Merimbula Sewage Treatment Plant Upgrade and Ocean Outfall

Appendix G

Marine Ecology Assessment

Merimbula Sewage Treatment Plant Upgrade and Ocean Outfall Concept Design and Environmental Assessment

Marine Ecology Assessment

FINAL

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elgin associates

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Author (s):	Dr Nicholas Yee Andrew Roberts Annette Heath Django Van Tholen	Dr Luke Finley Dr Penny Ajani Dr Ruan Gannon Dr Will Macbeth
Reviewed by:	Dr Luke Finley	
Project Manager: **Project Director:**	Dr Nicholas Yee Dr Luke Finley	**Date:** 13 May 2021 **Status:** Final
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Contact:	Elgin Associates Pty Ltd ABN 59123488639 Level 1, 45-47 Church Street, PO Box 829 Bega, New South Wales, 2550 Telephone: +61 400 365 234 Fax: +61 3 86486336 www.elgin.com.au	

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Executive Summary

This marine ecology report was undertaken as part of the Environmental Impact Statement (EIS) requirements for the Merimbula Sewage Treatment Plant (STP) Upgrade and Ocean Outfall project, 'the Project' with key objectives including:

- To provide a preliminary description of marine and estuarine ecological values (i.e. habitats and communities) and identify constraints occurring within the area of investigation to inform potential pipeline alignment options.
- To design and implement a marine monitoring program (MMP) to establish baseline conditions for the purposes of future assessment of potential impacts to these habitats and communities from both the construction and operational phases of the Project.
- To provide an assessment of potential impacts to marine ecology from the Project addressing the environmental assessment requirements of the Secretary of the Department of Planning and Environment (the SEARs) and support preparation of the EIS.

The report draws on previous findings in the *Stage 1 Marine Ecology Report* (Elgin, 2018), as well as the *30% Concept Design Report* (AECOM, 2019), *Water Quality Technical Report* (Elgin, 2021) and *Dispersion Modelling Report* (AECOM, 2020).

Description of the Project

Bega Valley Shire Council's (BVSC) current strategy for managing treated wastewater from the Merimbula STP is a combination of 25% beneficial reuse and 75% disposal. Disposal of excess treated wastewater to the environment is via a combination of dunal ex-filtration ponds (since 1991) or via the existing beach-face outfall. The disposal of treated wastewater to Merimbula Bay has occurred since 1971.

The upgrade Project includes the design, construction and operation of the STP upgrade (to support ongoing treated wastewater reuse), and a new ocean outfall for disposal of any excess treated wastewater not able to be used as part of the existing beneficial re-use scheme - or future expansions thereof. The new ocean outfall would replace the current beach-face outfall and dunal ex-filtration methods of excess treated wastewater disposal. Once commissioned, the operation of the proposed outfall would result in the discharge of treated wastewater to a diffuser located 2.7 km offshore over the soft sediment habitat at 30 m depth. Based on the physical properties of the wastewater (*i.e.* lower in salinity and less dense than seawater), the wastewater would be buoyant upon release from the diffuser and mix rapidly with ambient seawater, rising upwards through the water column. Hydrodynamic processes (*i.e.* wind, waves and currents) would act to dilute and disperse the wastewater within zone of wastewater influence, referred to as the 'mixing zone'.

The wastewater mixing zone is defined as an area around the discharge point where some, or all, marine water quality objectives (MWQOs) may not be met. The size of the mixing zone is determined by the distance required to achieve the necessary dilution to meet all MWQOs. Hydrodynamic modelling of the study area provided in the dispersion modelling report (AECOM, 2020) describes the range of ocean current conditions expected at the outfall location and the potential behaviour of treated wastewater plume subject to hydrodynamic processes. Modelling shows that treated wastewater discharged at the proposed outfall offers a significant improvement in dispersion over the existing beach-face outfall.

