

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Words and terms	Definition in the Conditions Approval (EPBC 2024/10031)
<b>Cockburn Sound</b>	means the location represented in Appendix A Map 1 of the EPBC approval by the zone designated 'Cockburn Sound'. For maps, see EPBC Conditions of Approval 2024/10031.
<b>Commencement of maritime works</b>	Means the first instance of marine works in the <b>Action areas</b> .
<b>Disturbance area</b>	Means any area subject to temporary or permanent modification within the <b>Action area</b> , be it by <b>clearing</b> , dredging, <b>piling</b> , or any other activity associated with the <b>Action</b> .
<b>eDNA or environmental DNA</b>	Means the genetic material left by organisms in the <b>environment</b> . eDNA is used to detect the presence of species and assess biodiversity.
<b>EPBC Act</b>	Means the <i>Environment Protection and Biodiversity Conservation Act 1999</i> (Cth).
<b>Harm or harmed</b>	Means to cause any measurable direct or indirect disturbance or deleterious change as a result of any activity associated with the Action.
<b>Maritime works</b>	Means any <b>construction</b> undertaken within the marine <b>environment</b> .
<b>Monitoring data</b>	Means the data required to be recorded under the Conditions of this approval, including <b>sensitive biodiversity data</b> .
<b>National Policy Guidelines for the Translocation of Live Aquatic Animals</b>	Means the <i>National Policy Guidelines for the Translocation of Live Aquatic Animals</i> , Commonwealth of Australia 2020.
<b>Piling</b>	Means the process of driving or boring deep, vertical structural elements (piles) into the ground to create a foundation or support structure.
<b>Protected matter</b>	Means a matter protected under a controlling provision in Part 3 of the <b>EPBC Act</b> for which this approval has effect.
<b>Relocate or relocating</b>	Means to move individuals from one location to another in a deliberate manner to maximise the chances of survival of the individuals in their new location.
<b>Salvage area</b>	Means the activities of locating, capturing and <b>relocating</b> individuals of a particular species to appropriate habitat outside of the <b>disturbance area</b> .
<b>Seagrass</b>	Means the areas within the <b>Action area</b> , represented in Appendix A Map 2, Map 5 of the EPBC approval by the zone designated in the legend 'Seagrass in Action area'. For maps, see EPBC Conditions of Approval 2024/10031.
<b>Seagrass avoidance area</b>	Means the areas within the <b>Action area</b> represented in Appendix A Map 2 and Map 3 by the zones designated in the legend 'Seagrass avoidance area'. For maps, see EPBC Conditions of Approval 2024/10031.
<b>Seagrass disturbance area</b>	Means the areas within the <b>Action area</b> , represented in Appendix A Map 5 by the zone designated in the legend 'Seagrass disturbance area'. For maps, see EPBC Conditions of Approval 2024/10031.
<b>Sensitive biodiversity data</b>	Means <b>biodiversity data</b> which, if released, published or otherwise exposed, may result in harm to the relevant protected matter as result of the intentional or unintentional misuse of that <b>biodiversity data</b> .
<b>Suitably qualified marine field ecologist</b> (for the purposes of Syngnathid translocation surveys and translocating collected Syngnathids)	Means a person who is authorised by the Western Australian Government to capture and handle wildlife, and who has relevant professional qualifications and at least 3 years of work experience implementing surveys and translocations for <b>Syngnathids</b> and can give an authoritative assessment and advice on the presence of <b>Syngnathids</b> .

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Words and terms	Definition in the Conditions Approval (EPBC 2024/10031)
<p><b>Suitably qualified Syngnathid ecologist</b> (for the purpose of preparing and implementing environmental management strategies)</p>	<p>Means a person who has relevant professional qualifications and:</p> <ul style="list-style-type: none"> <li>- at least 5 years of work experience designing and implementing surveys and translocations for <b>Syngnathids</b></li> <li>- at least 5 years of work experience writing and implementing management plans for <b>Syngnathids</b></li> <li>- at least 5 years of work experience with <b>Syngnathids</b>, with both aquaculture (capture and movement) expertise and an ecological (in-situ populations) expertise</li> <li>- can give authoritative assessment and advice regarding <b>Syngnathids</b> and <b>Syngnathid habitat</b> using relevant protocols, standards, methods and/or literature.</li> </ul>
<p><b>Syngnathid habitat</b></p>	<p>Means <b>seagrass</b> and/or growth such as macroalgae on submerged structures such as piles. Also submerged reef and bare sand areas.</p>
<p><b>Syngnathid</b></p>	<p>Means any animal belonging to the marine family <b>Syngnathidae</b> (including seahorses, pipefish and seadragons).</p>
<p><b>Translocation</b></p>	<p>The action of relocating Syngnathids for the purpose of undertaking translocation surveys as per the Conditions of Approval under EPBC 2024/10031.</p> <p>The human-mediated movement of living organisms from one area, with release in another (IUCN/SSC, 2013). Intentional translocations can address a variety of motivations, including for reducing population size, for welfare, political, commercial or recreational interests, or for conservation objectives. A translocation involves releasing organisms. Release here specifically excludes the act of placing organisms into Conditions that, for management purposes, differ significantly from those experienced by these organisms in their natural habitats. Translocation defined here does not relate to 'conservation translocations', rather it relates to 'salvage translocation'.</p>
<p><b>Translocation survey</b></p>	<p>Means the activities of locating and capturing <b>Syngnathids</b> for future translocation.</p>
<p><b>White colonial sea squirt</b></p>	<p>Means the species White colonial sea squirt (<i>Didemnum perlucidum</i>).</p>

# 1. Introduction

## 1.1 Project overview

Australia, the United Kingdom (UK) and the United States (US) have joined together through the AUKUS partnership to support a stable, secure and prosperous Indo-Pacific region. The AUKUS partners have identified an Optimal Pathway that will:

- deliver Australia a conventionally armed, nuclear-powered submarine (SSN) capability
- elevate all 3 nations’ industrial capacity to produce and sustain advanced and interoperable SSNs for decades to come
- expand the partner nations’ individual and collective presence in the Indo-Pacific and contribute to global security and stability in the region.

The first major initiative of the Optimal Pathway is the increased rotational presence of US and UK SSNs in Australia (Figure 1-1). This initiative is known as the Submarine Rotational Force – West (SRF-West).

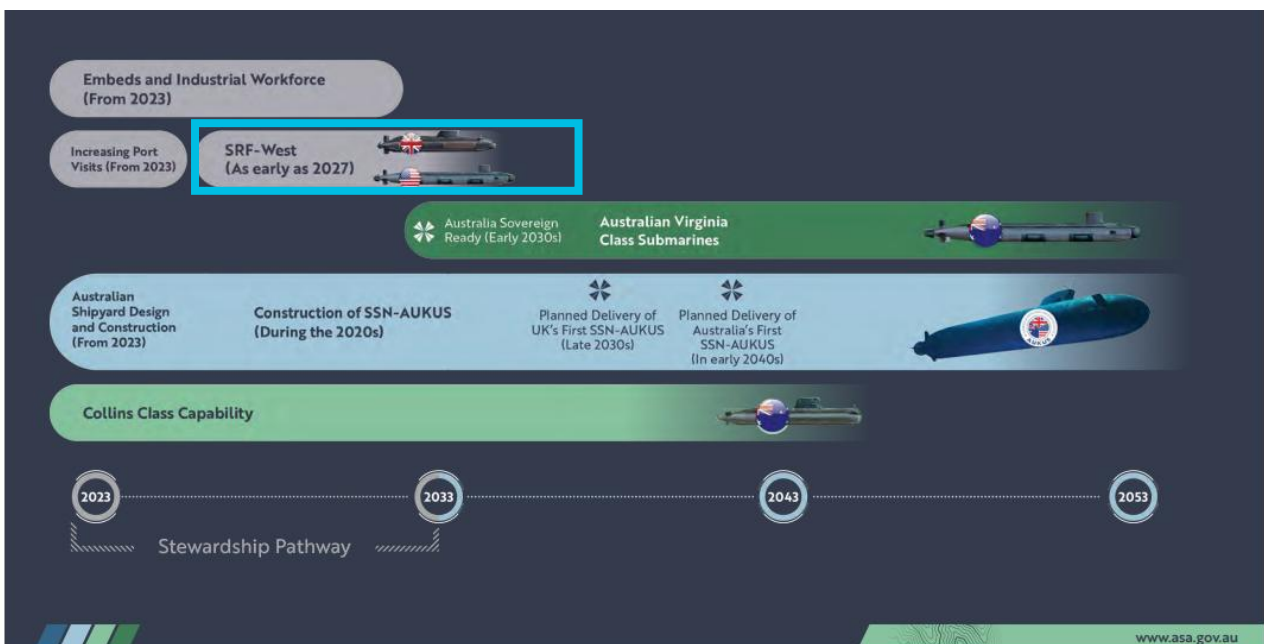


Figure 1-1 The AUKUS Optimal Pathway to Australia’s Nuclear-Powered Submarine Capability (Source: Australian Submarine Agency)

From as early as 2027, AUKUS partners will have a rotational presence at HMAS Stirling, which is located on Garden Island, also known as *Meeandip*, south-west of Perth in Western Australia (WA). One UK Astute Class and up to 4 US Virginia Class SSNs are expected to rotate through HMAS Stirling. SRF-West will help Australia build the necessary operational capabilities and skills so that Australia can safely and securely own, operate, maintain and regulate a fleet of SSNs from the early 2030s.

The Department of Defence (Defence) is responsible for delivering the priority infrastructure upgrades and enhancements at HMAS Stirling to accommodate AUKUS SSNs ready for SRF-West by 2027.

### 1.1.1 Location

The location of the Action is illustrated in Map 1 of the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) approval 2024/10031 and is situated within HMAS Stirling on Garden Island/*Meeandip*. The Action area approved in EPBC Act approval 2024/10031 comprises 2 areas, being the Careening Bay Action area and the Armament Wharf Action area.

Careening Bay, located on the south-eastern coastline of Garden Island/*Meeandip*, is the main operational centre of HMAS Stirling. The existing maritime infrastructure at Careening Bay includes Diamantina Pier, Parkes and Oxley Wharves, and Moresby Harbour. The landside components of the Action area include existing disturbed areas (i.e., roads, car parks, buildings), existing operational areas of Diamantina Pier, and areas of native vegetation. Sulphur Bay, located on north-eastern shoreline of Garden Island, is home to the Armament Wharf, which is exclusively used for the loading and unloading of Explosive Ordnances. Long term berthing is not permitted at the Armament Wharf.

## 1.1.2 Site layout and avoidance areas

Maritime infrastructure upgrade works are summarized in Table 1.1 and Action areas are provided in Figure 1-2 and Figure 1-3.

Table 1.1 Works summary

Location	Proposed works
<b>Diamantina Pier (Careening Bay)</b>	<ul style="list-style-type: none"> <li>– Removal of redundant fender frames and piles</li> <li>– Construction of new piles and associated fender frames</li> <li>– Bed leveling</li> </ul>
<b>Moresby Harbour (Careening Bay)</b>	<ul style="list-style-type: none"> <li>– Removal of timber piles</li> <li>– Construction of new pilings</li> <li>– Construction of floating pontoon including piling</li> <li>– Construction of mooring dolphin</li> <li>– Bed leveling</li> </ul>
<b>Armament Wharf (Sulphur Bay)</b>	<ul style="list-style-type: none"> <li>– Removal of redundant fender frames and piles</li> <li>– Construction of new piles and associated fender frames</li> <li>– Construction of a wharf extension including piling</li> <li>– Bed leveling</li> </ul>

## 1.2 The approved Action

The Project was referred under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) to the Department of Climate Change, Energy, the Environment and Water (DCCEEW) and assessed under the 'Preliminary Documentation' pathway.

Defence was granted approval with Conditions by DCCEEW for the proposed Action on 27 May 2025 (**EPBC Act approval 2024/10031**).

An 'Action' can include a project, development, undertaking, activity or series of activities, which may have a significant impact matter/s protected by the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). SRF-West is an approved Action following approval under the *Environment Protection and Biodiversity Act 1999* (EPBC Act), with effect until 31 May 2085. The Conditions of approval (EPBC 2024/10031) relevant to Syngnathids are outlined in Table 2.1.

## 1.3 Purpose of this Plan

The purpose of this Syngnathid Management Plan (SMP) is to meet the requirements of the EPBC 2024/10031 Conditions of Approval, specifically by providing a detailed strategy to:

1. minimise harm (direct or indirect disturbance or deleterious changed) as a result of any activity associated with the approved Action on Syngnathids (Condition 25)
2. translocate Syngnathids from the disturbance area to a suitable receiver site (Condition 25, Condition 27 and Condition 28)
3. contribute to Syngnathid knowledge in Cockburn Sound (Condition 26 e).

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This SMP has been prepared by suitably qualified Syngnathid ecologists as required by Condition 25 of EPBC 2024/10031 approval. The definition for a suitably qualified Syngnathid ecologist per the EPBC 2024/10031 approval is as follows:

*Suitably qualified Syngnathid ecologist (for the purpose of preparing and implementing environmental management strategies) means a person who has relevant professional qualifications and:*

- *at least 5 years of work experience designing and implementing surveys and translocations for Syngnathids*
- *at least 5 years of work experience writing and implementing management plans for Syngnathids*
- *at least 5 years of work experience with Syngnathids, with both aquaculture (capture and movement) expertise and an ecological (in-situ populations) expertise*
- *can give authoritative assessment and advice regarding Syngnathids and Syngnathid habitat using relevant protocols, standards, methods and/or literature.*

An overview of the suitably qualified Syngnathid ecologists' qualifications is provided in Table 1.2.

The maritime construction works areas for which this SMP applies is shown in Figure 1-2 and Figure 1-3 for the Careening Bay and Armament Wharf Action areas respectively.

This SMP is only to be used by the Department of Defence for the activities associated with approved Action (EPBC 2024/10031).

## 1.4 Subject matter experts and project advisors

### 1.4.1 Suitably qualified Syngnathid experts

This SMP has been developed with the suitably qualified Syngnathid ecologists as required by the EPBC 2024/10031 approval Conditions. Abridged biographies of the independent suitably qualified Syngnathid ecologists are provided in Table 1.2.

Table 1.2 Suitably qualified Syngnathid ecologists

Personnel	Abridged biography	Mapping against definition of suitably qualified Syngnathid ecologist and marine field ecologist (EPBC 2024/10031)
<p>Dr. Glenn Moore</p> <p><u>Education:</u></p> <p>PhD (Zoology)</p> <p>MSc (Research)</p> <p>BSc (Hons) (Zoology and Botany, MSc,</p>	<p>Position: Curator of Fishes, Department of Aquatic Zoology. Western Australian Museum.</p> <p>Adjunct Research Fellow, School of Animal Biology, University of Western Australia. Adjunct</p> <p>Experience: Glenn is an experienced ichthyologist; Glenn has been researching Western Australia's fishes for more than 30 years. He is the state's recognised authority for the identification and taxonomy of both marine and freshwater fish. He actively collaborates on many and diverse projects with a range of research agencies, government and community stakeholders. His research involves taxonomy, genetics, biodiversity, biogeography, ecology and evolution, with a proven publication record on fishes as well as other fauna and museology. Glenn is an experienced field-based researcher, including extremely remote marine and terrestrial regions, with proficiency in planning, collection and preservation methods, data collection and post-trip processes. He regularly uses outreach opportunities to engage with the public, raising awareness about fish through popular publications, media, public enquiries and citizen science initiatives.</p>	<p><i>Designing and implementing surveys and translocations for Syngnathids</i></p> <p>Glenn has been surveying Syngnathid fishes in a professional capacity since 1995. His research on the reproductive behaviour of the Western Australian Seahorse involves <i>in situ</i> surveys of multiple populations across the greater Perth metropolitan area. This includes population size estimates, sex ratio, home range mapping and breeding. This was intensive from 1995-2000 and 2007-2008 but continues intermittently.</p> <p>This project included constant handling of seahorses – hand capture, removal from water, collecting a range of morphometric data, attaching a collar tag, taking a small fin clip and sampling embryos from the pouch before returning to the site they were collected.</p> <p>Glenn has undertaken surveys for Syngnathids (especially seahorses and pipefishes) during extensive fish surveys across Western Australia. This includes Kimberley (across 14 years), Pilbara (5 years), Mid-west coast (3 years), South-west coast (30 years), South coast (10 years). These surveys include SCUBA, large and small trawl, seine, intertidal surveys and collections.</p> <p>Glenn provided expert advice to consultants undertaking Syngnathid surveys and translocations during infrastructure development for the Department of Defence Preston Point jetty in the Swan River in 2014/2015.</p> <p><i>Writing and implementing management plans for Syngnathids</i></p> <p>Glenn's role does not include writing management plans. His recent project (Spatio-temporal distribution of Syngnathids of Cockburn Sound) included detailed consideration of the impacts of port construction and ongoing activities on Syngnathids and recommendations for mitigation. This required compilation of contemporary literature on Syngnathid conservation risks and mitigation strategies from across the world.</p> <p>Glenn provided expert advice to consultants undertaking Syngnathid surveys and translocations during infrastructure development for the Department of Defence Preston Point jetty in the Swan River in 2014/2015.</p> <p><i>Experience with Syngnathids, with both aquaculture (capture and movement) expertise and an ecological (in-situ population) expertise</i></p> <p>Glenn has considerable experience with <i>in situ</i> observations of seahorse behaviour, comprising more than 800 hours on SCUBA. This includes population surveys, home range mapping, recording courtship and general ecological behaviours. As part of wide-ranging fish surveys, he also has <i>in situ</i> experience with other Syngnathids.</p>

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Personnel	Abridged biography	Mapping against definition of suitably qualified Syngnathid ecologist and marine field ecologist (EPBC 2024/10031)
		<p>He has considerable experience in handling of seahorses, including hand capture and release, removal from water, collecting a range of morphometric data, attaching collar tags, taking small fin clips and sampling embryos from the pouch. He has collected pipefishes from seines and trawls, undertaken basic measurements and released.</p> <p>Glenn has tagged and tracked hundreds of seahorses <i>in situ</i> to determine home-range movements. Glenn has also performed breeding experiments on seahorses in both aquaria (5 years) and <i>in situ</i> cages (2 years).</p> <p><i>Can give authoritative assessment and advice regarding Syngnathids and Syngnathid habitat using relevant protocols, standards, methods and/or literature</i></p> <p>As the State authority for fish identification, taxonomy and distribution, Glenn holds the most extensive knowledge on Western Australian Syngnathid fishes. Having recently completed a large meta-analysis of existing and new data for the Syngnathids of Cockburn Sound, he has demonstrated expertise for this region. He has substantial understanding of the challenges of surveying and collecting Syngnathid fishes including methodology, habitat preferences and seasonality. He established the citizen science initiative: <i>Seahorses pipefishes and seadragons of Western Australia</i>.</p>
<p>Dr. David Booth</p> <p><u>Education:</u> PhD (Zoology) MSc (Fish Biology) BSc (Zoology)</p> <p><u>Associations:</u> <i>Australian Coral Reef Society</i> AMSA <i>Australian Society of Fish Biology</i> <i>International Coral Reef Society</i></p>	<p>Position: Professor of Marine Ecology (University of Technology Sydney) and Research Associate (Sydney Institute of Marine Science)</p> <p>Experience: David is a highly cited marine researcher whose work over many years has heightened awareness of the impact of anthropogenic forces, such as pollution and climate change on fish.</p> <p>As a Professor of Marine Ecology, David has more than 180 papers on fish ecology, climate change and other anthropogenic impacts on fish and fisheries.</p> <p>David is a leader in Australia on fish, including Syngnathids. David's research focusses on the ecology and behaviour of threatened fishes such as seadragons and seahorses, black rockcod and white sharks. David's research spans artificial structures from understanding the positive and negatives of small artificial reef structures through to offshore oil and gas structures.</p> <p>David has shown leadership in Australian marine sciences, serving as President, Australian Coral Reef Society (2015-2017) President NSW Branch Australian Marine Sciences Association (2001-2004), Earthwatch</p>	<p><i>Designing and implementing surveys and translocations for Syngnathids</i></p> <p>David has 20 years' experience, of his total 45 years of experience, in the field of Syngnathid ecology including for the design and implementation of surveys and translocation advice for Syngnathids.</p> <p><i>Writing and implementing management plans for Syngnathids</i></p> <p>David has been the chief investigator for the 'co-restoration of Posidonia seagrass and White's Seahorse in NSW estuaries. As the only EPBC listed threatened species of Syngnathid, David is well versed in the writing and implementation of management plans for Syngnathids.</p> <p><i>Experience with Syngnathids, with both aquaculture (capture and movement) expertise and an ecological (in-situ population) expertise</i></p> <p>David has experience in over 20 projects in locations including eastern Australia, Pacific Islands, Caribbean. 1980-present, with a focus on ecology of fishes. He is a highly cited marine researcher whose work over many years has heightened awareness of the impact of anthropogenic forces, such as pollution and climate change, on fisheries. He is Professor of Marine Ecology in the School of Life Sciences at UTS, has published more than 200 papers about reef-fish ecology, climate change and other anthropogenic impacts on fishes and fisheries, in the Caribbean, Hawaii, and the Great Barrier Reef and is a strong advocate of sustainable fisheries and marine parks, and a supporter of citizen science.</p> <p><i>Can give authoritative assessment and advice regarding Syngnathids and Syngnathid habitat using relevant protocols, standards, methods and/or literature</i></p> <p>David has 45 years of experience in the field of fish ecology and behaviour including 20 years specifically in Syngnathid research.</p>

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<b>Personnel</b>	<b>Abridged biography</b>	<b>Mapping against definition of suitably qualified Syngnathid ecologist and marine field ecologist (EPBC 2024/10031)</b>
	<p>Scientific Advisory Committee (2016-present). and Chair SAC Sydney Institute of Marine Sciences (2011-2014). David is a member of the Sustainable Australian Seafood Assessment panel (2013-present), the Ocean Science Council of Australia (2015-present). He has been an invited speaker at the 12th International Coral Reef Symposium in 2012, the NSW Royal Society of Zoology 2008 and Australian Society of Fish biology 2010 (invited seminar and talk: climate change and fish distribution), ACRS Annual conference 2013 (Keynote speaker), and regularly speaks in public forums, such as Bondi Ocean Lovers' Festival and has an extensive media engagement.</p> <p>David is also a member of IUCN SSC Seahorse, Pipefish and Seadragon Specialist Group.</p>	

## 1.4.2 Independent consultation and review

GHD worked closely with the independent suitably qualified Syngnathid ecologists during development of the approach to Syngnathid management for the Project and in developing this SMP. Discussions and advice sought was formalised during the review of the SMP deliverable. Table 1.2 outlines the review history log for the suitably qualified Syngnathid ecologists used for external peer review and direction setting of this SMP.

*Table 1.3 Suitably qualified Syngnathid ecologists review history*

<b>Version</b>	<b>Reviewer</b>	<b>GHD response</b>
S3 (A) first external draft following two internal draft revisions	Dr. Glenn Moore – provided comments to GHD on 4 December 2025 Dr. David Booth – provided comments to GHD on 25 November 2025	GHD has actioned comments and provided second draft for external review in January 2026
S3 (B) second external draft following one external draft revision	Dr. Glenn Moore – provided comments to GHD on 5 February 2026 Dr. David Booth – provided comments to GHD on 27 February 2026	GHD has actioned comments and provided third draft for client review in March 2026.

## 1.5 Suitably qualified marine field ecologists

Translocation activities for Syngnathids are required to be undertaken by a suitably qualified marine ecologist under the guidance of the suitably qualified Syngnathid ecologist per Condition 28 of EPBC 2024/10031. The SMP and baseline survey was prepared in consultation with and supported by the suitably qualified marine ecologist personnel outlined in Table 1.4.

Table 1.4 Suitably qualified marine field ecologists

Personnel	Abridged biography	Mapping against definition of suitably qualified Syngnathid ecologist and marine field ecologist (EPBC 2024/10031)
<p>Dr. Justin Meager</p> <p><u>Education:</u>  <i>PhD, Marine Ecology</i>  <i>BASc(Hon, Marine Biology)</i>  <i>BASc(Ecology)</i></p> <p><u>Associations:</u>  <i>Australian Marine Sciences Association</i>  <i>World Wildlife Fund Marine Turtle Expert Advisory Panel</i></p>	<p>Position: Technical Director – Marine Ecology</p> <p>Experience: Justin is a leading technical director at GHD in the field of marine ecology with over 30 years of experience across academia, government and consulting in a wide range of marine environments. Justin has substantial experience in managing large, complex projects, across regulatory frameworks and conservation management of wildlife having held positions on numerous national and international working groups and expert advisory panels.</p> <p>Justin has extensive experience working on marine projects across a number of jurisdictions including Australia, Europe, the Middle East, Philippines and the Pacific. Justin has authored over 100 scientific articles/major reports/book chapters on topics including marine mammals, fishes, marine turtles, birds and marine invertebrates, the impacts of water quality, pollution, aquaculture, floods and noise on fauna. He has acted as an expert reviewer on grant applications, reports, regulations, strategic documents, recovery plans and on 107 scientific articles. Justin has also acted as an independent reviewer for DBCA in WA.</p>	<p>Justin has more than 30 years of experience as a marine field ecologist/ marine fish ecologist, and three years of fieldwork experience in Western Australia that includes translocation of Syngnathids. He is eligible to be authorised under the Western Australian Government for the capture and handling of wildlife.</p> <p>Justin will work under guidance and direction of Dr Glenn Moore and Dr David Booth. Prior to working at GHD, Justin was a senior marine scientist for the Aquatic Threatened Species Program for the Queensland Government for 11 years, where he was responsible for fishes and other threatened marine species. He was also responsible for approvals of translocation plans for threatened freshwater fishes. Justin’s postgraduate and postdoctoral research focused on fish, including Syngnathids. At GHD, Justin is responsible for technical review and guidance on environmental impact assessments and management plans for Syngnathids.</p>
<p>Madelaine Hooper</p> <p><u>Education:</u>  <i>MEnvSc</i>  <i>BEnvSc(Biology)(Environmental Monitoring)</i>  <i>BIntBus</i>  <i>BCom(Economics)</i></p> <p><u>Associations:</u>  <i>Environment Institute of Australia and New Zealand</i>  <i>Australian Marine Sciences Association</i></p>	<p>Position: Marine Science Lead – NSW</p> <p>Experience: Madelaine is one of GHD’s leading marine scientists with over 13 years’ experience across tier one consulting and specialist consulting firms and in scientific research. Madelaine has experience in large-scale, nationally and internationally significant environmental assessments and ecological monitoring programs delivered under international, Commonwealth and state regulatory frameworks. Madelaine has experience working on marine projects across numerous jurisdictions including Australia, Middle East and across the Pacific.</p> <p>Madelaine’s technical areas of expertise include technical direction and lead scientist, conservation management, design and implementation of complex ecological monitoring programs including targeted species assessment to fit regulatory and scientific objectives, marine ecology, habitat mapping, threatened species impact assessments, artificial reef design and marine pollution.</p>	<p>Madelaine has over 13 years of experience as a marine ecologist, relevant qualifications and is eligible to be authorised under the Western Australian Government for the capture and handling of wildlife. Madelaine has both led and contributed to Syngnathid in field surveys using diver, eDNA and netting based approaches, management plans, environmental approvals and permitting, relocation site scoping, translocations of populations of Syngnathids, the design and implementation of post relocation monitoring programs and the design and development of artificial habitat enrichment (i.e. seahorse hotels), including for species with no known basis of designs or relocation history. Madelaine is also a principal investigator under the Animal Ethics Committee.</p> <p>Madelaine can give an authoritative assessment and provide scientifically sound technical advice on site selection criteria, habitat requirements and appropriate translocation consideration and approaches. Madelaine has an in depth</p>

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Personnel	Abridged biography	Mapping against definition of suitably qualified Syngnathid ecologist and marine field ecologist (EPBC 2024/10031)
<p><i>Professional Association of Scientists and Engineers</i> <i>Australian Coastal Society</i></p>		<p>understanding of Syngnathid ecology having worked on a number of Syngnathid projects. A number of projects have involved the Commonwealth listed endangered White's Seahorse (<i>Hippocampus whitei</i>). Madelaine is competent to give an authoritative assessment and advice regarding Syngnathids and habitat using relevant protocols, standards, methods and/or literature.</p> <p>Madelaine will work under guidance and direction of Dr. Glenn Moore, Dr. David Booth and Dr. Justin Meager.</p>







Central multi user pontoon

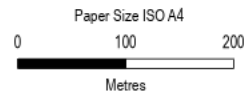
Controlled industrial area

Mooring Dolphin

Diamantina pier berthing, mooring and security upgrades

Southern boats harbour

- Legend**
-  Precinct Boundary
  -  Southern boats harbour
  -  Maritime construction works areas
  -  Controlled Industrial area



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 50



**DEPARTMENT OF DEFENCE**  
**SEA1010-1 USW SUPPORT FACILITIES AND**  
**INFRASTRUCTURE PROGRAM SRF-W PRIORITY WORKS**

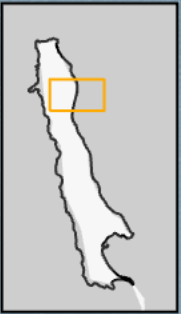
**SYNGNATHID MANAGEMENT PLAN**  
**SCOPE OF WORKS - CAREENING BAY**

Project No. **12613283**  
 Revision No. **A**  
 Date **14/04/2026**





**FIGURE 1.2**

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 Print date: 14 Apr 2026 - 10:04

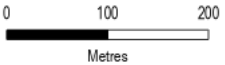
Data source: Human Geography Detail: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community  
 World Hillshade: Esri, Geoscience Australia, NASA, NOAA, USGS  
 Human Geography Label: Sources: Esri, TomTom, Garmin, FAO, NOAA, USGS, © OpenStreetMap contributors, and the GIS User Community



EO Pier dredging, upgrades and deployable services

- Legend**
-  Precinct Boundary
  -  Southern boats harbour
  -  Maritime construction works areas
  -  Controlled Industrial area

Paper Size ISO A4



Metres

Map Projection: Transverse Mercator  
Horizontal Datum: GDA2020  
Grid: GDA2020 MGA Zone 50



**DEPARTMENT OF DEFENCE**  
**SEA1010-1 USW SUPPORT FACILITIES AND**  
**INFRASTRUCTURE PROGRAM SRF-W PRIORITY WORKS**

**SYNGNATHID MANAGEMENT PLAN**  
**SCOPE OF WORKS - ARMAMENT**  
**WHARF**

Project No. **12613283**  
 Revision No. **A**  
 Date **14/04/2026**

**FIGURE 1.3**

## 2. Conditions of approval

The SMP has been prepared to address the relevant Conditions of approval under EPBC Act approval 2024/10031 relating to Syngnathid management including translocation. Table 2.1 summarises how each relevant Condition has been addressed in this Plan.