Modelling based on existing treated wastewater quality (ETWWQ) indicates that under most conditions and the majority of time (estimated at 99%), a mixing zone of 25 m is required to achieve necessary dilution to meet MWQOs. There would be minor instances where treated wastewater may discharge at higher concentrations, such as during wet weather flows or at licence discharge limits that may also coincide with weak ocean current conditions. Under this modelled worse-case scenario, the mixing zone required to achieve all MWQOs is predicted to occur within 200 m from the diffuser location. Based on weak currents being in the lower 10^{th} percentile and higher treated wastewater concentrations at upper 90^{th} percentile, these combined conditions are predicted a minority, or 1%, of the time. Following STP upgrades that would result in improved wastewater quality, the mixing zone may be further reduced.

Assessment Approach

This report assesses potential impacts on marine ecological values in accordance with relevant Commonwealth and NSW legislation and policies that includes Matters of National Environmental Significance (MNES) listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), *Policy of Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013) under the *Fisheries Management Act 1994* (FM Act) and *Biodiversity Conservation Act 2016* (BC Act).

Marine ecological investigations were undertaken in two stages and included combination of desktop review of existing datasets, agency and stakeholder consultation, and field surveys to collect data to address knowledge gaps. The scope of work conducted to inform the marine ecology assessment included:

- Desktop review of existing information such as previous studies, available datasets, biodiversity databases, fisheries catch data, existing mapping layers and species/habitat observations. Review of bio-accumulative contaminants in wastewater and potential risk to fish and shellfish.
- Assessment of threatened marine species and critical habitats listed under NSW and Commonwealth legislation.
- Consultation with DPI Fisheries regarding commercial and recreational fishing.
- Field survey investigations conducted over Stage 1 and 2 including:
  - Broadscale survey of seabed within the study area using towed underwater video and remote operated video (ROV) to map and validate distribution of benthic habitats
  - Field surveys of aquatic biota and habitat types to describe community structure, compile species lists, and confirm presence of rare and/or threatened species (and their habitat).
  - Field sampling to establish baseline descriptions of aquatic biota – soft sediment infauna, fish assemblages, intertidal and sub-tidal communities and phytoplankton.
  - Diving surveys to provide an assessment of local abalone population at Haycock Point
  - Tissue sampling of flathead, mussels and abalone to provide a baseline dataset to address risk of bioaccumulative metals in local fish and shellfish resources

Existing Environment

Merimbula Bay is located on the far south coast of New South Wales with the townships of Merimbula and Pambula situated on its northern and southern shoreline respectively. It is a large sandy embayment bounded by the rocky headlands of Long Point at the north and Haycock Point at the south. It is the receiving environment of the Merimbula and Pambula River estuaries whose ocean entrances are situated at the northern-most and southern-most extent respectively.

The embayment has an easterly aspect and bathymetric charts show seabed depth gradually increases with increasing distance from the shoreline. The seabed of Merimbula Bay is predominantly sand with extensive subtidal reefs extending from Long Point at the north and Haycock Point at the south. A large isolated subtidal reef that is surrounded by sand, known as Hunter Reef, exists approximately 500 m north of Haycock Point.

The marine area of investigation (14.26 km^2) is characterised primarily of unconsolidated soft sediment habitat (12 km^2) with consolidated reef substrates (2.26 km^2) of Hunter Reef a minor proportion of habitat.

- Six benthic communities were identified within the area of investigation including:
  - Infauna and epifauna of the unconsolidated soft sediments;
  - Mussel beds on shallow areas of Hunter Reef;

  - Turf algal community on shallow areas of Hunter Reef;
  - Sea urchins, invertebrates and fish fauna associated with barrens habitat on Hunter Reef;
  - Sessile filter feeding invertebrate community (sponges, ascidians, bryozoans and soft coral dominated) on deep areas of Hunter reef typically occurring below 25 m depth; and
  - An isolated and small patch of *Zostera* seagrass in 14 m depth 40 m north of the pipeline alignment.
- In terms of key fish habitat classification (DPI, 2013), the area of investigation comprises:
  - 16% of *Type 2 - moderately sensitive fish habitat* that includes the areas of rocky reef supporting assemblages of macroalgae and sessile filter feeding invertebrates, and an isolated patch of *Zostera* seagrass estimated at less than 5 m^2 in area.
  - 84% of *Type 3 - minimally sensitive fish habitat* that includes the area of unconsolidated soft sediment and infauna and epifauna community
  - Type 1 highly sensitive fish habitat that includes seagrasses (greater than 5 m^2 in area), marine park or aquatic reserve, or declared critical habitat under the FM Act does not occur within the area of investigation.