Bolded words and terms have definitions assigned to them per the EPBC 2024/10031 approval. The definitions are provided in the glossary at the front of this SMP.

Table 2.1 EPBC 2024/10031 Conditions of approval applicable to this Syngnathid Management Plan

Condition Number	Requirement	How this plan meets requirements	Section reference
25)	The approval holder must, before the <b>commencement of maritime works</b> , develop a detailed strategy to minimise <b>harm</b> to <b>Syngnathids</b> . The strategy must be prepared by a <b>suitably qualified Syngnathid ecologist</b> and must use best practice to translocate <b>Syngnathids</b> from the <b>disturbance area</b> to a receiver site such as natural habitat, or other suitable habitat, prior to the <b>commencement of maritime works</b> .	This plan has been developed and reviewed by marine scientists that meet the Conditions of approval definitions of suitably qualified marine field ecologist and/or suitably qualified Syngnathid ecologist in full or in part and outlines best-practice methods to minimise harm to Syngnathids prior to the commencement of maritime works. It includes pre-construction surveys, targeted capture, and translocation of individuals from the disturbance area to carefully selected receiver sites with comparable habitat Conditions (e.g., natural seagrass beds, macroalgal habitats, or fouled artificial structures such as wharf pilings).  Measures for pre-establishing receiver sites, minimising handling stress, and undertaking post-relocation monitoring are incorporated to ensure compliance with EPBC Act obligations and the specific Conditions of approval.	This SMP Section 1.5 Section 5
26)	The approval holder must ensure that all <b>maritime works</b> involving <b>Syngnathids</b> or <b>Syngnathid habitat</b> are planned and overseen by a <b>suitably qualified Syngnathid ecologist</b> . These activities must include:	This plan outlines how all maritime works involving Syngnathids or their habitats are planned and overseen by a suitably qualified Syngnathid ecologist. It details protocols for habitat assessment, pre-construction surveys, capture, and relocation, ensuring activities are conducted in line with best-practice methods and relevant legislative requirements.	This SMP Section 1.5
26) a)	Preparing a risk assessment for translocation, with consideration of the <b>National Policy Guidelines for the Translocation of Live Aquatic Animals</b> .	A detailed risk assessment for translocation has been prepared in accordance with the National Policy Guidelines for the Translocation of Live Aquatic Animals (DAFF, 2020). It identifies potential hazards, outlines mitigation measures, and specifies procedures to minimise stress, injury, and mortality, ensuring safe and effective relocation to suitable habitats.	Section 6 Section 6.8

Condition Number	Requirement	How this plan meets requirements	Section reference
26) b)	<p>Developing and overseeing baseline and monitoring surveys which include both diving and <b>environmental DNA (eDNA)</b> methodologies to:</p> <ul style="list-style-type: none"> <li>i. establish the baseline species presence, abundance and distribution within the <b>disturbance area</b>, and</li> <li>ii. monitor receiver sites at 1, 3, and 6 years following completion of the <b>maritime works</b>.</li> </ul>	<p>This plan includes baseline and monitoring surveys, using both diver observations and environmental DNA (eDNA) techniques, to document species presence, abundance, and distribution within the disturbance area before works commence. It also sets out a schedule for monitoring receiver sites at 1-, 3-, and 6-years post completion of maritime works.</p>	Section 4
26) c)	<p>Developing and overseeing the implementation of the translocation process, including <b>translocation surveys</b>.</p>	<p>This plan details the development and oversight of the entire translocation process by a suitably qualified Syngnathid ecologist, including the design and execution of pre and post translocation surveys. These surveys will identify individuals for relocation, confirm habitat suitability at receiver sites, and ensure the process follows best-practice methods to minimise stress, injury, and mortality as far as reasonably practicable.</p>	Section 4
26) d)	<p>Selecting and preparing appropriate receiver site locations, such as natural habitat or other suitable habitat.</p>	<p>This plan outlines the process for selecting and preparing suitable receiver sites, prioritising natural habitats or other locations with comparable environmental characteristics to the source site. Preparation may include installing artificial structures and allowing sufficient time for biofouling to provide immediate shelter and holdfasts for relocated Syngnathids.</p>	Section 6.9
26) e)	<p>Contribute to <b>Syngnathid</b> knowledge in <b>Cockburn Sound</b>. Prior to the <b>translocation surveys</b> in the <b>seagrass disturbance area</b>, the <b>Suitably qualified Syngnathid ecologist</b> must engage with West Australian Marine Science Institution (WAMSI) Westport Marine Science Program and investigate opportunities to collaborate during <b>translocation surveys</b> by contributing reference <b>Syngnathid</b> specimens to the <b>Cockburn Sound Syngnathid eDNA</b> library.</p>	<p>This plan proposes that GHD will be running the program in full while engaging with the West Australian Marine Science Institution (WAMSI) to seek local expertise and collaboration. The suitably qualified Syngnathid ecologist will coordinate with WA-based specialists during translocation surveys and share any non-sensitive biodiversity data to contribute to the Cockburn Sound Syngnathid eDNA library and broader regional knowledge, as far as reasonably practicable.</p>	Section 6
27)	<p>The approval holder must ensure a <b>translocation survey</b> is undertaken no earlier than 30 days prior to <b>harming</b> any <b>Syngnathid habitat</b>, to avoid Syngnathids recolonising the <b>disturbance areas</b>, in accordance with advice provided by a <b>suitably qualified Syngnathid ecologist</b>. <b>Translocation surveys</b> must include diving surveys of pylons, which are more effective at capturing seahorses, and</p>	<p>This plan proposes that translocation surveys are no earlier than 30 days prior to any activity that may harm Syngnathid habitat, in the aim that individuals do not recolonise the disturbance area between survey and impact. Syngnathid surveys will be completed in accordance with advice from a suitably qualified Syngnathid ecologist and will use diver surveys for piles and seagrass areas as the primary method. Supplementary methods to capture Syngnathid will be used for seagrass disturbance areas in accordance with advice from a suitably qualified Syngnathid ecologist.</p>	Section 6 Section 7

Condition Number	Requirement	How this plan meets requirements	Section reference
	<p>supplementary methods for more cryptic <b>Syngnathids</b> in <b>seagrass disturbance areas</b>, in accordance with advice provided by a <b>suitably qualified Syngnathid ecologist</b>.</p> <p><i>*Note: This is a variation to condition under review by DCCEEW. Draft agreed wording at the time of publication is reflected here.</i></p>	<p>This approach maximises detection rates across habitat types, reduces the risk of missed individuals, and ensures the timely and safe relocation of all Syngnathids present.</p>	
28)	<p>The approval holder must ensure that at a minimum, translocation activities are carried out by a <b>suitably qualified marine field ecologist</b>, under the guidance of the <b>suitably qualified Syngnathid ecologist</b>.</p>	<p>This plan outlines that translocation activities are undertaken by a suitably qualified marine field ecologist, working under the guidance of a suitably qualified Syngnathid ecologist. This approach supports the application of best-practice methods for handling, relocation, and surveys, with specialist oversight to reduce stress, injury, and mortality risks to Syngnathids.</p>	<p>Section 1.5 Section 1.6</p>

## 3. Background information

### 3.1 Legislative context

#### 3.1.1 EPBC Act

The EPBC Act is the Commonwealth Government's main environmental legislation and provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places defined as matters of national environmental significance.

Syngnathids, as defined as all species of the Syngnathidae Family (seahorses, seadragons and pipefish), are listed as 'Marine' species under the Section 248 of the EPBC Act.

Only one Syngnathid is listed as threatened by the EPBC Act, the White's Seahorse (*Hippocampus whitei*), which is endemic to the east coast of Australia with other Syngnathids under the Syngnathidae family as listed Marine Species under the Act. The White's Seahorse is not present at HMAS Stirling.

The EPBC Act recommends that relocation/translocation are impact mitigation strategies that may be considered for a listed marine species when an impact cannot be avoided and where it is feasible to move the species. Viewed from the lens of the mitigation hierarchy, translocation is one of the few alternatives remaining to manage Syngnathids when habitat needs to be removed or substantially modified. This is due to the families' inherent vulnerabilities in their biology and ecology. Syngnathids are generally poor swimmers considering their morphology and body characteristics, exhibit high site fidelity and limited home ranges which governs their reliance on sheltered environments. This is best known for seahorses, which typically have limited home ranges, although the movement ecology of most other Syngnathids has been poorly studied. Syngnathids are also vulnerable to noise and water quality impacts, in addition to direct habitat disturbance and/or removal.

#### 3.1.2 National Policy Guidelines for the Translocation of Live Aquatic Animals

The National Policy Guidelines for the Translocation of Live Aquatic Animals 2020 (DAFF, 2020) (The Policy) provides information on best practice for translocation activities and provides guidance on how to use a risk-analysis approach to assess possible impacts of translocation on live aquatic animals within Australia. In the context of the Policy and the project, translocation works would be considered a 'conservation translocation'.

The policy was used as a basis for the translocation risk assessment for the approved Action, discussed in Section 6.

#### 3.1.3 Biodiversity Conservation Act 2016 (WA)

The *Biodiversity Conservation Act 2016* and Biodiversity Conservation Regulations 2018 provide greater protection for biodiversity, particularly threatened species and threatened ecological communities. Section 13 of the Act provides protection for 'specially protected species', including species of special conservation interest, migratory species, cetaceans, species subject to international agreement and species otherwise in need of special protection.

All fauna and flora, regardless of their inclusion of the categories are protected in WA by the provisions of Part 10 of the BC Act for species, subspecies or populations of native animals. Within which, species are classified a conservation significance status, including critically endangered, endangered or vulnerable. Activities that take or disturb fauna more broadly require lawful authority under the BC Act.

Under the Act, Section 5 defines 'take' or 'disturb' to include the following:

- Killing, injuring or removing fauna.
- Engaging in activities that alter the natural behaviour of fauna to its detriment.
- The Department of Biodiversity, Conservation and Attractions (DBCA) administers the licensing system for activities that involve fauna including collection, possession and disturbance. No translocation approval is

required from DBCA as approval is only required for non-endemic species entering the State or non-endemic species being moved within WA.

There are no Syngnathids listed as threatened by the *Biodiversity Conservation Act 2016* (WA). The Leafy Seadragon (*Phycodurus eques*), is considered a Priority 2 ('poorly known species') in WA by the DBCA Priority Fauna List. Permit requirements are discussed in Section 6.3.

### 3.1.4 *Fish Resources Management Act 1994* and Fish Resources Management Regulations 1995 (WA)

The *Fish Resources Management Act 1994* and supporting Fish Resources Management Regulations 1995 regulate fishing, aquaculture, pearling and other aquatic resources in Western Australia. The Act provides protections for WA species that must not be taken by any means, with sections 46-48A providing specific protections against the taking, possession, sale, purchase, consignment or bringing into WA waters any protected fish species. All totally protected, commercially protection and recreationally protected fish are listed in Schedule 2 Part 1 – 3.

The Leafy Sea Dragon (*Phycodurus eques*) and Common Seadragon (*Phyllopteryx taeniolatus*) are also totally protected species under the *Fish Resources Management Act 1994* (WA), and subordinate Fish Resources Management Regulations 1995, which means that they protected from both recreational and commercial fisheries. There are also restrictions for certain species of fish, such as noxious or non-endemic fish species. The action of 'translocation' as provisioned under the Act is unlikely to trigger the requirements for translocation approval as the species are not being moved into State waters

## 3.2 Syngnathids in Cockburn Sound

### 3.2.1 General biology and ecology

The rigid body morphology and reduced fin structure, characteristic of Syngnathids, confer limited swimming capacity, constraining their ability to execute rapid escape responses from disturbance or predation events. Consequently, the primary antipredator strategy employed by Syngnathids involves crypsis and camouflage within their surrounding habitat. In accordance with this strategy, seahorses and certain pipefish species possess prehensile tails that facilitate attachment to structural elements including macrophytes, sponges, and bryozoans (Foster & Vincent, 2004). This morphological adaptation enables individuals to maintain positioning during periods of current flow and hydrodynamic disturbance from wave action.

Syngnathids are predominantly carnivorous, with diets consisting primarily of zooplankton and small nektonic organisms. Foraging strategies correspond closely with habitat preference and prey availability. Syngnathids employ active prey capture through either free-swimming or anchored positioning via prehensile tail attachment, consuming prey through suction-feeding mechanisms with their elongated snouts. Generally, species exhibiting shorter rostral morphology target benthic invertebrates within vegetated substrates or detrital accumulations on the seafloor, whereas long-snouted species preferentially consume pelagic prey including mysid crustaceans and other planktonic invertebrates within the water column (Claassens *et al*, 2018; Lourie, *et al*, 2019).

Syngnathids occupy demersal habitats and typically exhibit cryptic behaviour, with distributions concentrated in shallow to moderate depths on continental shelf waters. Habitats supporting maximal Syngnathid diversity and population density include seagrass meadows, coral reef systems, mangrove forests, macroalgal beds, and artificial structures within tropical and temperate coastal zones.

The majority of Syngnathid species exhibit monogamous mating systems within individual breeding cycles, though partner switching between successive cycles has been documented (Moore, 2001). Females transfer eggs to specialized brooding structures located on either the ventral abdomen or beneath the tail of conspecific males. Male parental care through brooding represents a universal characteristic among Syngnathids, though brooding structure morphology exhibits interspecific variation. Males provide exclusive parental investment throughout embryonic development. The incubation period ranges from 20 to 40 days, with duration inversely correlated with water temperature (Browne, 2008). Newly emerged juveniles are free-swimming and commence independent

feeding immediately post-hatching, with no subsequent parental care or offspring recognition observed. As mentioned, Moore (2004) noted that breeding potentially occurs year-round, with most reproductive activity occurring in spring and summer months.

Syngnathids are hearing generalists. Hearing generalists, in the context of bony fish, refers to species whose swim bladder is not involved in hearing because its swim bladder lacks connections to the inner ear or is not structurally adapted to amplify sound, meaning it relies on sensing sound's particle motion than pressure, unlike hearing specialists. Hearing generalists typically has a less sensitive hearing system capable to detecting a lower range and lower frequency sounds. On the other hand, hearing specialists often have a wider range of detection.

### 3.2.2 Syngnathids of conservation significance in the Approved Action Area

#### West Australian Seahorse

The West Australian Seahorse (*Hippocampus subelongatus*) is an endemic species restricted to southwestern Australia. This species exhibits broad habitat plasticity, inhabiting both natural and anthropogenic substrates including rocky reef margins, soft-bottom sediments, turbid environments, seagrass meadows (to 10 m depth during winter), and artificial structures such as pontoons and pilings. Consistent with Syngnathid ecology, *H. subelongatus* exhibits limited mobility and employs crypsis as a primary antipredator strategy.

The species demonstrates considerable chromatic polymorphism, with coloration corresponding to proximate sponge communities. Gestation duration ranges from two to three weeks, exhibiting thermal dependence, with brood sizes varying from 20 to 600 offspring (Moore, 2001).

The West Australian Seahorse has been documented extensively in the lower Swan River estuary, within seagrass meadows and anthropogenic structures of Cockburn Sound and Shoalwater Islands Marine Park. Within Cockburn Sound, the species has been recorded at Diamantina Pier during systematic surveys.

The West Australian Seahorse is anticipated to exhibit heightened vulnerability to anthropogenic stressors during the austral summer reproductive period (December–February) (Moore, 2001), with temporal variation in peak breeding activity observed interannually within this window.

The home range of the West Australian Seahorse is ~64 m<sup>2</sup> for unpaired females, ~94 m<sup>2</sup> for paired females, ~37 m<sup>2</sup> for unpaired and paired males (Kvarnemo *et al.* 2021). Assuming an approximately circular home range and the animals in the centre of that, this would be approximately 4.51 m for unpaired females, 5.47 m for paired females and 3.34 m for unpaired and paired males<sup>1</sup>. Accordingly, the species should be moved at 8 x the distance of paired females to be conservative (as this formula uses radius), being ~44 m from the location of the slipway or to the nearest artificial or natural habitat at least >44 m from the habitat to be removed.

**This species was recorded during the baseline survey (Section 4).**

#### Tiger Pipefish

The Tiger Pipefish (*Filicampus tigris*) is a demersal Syngnathid species, inhabiting shallow coastal waters of temperate Australia and occurs in Cockburn Sound. The species prefers to inhabit soft-bottom substrates including mud, sand, rubble and rocky environments in waters ranging from 2 to 30 m, typically in proximity to structurally complex habitats such as seagrass or sponges (Moore *et al.*, 2024). Within these habitats the species is afforded essential refugia from predation and optimal foraging habitat for small crustaceans.

Like other Syngnathids, the species exhibits male pregnancy, with males carrying eggs in a specialised brood pouch located beneath the tail (Kendrick and Hyndes, 2005). This species demonstrates monogamous mating behaviour, which has been documented as both obligate and genetically confirmed in Syngnathid fishes (Kendrick and Hyndes, 2005). The persistence of the Tiger Pipefish populations in Cockburn Sound occurs within the context of significant historical habitat degradation, with extensive seagrass loss in the mid-20<sup>th</sup> century from industrial development.

<sup>1</sup> A conversion of an area measurement (as two dimensional) to a linear distance (as one dimensional) can be estimated by calculating the radius of a circle. Assuming the home range is a circular area (noting that home ranges are likely an irregular shape governed by habitat and prey availability), a formula for the area of a circle has been adopted to find the radius expressed as a linear distance. The formula adopted was  $Area = \pi \times radius^2$ . Solving for radius, unpaired females is 4.51 m, paired females is 5.47 m and unpaired and paired males is 3.34 m.

The Tiger Pipefish also exhibits poor swimming ability, and its defined home range is not known.

**This species was recorded during the baseline survey (Section 4).**

**Pugnose Pipefish**

The Pugnose Pipefish (*Pugnaso curtirostris*) is endemic to southern Australia, where it occupies shallow seagrass meadows—primarily those dominated by Narrow-leaf Tapeweed (*Posidonia sinuosa*) and Leathery Tapeweed (*Posidonia coriacea*)—as well as eelgrass and algal assemblages within sheltered bays and estuarine environments (Moore *et al*, 2024). The species is typically found at depths of up to approximately 11 m, occurring in association with sponges, macroalgae, seagrass, and ascidians. Seasonal movements into deeper waters have been observed during winter, although individuals are generally recorded between 0 and 20 m in depth.

Life-history information for the species remains limited; however, within Cockburn Sound, reproductive activity has been documented from late spring through summer (November–February), with brood sizes ranging from 30 to 90 eggs (Moore *et al*, 2024).

The Pugnose Pipefish has been recorded along the eastern coastline of Garden Island, including observations from Careening Bay in 2022, and at sites near Woodman Point in 2019 and 2023 (GHD, 2024).

**This species was not recorded during the baseline survey.**

**Other Syngnathids with the potential to occur**

Cockburn Sound represents a distinctive coastal embayment in southwestern Australia, characterised by an uncommon geomorphological configuration comprising deep silt-dominated basis and seagrass dominated shallow waters close to the coastline and Garden Island. The combination of the above is not otherwise well represented in the region. Cockburn Sound supports a rich diversity of Syngnathids, with 21 species identified, including 2 species of seahorse, 16 pipefish, 1 pipehorse and 2 species of seadragon (Moore *et al*, 2024). This species richness is notably elevated relative to comparable Australian embayments. Moore *et al* (2024) identified the 21 species to include:

- Australian Smooth Pipefish (*Lissocampus caudalis*)
- Australian Long-Nosed Pipefish (*Vanacampus poecilolaemus*)
- Common Seadragon (*Phyllopteryx taeniolatus*)
- Gale’s Pipefish (*Campichthys galei*)
- Hairy Pipefish (*Urocampus carinirostris*)
- Javelin Pipefish (*Lissocampus runa*)
- Knobby Seahorse (*Hippocampus tuberculatus*)
- Leafy Seadragon (*Phycodurus eques*)
- Mother Of Pearl Pipefish (*Vanacampus margaritifer*)
- Port Phillip Pipefish (*Vanacampus phillipi*)
- Prophet’s Pipefish (*Lissocampus fatiloquus*)
- Pugnose Pipefish (*Pugnaso curtirostris*)
- Rhino Pipefish (*Histiogamphelus cristatus*)
- Ring-Backed Pipefish (*Stipecampus cristatus*)
- Sawtooth Pipefish (*Maroubra perserrata*)
- Southern Pygmy Pipehorse (*Idiotropiscis australe*)
- Spotted Pipefish (*Stigmatopora argus*)
- Tiger Pipefish (*Filicampus tigris*)
- West Australian Seahorse / Tiger Snout Seahorse (*Hippocampus subelongatus*)
- Western Crested Pipefish (*Mitotichthys meraculus*)
- Wide-Bodied Pipefish (*Stigmatopora nigra*).

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Syngnathid assemblages within Cockburn Sound exhibit year-round occupancy across all available habitats, with individual species demonstrating variable degrees of habitat specialisation. Seagrass meadows constitute important habitat for Syngnathids, particularly those dominated by *Posidonia sinuosa* and *P. coriacea*, though artificial structures and natural reef systems provide important habitat resources. Moore *et al* (2024) identified that the Spotted Pipefish (*Stigmatopora argus*) and the Widebody Pipefish (*S. nigra*), as the most abundant species, both of which demonstrate strong associations with seagrass beds. Additionally, Moore *et al* (2024) documented that the West Australia Seahorse (*Hippocampus subelongatus*) exhibited a pronounced affinity for artificial structures, specifically bio fouled piles, with Cockburn Sound supporting one of three major populations of this endemic, range-restricted species (Moore *et al*, 2024). Habitat preferences for key Syngnathids in the region are provided in Table 3.1.

Breeding appears to be year-round for most Syngnathid species occurring in Cockburn Sound, with a peak in summer and spring.

This SMP relates to translocation of Syngnathids, but details of impact avoidance and mitigation are available in Appendix B, Section 5.3.4 of the Environment and Heritage Assessment (GHD 2024).

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Table 3.1 Key Syngnathid species in Cockburn Sound

Common name	Scientific name	EPBC Act listing / BC Act DBCA (WA)	Habitat preferences (derived from Moore <i>et al</i> , 2024)	Recorded in approved action area during baseline survey (eDNA or visual diver surveys)
Australian Smooth Pipefish	<i>Lissocampus caudalis</i>	M	<i>Posidonia coriacea</i> , <i>Posidonia</i> undefined, <i>Amphibolis</i> spp., other seagrass, reef, sponge, sand, mud, rubble	Not detected
Australian Long-nosed Pipefish	<i>Vanacampus poecilolaemus</i>	M	<i>Posidonia coriacea</i> , <i>Posidonia sinuosa</i> , sponge, sand, mud, rubble	Not detected
Bonyhead Pipefish	<i>Nannocampus subosseus</i>	M	Seagrass, algae dominated reefs	Not detected
Common Seadragon	<i>Phyllopteryx taeniolatus</i>	M	<i>Posidonia coriacea</i> , <i>Posidonia sinuosa</i> , <i>Amphibolis</i> spp., other seagrass, algae, reef, sand, sponge, mud, rubble	Not detected
Gale's Pipefish	<i>Campichthys galei</i>	M	Sand, algae, reef, sponges, mud, rubble	Not detected
Gunther's Pipehorse	<i>Solegnathus lettiensis</i>	M	Deeper waters, sponges, reef, corals	Not detected
Hairy Pipefish	<i>Urocampus carinirostris</i>	M	Other seagrass	Not detected
Javelin Pipefish	<i>Lissocampus runa</i>	M	<i>Posidonia sinuosa</i> , <i>Posidonia</i> unidentified, other seagrass, algae, reef, sponge, sand, mud, rubble	Not detected
Knobby Seahorse	<i>Hippocampus tuberculatus</i> ( <i>Hippocampus breviceps</i> )	M	<i>Posidonia coriacea</i> , <i>Posidonia sinuosa</i> , <i>Amphibolis</i> spp., algae, reef, sponge, sand, mud, rubble, jetties/wrecks	Not detected
Leafy Seadragon	<i>Phycodurus eques</i>	M / P2 <sup>2</sup>	<i>Posidonia</i> spp., algae, reef, jetties/wrecks	Not detected
Mother-of-pearl Pipefish	<i>Vanacampus margaritifer</i>	M	<i>Posidonia sinuosa</i> , <i>Posidonia</i> undefined, other seagrass, algae	Not detected
Port Phillip Pipefish	<i>Vanacampus phillipi</i>	M	<i>Posidonia coriacea</i> , <i>Posidonia sinuosa</i> , <i>Amphibolis</i> spp., other seagrass, reef, sponge, sand, mud, rubble	Not detected
Prophet's Pipefish	<i>Lissocampus fatiloquus</i>	M	<i>Amphibolis</i> spp., algae, reef, sponge, sand, mud, rubble, jetties/wrecks	Not detected
Pugnose Pipefish	<i>Pugnaso curtirostris</i>	M	<i>Posidonia coriacea</i> , <i>Posidonia sinuosa</i> , <i>Amphibolis</i> spp., other seagrass, algae, reef, sand, sponge, mud, rubble, jetties/wrecks	Not detected
Rhino Pipefish	<i>Histiogamphelus cristatus</i>	M	<i>Posidonia coriacea</i> , <i>Posidonia sinuosa</i> , <i>Amphibolis</i> spp., reef, sponge, sand, mud, rubble, jetties/wrecks	Not detected
Ringback Pipefish	<i>Stipecampus cristatus</i>	M	<i>Posidonia coriacea</i> , <i>Posidonia sinuosa</i> , <i>Amphibolis</i> spp., other seagrass, algae, reef	Not detected

<sup>2</sup> P2 is not a listing category under the BC Act but designates a priority, poorly known species

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Common name	Scientific name	EPBC Act listing / BC Act DBCA (WA)	Habitat preferences (derived from Moore <i>et al</i> , 2024)	Recorded in approved action area during baseline survey (eDNA or visual diver surveys)
Sawtooth Pipefish	<i>Maroubra perserrata</i>	M	Reef, jetties/wrecks	Not detected
Short-head Seahorse	<i>Hippocampus breviceps</i>	M	Other seagrass, algae, reef, sponge, sand, mud, rubble, jetties/wrecks	Not detected
Southern Pygmy Pipehorse	<i>Idiotropiscis australe</i> ( <i>Acentronura australe</i> )	M	Other seagrass, algae, reef, sponge, sand, mud, rubble, jetties/wrecks	Not detected
Spotted Pipefish	<i>Stigmatopora argus</i>	M	<i>Posidonia coriacea</i> , <i>Posidonia sinuosa</i> , <i>Amphibolis</i> spp., other seagrass, algae, reef, sand, sponge, mud, rubble, jetties/wrecks	Not detected
Tiger Pipefish	<i>Filicampus tigris</i>	M	<i>Amphibolis</i> spp., algae, reef, sponge, sand, mud, rubble, jetties/wrecks	<b>Detected: Visual</b>
West Australian Seahorse	<i>Hippocampus subelongatus</i> ( <i>Hippocampus angustus</i> )	M	<i>Posidonia coriacea</i> , <i>Posidonia sinuosa</i> , algae, reef, sponge, sand, mud, rubble, jetties/wrecks	<b>Detected: Visual eDNA</b>
Western Crested Pipefish	<i>Mitotichthys meraculus</i>	M	<i>Posidonia coriacea</i> , other seagrass, reef, sponge, sand, mud, rubble	Not detected
Widebody Pipefish	<i>Stigmatopora nigra</i>	M	<i>Posidonia coriacea</i> , <i>Amphibolis</i> spp., other seagrass, algae, reef, sand, sponge, mud, rubble, jetties/wrecks	Not detected

### 3.2.3 Potential for harm to Syngnathids from the approved Action

Syngnathids represent a family of marine fish with unique vulnerabilities. As Syngnathids are slow-moving, have high site fidelity and range restriction, exhibit a strong dependence on structurally complex habitats, such as seagrass, rocky reef, sponges and increasingly artificial structures, Syngnathids are particularly vulnerable to disturbance. The planned development activities, including substrate modification pose a potential threat of habitat degradation, mobilisation of potentially contaminated sediments, increased turbidity, acoustic and vibrational disturbances and declining water quality. Secondary impacts from nearby land clearing to facilitate the construction of the Controlled Industrial Facility (CIF) may exacerbate these impacts. Such pressures are likely to result in direct disturbance in the way of injury or mortality and sub-lethal impacts such as disturbed foraging activity and availability, declining body condition, reduced breeding attempts or success to Syngnathids resident to the Action area.