Marine Ecological Values

Potential impacts to marine ecological values from Project construction and operational phase activities involved a Stage 1 preliminary risk analysis to identify sensitive ecological receptors and values that could be impacted by each project activity and the pathways by which potential impact could occur.

Sensitive ecological receptors and values considered in the impact assessment included:

- Threatened and protected species – marine mammals and fish listed under FM Act, BC Act and or EPBC Act
- Marine habitats and communities of Merimbula Bay that includes -
  - Soft sediment habitat (Type 3 fish habitat)
  - Soft sediment infauna and epifauna communities
  - Sub-tidal reef invertebrate and algal communities (Type 2 fish habitat)
  - Isolated patch of *Zostera* seagrass less than 5 m^2 (Type 2 fish habitat)
  - Fish assemblage
  - Intertidal reef communities
  - Phytoplankton and drift algae
- Estuarine habitats and communities Merimbula Lake and Pambula River estuary.
- Estuarine and marine waters aquaculture
- Recreational and commercial fishing
- Abalone fishery

Potential Project Impacts to Marine Ecology

Assessment of potential impacts to marine ecological values from Project activities were considered in further detail in Stage 2 in a qualitative risk analysis based on information provided in the Project 30% design report (AECOM, 2019a) that describes the ocean outfall pipeline alignment, diffuser design and anticipated construction methods; and findings from the dispersion modelling report (AECOM, 2020) that predicts the behaviour and dilution of the treated wastewater plume in the near-field and far field and the predicted water quality impacts (Elgin, 2021).

Construction phase impacts

Construction phase activities include establishing the proposed ocean outfall pipeline in two sections:

- Section one - STP to a location beyond surf zone: underground trenchless drilling method.
- Section two - Location beyond surf zone to offshore pipeline termination point: laying of pipeline on seabed floor and covering with rock or concrete mattresses.

Construction of pipeline section one is not expected to cause impacts to marine ecological values and has not been assessed. Construction of pipeline section two would involve laying a 450 mm diameter pipeline directly over the seabed and anchoring with either a cover of concrete mattress and/ or rock armour. Potential impacts to marine ecological receptors and values from the proposed construction activities associated with establishing section two of the pipeline include:

- Introduction or translocation of an invasive marine pest (IMP) via construction vessels and equipment
- Disturbance and loss of Type 3 soft sediment habitat establishing the pipeline and diffuser infrastructure
- Noise impact from construction activities, vessels and equipment
- Vessel or cable strike
- Accidental spill from construction vessels and equipment causing water pollution
- Disturbance of sediments resulting in a turbidity plume
- Reduced opportunities for future marine waters aquaculture

Operational phase impacts

The potential impact to marine ecological values during the Project operational phase relates primarily to how the discharge of treated wastewater would impact the water quality of Merimbula Bay and the scale of that impact. Assessment of operational phase impacts was based on key findings from the *Water Quality Technical Report* (Elgin, 2021) that identified the following water quality impacts:

- Discharge of nutrients and toxicants above MWQOs to the mixing zone that includes oxides of nitrogen (NOx), ammonia, total phosphorus, orthophosphate, faecal coliforms, enterococci, aluminium, arsenic, copper, iron, lead, selenium and zinc.
- Reduced salinity in the mixing zone due to freshwater discharge that can result in mortality or reduced fitness of stenohaline species.
- Discharge of suspended sediment load, organic particulate material, nutrients and toxicants settling to seabed zone around the diffuser and within the mixing zone.

These impacts were also considered in the context of dispersion modelling predictions that indicate water quality impacts would typically be limited to a localised 25 m mixing zone majority of the time, and proposed upgrades to STP treatment processes relevant to the disposal of treated wastewater at the ocean outfall. Upgrades include PAC dosing for enhanced phosphorus removal and UV treatment for improved removal of virus, bacteria and pathogens. Other potential upgrade option includes tertiary filtration if required, that would provide improved removal of aluminium and additional removal of protozoa, viruses, bacteria, TSS and BOD. However, this is noted as a project uncertainty that may not be included. Therefore, the impact assessment is based on no tertiary filtration.