The approved Action areas and disturbance footprint encompass known habitat for the West Australian Seahorse, notably on piles at Diamantina Pier. The Tiger Pipefish was also noted during the baseline survey. The approved Action areas are also neighbouring natural seagrass meadows, particularly at Armament Wharf.

The following disturbance pathways have the potential to cause harm and/or injury to Syngnathids in the action area:

- Increased sedimentation can smother seagrass beds, affecting the foraging grounds and refuge habitats for Syngnathids.
- Contaminant mobilisation from disturbed sediments and land based run off can release disruptive chemicals into the water column for uptake by Syngnathids and their prey.
- Noise and vibration created from piling activity and bed levelling, in addition to increased vessel traffic noise. Syngnathid.
- Direct physical disturbance from construction vessels and equipment.
- Habitat loss and modification will result from piling activity and dredging.
- Hydrological changes may result from alterations to water flow and sediment dynamics from construction that can affect the distribution or habitats and prey availability.

The primary mitigation strategy for Syngnathids consists of a translocation and post-translocation monitoring program. Translocation will involve the targeted capture and transfer of individuals to an ecologically suitable receiver site. When implemented in accordance with a species-specific protocol developed by suitably qualified Syngnathid ecologists and marine field ecologists this approach is expected to materially reduce direct impacts on Syngnathids. Translocation also involves inherent risk, principally related to acute handling and transport stress, potential mechanical injury due to the fragile morphology and short-term alterations to behavioural patterns such as courtship and breeding.

To minimise these indirect impacts, receptor sites will be selected based on close environmental equivalence to the source habitat, including parameters such as depth, hydrodynamic regime (e.g. dominant current speed and direction), and structural complexity. Where artificial habitats are required as supplementary, they will be deployed 3-4 months prior to relocation to allow biofouling and the development of epibiotic communities, thereby enhancing habitat suitability and attachment opportunities for the species.

Ongoing post-translocation monitoring will be incorporated into the program to confirm the survivorship, behaviour and habitat use of relocated individuals, and to assess the magnitude and duration of any stress related indirect impacts. The disturbance pathways, biological sensitivities and overarching mitigation strategy outlined is applicable to all Syngnathids. Nuance will be required for each species anticipated to be encountered during the relocation effort.

### 3.3 Syngnathid Management Plan Approach

This section outlines the framework underpinning the SMP, which serves as the primary directive for Syngnathid management throughout the construction phase of the approved Action and the post-translocation monitoring until 6 years following the completion of the approved Action.

In accordance with the National Policy Guidelines for the Translocation of Live Aquatic Animals (DAFF, 2020), effective translocation projects require a phased implementation approach. The SMP methodology facilitates systematic risk assessment and enables adaptive management of the SMP throughout its execution.

The SMP is consequently structured across five distinct phases, as described below and illustrated in Figure 3-1:

- Phase 1: Baseline Survey  
Establishment of baseline Syngnathid populations, with particular focus on sites subject to potential disturbance from the approved action (Section 4).
  
- Phase 2: Syngnathid Management Plan  
Development of the SMP (this document), incorporating Phase 1 baseline survey data and informed by consultation with relevant subject matter experts (this document; additional detail provided in Section 5).
  
- Phase 3: Translocation  
Execution of the SMP, including implementation of the translocation program as specified within the SMP with embedded adaptive management.
  
- Phase 4: Pre-clearance surveys  
Conduct pre-clearance surveys in accordance with the Conditions with embedded adaptive management (Section 7.3).
  
- Phase 5: Post-translocation monitoring  
Post-translocation monitoring and reporting activities with embedded adaptive management (Section 7.2).

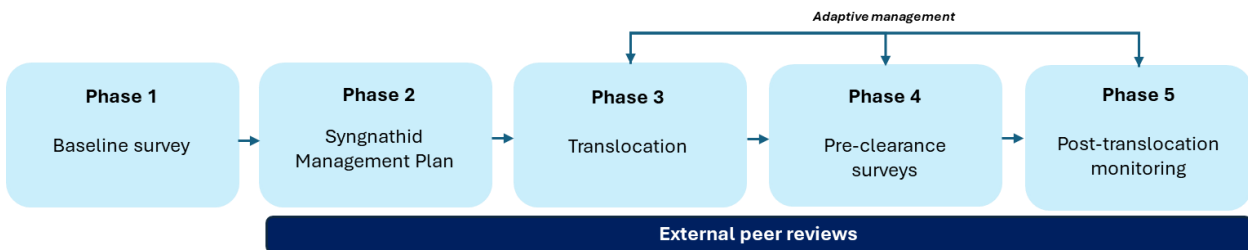


Figure 3-1 Phased approach of Syngnathid management for SRF-W

## 4. Phase 1 - Baseline survey

### 4.1 Objective

A baseline Syngnathid survey was undertaken in July and August 2025 by suitably qualified marine field ecologists. The aim of the baseline survey was to investigate the spatial distribution, biodiversity and abundance of Syngnathids within and surrounding both the approved Action areas and potential relocation area. The results of the survey have been used to inform and plan the mitigation measures required to protect Syngnathids during the Action.

### 4.2 Methods

#### 4.2.1 Approach

Development of survey methods to satisfy EPBC Act approval 2024/10031 Condition 26) b) require development of a baseline monitoring survey. Several methods are available for baseline surveys. The suitability of these methods and ultimate rationale of the method selected is outlined below.

Quantitative sampling of small, cryptic Syngnathids species present significant methodological challenges. Traditional techniques such as trawling and seine netting have limited efficacy in the vicinity of artificial structures due to gear constraints and habitat complexity.

Standardised diver-based visual census methods have been developed in recent decades and are now routinely employed for monitoring the threatened White's Seahorse (*Hippocampus whitei*) on the east coast of Australia (Harasti *et al*, 2012; Harasti, D., 2014; Harasti *et al*, 2014; Claassens and Harasti, 2020). This method has also been used to survey Syngnathids in the Cockburn Sound area (Moore *et al*, 2024). A key advantage of visual census techniques is their non-invasive nature, as they do not require physical capture of individuals. The standard protocol involves diver surveys conducted at a constant swim speed over a fixed duration, typically 60 minutes (Harasti *et al*, 2014). Survey designs may employ either haphazard but independent search paths (Harasti *et al*, 2014), or using a more structured survey approach (i.e. transect-based).

Visual survey methods have demonstrated limitations in detecting small, cryptic and/or nocturnal Syngnathid species, particularly pipefish, which are often underrepresented in visual surveys (Moore *et al*, 2024). This limitation is particularly pronounced when survey effort is concentrated on seahorse-associated habitats such as artificial structures. To address these methodological constraints, the baseline survey employed a multi-method approach comprising three complementary techniques:

1. Visual diver-led swim survey following a 50 m transect tape.
2. Visual diver-led survey searching a sub-set of piles at action areas of Diamantina Pier, Moresby Harbour and Armament Wharf with a focus on those frames proposed to be impacted during the approved action.
3. Environmental DNA (eDNA) supplementary samples.

eDNA methods are now routinely applied in biodiversity monitoring across diverse ecosystems both within Australia and internationally. In marine environments, eDNA sampling serves as a valuable complement to conventional survey techniques due to its capacity to detect cryptic or low-abundance species, although its application may be constrained by the availability of species-specific genetic markers and a validated DNA reference library.

Pursuant to Condition 26) of the approval Conditions, eDNA sampling is required for both baseline surveys and subsequent monitoring.

## 4.2.2 Survey overview

Diver support was used for the survey, provided by Indianic Group. The survey was completed over an 8-day survey period, with divers operating on a rotating basis. Divers conducted concurrent searches within pre-defined survey areas encompassing existing artificial structures (piles), adjacent benthic substrata and seagrass habitats throughout the proposed action areas and disturbance footprints.

Three candidate relocation (receiver) sites were selected using existing habitat maps and were assessed for suitability via visual inspection. Site suitability criteria included extant Syngnathid density, species diversity, and known ecological and habitat requirements for each species of consideration identified during the baseline survey. The suitability of placement of artificial habitats (*sensu* Simpson *et al.* 2020) was also considered during the baseline survey where possible. This was undertaken by a review of the general benthic condition, depth and distance from action areas.

The transects used in the underwater visual surveys were 50 m long and were laid out using a plastic measuring tape held in place by dive weights. Divers focussed on searching for cryptic fauna and gently disturbed macrophytes to elicit movement of cryptic species. Search effort along each transect was standardised by divers maintaining a constant swimming speed and a fixed dive duration (of 60 minutes). The species, number and location of individuals along the transect line was recorded during dives and used to estimate density. A total transects width of approximately 2 m (1 m either side of the transect line) were searched.

A subset of the total piles across HMAS Stirling were also searched. One pile was searched by each diver systematically from the sea surface to the sea floor. At 1 m depth intervals, the full circumference of each pile was searched for a total of 2 minutes, each 1 m of vertical height. This approach allowed for a standard survey effort across piles, regardless of depth. For instance, a pile that was 10 m in length was searched for 20 minutes, while a pile that was 15 m in length was searched for 30 minutes, excluding the 4-minute search of the substrate on the seafloor at a 1 m radius from the pile. Piles at Armament Wharf (n=8), Moresby Harbour (n=6), Oxley Wharf (n=8), Parkes Wharf (n=8) and Diamantina Pier (n=23) were searched.

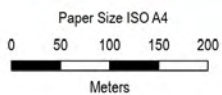
For this project, eDNA sampling involved a total of 22 marine water samples (7 at Diamantina Pier, 7 at Moresby Harbour and 7 at Armament Wharf) in addition to a field negative. Samples were taken at using a Smith-Root Citizen Science eDNA Sampler (pump) with 5µm Smith-Root self-preserving filters and were taken from depths ranging from 3 – 15 m to align with the habitat depth ranges of Syngnathids.

One field negative sample was also collected using tap water in order to identify the presence of any contamination in the field sampling process. Filtration was undertaken on-site to reduce DNA degradation during transport of water samples (Yamanaka *et al.* 2016). Filters were stored out of sunlight and at ambient temperature before being transported to the laboratory for processing. Filters were sent to EnviroDNA for analysis, where DNA was extracted from the filters and library construction involved to rounds of Polymerase Chain Reactions (PCR), whereby the first round employed a panel of gene-specific primers targeting Marine Fish (MiFish, Miya *et al.* 2015) and Syngnathidae (16s\_fish\_syn\_short; Nester *et al.* 2020) and the second round incorporated sequencing adapters and unique barcodes for each sample-amplicon combination included in the library. Full details are provided in Appendix A.

The locations of the survey sites, including pile inspections, transect lines and eDNA locations across both the action areas and the potential relocation areas are provided spatially in Figure 4-1 to Figure 4-16. The details of the survey design are summarised in Table 4.1.

Table 4.1 Survey design details

	Details
<b>Survey days / dates</b>	8 days = 24 July, 25 July, 28 July, 29 July, 30 July, 31 July, 1 August, 2 August
<b>Number of divers</b>	6
<b>Transect length (m) / width (m)</b>	50 L, 2 (1 m either side) W
<b>Transect area (m<sup>2</sup>)</b>	100 m <sup>2</sup>
<b>Number of transects</b>	17
<b>Swim speed (transects)</b>	1.67 m per minute
<b>Survey duration per transect (min)</b>	30 (2 divers, total effort per transect = 60)
<b>Number of piles</b>	53
<b>Pile length (m) as range</b>	3 – 17
<b>Pile width (m) as range</b>	Diamantina Pier provided as '760 x 14 CHS' meaning 760 mm diameter x 14 mm wall thickness circular hollow section. Circumference calculated using $C = \pi d$ , being $C = 238.89$ cm (2.39 m). Pile sizes are consistent at Diamantina Pier. Moresby Harbour has 2 sizes: 135 cm (1.35 m) and 146 cm (1.46 m) CHS.
<b>Swim speed (piles)</b>	2 minutes per 1 m, 4-minute search of substrate at base of pile at a distance of 1 m out from the pile



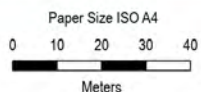
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Horizontal Datum: GDA2020  
Grid: GDA2020 MGA Zone 50



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**SYNGNATHID SURVEY - JULY 2025**  
**ARMAMENT WHARF**

Project No. 1213283  
Revision No. F  
Date 27/03/2026

**FIGURE 4.1**



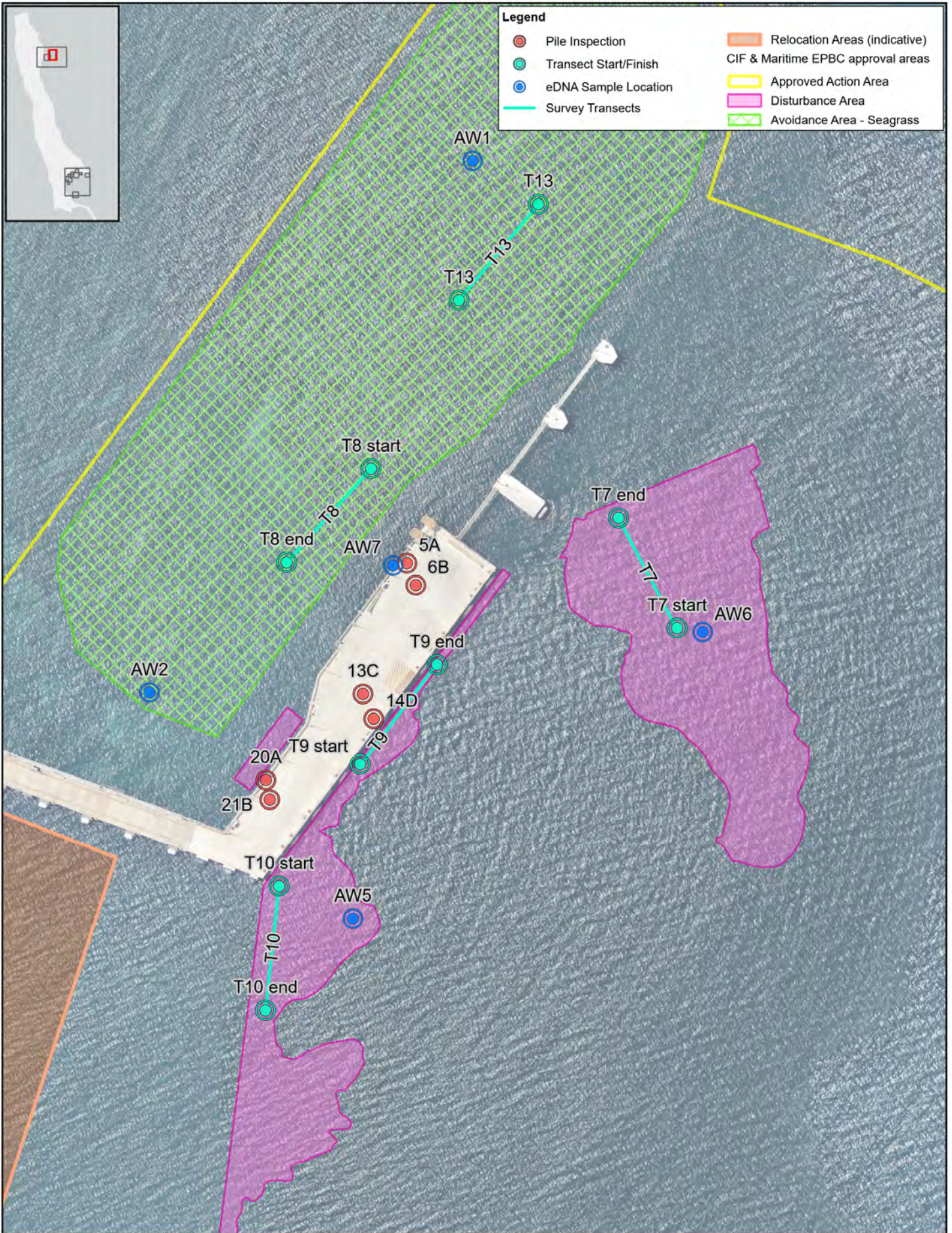
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**FIGURE 4.2**



**Legend**

- Pile Inspection
- Transect Start/Finish
- eDNA Sample Location
- Survey Transects
- Relocation Areas (indicative)
- CIF & Maritime EPBC approval areas
- Approved Action Area
- Disturbance Area
- Avoidance Area - Seagrass

Paper Size ISO A4  
 0 10 20 30 40  
 Meters

Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 50

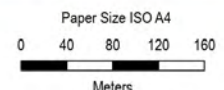


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**FIGURE 4.3**



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**SYNGNATHID SURVEY - JULY 2025  
CAREENING BAY**

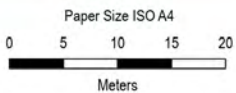
**FIGURE 4.4**



**FIGURE 4.5**



- Legend**
- Pile Inspection
  - Transect Start/Finish
  - eDNA Sample Location
  - Survey Transects
  - CIF & Maritime EPBC approval areas
  - Approved Action Area

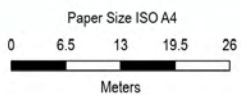


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**SYNGNATHID SURVEY - JULY 2025**  
**PARKES WHARF STH**

**FIGURE 4.6**



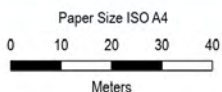
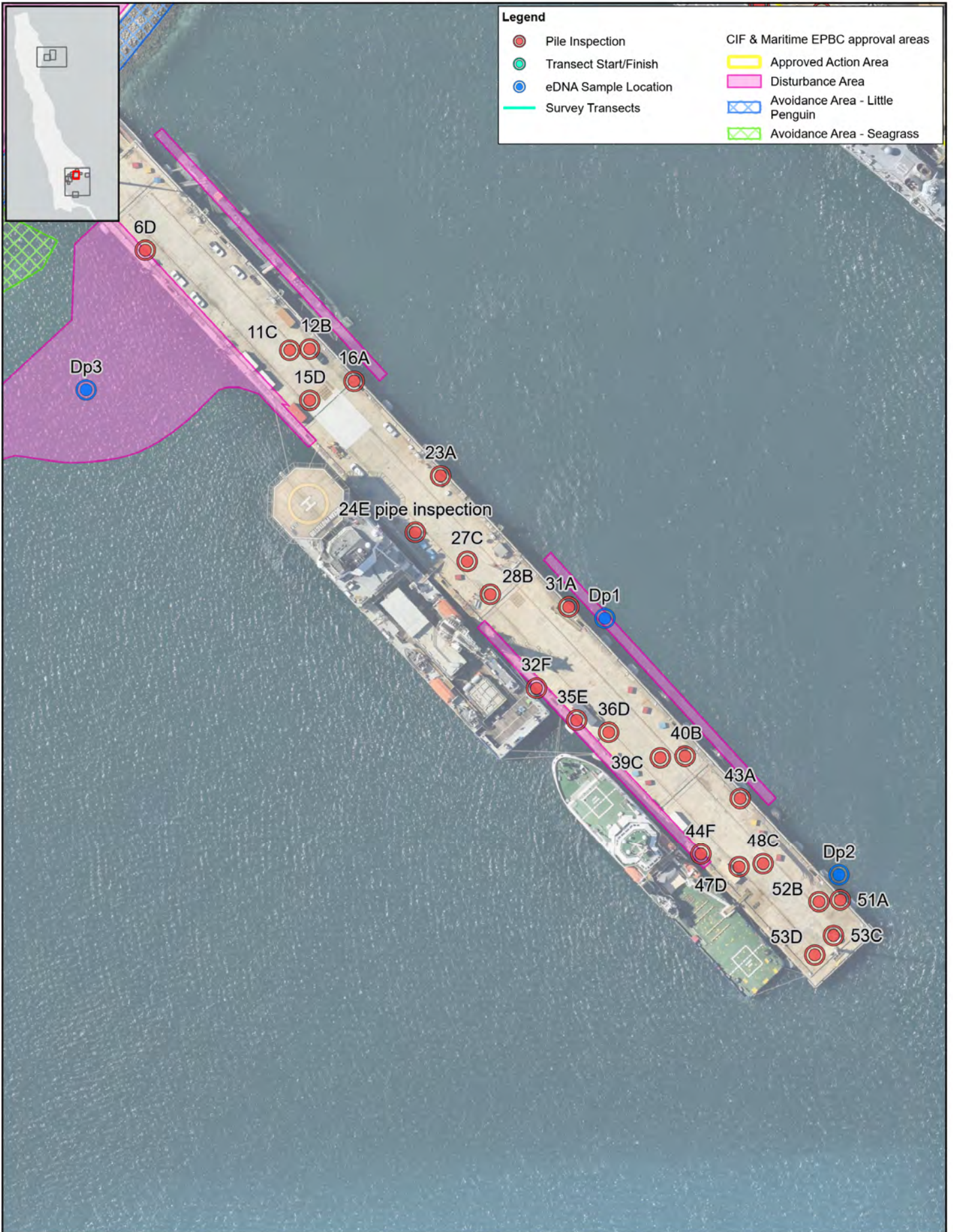
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**FIGURE 4.7**



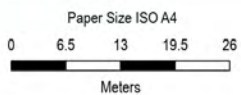
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**FIGURE 4.8**



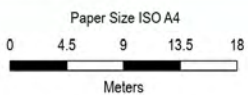
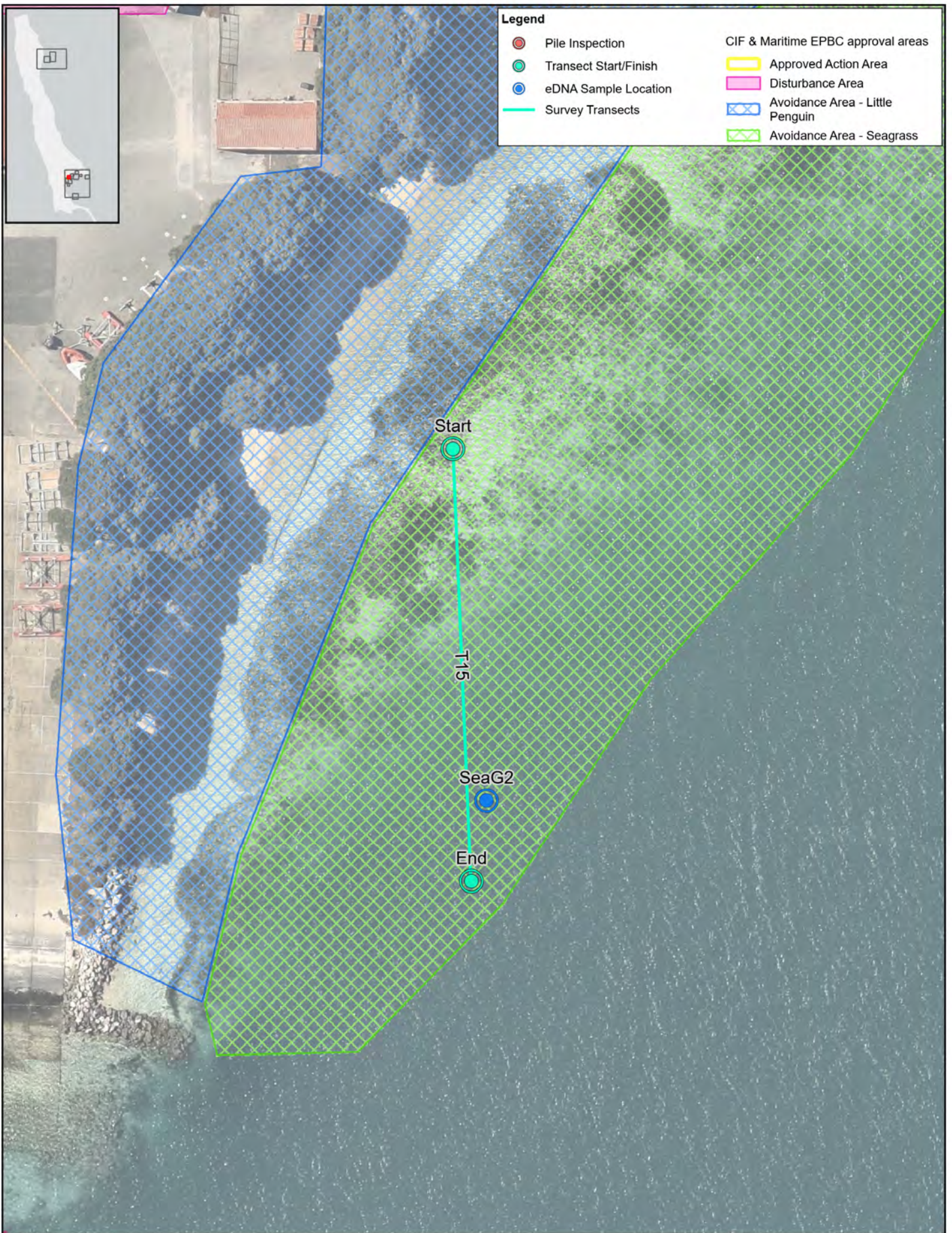
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**FIGURE 4.9**



Map Projection: Transverse Mercator  
Horizontal Datum: GDA2020  
Grid: GDA2020 MGA Zone 50

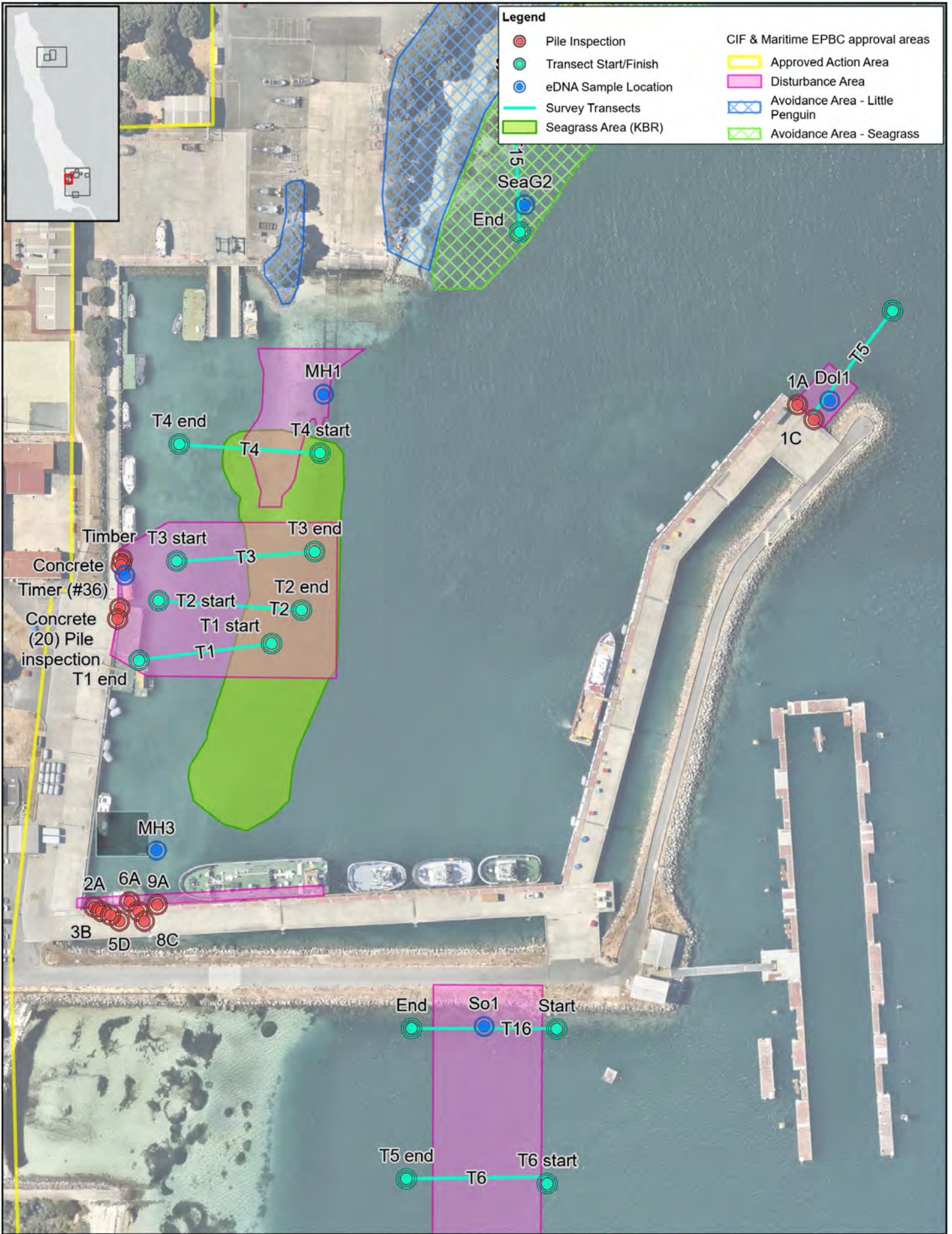


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**FIGURE 4.10**



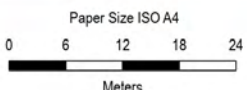
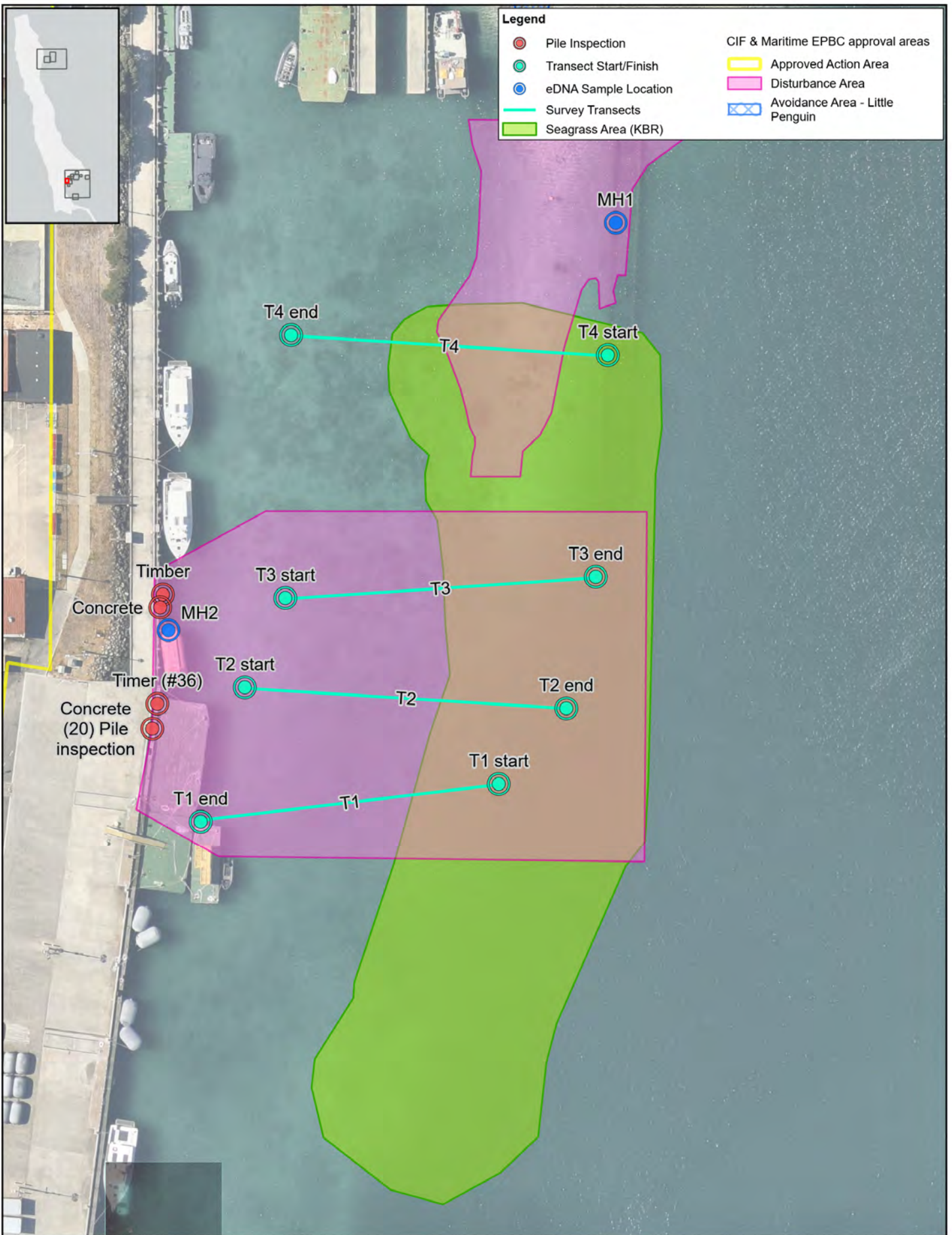
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 Grid: GDA2020 MGA Zone 50



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**FIGURE 4.11**



Paper Size ISO A4  
 Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 50

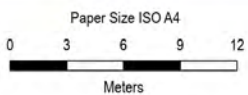


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**FIGURE 4.12**



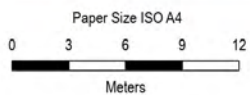
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 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 50



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**FIGURE 4.13**



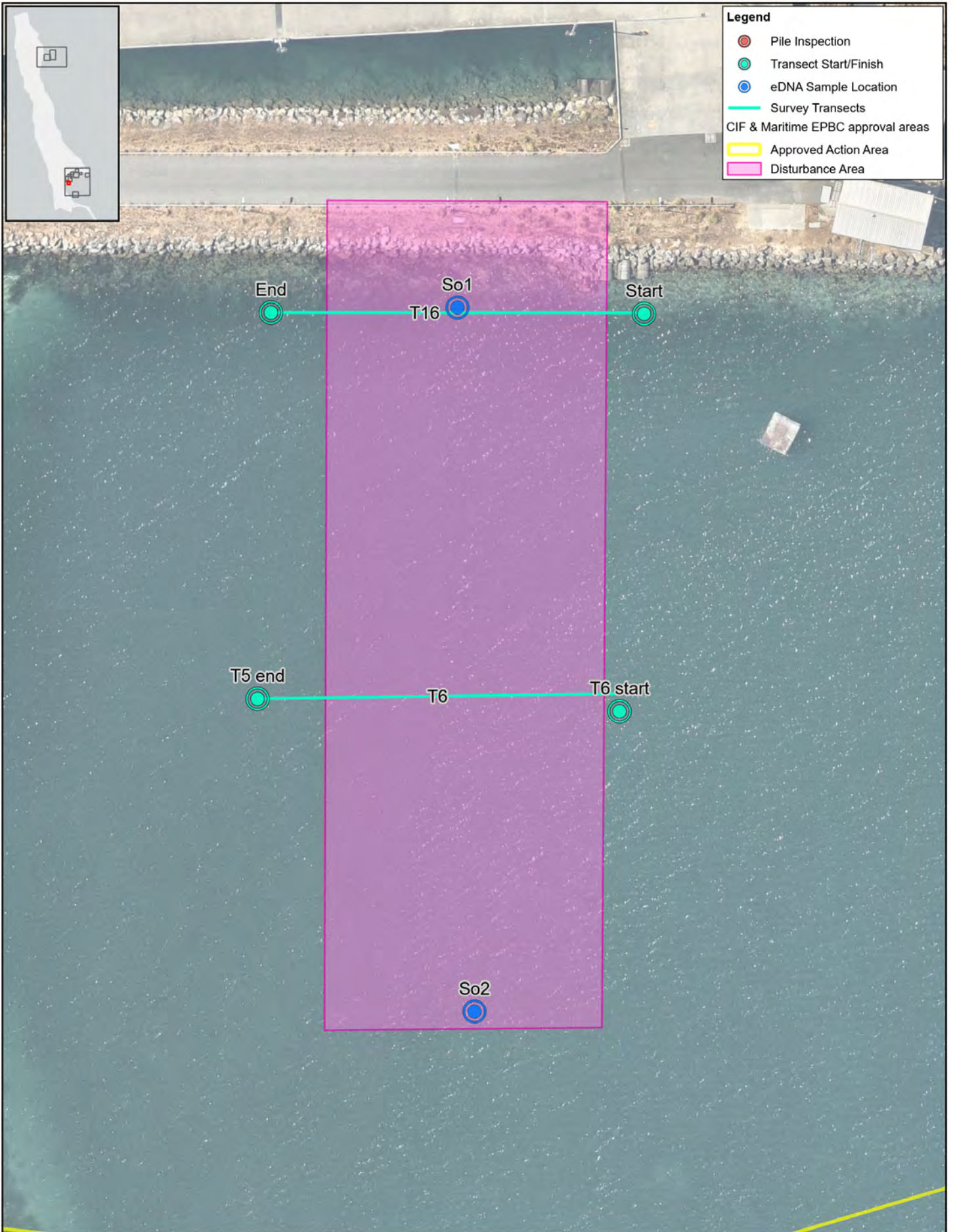
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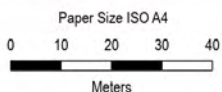
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**FIGURE 4.14**



**FIGURE 4.15**



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 50



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**FIGURE 4.16**

## 4.3 Summary of results

### 4.3.1 Abundance, density and distribution

Syngnathids were detected at three of the five sites, being Armament Wharf, Diamantina Pier and Oxley Wharf. No Syngnathids were detected with eDNA or visual diver survey at Parkes Wharf or Moresby Harbour during the eight survey days. As the survey was a single survey, in a single season, it is still possible that there is a population at Moresby Harbour and/or Parkes Wharf. The West Australian Seahorse has previously been observed by Indianic divers in these areas despite not being observed during the GHD survey (pers.com, 2025). eDNA has limitations, particularly with cryptic or small species (Section 4.3.5). The relative abundance (expressed as number per pile or number per transect) and total population estimate (density) is provided in the following sections.

### 4.3.2 Distribution and microhabitat preferences of Syngnathids from piles

A total of 53 piles were surveyed (Table 4.2). West Australia Seahorses were recorded at Armament Wharf ( $n = 2$ ), Diamantina Pier ( $n = 48$ ) and Oxley Wharf ( $n = 32$ ), but no other Syngnathid species were recorded. The average vertical density (i.e. number of Seahorses per vertical m of pile examined) was the highest at Diamantina Pier, followed by Oxley Wharf (Table 4.2). The total number of seahorse detection on the piles during the survey period was 82 individuals. Population abundance for each site was estimated by calculating the vertical density of Syngnathids for each pile, calculating the mean vertical density across all piles surveyed at each site, and then by extrapolating the density across all piles at each site.

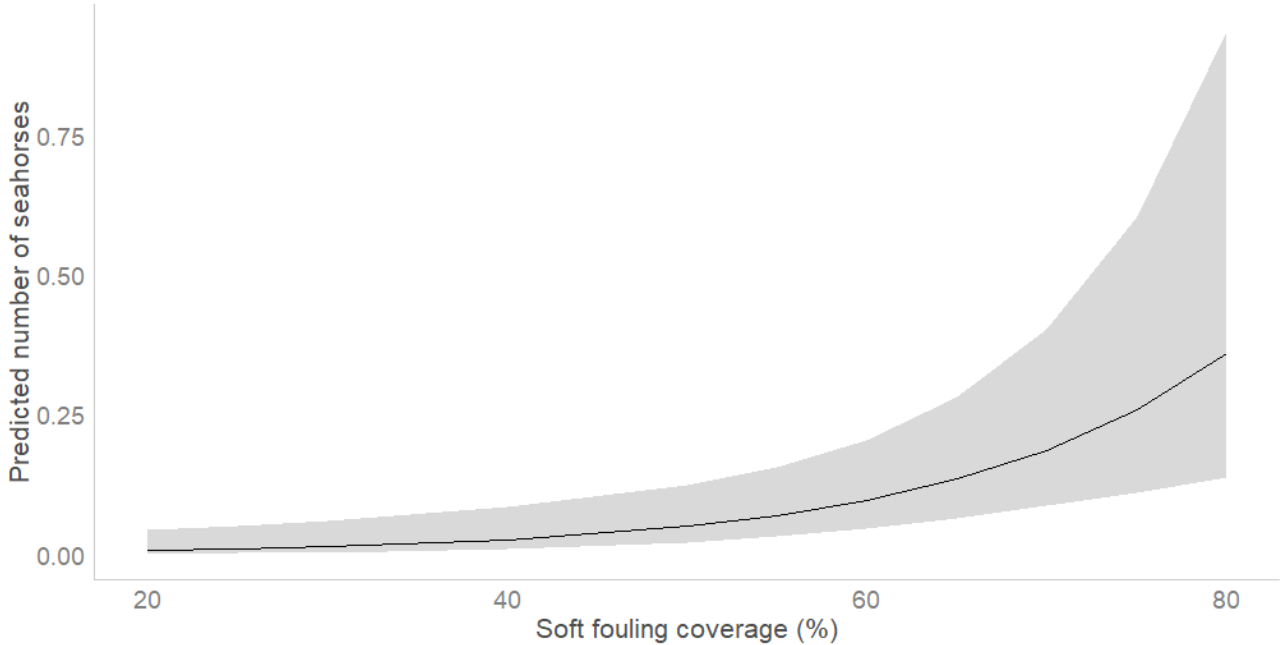
Table 4.2 Abundance of West Australian Seahorses in pile surveys

Site	Number of total piles	Number of piles surveyed	Number of seahorses recorded	Mean vertical density (seahorses per m $\pm$ standard deviation)	Relative average abundance per pile	Total population estimate on piles
Armament Wharf	346	8	2	0.75 $\pm$ 2.12	0.25	87
Diamantina Pier	308	23	48	4.46 $\pm$ 5.58	2.09	644
Moresby Harbour	568	6	0	0	0	0
Oxley Wharf	284	8	32	1.59 $\pm$ 2.20	4	1,136
Parkes Wharf	323	8	0	0	0	0

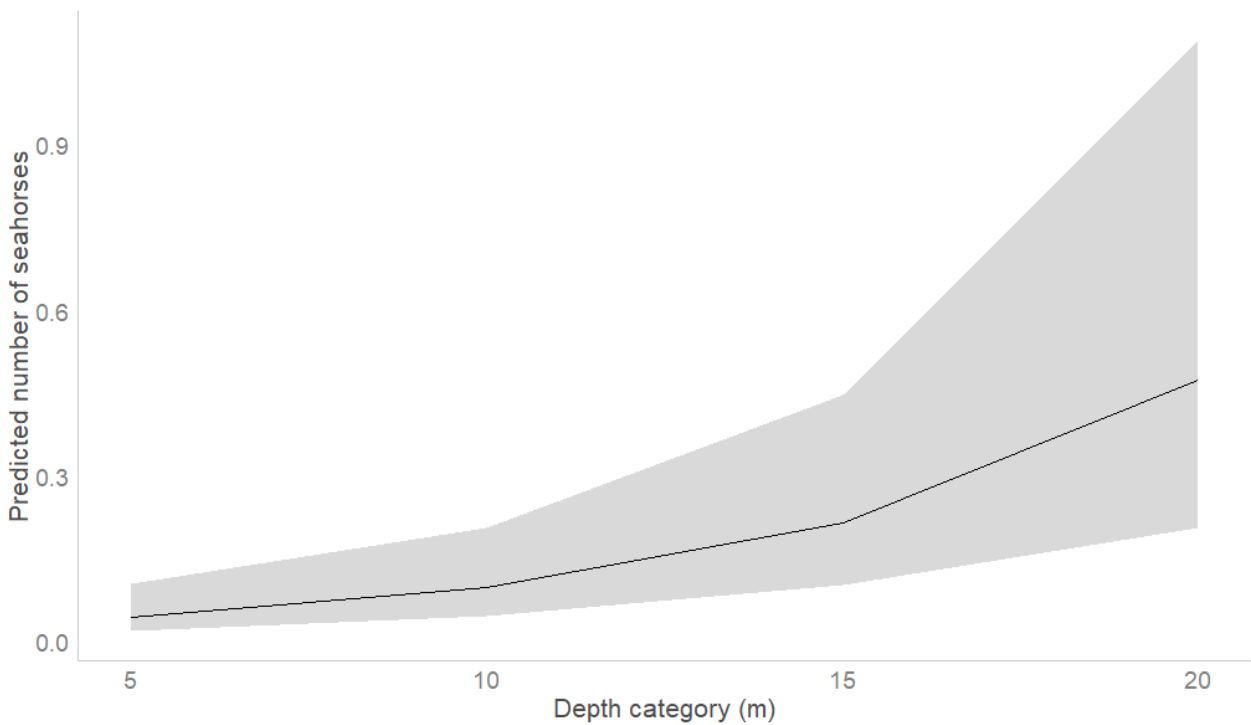
Statistical models were then used to determine which factors had the greatest influence on the number of West Australian Seahorses recorded. The factors (covariates) recorded in the surveys included depth category (in 5 m intervals), water visibility (in metres), time and date observed, site, soft cover (%), hard cover (%), fouling thickness, temperature ( $^{\circ}\text{C}$ ) and the observer's name. Generalised linear mixed effect models were then fitted to the survey data using the 'lme' package of R (v 4.5.1), using a Poisson error, a logit link function (because the data were counts) and a random intercept for each pile. Log-likelihood ratios ( $G^2$ ) were used to arrive at the final model that was fitted with restricted maximum likelihood (REML). The fit of the final model was then validated using the DHARMA package of R.

More West Australian Seahorses were observed when visibility was lower ( $\beta = -0.47 \pm 0.20$ ,  $p = 0.02$ ), at greater depths ( $\beta = 0.16 \pm 0.03$ ,  $p < 0.001$ ) and where soft-fouling coverage was highest ( $\beta = 0.066 \pm 0.02$ ,  $p < 0.001$ ). However, visibility was confounded with site, with seahorses sighted in poor visibility (visibilities of 3 to 4 m) at Oxley Wharf and Armament Wharf, whereas they were recorded in clearer water with visibilities from 6 to 8 m at Diamantina Pier. Hence, abundance may have been related to other, site-specific factors instead of depth. In contrast, soft-fouling coverage had a more consistent influence on seahorse abundance, with higher abundance on pile locations with the highest soft-fouling coverage at the three sites where seahorses were recorded

(Figure 4-17). Similarly, seahorse abundance increased from the shallowest depth category of 0-5 m to the depth category of 10-15 m, which led to the model predicting seahorse abundance to increase with depth (Figure 4-18). However, no seahorses were observed at depths greater than 15 m. The results suggest that soft fouling cover (which increased with depth) and depth are two key habitat criteria for receiver sites.



**Figure 4-17** Predicted number of West Australian Seahorses in the pile diver surveys as a function of soft fouling coverage, after depth and visibility are adjusted



**Figure 4-18** Predicted number of West Australian Seahorses pile diver surveys as a function of depth, after visibility and soft fouling coverage are adjusted. Note that each category represents the deeper limit, i.e. a category of '5' represents depths from 0 to 5 m, the category of '10' represents 5-10 m, etc

### 4.3.3 Population abundance estimates from transect surveys

The population abundance estimates of Syngnathids from the transect surveys are outlined in Table 4.3 below. Population abundance was estimated by calculating the density of Syngnathids for each transect, calculating the average density across replicates for each location, and then by extrapolating the density across the total area for each site. Maps of abundance estimates from transect surveys for pipefish and seahorses, respectively, are provided in Figure 4-19 and Figure 4-20 for Armament Wharf. No Syngnathids were recorded in transect surveys at Careening Bay (Table 4.3).

Table 4.3 Density and population estimate of Syngnathids from transects

Site and GIS reference	Area (m <sup>2</sup> )	Number of transects (replicates per location)	Pipefish abundance			Seahorse abundance		
			Count	Average density (m <sup>-2</sup> )	Abundance estimate	Count	Average density (m <sup>-2</sup> )	Abundance estimate
<b>Armament Wharf</b>								
Disturbance area 4	8,782	1 (2)	3	0.03	263.5	0	0	0
Disturbance area 5	5,701	4 (8)	1	0.02	25.5	0	0	0
Seagrass avoidance area 2	49,5502	2 (4)	0	0	0	0	0	0
Seagrass avoidance area 18	39,179	2 (4)	2	0.01	391.8	4	0.02	783.6
<b>Careening Bay</b>								
Seagrass avoidance area 15	12,954	2 (4)	0	0	0	0	0	0
Disturbance area 9	4,333	3 (6)	0	0	0	0	0	0
Disturbance area 24	1,197	1 (2)	0	0	0	0	0	0
Disturbance area 25	263	1 (2)	0	0	0	0	0	0
Disturbance area 23	4,585	2 (4)	0	0	0	0	0	0
<b>Seagrass reference area</b>								
Reference area		1 (2)	3	0.04				

### 4.3.4 Total population estimates

Overall, West Australian Seahorses were recorded in higher abundances than other Syngnathid species in both transect and pile surveys, with abundance estimates at each site ranging from 0 to 1,136 individuals.

Notwithstanding the fact that pipefish are known to be underestimated by diver surveys, the total population at Armament Wharf was estimated to be 680.8 individuals. Including the West Australian Seahorse, the total estimated abundance of Syngnathids was 1,551 individuals at the Armament Wharf location.

Table 4.4 Total population estimate of Syngnathids at each location (transects and pile surveys)

Site	Total pipefish population estimate	Suitable habitat noted during survey for pipefish	Total seahorse population estimate	Suitable habitat noted during survey for seahorses
Armament Wharf	680.8	Yes	870.6	Yes
Diamantina Pier	0 <sup>^</sup>	Yes	644	Yes
Moresby Harbour	0 <sup>^</sup>	Yes	0 <sup>^</sup>	Yes
Oxley Wharf	0 <sup>^</sup>	Yes	1,136	Yes
Parkes Wharf	0 <sup>^</sup>	No – west of dolphin mooring, potentially – east of dolphin mooring	0 <sup>^</sup>	No – west of dolphin mooring, potentially – east of dolphin mooring

Site	Total pipefish population estimate	Suitable habitat noted during survey for pipefish	Total seahorse population estimate	Suitable habitat noted during survey for seahorses
Estimated total	680.8		2,650.6	

### 4.3.5 Limitations of diver surveys for Syngnathids

Given the known low diver visual survey detection rates for smaller and/or cryptic species such as pipefishes, coupled with the fact that there is no strong evidence that any of the sites are totally unsuitable for Syngnathids, the precautionary approach will be taken for the translocation plan. A total cited abundance of 0 is likely to be a false negative and not conclusive evidence that no Syngnathids are present.

Parkes Wharf is the only site searched that is likely unsuitable for both pipefish and seahorses. This is due to the large concrete block substrate that does not align with the habitat preferences of pipefish nor seahorses, shallow depth and the lack of soft growth on the piles. This is particularly prominent west of the dolphin mooring halfway along Parkes Wharf. There is potential for suitable habitat east of the dolphin mooring (i.e. further into Cockburn Sound), principally for pipefish as the substrate changes to gravelly silty sand absent of large concrete blocks noted to the west. Growth of the piles is not particularly aligned with the soft growth types noted where seahorses were observed at other sites, but growth composition is likely to change seasonally, and it is reasonable to assume that the piles east of the dolphin mooring could support Syngnathids.

At Moresby Harbour, the fouling growth on the piles was mostly hard growth (i.e. bivalves) which reduces attachment opportunity for seahorses. The substrate is mix of silty sands and dominant sand. There is patchy seagrass growth throughout Moresby Harbour. As the survey was undertaken in winter, there was significant epiphyte growth. In summer for previous surveys, this epiphyte growth is significantly reduced from the winter load. The West Australian Seahorse has been seen in Moresby Harbour in the past by commercial divers (pers. Comms) and therefore it is reasonable to presume presence in lower abundances to those found in other sites.

Considering the above, applying a precautionary approach for the translocation plan, presence will be assumed for sites even where no Syngnathids were detected during the baseline survey.

### 4.3.6 eDNA surveys

A total of 22 water samples (in addition to a field negative) were analysed by EnviroDNA. All samples were screened for marine fish biodiversity, particularly seahorses, using a metabarcoding analysis. Across all samples, 117 taxa were detected, including 96 fish taxa. Overall, 44 % of all taxa were resolved to the level of species, with one species from the Syngnathidae family (West Australian Seahorse, *Hippocampus subelongatus*) detected at the AW1 location (Figure 4-1). Overall, 44 % of all taxa were resolved to species level. The full metabarcoding results are presented in Appendix A.

The low detection rate of Syngnathids in the eDNA samples is likely to be due to several factors including (a) low relative abundance (compared to other fish species), (b) low overall biomass, (c) low DNA shedding rates, and (d) the detectability of Syngnathid species (Nester *et al.* 2020). The commonly used MiFish and 16S Fish assays are unsuitable for detecting Syngnathids in complex, multispecies environmental samples (Nester *et al.* 2020). The '16s\_fish\_syn\_short assay' that was used has been shown to detect four species in the Perth metropolitan area, the West Australian Seahorse; the Shorthead Seahorse, *Hippocampus tuberculatus*; the Spotted Pipefish, *Stigmatopora argus*; and the Tiger Pipefish (Nester *et al.* 2020; Moore *et al.* 2024), but have provided false negatives for other Syngnathid species. Even so, Tiger Pipefish were confirmed visually by the visual diver surveys but not in the eDNA, suggesting that detection rates may have also been low. The limitation of eDNA for Syngnathid surveys is discussed in further detail below.