The outcomes of the risk analysis are summarised in **Table 14-4** in **Section 14**. Key findings from the risk analysis included:

- Risk analysis of potential project impacts found that there would be no high risks to marine ecological receptors or values.
- For construction phase activities, the majority of potential impacts can be effectively managed at low risk levels with the implementation of routine control measures. Exceptions include the physical disturbance and loss of Type 3 soft sediment habitat and impact to the soft sediment infauna and epifauna communities during establishment of the ocean outfall pipeline and diffuser infrastructure, and the potential introduction of a marine pest, both considered a medium risk.
- For operational phase activities, predicted water quality impacts would typically be confined to a 25 m near-field mixing zone majority of the time (99% of time), extending to 200 m under worse-case conditions that may occur a minor proportion of the time (1% of time). Marine ecological receptors within the mixing zone is limited to Type 3 minimally sensitive soft sediment habitat and the above water column. Potential changes to the soft sediment infauna community within the mixing zone is considered a medium risk while potential changes to the phytoplankton community is considered a minimal risk. The threat risk to other ecological receptors and values associated with Type 2 rocky reef habitats within Merimbula Bay or estuarine systems of Merimbula Lake and Pambula River is considered minimal to low based on their distance to the mixing zone:
    - Hunter Reef ~1400 m to the south-east.
    - Rocky reef shorelines of Haycock Point ~2,000 m to the south south-west.
    - Rocky reef shorelines of Long Point ~2,300 m to the north.
    - Merimbula Offshore Artificial Reef (OAR) ~1,000 m to the north-east;
    - Estuary entrances to Merimbula Lake and Pambula River ~2,700 m to 3, 000 m to the southwest, west and northwest.

  The above receptors are located beyond the modelled mixing zones, both for discharge under normal conditions expected for the majority of time (25 m), and at a modelled worse-case scenario expected a minority of time (200 m).

Project Key Issues

The risk analysis was used to identify key issues associated with the Project. Key issues were determined by consideration of the level of risk, sensitivity of the ecological value (i.e. threatened species, habitat and community type) to the threat/s, and scale of the potential impact relative to the overall extent of the ecological value within the broader Merimbula Bay environment.

Six key issues identified from the risk analysis include:

- Potential introduction or translocation of marine pest during construction works
- Noise impacts from construction activities, vessels and equipment to marine mammals
- Vessel or cable strike to marine mammals
- Accidental spill of fuel, oil or other harmful substances from construction vessels
- Disturbance and loss of Type 3 soft sediment habitat
- Discharge of treated wastewater at the ocean outfall to Type 3 soft sediment habitat

Potential introduction or translocation of marine pest during construction works

The potential risk exists for the introduction or translocation of an IMP to Merimbula Bay from Twofold Bay via construction vessels. The most likely pathway for introduction of an IMP to Merimbula Bay would be via transport of organisms or their eggs or cysts attached to hulls of construction vessels, equipment or in ballast water of vessels. Overall, the potential risk of introducing an IMP during construction phase activities is considered a medium risk that can be reduced to a low risk by implementing routine control measures in accordance with the *National Marine Pest Plan 2018-2020*.

Noise impacts from construction activities, vessels and equipment to marine mammals

Underwater noise generating activities from the Project construction phase would comprise non-impulsive noise sources such as vessel movements and construction activities to establish the pipeline and diffuser infrastructure on the seabed and anchoring of the pipeline with protective concrete mattress or rock armour. A number of listed threatened and protected marine mammals have a high likelihood of occurrence at the study area and are known to be sensitive to noise. These include humpback whales, southern right whales, orcas, bottlenose dolphins and seals. The risk of noise impacts to whales can be minimised by undertaking works outside of the peak whale migration period (June to November), where practicable. If works are required during June to November, the risks can be managed by adopting a safety shut-down zone of 170 m and a safety watch zone of 2.3 km where work activity would either be temporarily halted or varied in event that a whale occurs within these zones. For works undertaken outside of June to November period, a safety watch zone of 500 m would be implemented (for observing and mimising risk to dolphins and seals) but no shut down zone is required. The potential impacts of non-impulsive underwater noise on marine fauna is considered a low risk with adoption of mitigation measures to minimise exposure to underwater noise during construction.