### 4.3.7 Limitation of eDNA for Syngnathid surveys

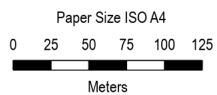
eDNA has emerged as an important approach for marine fauna surveys owing to the fact that it is non-invasive and simple to undertake. It can also detect cryptic species that are difficult to detect with other survey approaches. However, several methodological and biological limitations constrain its application for Syngnathid surveys.

A primary constraint is the inherently low biomass and relative sedentary nature of most Syngnathid species, which may result in reduced eDNA shedding rates compared to more mobile or abundant taxa. Factors such as shedding rates of target fish species, among other biotic and abiotic considerations could affect DNA persistence and degradation rates at sampling sites (Colmenares *et al*, 2023). Increased feeding behaviour has been associated with increased eDNA shedding rates, while warmer water is associated with increased eDNA shedding rates, yet eDNA degradation rates are also elevated by water temperature (Bessey *et al*, 2020). Consequently, eDNA concentrations in the water column may fall below detection thresholds, particularly in areas supporting low-density populations. Detection rates can also be limited in open ocean systems compared to semi-closed environments such as estuaries (Colmenares *et al*, 2023).

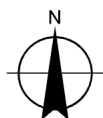
The persistence and degradation dynamics of eDNA in marine environments present additional challenges for Syngnathid detection. Fish eDNA degradation rates are even greater in field-collected seawater than in freshwater systems (Yao *et al*, 2022), from a combination of biological decay and physical dispersion which could be accelerated by high water temperature due to microbial activity (Murakami *et al*, 2019). In the ocean, physical variables including temperature, depth, salinity, currents and tides can all affect eDNA dispersal, making it difficult to interpret eDNA results and determine the presence of Syngnathids.

Reference database completeness and primer specificity represent significant technical limitations for eDNA based Syngnathid surveys. Existing broad-spectrum fish metabarcoding assays such as MiFish and 16S Fish do not detect Syngnathids in environmental samples well (Nester *et al*, 2020). False negatives will occur due to a combination of PCR efficacy, primer binding, assay sensitivity, degeneracies in the primers, template competition and amplicon length (Nester *et al*, 2020). Primers for Syngnathids are still in development and the lack of large-scale applications of eDNA-based inventories in public genetic databases is a gap eDNA's utility in detecting Syngnathids.

eDNA also has no means to detect fish condition, sex ratio, growth, or other demographic information and is supplementary to traditional methods (i.e. visual census, baited underwater video) for fish surveys more broadly but particularly so for Syngnathids due to their low DNA shedding rates and presence in the marine environment.



Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 50

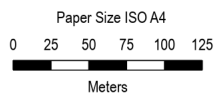
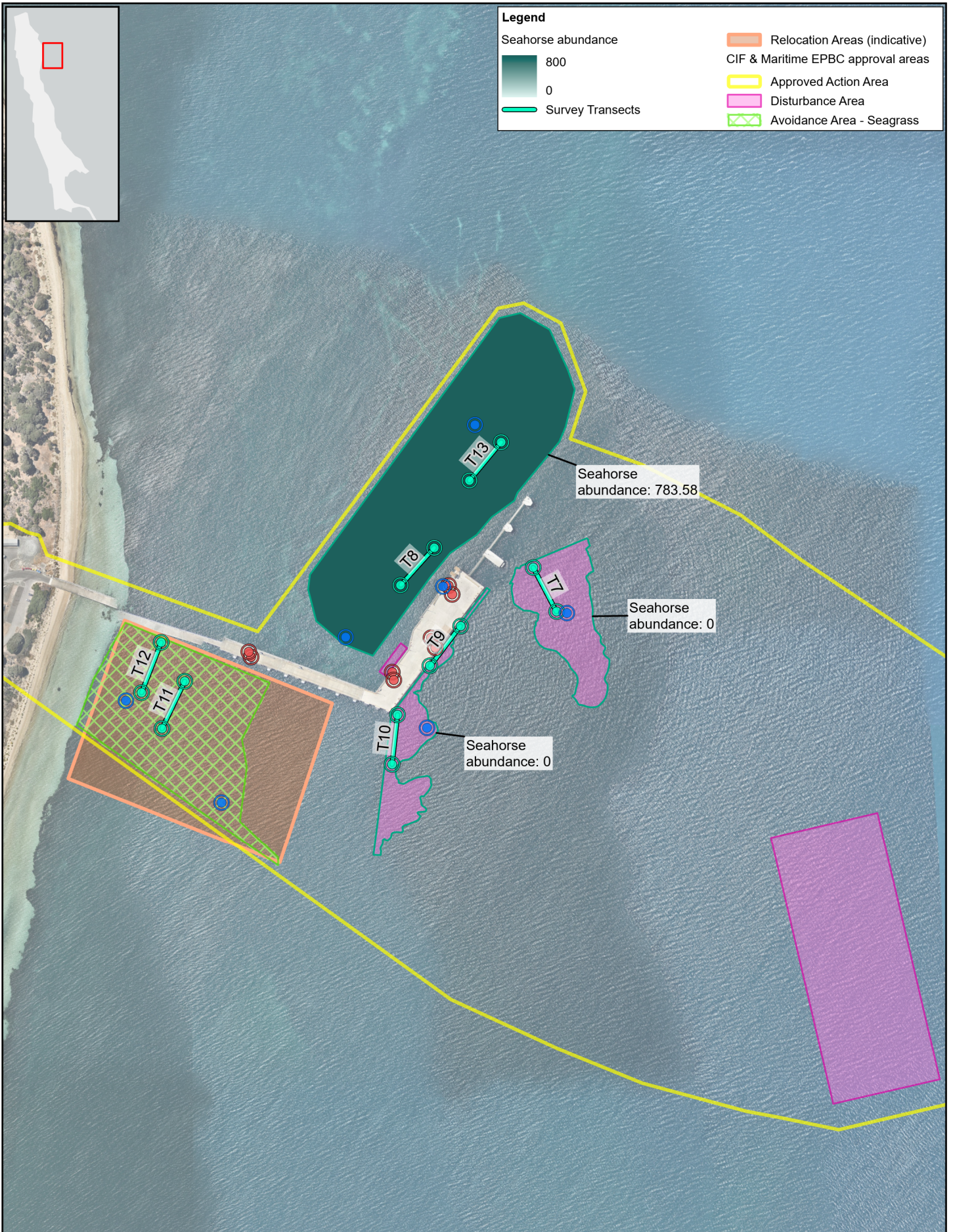


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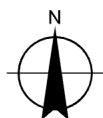
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**FIGURE 4.19**



Map Projection: Transverse Mercator  
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**FIGURE 4.20**

## 5. Phase 2 – Development of the SMP

### 5.1 Approach

This SMP has been developed in accordance with the precautionary principle, adopting conservative assumptions regarding potential adverse impacts to Syngnathid populations within the approved Action area. For the purposes of this SMP, the act of relocating Syngnathids from the area that will be adversely affected by the Project, to an area outside of the area of influence of the Project is referred to as 'translocation' for consistency with the EPBC 2024/10031 Conditions. However, it should be noted that this does not align with the definition of translocation in the National policy guidelines for the translocation of live aquatic animals (DAFF, 2020), which defines translocation as the "deliberate movement of live aquatic animals (including at all stages of the life cycle and any derived, viable genetic material) beyond":

- their accepted distribution
- to areas that contain genetically distinct populations
- to areas with different disease status.

This is because the translocation strategy for this project aims to move Syngnathids to an area within their accepted distribution, where the genetic composition of the population and disease status are considered not likely to significantly differ from the source population. Hence the risks, that are presented in more detail (Section 6.2), are likely to be less than the risks associated with moving Syngnathids outside their accepted distribution.

The proposed translocation strategy aligns with the definition of 'mitigation translocation' (Germano, *et al*, 2015), implemented in response to regulation with the intent to reduce a development's impact on biota. Scientific reviews of the success of mitigation translocation as a management tool have emphasised the importance of including sound scientific principles, considering impacts and carrying capacity at the receiver site, and an experimental approach to monitor the outcome of the translocation (Germano *et al*, 2015; Bradley *et al*, 2022).

## 5.2 Induction and training requirements

Requirements for inductions and training are identified in Section 8 of the CEMP. The SMP will be provided to all staff engaging in onsite maritime works and any phase of this SMP. All personnel attending site and needing to enter the construction area will complete the requisite level of training and induction commensurate with their role as outlined in the CEMP.

### 5.2.1 Responsibility

The key roles and responsibility for implementation of the CEMP, including the associated environmental management annexures, are provided in Section 6 of the CEMP. Responsibilities for the specific management control and monitoring requirements in this SMP are provided in Table 5.1.

Table 5.1 Responsibilities for this SMP

Role	Responsibilities
<b>Suitably qualified Syngnathid ecologist</b>	<ul style="list-style-type: none"> <li>– Adhering to animal ethics and established procedures for the humane handling of live organisms. Responsible to work in accordance with any animal ethics application and Conditions required for the implementation of the SMP.</li> <li>– Holds relevant qualifications (i.e. ecology/biology) with demonstrated industry experience as a marine scientist.</li> <li>– Has at least 5 years of experience designing and implementing surveys and translocations for Syngnathids.</li> <li>– Has at least 5 years of experience writing and implementing management plans for Syngnathids.</li> <li>– Has at least 5 years of experience with Syngnathids, with both aquaculture (capture and movement) and an ecological (<i>in situ</i> populations expertise).</li> <li>– Can give authoritative assessment and advice on the presence of Syngnathids, Syngnathid ecology and management measures.</li> <li>– Provide oversight of: <ul style="list-style-type: none"> <li>– the implementation of the SMP or where not feasible, provides delegated authority to the suitably qualified marine field ecologist.</li> </ul> </li> <li>– Selection and preparation of appropriate receiver site locations, such as natural habitat or other suitable habitat.</li> <li>– Provide an authoritative assessment of the need and methods by which, reference Syngnathid specimens are to be provided to the Cockburn Sound Syngnathid eDNA library.</li> <li>– Review of Syngnathid management plan and approach to translocation.</li> <li>– Review approach to post translocation monitoring and reporting.</li> <li>– Responsible for handling <i>ad hoc</i> advice or requests through the SMP implementation and project.</li> </ul>
<b>Suitably qualified marine field ecologist</b>	<ul style="list-style-type: none"> <li>– Adhering to animal ethics and established procedures for the humane handling of live organisms. Responsible for holding and overseeing any animal ethics approval required for the implementation of the SMP.</li> <li>– Holds relevant qualifications (i.e. ecology/biology) with demonstrated industry experience as a marine scientist.</li> <li>– Has at least 3 years of experience implementing marine ecology surveys and/or translocations for Syngnathids.</li> <li>– Can give authoritative assessment and advice on the presence of Syngnathids, Syngnathid ecology and management measures.</li> <li>– Has experience in the handling of Syngnathids and is responsible for husbandry while on board a vessel and undertaking of handling for the purposes of gathering health information, tagging and releasing to the commercial diver team to place in receiving habitat.</li> <li>– Preparation and implementation of the Syngnathid management plan.</li> <li>– Undertake post translocation monitoring and reporting.</li> <li>– Responsible for handling <i>ad hoc</i> advice or requests through the SMP implementation and project.</li> </ul>

<b>Commercial diver</b>	<ul style="list-style-type: none"> <li>– Must hold a minimum of an ADAS 2 qualification with nitrox endorsement (enriched air nitrox) in accordance with AS/NZS 2299.1 standard and have demonstrated experience in commercial diving activities within HMAS Stirling waters.</li> <li>– Syngnathid diver survey/translocation experience with proposed methods at HMAS Stirling.</li> <li>– Safely and efficiently collect Syngnathids in the area defined by the suitably qualified marine field ecologist / Syngnathid ecologist using methods defined by the Syngnathid management plan.</li> <li>– Transfer individual specimens to the vessel dry dock ready for translocation.</li> <li>– Actively communicate to the dive supervisor any incidents of Syngnathid welfare concerns to the dive supervisor and on board suitably qualified marine field ecologist / Syngnathid ecologist as soon as reasonably practicable.</li> <li>– Follow the guidance, for the purposes of the implementation of the Syngnathid management plan, of the suitably qualified marine field ecologist and/or suitably qualified Syngnathid ecologist at all times.</li> </ul>
<b>Dive supervisor / vessel master</b>	<ul style="list-style-type: none"> <li>– Must hold a minimum of an ADAS 2 qualification with nitrox endorsement (enriched air nitrox) in accordance with AS/NZS 2299.1 standard, have demonstrated experience in commercial diver supervision activities within HMAS Stirling waters, hold a minimum certification of SSBA to 30 m Supervisor and meet the requirements for competencies listed under the ADAS SSBA to 30 m Supervisor certification.</li> <li>– Syngnathid diver survey experience and with proposed methods at HMAS Stirling.</li> <li>– Must conduct pre-dive safety checks on all commercial divers.</li> <li>– Follow and enforce strict safety protocols for diving operations, including managing air supply and decompression if required.</li> <li>– The safety and command of the vessel, crew, passengers and cargo.</li> <li>– The operations and navigation of the vessel including route planning, navigation and compliance with all relevant legislation and license Conditions.</li> <li>– Maintain official logbook, 15-minute daily logs and communication with Port Services.</li> <li>– Follow the guidance, for the purposes of the implementation of the Syngnathid management plan, of the suitably qualified marine field ecologist and/or suitably qualified Syngnathid ecologist at all times.</li> </ul>

### 5.3 Overview of reporting and documentation requirements for the SMP

All reporting requirements of the CEMP with reference to the EPBC Act approval 2024/10031 are detailed in Section 7 of the CEMP.

All compliance documents and records required by this SMP must be maintained and stored in accordance with the document control requirements specified in Section 12.2 of the CEMP. Compliance records may be subject to audit and/or be used to verify compliance with the Conditions of approval in accordance with Section 12 of the CEMP.

In accordance with Condition 26) e), Syngnathid specimens encountered during translocation surveys will be referenced to the Cockburn Sound Syngnathid eDNA library and other relevant state biodiversity databases where practical, as decided by ecologists and in consultation with DEPAC.

The following reports will be generated as part of the Syngnathid management for SRF-West:

- Syngnathid Management Plan (this document) (Phase 2).
- Phase 3 and 4: Translocation and pre-clearance survey outcomes report (including for any ancillary works – Section 6 and 7).
- Phase 5: Post-translocation monitoring plan and risk assessment.
- Phase 5: Post-translocation outcomes report - within 4 weeks of translocation effort, Year 1, Year 3 and Year 6 monitoring phases.
- Various reporting during the post-translocation monitoring phase.
- Post translocation reports will be prepared for DEPAC and are anticipated to include:

- details on the total number of relocated animals, including species. Where possible, details such as sex, health, colouration and size will be recorded.
- details on the success of the relocation program and discussion of deviations to the proposed work approach as detailed in this plan.
- ongoing monitoring requirements at translocation sites and tracking against objectives and compliance with Conditions of Approval.

## 5.4 Adaptive management approach

The overarching purpose of adaptive management is to minimise the impact on Syngnathids in the action area from the project activities. The adaptive management approach will be undertaken on a continuous and iterative basis, with clear, measurable goals and performance indicators (SMART goals framework).

Triggers for adaptive management are aligned to a tiered response framework that includes thresholds based on factors such as behavioural and physiological stress indicators, as summarised below and outlined in Table 5.2.

### Tier 1 – Standard approach

Translocation proceeds as planned. Syngnathids will be hand captured by divers and supplementary use of seine nets for more cryptic species will be used. Syngnathids will be transported in aerated containers and released at the receiver site(s) with suitable habitat that have been pre-determined and prepared to receive the population.

### Tier 2 - Modified approach

A modified approach will be triggered with monitoring during the translocation effort, pre-clearance effort and/or during the post-translocation monitoring phase where the monitoring indicates suboptimal outcomes. The purpose of tier 2 is to provide early warning so that an identified impact is mitigated as soon as reasonably practicable. Adjustments that may be required include changes to the standard approach technique (i.e. capture approach, acclimation periods, modifying release timing (i.e. avoiding tidal extremes), or supplementary structure (i.e. additional habitat modification and enhancement)) at the receiver site(s).

### Tier 3 – Program review

A program review will be triggered when monitoring during the translocation effort, pre-clearance effort and/or post-translocation monitoring phase indicates that significant suboptimal outcomes have arisen. An SMP program will be reviewed when triggers are reached and will be undertaken in consultation with the suitably qualified Syngnathid experts, Dr. Glenn Moore and Dr. David Booth, and DEPAC. All active translocation efforts or pre-clearance efforts must be ceased as soon as reasonably practicable. A thorough reassessment of approach is required and may involve reassessment of receiver site suitability, approach to translocation, or the investigation of alternative mitigation measures.

Table 5.2 Tiered response framework for adaptive management of Syngnathids

Performance Indicator	Tier 1 (no change)	Tier 2 (Modify)	Tier 3 (Review and stop)
Capture stress mortality <sup>3</sup>	<1 % capture-stress mortality of baseline population (a mortality of 7 pipefish and/or 9 seahorses)	1 – 3 % mortality (7-20 pipefish and/or 9-26 seahorses)	>3 % mortality (>20 pipefish and/or >26 seahorses)
< 1 % of baseline population (a mortality of 7 pipefish or 9 seahorses)	<1 % of baseline population (7 pipefish and/or 9 seahorses)	1 – 3 % increase (7-20 pipefish and/or 9-26 seahorses)	>3 % increase (>20 pipefish and/or >26 seahorses)
Post-release mortality of tagged individuals compared to baseline	<5 % post-release mortality of baseline population (34)	5 - 10 % post-release mortality of baseline population (34-68)	>10 % post-release mortality of baseline population (>68 pipefish and/or >87 seahorses)

<sup>3</sup> Natural mortality rates are unknown for the Syngnathid species that will be translocated but are age dependent (decreasing with age) and likely to be relatively high. Mortality rates in *Hippocampus comes* range from 0.83 to 1.5 (22 to 46 %) (reviewed by Foster and Vincent, 2004), and from approximately 1.145 to 3.604 in *H. whitei* (2.7 to 31 %, Harasti *et al.* 2012).

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<b>Performance Indicator</b>	<b>Tier 1 (no change)</b>	<b>Tier 2 (Modify)</b>	<b>Tier 3 (Review and stop)</b>
	pipefish and/or 43 seahorses)	pipefish and/or 43-87 seahorses)	
<b>Post translocation site fidelity (Individuals remaining at receptor site after 2 weeks)</b>	>70 % of translocated individuals remain	50 - 70 % of translocated individuals remain	<50 % of translocated individuals remain
<b>Pre-clearance success (Individuals remaining or returning to the action area prior to the action)</b>	None detected	Syngnathids recorded	Syngnathids recorded
<b>Syngnathid abundance at receiver sites at 1, 3 and 6 years</b>	>70 % of translocated individuals remain	50 - 70 % of translocated individuals remain	<50 % of translocated individuals remain
<b>Breeding activity (in first available breeding season – full or partial)</b>	Comparable to baseline breeding activity	10 - 15 % reduction from baseline breeding activity	> 15 % reduction from baseline breeding activity
<b>Body condition</b>	No decline observed	Minor decline in <5 % of individuals translocated	Widespread decline >5 % individuals translocated
<b>Catastrophic environmental event (e.g. marine heatwave, pollution event)</b>	No event	Any event that has the potential to impact Syngnathids in the action area	Any event that has the potential to impact Syngnathids in the action area

## 6. Phase 3 – Translocation strategy

Phase 3 provides a framework for Syngnathid translocation strategy from the approved Action areas (source sites) to suitable habitat outside of the approved Action area (receiver sites) and presents a comprehensive risk assessment conducted in accordance with the National Policy Guidelines for the Translocation of Live Aquatic Animals (DAFF, 2020).

The translocation strategy is contingent upon the outcomes of Phase 1, which provides baseline data regarding Syngnathid abundance, population density and spatial distribution within, and proximal to, the action areas. The baseline data is foundational to optimise the translocation success probability and ensure compliance with the Conditions of approval.

This strategy is intended to be a 'live document' will be revised in accordance with changing information, scope or requirements and the framework outlined in Section 12.3.2 of the CEMP.

### 6.1 Objectives and rationale

The objective of this translocation strategy (Phase 3) is to:

- comply with the EPBC 2024/10031 to minimise harm on the local Syngnathid population from the Action (Condition 25); Condition 26) a) to e); Condition 27); Condition 28).

Specific aims associated with the translocation activities include identifying and implementing opportunities to:

- minimise the risk of harm on the Syngnathid population in the approved Action area through the design of a translocation strategy that is compliant with the EPBC Conditions of Approval and with the National Policy Guidelines for the Translocation of Live Aquatic Animals (Condition 26))
- design a monitoring protocol that at a minimum meets the applicable EPBC 2024/10031 and also provide certainty beyond a reasonable doubt that the translocation action has minimised harm to the population in accordance with the tiered response framework as part of the adaptive management approach described in Section 5.4. (Condition 26b(ii))
- translocate Syngnathids to a like-for-like habitat with minimal impact on translocated individuals' life history function (Condition 26d))
- maintain the translocated Syngnathids abundance and range or establish new populations (Condition 25))
- contribute to Syngnathid knowledge in Cockburn Sound by contributing reference specimens to the Cockburn Sound Syngnathid eDNA library (Condition 26) e)).

#### 6.1.1 Actions to address objectives

- Establish a species-specific translocation procedure to enable the harvesting, transport and release for translocation and for emergency extraction if needed (i.e. predator / disease incursion etc).
- Implement a monitoring program aligned with the tiered response framework as part of the adaptive management approach described in Section 5.4.
- Monitor receiver sites at 1, 3 and 6 years following the completion of the maritime works (Condition 26) b) ii)).

## 6.2 Success criteria

The success criteria detailed in Table 6.1 will be adopted for the translocation program. The success criteria will apply during the post-translocation monitoring phases from the short term (at time of translocation to 12 months), medium term (1 – 3 years) and long term (3 – 6 years) described in Section 6.7. Measuring the success criteria will be in line with the adaptive management framework provided in Table 6.1.

Table 6.1 Success criteria adopted for the translocation

Term	Success criteria
<b>Short term Translocation – 12 months</b>	<ul style="list-style-type: none"> <li>– Negligible capture stress mortality</li> <li>– Negligible injury during handling</li> <li>– Objectives of the SMP achieved</li> <li>– No return of translocated individuals to the action area</li> <li>– ≥90 % survival</li> <li>– No mass mortality events or reduction in body condition (stable body condition)</li> <li>– Evidence of site fidelity</li> <li>– Normal feeding behaviour observed</li> </ul>
<b>Medium term 1 – 3 years</b>	<ul style="list-style-type: none"> <li>– Evidence of successful reproduction</li> <li>– Juvenile recruitment detected</li> <li>– Stable home ranges established</li> <li>– Population abundance for each species at recipient sites stable or increasing, at rates comparable to reference populations</li> </ul>
<b>Long term 3 – 6 years</b>	<ul style="list-style-type: none"> <li>– Self-sustaining population (recruitment ≥ mortality)</li> <li>– Multiple age classes present</li> <li>– Spatial expansion into suitable adjacent habitat evidence of integration with broader habitat</li> <li>– Population abundance for each species at recipient sites stable or increasing, at rates comparable to reference populations</li> </ul>

## 6.3 Permits

### 6.3.1 Commonwealth

Under Part 13, Division 4 of the EPBC Act, a permit is required for activities in a Commonwealth area that:

- result in the death or injury of a member of a listed marine species (other than a cetacean or a member of a listed marine species that is also a listed threatened species or listed migratory species)
- take, trade, keep or move a member of a listed marine species (other than a cetacean or a member of a listed marine species that is also a listed threatened or migratory species).

Similarly, a permit under Part 8A of the Environmental Protection and Biodiversity Conservation Regulations 2025 (access to biological resources in Commonwealth areas) only applies to Commonwealth areas, or land where the Commonwealth or a Commonwealth agency holds the usage rights that entitles the lessee to control access to the biological resources in and on the land.

Per section 255(c) a permit is not required for the translocation of Syngnathids as an approval under Part 9 covers the Action.

### 6.3.2 State

The Western Australian DPIRD generally requires approval to be sought prior to translocating live fish or other marine species for both commercial and non-commercial uses. The standard approval process may take at least 10 days due to the need for a risk assessment. This permitting pathway applies only to the translocation of non-endemic species entering the state or non-endemic species being moved into Western Australia and therefore, a translocation permit is not required.

Under the *Fish Resource Management Act 1994*, an Instrument of Exemption is issued by DPIRD for interacting with aquatic resources within state coastal waters, unless an exemption is granted. There are specific purposes the DPIRD can grant an exemption to obtaining an IoE, including:

- research
- environmental protection
- public safety
- public health
- commercial purposes.

DPIRD has provided advice that should works be constrained to Naval Waters, that an exemption of any state permits can apply. As all translocation activities are constrained to Naval Waters, DPIRD has exempted this activity, if translocation and carriage of animals occur solely within Naval Waters, from any state permits.

### 6.3.3 Animal Ethics

The *Animal Welfare Act 2002 (WA)* provides for the protection of animals by regulating the use of animals, including for scientific purposes. For the purposes of this SMP, tagging will require an approval from an Animal Ethics Committee (AEC). GHD has an internal AEC established in accordance with the requirements of the *Australian Code of Practice for the Care and Use of Animals for Scientific Purposes*. GHD internal AEC Committee approval takes approximately 2 – 3 weeks. GHD's suitably qualified marine field ecologists are both principal investigators.

## 6.4 Equipment and personnel

All Syngnathid translocation must be directed by suitably qualified marine field ecologists and overseen by suitably qualified Syngnathid ecologists. The translocation must be as efficient as possible and will be undertaken using a team of local commercial divers on SSBA cycling compressed air and enriched air nitrox (EAN) that allows the translocation effort to maximise dive time and reduce surface intervals. Due to the logistical (time and estimated population size at source sites) constraints of this program, it is not appropriate to use SCUBA due to the inherent and significant inefficiencies of SCUBA. These include limited bottom time, restricted spatial coverage, reduced task efficiency underwater and cost inefficiency at scale and safety.

The equipment requirements for Syngnathid relocation includes:

- rigid transport containers/ coolers ( $\geq 10$  L)
- additional buckets for mixing acclimation water
- additional insulating materials
- oxygen supply system with portable oxygen and regulators
- battery powered air pumps as backup aeration
- digital thermometers
- holdfast structures (i.e. rope, mesh, seagrass, macroalgae)
- YSI water quality probe (if probe does not provide specific gravity, supplement with refractometer or hydrometer)
- SSBA dive equipment including diver cameras
- sanitised dive gloves
- headlamp / UV light
- power free nitrile or latex disposable gloves
- catch containers
- soft measuring board or callipers for sizing
- weighing scales
- net
- underwater slate and pencil

- translocation proforma field sheets
- vessel
- handheld GPS
- tags
- shade cloth.

## **6.5 Translocation methods**

Table 6.2 presents the Syngnathid translocation method applicable to both the West Australian Seahorse and Tiger Pipefish identified during the baseline survey, in addition to other Syngnathids that may be encountered during the translocation effort and all source locations.

Table 6.2 Syngnathid translocation methods summary for species noted present during the baseline survey

Translocation method	Prepare	Salvage/capture/locate	Release
<p><b>In-situ</b> <i>Diver based hand capture and seine netting</i></p>	<p><b>West Australian Seahorse, Tiger Pipefish and other Syngnathids</b></p> <ul style="list-style-type: none"> <li>– Agreement of receiver sites from DEPAC and suitably qualified Syngnathid ecologists Dr Glenn Moore and Dr. David Booth.</li> <li>– Obtain internal AEC approval</li> <li>– Prepare equipment list (Section 6.4).</li> <li>– Prepare onboard vessel fish transport systems and establish stable water quality using source water.</li> <li>– Establish all stations required (i.e. recovery tank, anaesthetic bath) and monitoring system.</li> <li>– Translocation proforma preparation.</li> <li>– Procure tagging equipment and tags</li> <li>– Field logistics pre-mobilisation.</li> </ul>	<p><b>West Australian Seahorse and other Syngnathids</b></p> <ul style="list-style-type: none"> <li>– Two divers search all potential Syngnathid habitat identified as source sites where Syngnathids were previously detected during the baseline survey as priority sites (Diamantina Pier, Armament Wharf, Moresby Harbour).</li> <li>– Syngnathids located to be captured by hand and placed in an extended catch bag or similar so that individuals are not injured from crushing or abrasion (e.g. storing individuals in catch containers filled with water, placed in the catch crate at depth). Syngnathids should always be submerged in marine water.</li> <li>– Maintain low density in bags, 2 – 4 per 10 L container. Placement of holdfast structures into the transport containers (i.e. rope, mesh, plants) to allow natural grip behaviour.</li> <li>– Use of seine net for final pre-clearance of seagrass habitats or bare substrata areas</li> <li>– Pairs or nearby groups of individuals are not to be separated and are to be placed in the same bag and storage on the vessel during transit to the receiver site.</li> <li>– Place Syngnathids into vessel-based fish transport systems, ensuring water quality controls are in place and stable, systems are shaded, and the light environment is low.</li> <li>– On board complete translocation proforma including metrics on species, physical characteristics and complete tagging.</li> </ul> <p><b>Tiger Pipefish and other pipefish</b></p> <p>As above, however translocation method will also involve a seine net rather than hand capture for both the translocation and pre-clearance.</p>	<p><b>West Australian Seahorse, Tiger Pipefish and other Syngnathids</b></p> <ul style="list-style-type: none"> <li>– Visual inspection of individuals.</li> <li>– Begin floating the transport bag in the receiver sit water for 30 minutes. Monitor both temperatures until within 1 – 2 °C.</li> <li>– Gradual water exchange. Open the transport bag and begin to slow drop acclimation process. Add small amounts of receiver site water to the transport containers every 10 – 15 minutes. This gradual mixing allows Syngnathids to adjust to any differences in salinity, pH and other physical water quality parameters. This process will take approximately 1 + hours.</li> <li>– Observe the behaviour of Syngnathids throughout this process for indications of stress, including colour changes, loss of balance, unusual swimming or rapid breathing. The correct physical response for seahorses includes upright posture, normal gill movement. If stress is visible, slow the acclimation process.</li> <li>– Plan release for either early morning or late afternoon to avoid full sun and the heat of the day. Consider tidal cycles secondary to time of day and select slack tide or incoming tide before strong currents develop.</li> <li>– Individuals carefully placed in the receiving habitat as close to the seafloor or structure as possible and observed to be responsive to stimulus or have attached to benthic habitat features. Release in small groups or individually, releasing pairs together as captured from source site. Observe for 15 minutes to ensure attachment and survey for predation.</li> <li>– Finalise translocation proforma.</li> </ul>

## 6.6 Artificial habitat enrichment

Artificial structures (i.e. seahorse hotels) represent an important conservation tool in managing Syngnathid populations given their vulnerability to impacts from maritime construction and the declining natural habitat in Cockburn Sound. The design, placement, layout and number of artificial habitats is critical to successful colonisation and long-term population support.

### 6.6.1 Design

Designing seahorse hotels has primarily been undertaken on the east coast of Australia, where the species White’s Seahorse (*Hippocampus whitei*) has a smaller home range than the West Australian Seahorse. Seahorse hotels have typically been made of rebar or fabricated mild-steel cages with mesh or rope inserts to create attachments points. Typical sizes are 1 m (L) x 1 m (W) x 0.5 m (H) for the relatively small *H. whitei*. Internal features for attachment provide critical refuge and allow Syngnathids to escape predation.

As the artificial structures will be primarily used by West Australian Seahorse, or other seahorses found during the translocation, and they are much larger than the *H. whitei* for which the seahorse hotel designs have been designed and iterated, the proposed design of the seahorse hotels artificial habitat is outline below.

**Material:** rebar or low carbon content steel with 2 x anodes per hotel. Internal rope to the inner sections to enhance structural complexity.

**Size:** 3 m (L) x 2 m (W) x 2 m (H) positioned horizontal on the seabed.

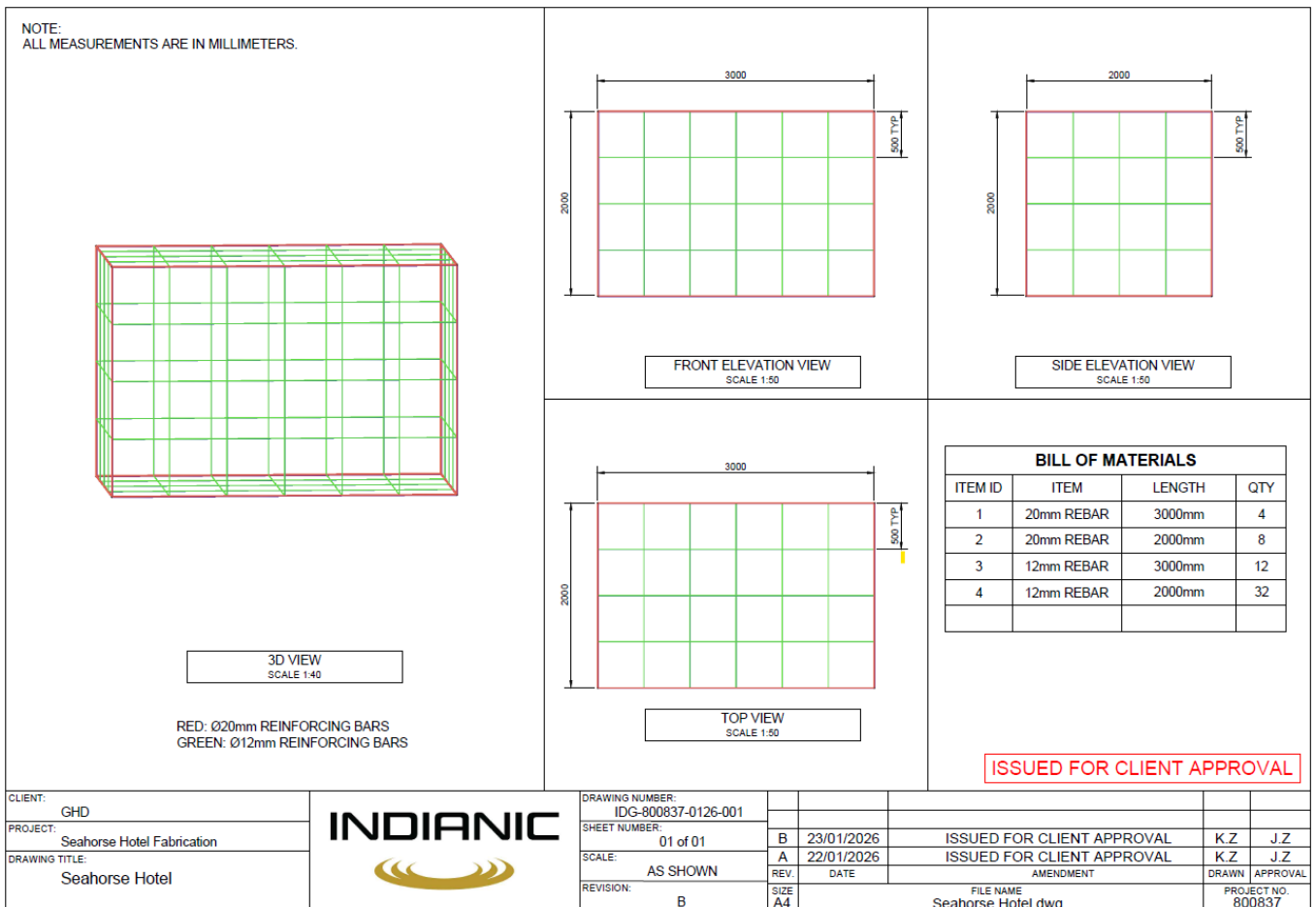


Figure 6-1 Design of seahorse hotel (3 m L x 2 m W x 2 m H)

## 6.6.2 Placement

Placement is required a minimum of two to three months prior to the commencement of the translocation to allow the structure to foul. Artificial habitat will be transported to the receiver location via vessels. Artificial habitat will require diver assistance and will be anchored to the seabed using pickets. The GPS locations of each unit will be provided to DEPAC and Port Services. There is no surface marking of the artificial habitat to discourage outside interference.

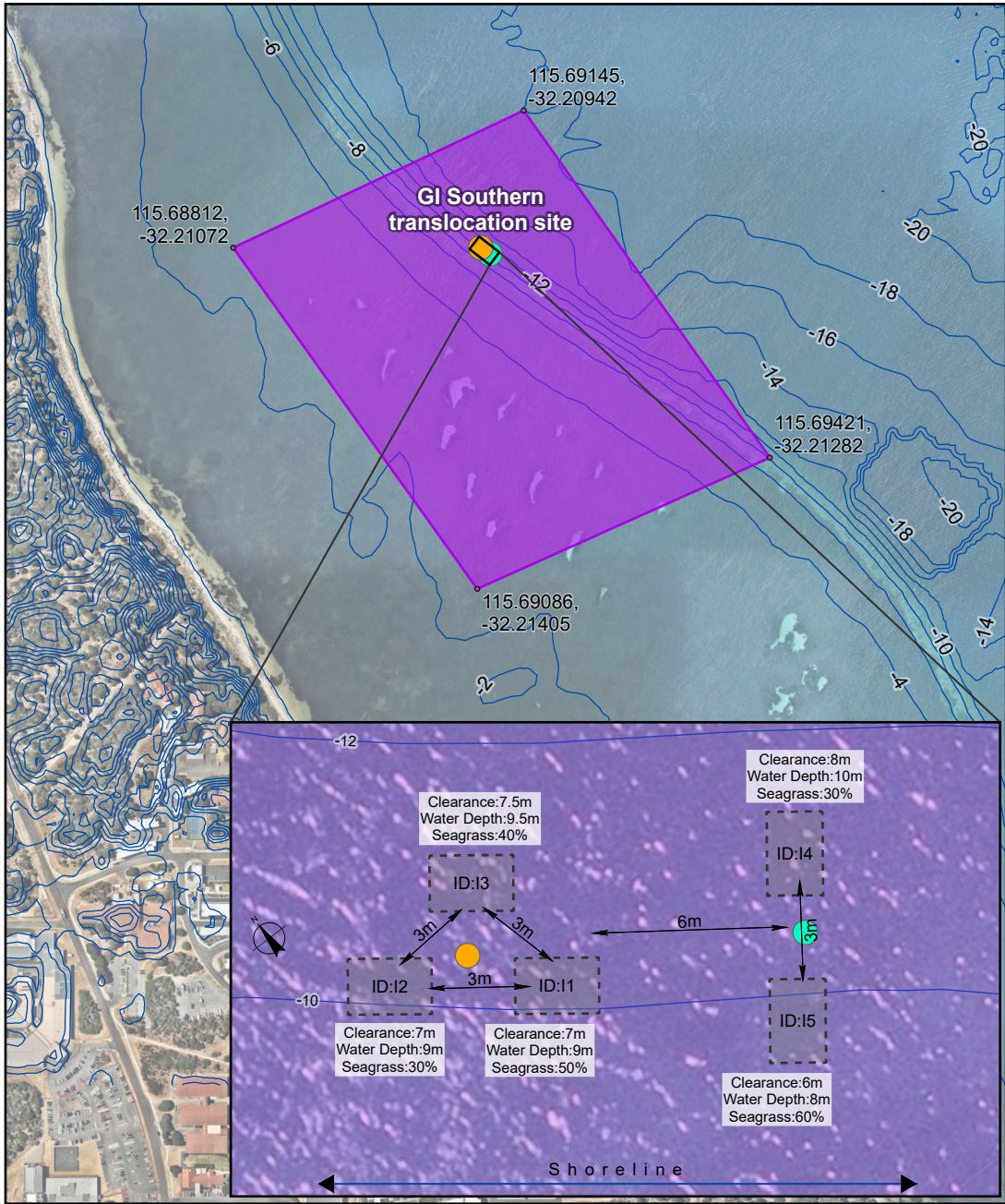
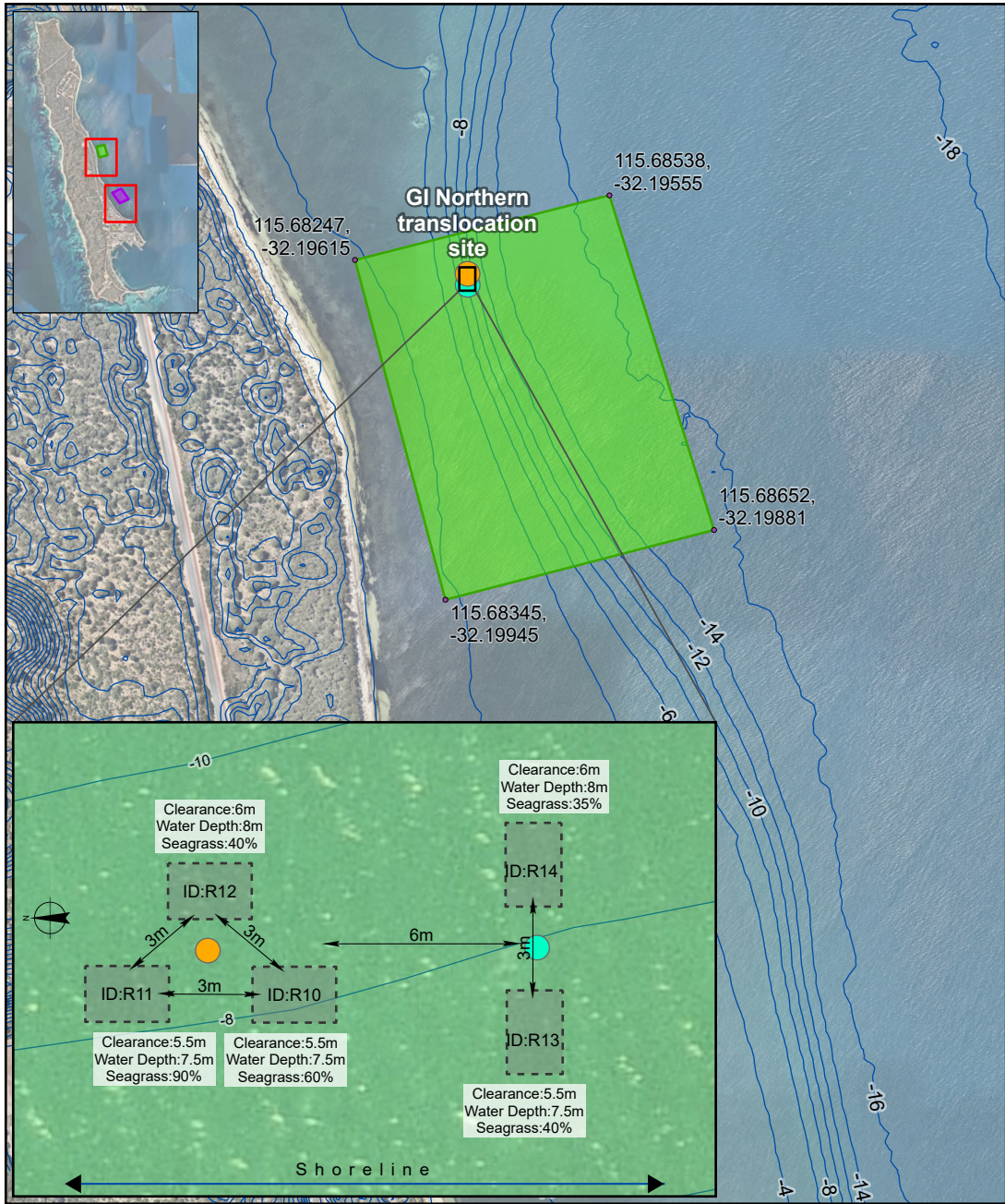
## 6.6.3 Siting

The site placement will be in depths greater than 6 m, with a targeted depth of 10 m and ideally placed alongside natural habitat so that artificial habitat is supplementary to natural habitat and is a like-for-like replacement of piles.

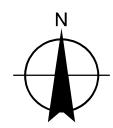
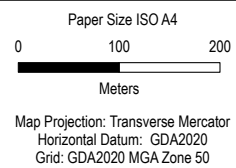
## 6.6.4 Quantity and layout

A total of 10 seahorse hotels were deployed on 11 March 2026, at the nominated translocation site(s), spaced a minimum of 3 m away from each other. Of the 10 hotels, 5 were at the GI Northern Translocation Site and 5 in the GI Southern Translocation Site. Within each Translocation Site, hotels were in 2 clusters. One cluster of 2 and 1 cluster of 3. The two clusters were 6 m away from each other. Hotels (units) within the cluster were 3 m away from each other. These distances have been considered in consultation with the suitably qualified Syngnathid ecologists and considers previous experience with and evidence of home ranges. This is visually represented in Figure 6-2.

Based on previous studies for White's Seahorse (Transport for NSW, 2024) and considering supplementing natural habitat, a stocking density of 12 to 16 individuals per 1 m<sup>2</sup> will be adopted for this SMP, noting that very little information on appropriate stocking densities is available for either the West Australian Seahorse or the Tiger Pipefish. GHD will adaptively manage the stocking densities throughout the SMP implementation.



- Legend**
- 2 cluster
  - 3 cluster
  - GI North translocation site
  - GI South translocation site
  - Bathymetry contours (2m)
  - Marine Translocation cluster sites



DEPARTMENT OF DEFENCE  
SEA1010-1 USW SUPPORT FACILITIES AND  
INFRASTRUCTURE PROGRAM SRF-W PRIORITY WORKS

**POTENTIAL TRANSLOCATION SITES  
CLUSTER POINTS**

Project No. 1213283  
Revision No. C  
Date 18/03/2026

**FIGURE 6.2**

## 6.7 Timing and tolerances

### 6.7.1 Sensitive time periods

Like many species of fish, the breeding period for most Syngnathids is generally considered to be during the warmer months of spring and summer (Moore, 2024), with limited information in specific breeding periods for most species in the family, however summer is anticipated to see the peak of breeding activity.

Table 6.3 provides a summary of the breeding records reported by Moore *et al* (2024) for the species noted during the baseline survey. If translocation is required within the breeding season, the length of the translocation period should not compromise more than 25 % of the total breeding period (i.e. 54 days for West Australian Seahorse and Tiger Pipefish) to constrain any potential impacts and stress during the period of heightened sensitivity. In the case of both species, translocation during more than 25 % of the summer breeding period will be avoided wherever possible.


**Table 6.3** West Australian Seahorse and Tiger Pipefish sensitive periods (orange indicates breeding and/or larval records from within Cockburn Sound or Owen’s Anchorage and yellow indicates breeding records from other sources)(Adapted from Moore *et al*, 2024)

Species	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
West Australian Seahorse	Orange	Orange	Orange	Orange	White	White	White	White	White	Orange	Orange	Orange
Tiger Pipefish	Yellow	Orange	Yellow	Yellow	Orange	White	White	White	White	White	Orange	Yellow

### 6.7.2 Translocation timing

All Syngnathids must be translocated prior to the commencement of any maritime works as described in the Condition 25). The proposed timing for Phase 3 and Phase 4 is outlined in Table 6.4.

**Table 6.4** Proposed translocation timing (Phase 3 and Phase 4)

Task	Description	Timing	Proposed time
Placement of artificial structures (Phase 3)	Placement of artificial structures for habitat enrichment and vertical habitat complexity as a replacement for vertical relief created by piles. Use commercial diver assisted (SSBA) for the placement and securing of units to the seabed, take GPS locations of final placement and provide to DEPAC / Port Services and site photos of placement for validation.	>2-3 months before relocation (ideally) Minimum of 4 weeks is recommended	March 2026
Pre-clearance surveys and translocation (Phase 4)	Primary translocation effort to translocate all Syngnathids from source sites to the receiver site. Assumed to take up to three weeks	To be completed no earlier than 1 month before the commencement of the maritime works action	April-August 2026
			
<b>Phase 5 post-translocation monitoring</b>			

### 6.7.3 Acceptable tolerances

Table 6.5 provides the acceptable tolerances for species specific receiver sites for the West Australian Seahorse and Tiger Pipefish.

Table 6.5 Acceptable tolerances for species-specific receiver sites

Metric	Acceptable tolerances	
	West Australian Seahorse	Tiger Pipefish
Depth	8 – 25 m	2 – 30 m
Temperature	18 – 24 °C	17 – 25 °C
Salinity	32 – 34 ppt and stable	32 – 34 ppt and stable
Specific gravity	1.020 – 1.025	1.020 – 1.025
Dissolved oxygen	>5 mg/L	>5 mg/L
pH units	8.1 – 8.4	8.1 – 8.4
Turbidity	Clear, but can tolerate some turbidity	Clear
Current flow	5 – 15 cm/s (moderate flow)	5 – 15 cm/s (moderate flow)
Substrate type	Soft growth, ample attachment points, seagrass	Rocky substrate, seagrass and sandy patches
Time limit	≤ 5 hours hold limit. For transport exceeding 6 – 8 hours, ammonia can accumulate. No use of ammonia-binding agents is proposed, and the program has instead opted to commit to not exceeding a 5 hour hold limit between the time of capture and release.	≤ 5 hours hold limit. For transport exceeding 6 – 8 hours, ammonia can accumulate. No use of ammonia-binding agents is proposed, and the program has instead opted to commit to not exceeding a 5 hour hold limit between the time of capture and release.

## 6.8 Risk assessment

Following the National Policy Guidelines for Translocation of Live Aquatic Animals and in accordance with Approval Condition 26a, a risk assessment was conducted for the translocation of Syngnathids present in the approved action area. This risk assessment follows the ISO/AS31000 Risk Management Guidelines standard, based on likelihood (Table 6.6) and consequence (Table 6.8) as defined in Appendix B in the Guidelines. This yielded the likelihood-consequence matrix in

Table 6.9.

Table 6.6 *Likelihood criteria*

<b>Likelihood</b>	<b>Description</b>
Certain	This event would definitely occur
High	The event would be very likely to occur
Moderate	The event is equally likely to occur or not occur
Low	The event would be unlikely to occur
Very Low	The event would be very unlikely to occur
Extremely Low	The event would be extremely unlikely to occur
Negligible	The event would almost certainly not occur
Zero	The event would not occur

Table 6.7 Likelihood ranges and qualitative likelihood categories

Likelihood	Minimum	Maximum
Certain	1	1
High	>0.7	1
Moderate	>0.3	0.7
Low	>0.05	0.3
Very Low	>0.001	0.05
Extremely Low	>10 <sup>-6</sup>	0.001
Negligible	>0	10 <sup>-6</sup>
Zero	0	0

Table 6.8 Consequence criteria

Consequence	Rating	Description
Negligible	0	Establishment of the disease or pest would have no significant biological consequences, may be transient and would require no management. Disease or pest would not affect economic performance at any level. Effects on the environment would be negligible.
Very Low	1	Establishment of the disease or pest would have very low biological consequence and be amenable to control or eradication. May harm economic performance at an enterprise level for a short period but be of limited significance at an industry level. Effects on environment would be very minor or temporary.
Low	2	Establishment of the disease or pest would have low biological consequence and be amenable to control or eradication. May harm economic performance at an enterprise level but be of limited significance at an industry level. Effects on environment would be minor or temporary.
Moderate	3	Establishment of the disease or pest would have moderate biological consequence and may be amenable to control or eradication at a significant cost. May harm economic performance at an industry level. May affect the environment but not seriously and may be reversible.
High	4	Establishment of the disease or pest would have serious biological consequences (high mortality or morbidity). Effects that would be felt for a prolonged period and would be difficult to control or eradicate. Will significantly harm economic performance at an industry level or regional level and may cause serious harm to the environment.
Catastrophic	5	Establishment of the disease or pest would significantly harm economic performance at a national level. May cause long-term or irreversible harm to the environment.

Table 6.9 Risk scores from likelihood-consequence matrix – the upper likelihood values were used as a precautionary approach, considering uncertainties

		Consequence					
		Negligible (0)	Very Low (1)	Low (2)	Moderate (3)	High (4)	Catastrophic (5)
Likelihood (upper range)	Zero (0)	Negligible (0)	Negligible (0)	Negligible (0)	Negligible (0)	Negligible (0)	Negligible (0)
	Negligible (10 <sup>-6</sup> )	Negligible (0)	Negligible (10 <sup>-6</sup> )	Negligible (20 <sup>-6</sup> )	Negligible (30 <sup>-6</sup> )	Negligible (40 <sup>-6</sup> )	Negligible (50 <sup>-6</sup> )
	Extremely low (0.001)	Negligible (0)	Negligible (0.001)	Negligible (0.002)	Negligible (0.003)	Negligible (0.004)	Negligible (0.005)
	Very low (0.05)	Negligible (0)	Negligible (0.05)	Negligible (0.1)	Negligible (0.15)	Negligible (0.2)	Negligible (0.25)
	Low (0.3)	Negligible (0)	Negligible (0.3)	Negligible (0.6)	Negligible (0.9)	Very low (1.2)	Very low (1.5)
	Moderate (0.7)	Negligible (0)	Negligible (0.7)	Very low (1.4)	Low (2.1)	Low (2.8)	Moderate (3.5)
	High (1)	Negligible (0)	Very low (1)	Low (2)	Medium (3)	High (4)	Very high (5)
	Certain (1)	Negligible (0)	Very low (1)	Low (2)	Medium (3)	High (4)	Very high (5)

### 6.8.1 Hazard identification

The national policy guidelines for the translocation of live aquatic animals (DAFF, 2020) lists pests, disease and genetic considerations for translocation. However, it should be noted that translocation and relocation have different risk profiles, with greater potential for risk when animals are translocated to new locations considerable distances away than when animals are relocated to nearby habitat. In conservation management, translocation is often used to re-establish populations in previously occupied habitat and at the extreme, has the potential to affect ecological interactions and ecosystems. In contrast, animals relocated to nearby habitat that is already occupied by the same species is less likely to modify ecosystem structure, but has the potential to change genetic structure, or introduce disease or parasites. These risks are assessed in more detail below in Table 6.10.

National policy guidelines for the translocation of live aquatic animals also relate to reportable/noxious diseases. However, there are no notifiable animal diseases that affect fish in Western Australia, according to Reportable Animal Diseases – Western Australia (DPIRD-195, November 2024). One invasive marine species has been identified in the Action area (Diamantina Pier), the Carpet Sea Squirt (*Didemnum vexillum*). This species fouls marine infrastructure and is discussed in more detail in section 6.3.6 of the Environment and Heritage Assessment (GHD, 2024). The main control for this species is that piles or in-water infrastructure will not be moved, and no Carpet Sea Squirt will be transferred.

Relocating animals can also result in the transfer of parasites. Syngnathids are known to be affected by a variety of parasites that affect other marine teleosts, such as metazoan, protozoa and ectoparasites.

Capture and handling of Syngnathids has the potential to increase stress levels, leading to mortality or susceptibility to other risks such as disease or post-release predation.

Syngnathids are also susceptible to food competition and overstocking. If the local carrying capacity is exceeded, and there is a lack of suitable adjacent habitat, this could result in reduced growth and survival. It is also possible that an increase in local abundance of relocated Syngnathids may attract predators that in turn also predate upon pre-existing Syngnathids

Genetic risks of moving animals from natural home ranges to other occupied habitats depend on the extent to which populations have genetically differentiated, and can result from hybridisation, genetic transgression and even fitness depression. While there is no evidence to suggest local genetic divergence within Syngnathid species

in Cockburn Sound, the potential for genetic transgression can be managed by minimising the distance between source and receiver populations. Minimising the geographic distances between source and receiver populations will also reduce the risk of transfer of parasites or disease.

## 6.8.2 Risk matrix

The risk matrix is shown in Table 6.10. The risk assessment matrix provides an assessment of the species-specific hazard, mitigation measures, an overview of the likelihood, consequence and risk of the translocation and suggested controls. A residual risk rating is provided based on the assumption that the risk controls as provided are implemented.

As stepped through in Table 6.10 the risk assessment determines the residual risk of the translocation on the West Australian Seahorse, Tiger Pipefish and other Syngnathids to be generally very low.