Vessel or cable strike to marine mammals

Vessel strike to marine fauna is a world-wide problem and there is a clear relationship between the number of vessels within a given area and the incidence of vessel strike. The risk of vessel strike during mobilisation to or during works at the study area is most likely to involve slower moving marine mammals such as whales, with seals or dolphins considered at lower risk of vessel strike as they can easily out manoeuvre approaching vessels. Cable strike is related to anchor cables that stretch and slacken in the water column. Cables or anchor lines may strike marine fauna, causing slashing injury. Risk of cable strike is considered higher for inquisitive young whales, dolphins and seals, compared to older individuals and potential risk of cable strike increases at night due to reduced visibility. The potential risk of vessel or cable strike is related to the number of individuals in the area, which is also related to the species seasonal migration period. The risk of vessel or cable strike is considered low with the risk further reduced by adopting routine control measures during construction phase activities.

Accidental spill of fuel, oil or other harmful substances from construction vessels

The potential risk of an accidental spill is not predicted but can be controlled by implementing measures to reduce the risk that would typically include procedures for storage and use of fuel, oil and hydraulic fluids and a spill response plan in a Construction Environmental Management Plan (CEMP).

Disturbance and loss of Type 3 soft sediment habitat

Pipeline construction would result in the direct disturbance and loss of 0.00432 km^2 Type 3 soft sediment habitat, considered minimally sensitive with regard to fish habitat. Based on estimate of 12 km^2 of soft sediment habitat within the study area, this represents a 0.04% loss of Type 3 soft sediment habitat mapped within the study area. Establishing the pipeline infrastructure would result in the smothering of soft sediment infauna and epifauna that occur directly below the pipeline footprint. No control measure is available to mitigate the loss of soft sediment habitat and infauna or epifauna directly below the construction footprint. The scale of the soft sediment habitat lost to the Project would be minor and is unlikely to have a long-term negative effect on the faunal assemblages that rely on soft sediment habitat within Merimbula Bay in terms of their diversity and abundance.

Conversely, establishment of the pipeline infrastructure with concrete mattress and or rock armour protection along its length constitutes a change from soft sediment habitat to hard substrate habitat, effectively resulting in the creation of an artificial reef. Any available hard substrate placed in the marine environment provides habitat opportunity in the short-term for a wide range of colonising sessile invertebrates such as ascidians, bryozoans, sponges, barnacles, oysters and mussels. The pipeline and diffuser are also likely to be colonised by various macroalgae. In effect, by laying the pipeline on the seabed rather than trenching and burial, the Project is creating and artificial reef that over the long-term would become colonised by sessile invertebrates and algae and be considered Type 2 fish habitat. Construction of the pipeline and diffuser infrastructure would result in loss of Type 3 fish habitat but a gain of Type 2 fish habitat, the latter recognised as being more valuable in terms of fish habitat. This may also result in improved recreational fishing opportunities within the vicinity of the pipeline providing an overall beneficial outcome.

Discharge of treated wastewater at the ocean outfall to Type 3 soft sediment habitat

The discharge of treated wastewater at the ocean outfall poses a medium risk to Type 3 soft sediment habitat and the infauna community occurring within the predicted mixing zone. The potential impact to Type 3 soft sediment habitat is a change in sediment chemistry that could arise from the deposition of particulate organic material (POM) and contaminants absorbed to particles discharged in treated wastewater. Accumulation of deposited POM can cause localised enrichment of sediments and or depletion of oxygen within those sediments. Typical effects include altered community structure (i.e. change is species richness and abundance), and changes in the proportions of opportunistic-sensitive species or trophic groups. Treated wastewater at Merimbula STP is characterised by typically low total suspended sediment load (median TSS = 5 mg/L), with intermittent higher suspended loads discharged during wet weather flows. Historical exceedance of the TSS discharge limit (30 mg/L) occurred six times over 10-year period and is attributed to microalgae growth within the wastewater storage pond prior to discharge. The discharge of freshwater microalgae in wastewater represents a potential food-source for filter-feeding invertebrates and zooplankton and may provide some benefit in the marine environment. Furthermore, TSS of ambient ocean waters can often be higher than that contained in wastewater discharge, particularly during upwelling events and catchment flood flow discharges. Overall, existing wastewater quality is very clear and the risk of POM accumulation to sediments within the mixing zone over long-term is considered low to medium noting that upgrades to the STP will result in further improvements in wastewater quality.