Table 6.10 Translocation residual risk assessment

Species and hazard	Mitigation	Likelihood	Consequence	Risk	Suggested risk control	Residual risk - assuming risk control implemented
<b>West Australian Seahorse</b>						
Exposure to other threats i.e. Future developments, increased predation	Avoid moving to areas with known future development (e.g. Henderson, Westport)  Selection of receiver habitat that provides sufficient refugia	Moderate (0.7)	Moderate (3)	Low (2.1)	Post-translocation monitoring	Low
Increased mortality in receiver or source populations i.e. Increased predation risk, poor husbandry	Best-practice husbandry (water quality, handling, captive management)  Use of artificial habitat enrichment for attachment and vertical complexity  Receiver site(s) to be like-for-like of source site	Moderate (0.7)	Moderate (3)	Low (2.1)	Baseline surveys of receiver location and post-translocation monitoring	Very Low
Disrupt reproduction in receiver or source populations	Limit the translocation effort to no more than 25 % of the breeding season	High (1)	Moderate (3)	Moderate (3.5)	Avoid translocation during West Australian Seahorse breeding period	Low
Impaired recruitment/growth in receiver or source	Baseline surveys at receiver locations and suitably qualified Syngnathid ecologist review of habitat suitability	Moderate (0.7)	Moderate (3)	Low (2.1)	Baseline surveys of receiver location and post-translocation monitoring	Low
Receiver population moves back to Action area (subsequent risk exposure)	Receiver sites outside the home range area at source areas	Moderate (0.7)	Moderate (3)	Low (2.1)	Situate receiver location outside of the home range of the source population	Very Low
Introduce or spread disease	Health assessment at time of sourcing and embedded health check into ongoing monitoring	Low (0.3)	High (4)	Very low (1.2)	Health checks of individuals during monitoring	Negligible
Genetic impacts	Minimise distance translocated	Low (0.3)	High (4)	Very low (1.2)	Minimise geographic distance between source and receiver populations	Negligible
Introduce/spread parasites	Health assessment at time of sourcing and embedded health check into ongoing monitoring	Low (0.3)	High (4)	Very low (1.2)	Health checks of individuals during monitoring	Negligible

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Species and hazard	Mitigation	Likelihood	Consequence	Risk	Suggested risk control	Residual risk - assuming risk control implemented
Introduce/spread invasive marine species (IMS)	Existing structure/piles will not be moved  <i>D. vexillum</i> will not be moved and Syngnathids not known vector	Low (0.3)	High (4)	Very low (1.2)	Visual inspection for <i>D. vexillum</i>	Very low
<b>Tiger Pipefish</b>						
Exposure to other threats i.e. Future developments, increased predation	Avoid moving to areas with known future development (e.g. Henderson, Westport)  Selection of receiver habitat that provides sufficient refugia	Moderate (0.7)	Moderate (3)	Low (2.1)	Post-translocation monitoring	Low
Increased mortality in receiver or source populations i.e. Increased predation risk, poor husbandry	Best-practice husbandry (water quality, handling, captive management)  Use of artificial habitat enrichment for attachment and vertical complexity  Receiver site(s) to be like-for-like of source site	Moderate (0.7)	Moderate (3)	Low (2.1)	Baseline surveys of receiver location and post-translocation monitoring	Very Low
Disrupt reproduction in receiver or source populations	Limit the translocation effort to no more than 25 % of the breeding season, avoid summer months	High (1)	Moderate (3)	Moderate (3.5)	Avoid translocation during known breeding periods	Low
Impaired recruitment/growth in receiver or source	Baseline surveys at receiver locations and suitably qualified Syngnathid ecologist review of habitat suitability	Moderate (0.7)	Moderate (3)	Low (2.1)	Baseline surveys of receiver location and post-translocation monitoring	Low
Receiver population moves back to Action area (subsequent risk exposure)	Receiver sites outside the home range area at source areas	Moderate (0.7)	Moderate (3)	Low (2.1)	Situate receiver location outside of the home range of the source population	Very Low
Introduce or spread disease	Health assessment at time of sourcing and embedded health check into ongoing monitoring	Low (0.3)	High (4)	Very low (1.2)	Health checks of individuals during monitoring	Negligible
Genetic impacts	Minimise distance translocated	Low (0.3)	High (4)	Very low (1.2)	Minimise geographic distance between source and receiver populations	Negligible
Introduce/spread parasites	Health assessment at time of sourcing and embedded health check into ongoing monitoring	Low (0.3)	High (4)	Very low (1.2)	Health checks of individuals during monitoring	Negligible

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Species and hazard	Mitigation	Likelihood	Consequence	Risk	Suggested risk control	Residual risk - assuming risk control implemented
Introduce/spread IMS	Existing structure/piles will not be moved  <i>D. vexillum</i> will not be moved and Syngnathids not known vector	Low (0.3)	High (4)	Very low (1.2)	Visual inspection for <i>D. vexillum</i>	Very low
<b>Other Syngnathids</b>						
Exposure to other threats -Future development	-Avoid moving to areas with known future development (e.g. Henderson, Westport)	Moderate (0.7)	Moderate (3)	Low (2.1)	Post-translocation monitoring	Low
Increased mortality in receiver or source populations -Increased predation risk -Poor husbandry	-Best-practice husbandry (water quality, handling, captive management) -Receiver site(s) to be like-for-like of source site	Moderate (0.7)	Moderate (3)	Low (2.1)	Baseline surveys of receiver location and post-translocation monitoring	Very Low
Disrupt reproduction in receiver or source populations	Limit the translocation effort to no more than 25 % of the breeding season, avoid summer	High (1)	Moderate (3)	Moderate (3.5)	Avoid translocation during known reproductive period	Low
Impaired recruitment/growth in receiver or source	Baseline surveys at receiver locations and suitably qualified Syngnathid ecologist review of habitat suitability	Moderate (0.7)	Moderate (3)	Low (2.1)	Baseline surveys of receiver location and post-translocation monitoring	Low
Receiver population moves back to Action area -subsequent risk exposure	Receiver sites outside the home range area at source areas	Moderate (0.7)	Moderate (3)	Low (2.1)	Situate receiver location outside of the home range of the source population	Very Low
Introduce or spread disease	Health assessment at time of sourcing and embedded health check into ongoing monitoring	Low (0.3)	High (4)	Very low (1.2)	Health checks of individuals during monitoring	Negligible
Genetic impacts	Minimise distance translocated	Low (0.3)	High (4)	Very low (1.2)	Minimise geographic distance between source and receiver populations	Negligible
Introduce/spread parasites	Health assessment at time of sourcing and embedded health check into ongoing monitoring	Low (0.3)	High (4)	Very low (1.2)	Health checks of individuals during monitoring	Negligible
Introduce/spread IMS	-Existing structure/piles will not be moved - <i>D. vexillum</i> will not be moved and Syngnathids not known vector	Low (0.3)	High (4)	Very low (1.2)	Visual inspection for <i>D. vexillum</i>	Very low

## 6.9 Source and receiver sites

### 6.9.1 Source sites

Syngnathids were recorded at Diamantina Pier, Armament Wharf and Oxley Wharf, and in surrounding seagrass. During the time of survey, no Syngnathids were detected in Moresby Harbour but are likely to be present, potentially in lower abundances than those found in the aforementioned. These locations are considered the 'source' sites for the purposes of the translocation.

### 6.9.2 Translocation site selection criteria

The Syngnathid species recorded in the baseline survey, or that are considered likely to occur in the Action area, differ in their microhabitat requirements. This has been considered when considering suitable receiver sites. The West Australian Seahorse is naturally associated with rocky reef structure with mixed macrophyte, macroalgae and sponges/ sea squirts (Moore 2001), but is also associated with artificial structure in Cockburn Sound such as jetties, piles and wrecks (Moore *et al.* 2024) which was consistent with the findings of the baseline survey. In contrast, Tiger Pipefish are typically seagrass specialists and would likely not benefit from translocation to artificial habitat structure but into seagrass habitat.


The success of translocation also depends on the fish not returning to the Action area and not being exposed to an additional impact or stressor. Typical home range sizes therefore also need to be considered. For the West Australian Seahorse, adults are known to have a home range of up to 93.5 m<sup>2</sup> in the breeding period (36.3 ± 40.9 m<sup>2</sup> to 93.5 ± 20.4 m<sup>2</sup>; Kvarnemo *et al.* 2021). Receiver sites therefore need to be outside of this home range area.

A standard multicriteria analysis was undertaken to compare each relocation option.

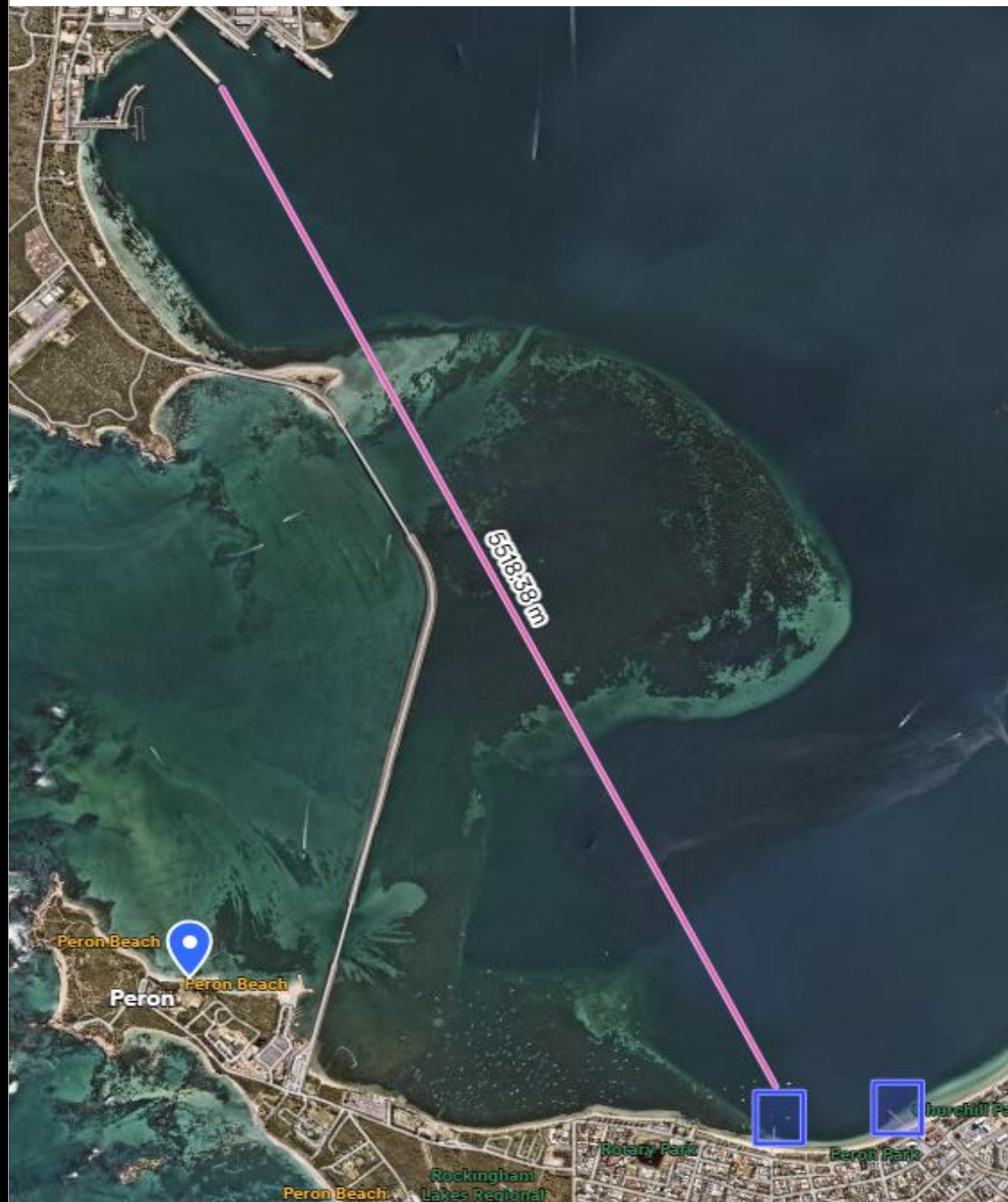
### 6.9.3 Receiver sites

Three receiver sites as general indicative locations were considered for the translocation using desktop information and knowledge of general areas. These are described in Table 6.11. Site C is the preferred site.

Table 6.11 Overview of potential receiver sites

Site	Approximate area	Pros and cons
<p><b>Site A - Careening Bay seagrass flats (southern flats)</b></p>		<p><b>Pros:</b></p> <ul style="list-style-type: none"> <li>- Natural habitat availability (i.e. presumed seagrass)</li> <li>- Significant distance from action area so certainty that translocated individuals would not recolonise source sites</li> <li>- Suitable habitat for both pipefish and seahorses</li> </ul> <p><b>Cons:</b></p> <ul style="list-style-type: none"> <li>- No survey effort to determine suitability of habitat for translocation</li> <li>- No understanding of current environment, potentially a lot of sediment transport</li> <li>- Relatively shallow</li> <li>- No validation of the condition of the seagrass</li> <li>- No understanding of existing population(s) in seagrass. Given the affinity demonstrated by the baseline surveys of West Australian Seahorse to artificial habitat, potentially may still require enrichment for a like-for-like replacement.</li> </ul>

Site B -  
Careening Bay  
existing  
infrastructure  
(along the east  
coast of  
Cockburn Sound)  
including  
shipwrecks, piers  
and jetties




**Pros:**

- Existing piles for vertical complexity on piers and jetties. Given the affinity for artificial structure demonstrated through the baseline survey, this appears to be important
- Range of piers and jetties (but limited to publicly accessible piers that are not involved in heavy industry / private ownership)
- Significant distance from action area so certainty that translocated individuals would not recolonise source sites

**Cons:**

- Outside naval waters, additional permits required
- No survey effort to determine suitability of habitat for translocation
- No understanding of current environment
- Subject to disturbance by other works happening on the east coast of Cockburn Sound, potentially needing to be translocated again
- No understanding of existing population(s) in natural adjoining or artificial habitat (from piles) of the jetties/piers
- Limited space without further enrichment

Site	Approximate area	Pros and cons
<p>Site C - Eastern shoreline of Garden Island (Sulphur Bay (top) and Buchanan Bay (bottom))</p>		<p><b>Pros:</b></p> <ul style="list-style-type: none"> <li>- Seagrass meadows patches present along the east coast of Garden Island, allowing for flexibility to target seagrass substrate</li> <li>- Suitable habitat for both pipefish and seahorses with nearby sandy and rocky rubble expanses</li> <li>- Within Naval Waters, no state permits are required</li> <li>- Outside of the potential zone of influence for construction related disturbance</li> <li>- Does not constrain shared users of the area</li> <li>- Adds vertical habitat complexity to an otherwise low vertical relief environment</li> <li>- Two sites allow for effective management of stocking densities across the two sites and can reduce mobilisation time between source sites at Armament Wharf and Careening Bay as the northern Sulphur Bay site can be used for Armament Wharf source population and the Buchanan Bay site for the Careening Bay populations</li> </ul> <p><b>Cons:</b></p> <ul style="list-style-type: none"> <li>- Limited understanding of existing population in natural habitat</li> <li>- Limited understanding of current environment</li> <li>- While within Naval Waters, not within Naval Closed Waters and public can access these areas</li> </ul>

## 6.9.4 Multicriteria analysis

Multicriteria analysis (MCA) is a structured approach used to evaluate and compare options based on multiple conflicting criteria (Belton et al, 2012; Zopounidis, & Pardalos, 2010). A MCA was undertaken to evaluate the suitability of receiver sites (Table 6.12 and Table 6.13). CRB refers to Careening Bay seagrass flats, CBI to Careening Bay existing infrastructure and ES refers to eastern sites and surrounds, including seagrass meadows north and south of the wharf. The MCA adopted the scoring of 1 being the poorest rating and 10 being the best rating.

Based on the MCA, Site C is the preferred translocation site.

Table 6.12 Multicriteria analysis criteria

Criteria	Weight	Site A – CRB seagrass flats	Site B – CBI existing infrastructure	Site C – ES Eastern sites
1. Habitat Suitability	0.25	8	6	7
2. Food Availability	0.15	9	7	6
3. Predation Risk	0.15	6	8	7
4. Water Quality	0.10	7	9	6
5. Accessibility for Monitoring	0.10	5	7	9
6. Community/Stakeholder Support	0.10	6	8	7
7. Cost of Relocation	0.15	5	7	9
<b>Total score</b>		<b>6.8</b>	<b>7.2</b>	<b>7.25</b>

## 6.10 Biosecurity

In Western Australia, biosecurity in the aquatic environment operates under the *Fisheries Resource Management Act 1994* and *Biosecurity and Agriculture Management Act 2007*.

The *Biosecurity and Agriculture Management Act 2007* require the presence of certain pests and diseases to be reported on if they are known or suspected. The *Fisheries Resource Management Act 1994* lists noxious fish. The *Biosecurity and Agriculture Management Act 2007* define diseases that are known as reportable diseases and are listed on the WA reportable aquatic animal diseases website (DPIRD, 2025).

The presence or suspected presence of an aquatic invasive species in marine or freshwater environment must be reported to the DPIRD. There is no specific reporting timeframe according to *Biosecurity and Agriculture Management Act 2007* and DPIRD, however reporting should occur as soon as a suspected invasive species is detected. Samples should be reported to [aquatic.biosecurity@dpiird.wa.gov.au](mailto:aquatic.biosecurity@dpiird.wa.gov.au) along with any digital photographs of the suspected invasive species sample.

The avenue for reporting aquatic pests is as follows:

- Contact FinWatch 24-hour hotline 1800 815 507.
- Email [animalbiosecurity@dpiird.wa.gov.au](mailto:animalbiosecurity@dpiird.wa.gov.au).
- Lodge on the MyPestGuide app.

Notifiable diseases defined under the *Biosecurity and Agriculture Management Act 2007* include (DPIRD, 2025):

- *Aeromonas salmonicida* subsp. *salmonicida* infection (Furunculosis)
- *Aeromonas salmonicida* infection – atypical strains (Goldfish ulcer disease)
- infectious pancreatic necrosis
- infectious salmon anaemia
- infectious spleen and kidney necrosis virus
- piscirickettsiosis (*Piscirickettsia salmonis*)
- red sea bream iridovirus

- bacterial kidney disease (*Renibacterium salmoninarum*)
- enteric redmouth disease (*Yersinia ruckeri*)
- enteric septicaemia of Catfish (*Edwardsiella ictaluri*)
- epizootic haematopoietic necrosis
- epizootic ulcerative syndrome (*Aphanomyces invadans*)
- gyrodactylosis (*Gyrodactylus salaris*)
- herpesvirus infection of Koi Carp (Cyprinid herpesvirus 3)
- infectious haematopoietic necrosis
- salmonid alphavirus
- scale drop disease virus
- Singapore grouper iridovirus (ranavirus)
- spring viraemia of carp
- Tilapia lake virus (TiLV) disease
- turbot reddish body iridovirus
- viral encephalopathy and retinopathy
- whirling disease of salmonids (*Myxobolus cerebralis*).

The standard biosecurity precautions outlined in Table 6.13 will be employed. PPE, training and fish husbandry procedures will be used to minimise stress of captive fish, and to reduce the risk of disease transfer. Individual fish will also be visually examined for overall health and condition prior to translocation. Syngnathids that are deemed to be unsuitable for translocation because of disease transfer risk will be euthanised using the AEC approved procedure for necropsy/examination by a veterinarian or suitably qualified Syngnathid specialist. Disease risk will also be managed by translocating fish to a location with a similar disease prevalence to the source location, and by minimising the geographical distance between source and recipient locations.

Table 6.13 Standard biosecurity measures to be employed

	Biosecurity measures
<b>Pre-translocation</b>	Liaison with DPIRD for advice on potential threats to biosecurity from the translocation Finalisation of emergency response procedure
<b>Transport and handling</b>	Use transport water from the receiving site to house Syngnathids from the source sites Use of secure containment that prevents stress and therefore reduces any potential disruption of the immune system All equipment must be thoroughly cleaned and disinfection before and after use and between sites Team members must wash hands between sites Release individuals captured together at the source sites together at the receiver site so as to maintain genetic integrity Take detailed records of health status of translocation Syngnathids to establish a baseline to allow for traceability of disease outbreak Establish appropriate containment procedures for Syngnathids that exhibit diseases prior to release at the receiver site
<b>Post-translocation</b>	Transport water must not be discharged into Cockburn Sound and must be disposed of on land Implement monitoring program (Phase 5) to assess effectiveness and impact of the translocation Establish contingency plans and emergency response procedures to control any outbreaks or diseases noted during the transport and handling of the translocation

## 6.11 Emergency response

### 6.11.1 Poor response to translocation

A tiered, adaptive management approach will be used to detect and respond to a poor response of Syngnathids to translocation, as detailed in Section 5.4 and Table 5.2. An emergency response may also be required if there is a sudden increase in post-capture or post-release mortality of Syngnathids, considered more than 34 pipefish<sup>4</sup> or more than 44 seahorses reported dead during the translocation procedures. In this case, all active translocation efforts or pre-clearance efforts must be ceased as soon as reasonably practicable.

<sup>4</sup> This is based on 5 % of the population estimates in Table 4.4.

The translocation program will be reviewed in consultation with the suitably qualified Syngnathid experts Dr. Glenn Moore and/or Dr. David Booth, and DEPAC. Subject to the outcome of this review, amendments to the translocation approach and/or receiver sites may be required. An assessment of alternative mitigation measures could also be undertaken.

### 6.11.2 Severe weather event or other unexpected circumstances

It is recognised that unforeseen circumstances that are outside of the control of the Project could occur that may impact the success of the SMP. This could include a severe weather event or disease that impacts Syngnathids or their habitats directly or indirectly. The translocation will not be undertaken during inclement weather, or during a severe weather event, upon which translocation will be delayed until more suitable conditions arise.

Post-relocation monitoring will be designed to detect major perturbations in the translocated population (see Table 5.2). If detected, this will trigger an adaptive management response and review in consultation with the suitably qualified Syngnathid experts Dr. Glenn Moore and Dr. David Booth, and DEPAC. Reporting and responding to invasive marine species during the translocation and post-translocation monitoring will follow the procedures outlined in the Maritime Piling annexure (annexure A8) of the CEMP.

## 6.12 Occupational health and safety requirements

GHD will prepare a Job Safety Analysis (JSA) for the relocation works. The JSA is to facilitate a safe working environment for GHD staff during the relocation process. GHD's subcontractors, Indianic Group, providing commercial diving services for the works will undertake their scope under a commercial diving specific safe work method statement. Due to task constraints, such as time and safety, all translocation works must be carried out with surface supplied air, and all divers are to be ADAS Part 2 SSBA (surface supplied breathing apparatus) certification and experienced local commercial divers with mixed use of EAN and compressed air to maximise bottom time and reduce surface intervals. This will save significant dive hours and reduce the amount of time handling Syngnathids to as low as reasonably practicable. As the location is a working Port and Navy facility, to ensure safe operations, commercial divers must have experience in commercial diving within Navy HMAS Stirling waters and be familiar with HMAS Stirling operations to ensure that works can be safely deconflicted as required.

Translocation activities must be directed by a suitably qualified marine field ecologist, under the guidance of the suitably qualified Syngnathid ecologist (Condition 28)). Suitably qualified marine field ecologists must have local experience in the region, have undertaken a Syngnathid survey and translocation, be familiar with the proposed methods and be familiar with Navy HMAS Stirling operations to lead the field activities in a safe manner that deconflicts with Navy operations.

## 7. Phase 4 – pre-clearance surveys

### 7.1 Objectives

For the purpose of the Approved Action, a 'pre-clearance survey' refers to the capture of Syngnathids for the purposes of translocation to the receiver sites, to be undertaken before a disturbance action. The objective and purpose of the pre-clearance surveys is to undertake a final clearance of the approved Action area deemed to be at risk of impacting Syngnathids with the purpose of removing the Syngnathids from direct and indirect harm. This activity should be completed as soon as practicable and no earlier than 30 days prior to the maritime construction activity commences.

Pre-clearance surveys will be undertaken as per Section 6.

### 7.2 Timing and integration with works

Once an area is cleared, it is assumed that the validity of that clearance is a **maximum of one (1) month**. Prior to the commencement of a disturbing action (including any habitat removal, dredging, underwater noise generating

action), or after any break in construction longer than one month, will trigger a pre-clearance survey to be undertaken.

For the commencement of the Diamantina Pier in May 2026, the clearance will be started at a known 'hot spot' of the West Australian Seahorse and conclude with a re-clearance in the same place to test the one-month clearance validity determination and allow an opportunity to refine.

## **7.3 Maritime infrastructure upgrades and installation part of the approved Action (piling works and habitat removal)**

Maritime fender frame removal (including Syngnathid habitat) and maritime piling is scheduled to commence in May 2026 for Diamantina Pier, June 2026 in Moresby Harbour and August 2026 at Armament Wharf. These activities involve the potential for direct and indirect harm to Syngnathids and therefore are covered by this SMP.

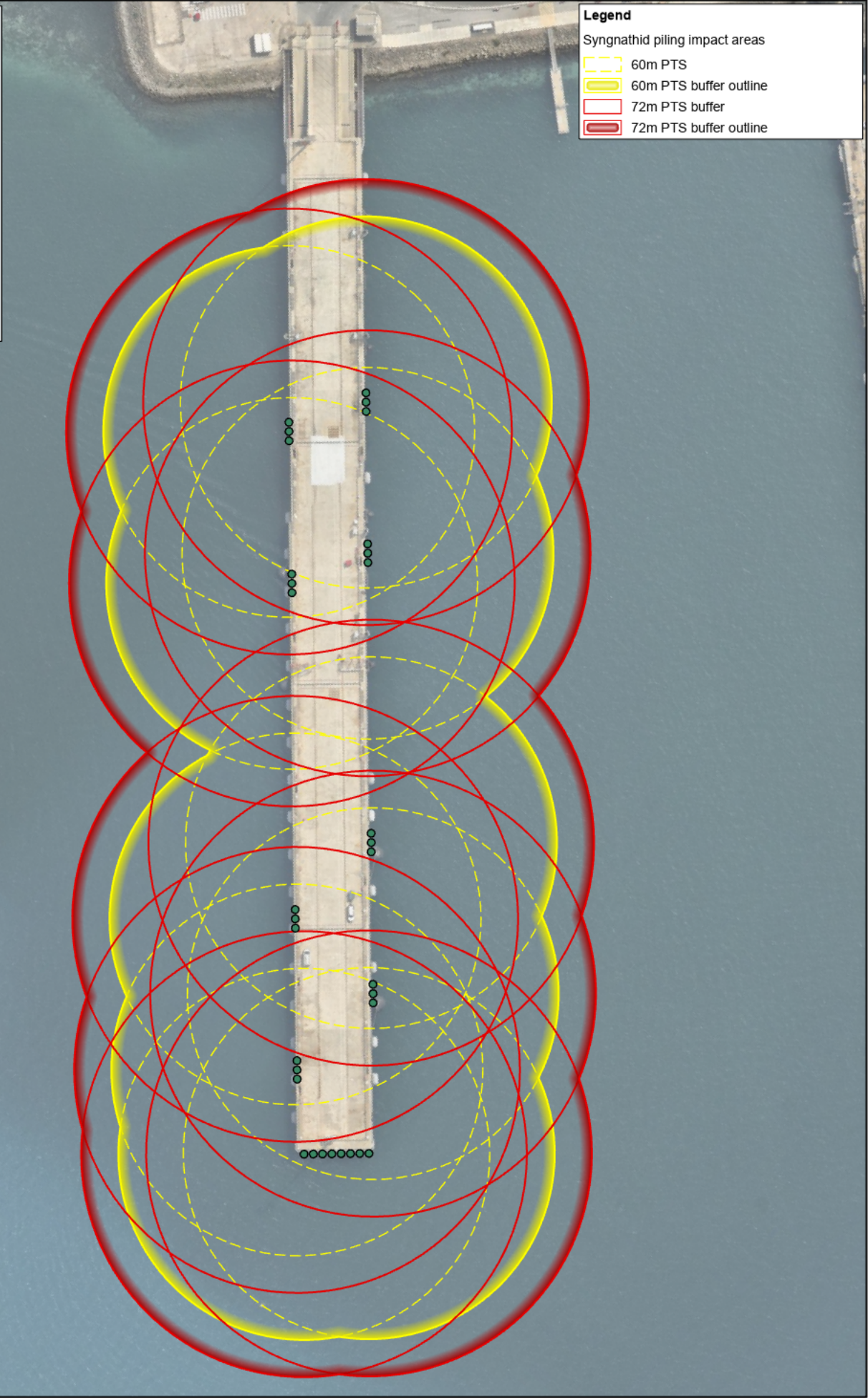
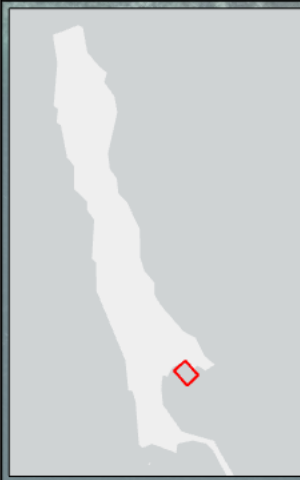
Pre-clearance surveys will be undertaken prior to the commencement of maritime works, although it will not be feasible or safe to do this on the same day as the works. The validity of a clearance is one month. This considers the time of potential recolonisation. Pre-clearances will occur when a one-month period of no construction activity has occurred. This one month stand down window considers the conservative buffer approach taken to the clearance activity and the known movement distances of Syngnathids.