Another pathway by which sediments may become enriched is if the discharge of dissolved nutrients to the water column stimulates excessive phytoplankton growth that could then deliver additional POM to the benthos. The threat of dissolved nutrient load discharged to the mixing zone and its potential effect on the phytoplankton community and risk of increased occurrence of algal blooms was assessed in **Section 9 – Phytoplankton**. It was concluded that the discharge of nutrients to the mixing zone would provide a localised stimulus for increased primary productivity where it is expected that the majority of this nutrient load would be assimilated by phytoplankton within the 25 m mixing zone. However, the overall effect this may have on the phytoplankton assemblage of Merimbula Bay would be minimal. This finding is based on the nutrient discharge being localised, small in scale compared to episodic nutrient inputs from upwellings and catchment flood events, and an understanding that phytoplankton assemblage dynamics of Merimbula Bay (i.e. change in species composition and abundance) are more likely to be influenced by environmental factors operating at broader bioregional, ocean basin scales.

Should changes to sediment chemistry occur from the Project, these would likely to be limited to the near-field mixing zone of 25 m radius from the diffuser with some level of change to the soft sediment infauna community possible. It is then expected that the magnitude and likelihood of potential change would decrease with increasing distance from the outfall and the ability to detect change beyond the mixing zone, if some change has occurred, becomes less likely.

Control measures to mitigate risk of potential impact to the soft sediment infauna community include proposed STP upgrades of PAC dosing for enhanced phosphorous removal and UV disinfection to remove microbial contaminants. If required, a mitigation measure to reduce the risk of metals in the wastewater would be the addition of tertiary filtration. Dispersion modelling shows that MWQOs for metals would be achieved within 5 to 25 m from the diffuser and risk of metals to the mixing zone and water quality is already considered low. Tertiary filtration if required, would improve removal of metals and other contaminants from the wastewater stream. However, with dissolved nutrients requiring the highest dilution and effectively defining the extent of the mixing zone, further metal removal would not change the mixing zone extent and would be expected to only marginally decrease an already low risk. Therefore, including tertiary filtration would be unlikely to be justified from a metal removal perspective.

It is recommended that soft sediment infauna monitoring at sites within and outside the mixing zone form a key element of operational phase environmental monitoring. Combined with water quality monitoring, an appropriately designed infauna and sediment quality monitoring program would provide a useful approach for validating assumptions of dispersion modelling, the extent of the mixing zone and predicted impacts on water quality and sediment quality from the Project.

Conclusion

The design of the Project has considered the findings of the marine ecology investigations and by selecting the North-Short outfall option at 30 m depth in the central region of Merimbula Bay, sensitive marine communities associated with Type 2 rocky reef habitat of Hunter Reef and Haycock Point have been avoided altogether with the nearest rocky reef more than 1,400 m away and unlikely to be impacted by either construction or operational phase activities.

Discharge of treated wastewater to Merimbula Bay has occurred since 1971, including from the existing beach-face outfall since 1974. The replacement of the beach-face outfall to ocean outfall would result in improved dispersion such that water quality impacts would typically be confined to a 25 m near-field mixing zone most of the time (estimated 99%), extending to 200 m under worse-case conditions that may occur a minor proportion of time (estimated 1%). Marine ecological receptors within the 25 m and 200 m mixing zone and at low to medium risk of impact is limited to Type 3 minimally sensitive soft sediment habitat and its infauna and epifauna communities.

Construction of the pipeline and diffuser infrastructure would result in loss of Type 3 fish habitat but over the long-term a gain of Type 2 fish habitat, the latter recognised as being more valuable in terms of fish habitat. Overall there would be no net loss of fish habitat and as such no biodiversity offset under the *Policy of Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013) is required.

The Project would not have an adverse effect on a threatened or protected species listed under the FM Act, BC Act, or EPBC Act or trigger a key threatening process.

Given these findings and consideration to the proposed environmental management measures to mitigate risk of key project issues, the Project has acceptable outcomes with respect to marine ecological values of Merimbula Bay.

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List of Abbreviations and Acronyms

ADWF	Average Dry Weather Flow
AHD	Australian Height Datum
AOBV	Area of Outstanding Biodiversity Value
ASS	Acid Sulfate Soils
AWQ	Ambient Water Quality
BC Act	*Biodiversity Conservation Act 2016*
BCF	Bioconcentration Factor
BRUV	Baited Remote Underwater Video
BVSC	Bega Valley Shire Council
CE	Critically Endangered
CMP	Coastal Management Program
CPUE	Catch Per Unit Effort
CWG	Community Working Group
DECCW	Department of Environment Climate Change and Water (now DPIE)
DPI	NSW Department of Primary Industries
DPIE	Department of Planning Industry Environment (formerly OEH)
DP&E	NSW Department of Planning and Environment
DGV	Default Guideline Values
E	Endangered
EAC	East Australian Current
EIS	Environmental Impact Statement
EP	Equivalent Population
EPA	Environment Protection Authority
EP&A Act	Environment Planning and Assessment Act 1979
EPL	Environment Protection Licence
EPBC	*Environment Protection and Biodiversity Conservation Act 1999*
ETWWQ	Existing treated wastewater quality
FM Act	*Fisheries Management Act 1994*
FSANZ	Food Standards Australia New Zealand
GEL	Generally Expected Levels
IDEA	Intermittently Decanted Extended Aeration
IMP	Introduced Marine Pest
KTP	Key Threatening Process
LML	Legal Minimum Length
LOR	Limit of Reporting
m^2	Meters squared
MDS	Multi-dimensional scaling
MHWS	Mean High Water Springs

ML	Maximum Level
ML	Megalitre
MMP	Marine Monitoring Plan
MWQO	Marine Water Quality Objective
N/A	Not Applicable
NHMRC	National Health and Medical Research Council
NPWS	National Parks and Wildlife Service
NSWSQAP	NSW Food Authority's shellfish quality assurance program
OAR	Ocean Artificial Reef
OEH	Office of Environment and Heritage (now DPIE)
PAC	Poly Aluminium Chloride
PFAS	Per and Poly Fluoro Alkylated Substances
PMGC	Pambula Merimbula Golf Course
PTS	Permanent Threshold Shift
PWWF	Peak Wet Weather Flow
RMS	Roads and Maritime Services
SEARs	Secretary of Planning and Environment's Assessment Requirements
SSI	State Significant Infrastructure
STP	Sewage Treatment Plant
TACC	Total Allowable Commercial Catch
TEC	Threatened Ecological Community
TN	Total Nitrogen
TOC	Total Organic Carbon
TP	Total Phosphorous
TTS	Temporary Threshold Shift
TTWQ	Treated wastewater quality
UV	Ultraviolet
V	Vulnerable

1 Introduction

Bega Valley Shire Council (BVSC) engaged AECOM to prepare a concept design and Environmental Impact Statement (EIS) for the Merimbula Sewage Treatment Plant (STP) Upgrade and Ocean Outfall project, referred to hereafter as the Project, in accordance with the Wastewater Management Strategy adopted by council on 25 June 2014.

The Project comprises the concept design and environmental assessment of two components:

1. upgrade of the existing Merimbula STP; and
2. construction of an ocean outfall.

Elgin Associates Pty Ltd (Elgin Associates) has been engaged by AECOM to complete this marine ecology assessment report for the EIS.

The report draws on previous findings in the *Stage 1 Marine Ecology Report* (Elgin, 2018), as well as the *30% Concept Design Report* (AECOM, 2019), *Water Quality Technical Report* (Elgin, 2021) and *Dispersion Modelling Report* (AECOM, 2020).