### **7.3.1 Clearance buffer**

For the purposes of the maritime infrastructure upgrade and installation works, including piling and habitat removal (i.e. fender frame removal), a base clearance radius of 60 m has been applied around each individual disturbance location (i.e. centre of pile at a piling location). This distance is aligned with the predicted zone where bony fish (generalist taxa) may experience permanent threshold shift (PTS) in response to underwater noise.

Beyond this, a 12-m buffer beyond the base clearance has been applied. This represents twice the average daily distance that individual West Australian Seahorses are expected to move (G. Moore, pers. comm; refer also to Section 3.2.2 and Kvarnemo et al. 2020 for more details). This buffer reduces the likelihood of seahorses or other Syngnathids re-entering the clearance area after the translocation activity has been completed. There is very limited available information available on the movements of the other Syngnathid species known or likely to occur in the approved Action area, and this buffer distance (i.e., 12 m) is therefore precautionary. Application of this buffer also avoids the need to clear Syngnathids on the same day/immediately prior to commencement of piling or habitat removal. The clearance areas, inclusive of this 72-m buffer, are shown in Figure 7-1, Figure 7-2 and Figure 7-3.

Any further works associated with the approved Action that have the direct or indirect potential to cause harm to Syngnathids or Syngnathid habitat will be addressed in a future iteration of this SMP.



**Legend**

Syngnathid piling impact areas

- 60m PTS
- 60m PTS buffer outline
- 72m PTS buffer
- 72m PTS buffer outline

Paper Size ISO A4

0 25 50  
Meters

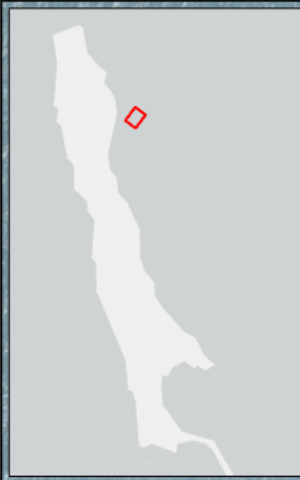
Map Projection: Transverse Mercator  
Horizontal Datum: GDA2020  
Grid: GDA2020 MGA Zone 50



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SEA1010-1 USW SUPPORT FACILITIES AND  
INFRASTRUCTURE PROGRAM SRF-W PRIORITY WORKS  
**SYNGNATHID MANAGEMENT PLAN  
PILING IMPACT AREAS  
- DIAMANTINA PIER**





Project No. **1213283**  
Revision No. **D**  
Date **13/05/2026**

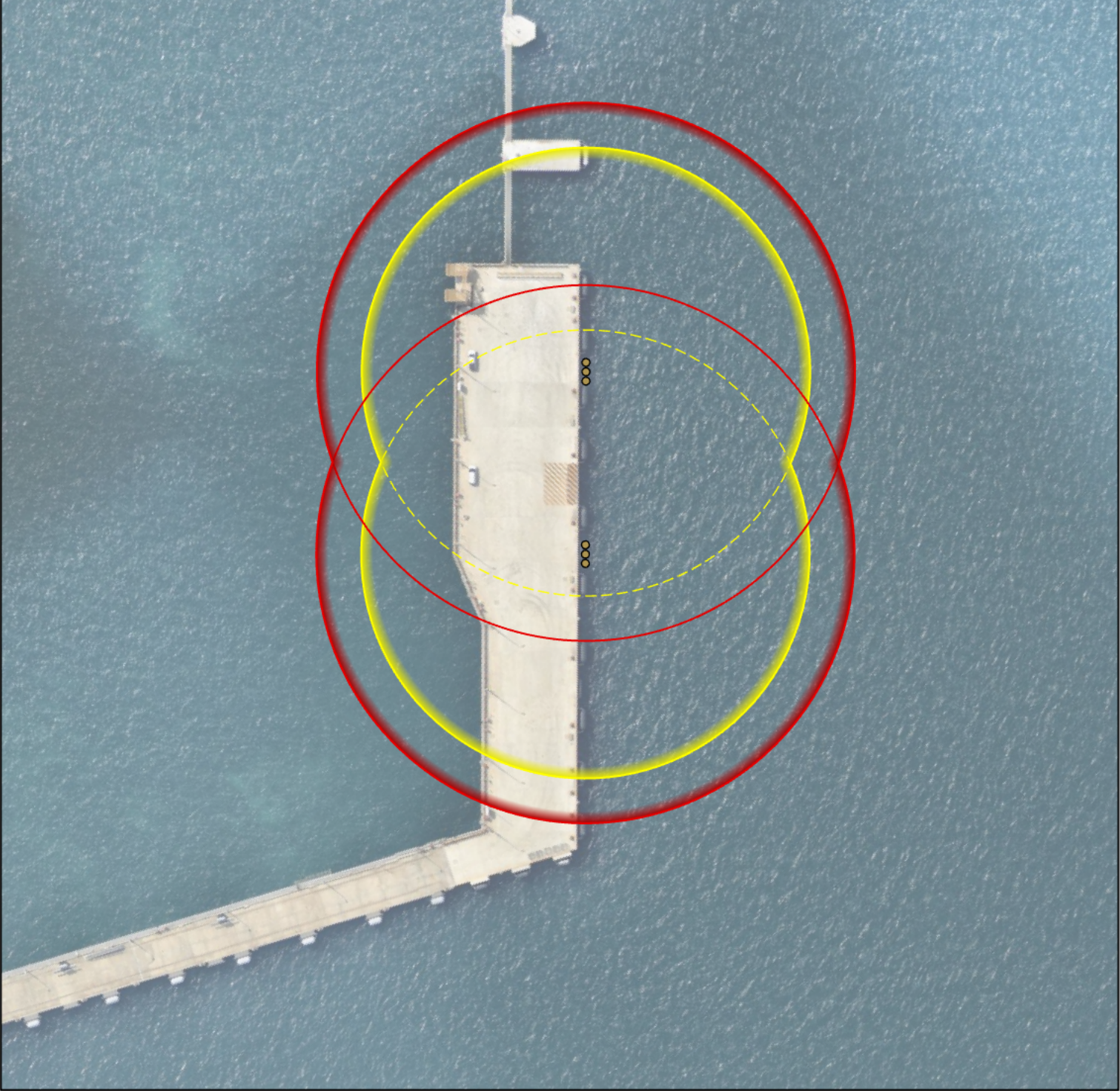
**FIGURE 7.1**



**Legend**

Syngnathid piling impact areas

-  60m PTS
-  60m PTS buffer outline
-  72m PTS buffer
-  72m PTS buffer outline



Paper Size ISO A4  
 0 25  
 Meters



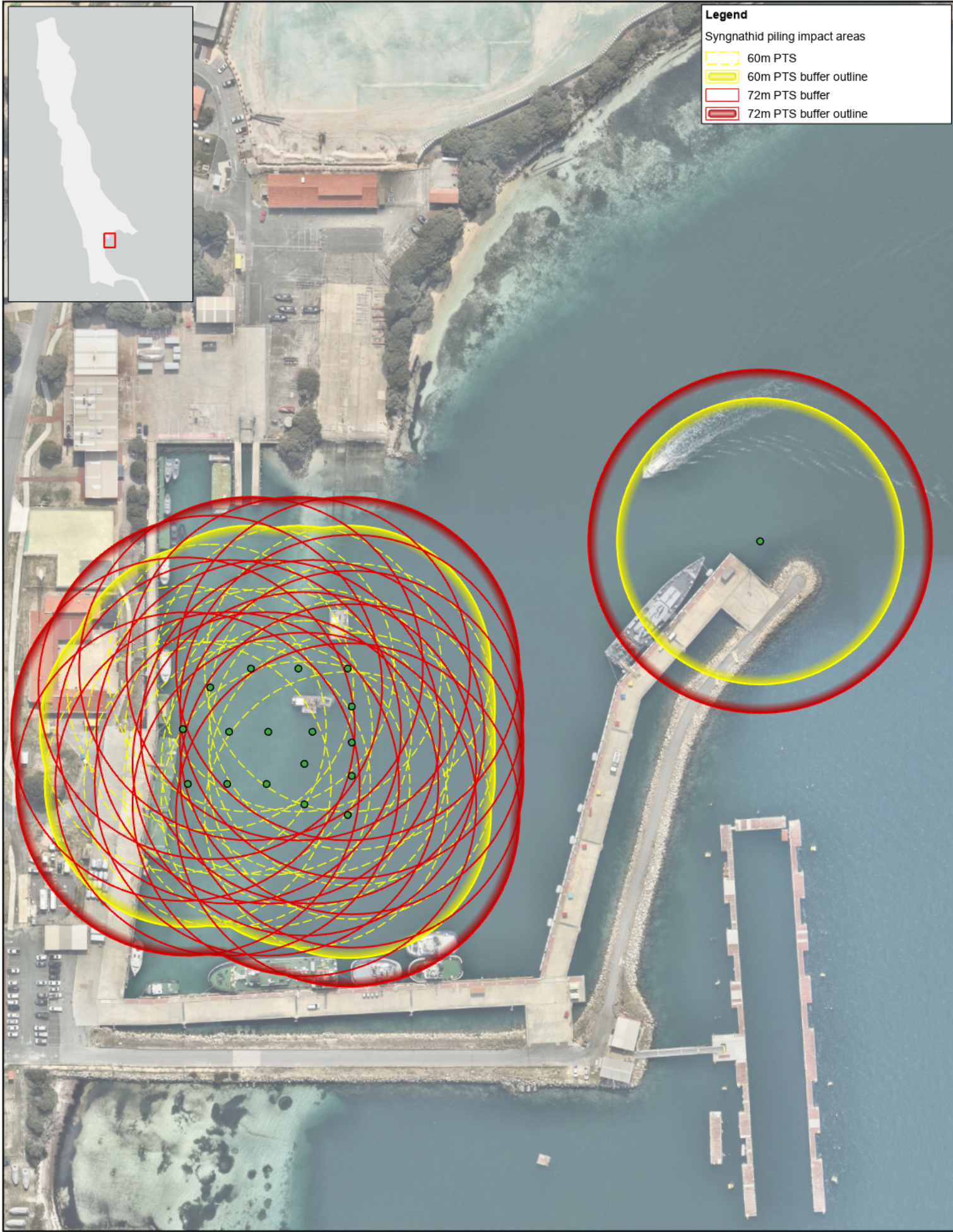
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 INFRASTRUCTURE PROGRAM SRF-W PRIORITY WORKS

Project No. 1213283  
 Revision No. D  
 Date 18/05/2026

Map Projection: Transverse Mercator  
 Horizontal Datum: GDA2020  
 Grid: GDA2020 MGA Zone 50

**SYNGNATHID MANAGEMENT PLAN  
 PILING IMPACT AREAS - EO PIER**

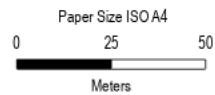
**FIGURE 7.2**



**Legend**

Syngnathid piling impact areas

- 60m PTS
- 60m PTS buffer outline
- 72m PTS buffer
- 72m PTS buffer outline



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**SYNGNATHID MANAGEMENT PLAN**  
**PILING IMPACT AREAS**  
 - MORESBY HARBOUR

Project No. **1213283**  
 Revision No. **D**  
 Date **18/05/2026**

**FIGURE 7.3**

## 8. Phase 5 – post-translocation monitoring

Post-translocation monitoring is required to evaluate the effectiveness of the translocation program and to inform ongoing adaptive management. Condition 26(b)(ii) states that monitoring of receiver sites is required at 1, 3 and 6 years following the completion of maritime works. Where maritime construction works extends beyond 12 months, additional monitoring may be required.

Consistent with the principles of adaptive management and harm minimisation and in satisfaction with the Conditions, the post-translocation monitoring timeframes outlined in this SMP may be reviewed and refined as necessary.

### 8.1 Tagging and tracking

To comply with Condition 26) and facilitate monitoring requirements, it will be necessary to monitor post-translocation residency and survival. Tagging is required to identify Syngnathids that have been translocated and to distinguish them from conspecifics at the receiver location. Syngnathids can be tagged using internal pit tags, external collar tags, visual implant fluorescent elastomer tags (Woods et al., 2004) and more recently through visually identifying features for *Hippocampus patagonicus* (Luzzatto and Cussac, 2023).

To support adaptive management and enable a robust assessment of post-translocation outcomes and validation that the program is successful, monitoring at 2 weeks, 3 months and 1 year after translocation will be required. Post-translocation at 1, 3 and 6 years after the completion of construction will be undertaken. To undertake the above, it is necessary to tag and track individuals. Two methods of tagging are proposed, including visible implant fluorescent elastomer (VIFE) and Syngnathid fingerprinting. The former tags are visible externally during visual surveys, and the latter refers to photography of left (L) and right (R) side of each individual to catalogue the unique individual facial markings and coronet structure. Blending both techniques allows for only a subset of the total translocated population to be tagged with VIFE. All translocated individuals will be photographed and catalogued.

Where feasible, Syngnathids naturally occurring at the receiver sites will also be tagged as controls. This will enable comparison of survival and residency between translocated and non-translocated conspecifics, providing a more rigorous and scientifically defensible evaluation of translocation outcomes. Any tagging of resident individuals will be undertaken where it can be demonstrated that additional handling will not result in disproportionate welfare risk, consistent with the principles of harm minimisation.

### 8.2 Monitoring

To comply with Condition 26), monitoring at receiver sites needs to be undertaken at 1, 3 and 6 years after completion of maritime works, using both visual (diving) surveys and eDNA. To comply with Condition 25) to minimise harm to Syngnathids using the best practice translocation strategy, additional monitoring is required at 2 weeks, 3 months and 1 year post translocation to assess the effectiveness of the translocation and undertake adaptive management. This also aligns the post-monitoring to post-translocation rather than to post-construction which would constrain the ability to adaptively manage or evaluate success as the length of the construction program is subject to change or delay.

#### 8.2.1 Site-based monitoring

Monitoring will be undertaken at each translocation site using diver-based visual surveys, eDNA and an evaluation of artificial habitat performance.


Monitoring conducted at the relocation site(s) will confirm the survival of the relocated Syngnathids by measuring abundance (total number), breeding condition, general health (i.e. parasites visible) and conditions that may affect Syngnathid numbers (e.g. water quality parameters, water depth, predator abundances) at each monitoring round following the translocation and the finalisation of construction. eDNA samples will also be taken.

## 8.2.2 Monitoring timeline overview post translocation and maritime construction works

To meet Conditions 25) and 26), it is necessary to undertake post-translocation at a frequency presented in Table 8.1. This is to enable an understanding of the success of the translocation program and provide an opportunity to intervene (i.e. adaptively manage) the Syngnathids to facilitate compliance with the minimisation of harm as stipulated by the Conditions.

The proposed monitoring to be undertaken following the translocation activity is provided as an overview in Table 8.1.

**Table 8.1** Post translocation validation and monitoring timeline (Phase 5)

Task	Timing
<b>Phase 3 and Phase 4 translocation</b>	
	
<b>Post-translocation validation</b>	Two weeks after translocation
	Three months after translocation
	One year after translocation
<b>Post-translocation monitoring</b>	To be undertaken 1 year after the <i>cessation</i> of the maritime works
	To be undertaken 3 years after the <i>cessation</i> of the maritime works
	To be undertaken 6 years after the <i>cessation</i> of the maritime works

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# Appendix A

eDNA Results

# Seahorse surveys off Western Australia.

## Friday, 19 September 2025

Project number:	ED_1913CR25
Client:	GHD
Prepared for:	Madelaine Hooper
Lab analysis by:	Haylo Roberts, Sue Song
Report prepared by:	Josh Griffiths
Assay(s):	Marine Fish, Syngnathidae (metabarcoding)
Filter used:	5µm Smith-Root self-preserving filter

## Highlights

- 22 water samples were collected off the coast of Western Australia in July 2025, plus 1 field negative.
- All samples were screened for marine fish biodiversity, particularly seahorses, using a metabarcoding analysis.
- Across all samples, 117 taxa were detected, including 96 fish taxa, and 1 Syngnathidae (West Australian seahorse, *Hippocampus subelongatus*).
- 44% of all taxa were resolved to species level.
- Taxon richness at the sample level ranged from 7 to 33.

## Background

Environmental DNA (eDNA) methods are being used routinely to monitor biodiversity throughout a range of ecosystems in Australia and globally. Here, we use a metabarcoding analysis to investigate the marine fish biodiversity off the coast of Western Australia with a particular focus on seahorses.

## Methods

### Sampling

During July 2025, 23 water samples were collected from marine sites off the Western Australia coast by GHD staff, including 1 field negative. At each site, samples were collected by passing up to 10,000 mL water (mean = 10,000 mL) through a Smith-Root 5 µm self-preserving filter (Thomas *et al.* 2019). One field negative sample was also collected using tap water in order to identify the presence of any contamination in the field sampling process. Filtration was undertaken on-site to reduce DNA degradation during transport of water samples (Yamanaka *et al.* 2016). Filters were stored out of sunlight and at ambient temperature before being transported to the laboratory for processing.

### Analysis - Metabarcoding

DNA was extracted from filters using a Qiagen PowerSoil Kit that minimises compounds that can inhibit Polymerase Chain Reactions (PCR) reactions in environmental samples. Library construction involved two rounds of PCR, whereby the first round employed a panel of gene-specific primers targeting Marine Fish ( mifish-ue ; Miya *et al.* 2015) and Syngnathidae ( 16s\_fish\_syn\_short ; Nester *et al.* 2020) and the second round incorporated sequencing adapters and unique barcodes for each sample-amplicon combination included in the library. Negative controls were included during library construction. Negative controls consisted of the extraction negative as well as PCR negatives, in which nuclease-free water was used in place of DNA during both rounds of PCR. Sequencing was carried out on an Illumina sequencing platform.

Following quality control filtering to remove primer sequences, truncated reads, and low-frequency reads, DNA sequences were denoised (UNOISE3 algorithm implemented in VSEARCH)(Rognes *et al.* 2016) to a set of unique amplicon sequence variants (ASVs). Default filters applied removed detections with <30 reads per ASV and sample, or < 0.02% of reads per assay and sample.

ASVs (Amplicon Sequence Variants) were assigned taxonomy using information from the SINTAX algorithm (implemented in VSEARCH; 0.95 bootstrap threshold) applied to curated reference databases and public NCBI (National Centre for Biotechnology Information) databases (BLASTN algorithm, excluding uncultured / environmental samples). Where these approaches disagreed, taxonomy was assigned to the lowest common ancestor of BLASTN hits within the following conservative ranges: species, 100% coverage and identity; genus, 99% coverage, 97% identity; family, 95% coverage and identity; order, 90% coverage and identity, and class, 90% identity and 85% identity. Taxonomic assignments are groundtruthed using independent external datasets (e.g. Atlas of Living Australia, Global Biodiversity Information Facility). In cases where an OTU could not be adequately resolved to a single species (e.g., due to shared haplotypes), either a list of multiple species is included, or the OTU is assigned to the lowest taxonomic rank without further classification.

## Results

A total of 22 water samples and 1 field negative were analysed for marine fish biodiversity. Raw data on per-sample detections can be found in an accompanying spreadsheet (ED\_1913CR25\_GHD\_Marine biodiversity). The spreadsheet provides the taxa detected in each sample, as well as the number of sequence reads for each taxon. Reads should not be directly

interpreted as taxa abundance. While some studies have shown a positive correlation between read numbers and abundance, reads can also be influenced by a number of other variables. Reads may be used to help assign a level of confidence in species detection along with the number of replicates in which the species was detected.

Overall, 117 taxa were detected, including 96 fish taxa, and 1 species within Syngnathidae (West Australian seahorse, *Hippocampus subelongatus*). The number of taxa at each sample ranged from 7 to 33.

44% of taxa were resolved at the species level. Where taxa could not be resolved at the species level is likely due to inadequate genetic sequence data available in the reference library for the region. Further reference sequences for species that are not currently captured in the reference database are needed to fully evaluate the potential for the target gene regions (e.g., 12S, 16S) to resolve these taxa to a species or genus level. Unresolved taxa can also arise due to limitations with the target regions and metabarcoding assays in general, whereby only a very small subset of the entire genome is interrogated for the purpose of species identification. Consequently, there is not always enough genetic variation in that short marker sequence to definitively assign it to a species.

A summary of the frequency of occurrence of each taxa as well as the percentage of reads across all samples is provided in Figure 1 below.

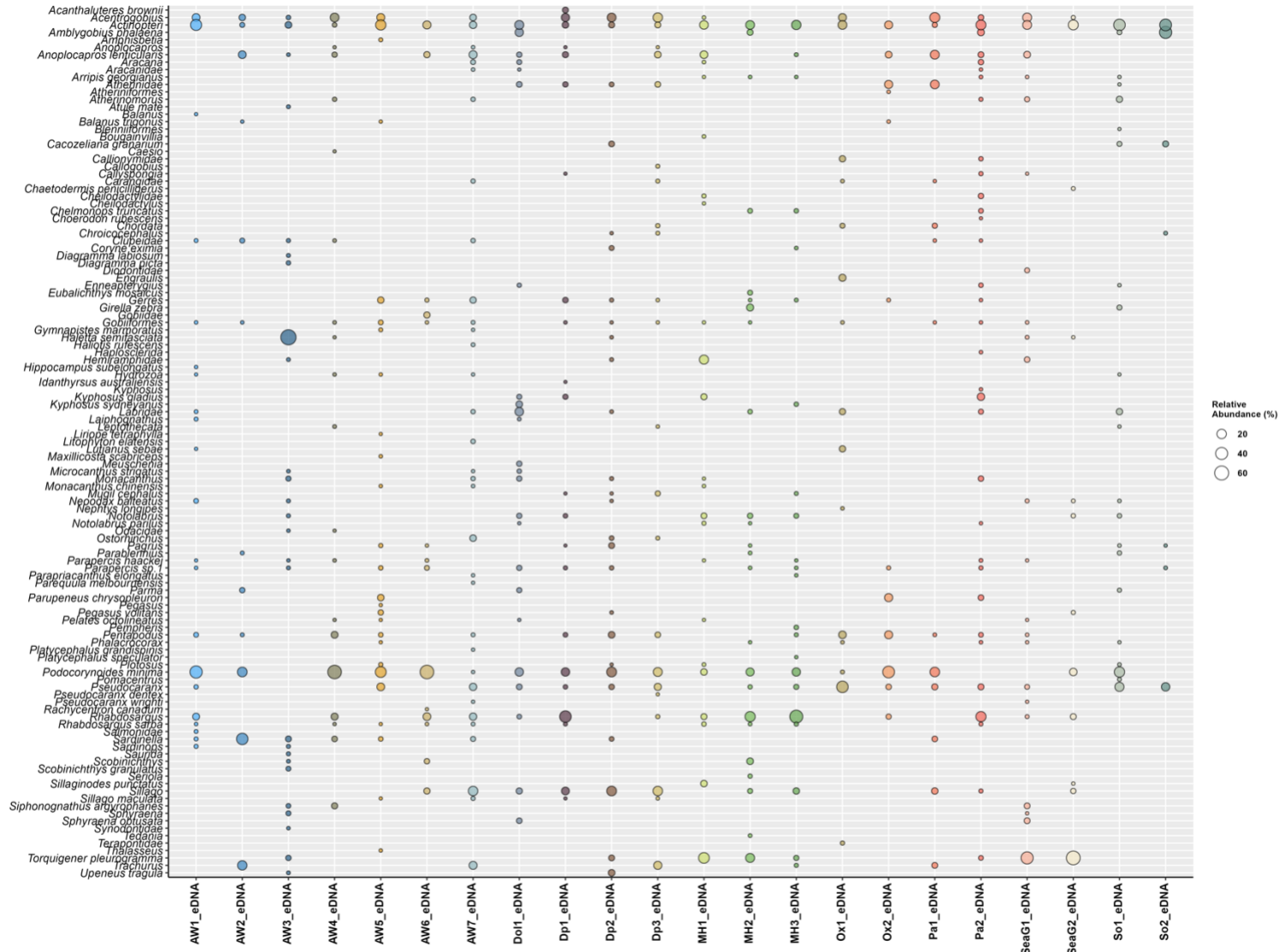


Figure 1. Percentage of reads assigned to each taxa and occurrence of taxa across all samples.

## Quality control and assurance

### Metabarcoding

- Amplification success was confirmed by gel electrophoresis.
- The following controls were used:
  - 3 extraction controls.
  - 5 mock community.
- The total number of reads was 6,428,005 (prior to filtering out non-target taxa).
- The median number of reads per sample across all amplicons was 86,861 (range = 254 - 316,447).
- Out of 22 field samples analysed, 0 samples had fewer than 5,000 non-human reads.
- All mock community positive controls produced reads of expected species, with no contamination from other species.
- Numbers of reads in laboratory controls were below the acceptable threshold.
- Cow was detected in the field negative sample.

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# Glossary

**Amplicon Sequence Variant (ASV):**

A unique DNA sequence derived from high-throughput sequencing of a targeted amplicon, such as a specific gene region. ASVs are defined at the level of individual sequence variants, allowing for more precise differentiation of biological sequences than traditional operational taxonomic units (OTUs).

**Basic Local Alignment Search Tool for Nucleotides (BLASTN):**

A bioinformatics tool used to compare a nucleotide query sequence (such as DNA or RNA) against a database of nucleotide sequences. It identifies regions of local similarity between the query sequence and database sequences, helping to find homologous sequences, predict gene function, or identify potential genetic variants.

**Identity:**

The percentage of identical nucleotide or amino acid residues between the query sequence and the aligned sequences in a database. In sequence alignment, identity measures the degree of exact matches between the compared sequences. High identity values suggest strong similarity and potential functional or evolutionary relationships between the sequences.

**National Centre for Biotechnology Information (NCBI):**

A US government-funded resource that provides access to a wide range of databases, tools, and resources for biotechnology and biomedical research. Its resources include genomic databases (such as GenBank), tools for sequence analysis.

**Polymerase Chain Reaction (PCR):**

A technique used to amplify and replicate specific segments of DNA. This involves repeated cycles of heating and cooling to denature DNA, anneal primers to the target sequence, and extend the DNA strands using a heat-stable DNA polymerase enzyme. This process results in the exponential amplification of the target DNA, enabling the detection and analysis of small amounts of genetic material.

**Query coverage:**

The proportion of the query sequence (e.g., DNA or protein) that aligns with sequences in a database during a search, such as in BLAST or other sequence alignment tools. It is typically expressed as a percentage of the total length of the query sequence that has a matching alignment with the database sequences. Higher query coverage generally indicates a more complete match to the target sequence.

**Taxa/taxon:**

The term given to a detected class, order, family, genus or species. Note that multiple species may be present in reads assigned to a single genus, family, order or class.

**Taxon richness:**

The number of unique taxonomic assignments at a given level (e.g., sample, site, project area). Species richness refers to taxa classified to species level.



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