1.1 Purpose of this report

The purpose of this report is to convey the marine ecology assessment findings from Stage 1 and Stage 2 investigations to address the three key objectives for the Project, including:

STAGE	Objective
STAGE 1	1. To provide a preliminary description of marine and estuarine ecological values (i.e. habitats and communities) and identify constraints occuring within the area of investigation to inform potential pipeline alignment options. These included: • Intertidal rocky shore • Sub-tidal rocky reef • Sandy seabed • Water column • Seagrass, saltmarsh and mangrove • Threatened species
STAGE 2	2. To design and implement a marine monitoring program (MMP) to establish baseline conditions for the purposes of future assessment of potential impacts to these habitats and communities from both the construction and operational phases of the Project; and 3. To provide an assessment of potential impacts to marine ecology addressing the project SEARs and support preparation of the EIS.

- Stage 1 marine ecology investigations (Elgin 2018) were completed between 2017-2018.
- Stage 2 marine ecology investigations, the implementation of the MMP, is ongoing at the time of this report with findings presented here based on data collected to July 2020.

1.2 Existing STP Operations

The Merimbula STP is located between the regional coastal townships of Merimbula to the north and Pambula to the south. It is an intermittently decanted extended aeration (IDEA) activated sludge plant designed to serve an equivalent population (EP) of 15,500. The STP has a capacity to accommodate an average dry weather flow (ADWF) of up to 3.7 megalitres per day (ML/day) and a peak wet weather flow (PWWF) of seven times the ADWF, or 26 ML/day. It treats an average of 790 megalitres (ML) of wastewater per year (AECOM 2019a).

The current strategy for managing treated wastewater is a combination of 25% beneficial reuse and 75% disposal as follows:

- Beneficial reuse of treated wastewater for irrigation (preferred disposal option) to Pambula Merimbula Golf Course (PMGC) (approximately 20% of annual wastewater); and Oaklands agricultural area (Oaklands) (approximately 5% of annual wastewater). It is understood this reuse has been underway at PMGC since 1980 and Oaklands since 2013.
- Disposal of excess treated wastewater to the environment via dunal exfiltration ponds located within the sand dunes east of the STP between the ocean and Merimbula Lake (approximately 25% of annual wastewater); or via the existing beach-face outfall east of the STP at Merimbula Beach (approximately 50% of annual wastewater). This disposal option commenced in 1991.

Sewage is pumped to the STP from pump stations in Merimbula, Pambula and Pambula Beach. The sewage flows into the inlet works and is screened by mechanical step-screens to remove non-organic macro solids (e.g. plastics, rags, etc). The screened sewage then flows into two IDEA tanks for secondary treatment. The IDEA tanks provide a regulated supply of oxygen from surface aerators for bacteria and other micro-organisms to coagulate and biochemically degrade the organic matter and reduce the number of faecal bacteria and pathogenic microorganisms. The aeration phase is followed by a settlement phase and then a decant phase. These three phases cycle about six to eight times per day.

Secondary treated wastewater is decanted from the IDEA tanks and flows to a catch pond for temporary storage. From the catch pond the wastewater flows to a chlorine contact pipe and is dosed with chlorine (sodium hypochlorite) to reduce the number of microorganisms in the wastewater.

Following disinfection, the wastewater is stored in the wastewater storage pond for between 5 and 9 days (detention time dependent on outflow volumes) from where it is pumped to either the PMGC or Oaklands for reuse; or the dunal exfiltration ponds or ocean outfall for disposal. Under high rainfall conditions, when inflows are elevated, the wastewater may be directed to the wet-weather overflow pond for temporary storage for pumping back to the wastewater pond upon the return of dry weather flows. The STP site layout is shown in **Figure 1-1**.

\\ausyd1fp001\Projects\605X\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR016_01_A4L_F2-3_STPUpgrade_KeyFeatures_200924.mxd Date Saved: 24/09/2020

FIGURE 1-1: KEY FEATURES OF THE PROJECT WITHIN THE MERIMBULA STP SITE

N

0 40 80 m

AECOM

Legend

- Project Area
- New pit
- New overflow pit
- Proposed ocean outfall pipeline
- New pipeline
- New overflow pipeline
- New site feature

Source: Nearmap, 2019

1.2.1 Existing beach-face outfall

The existing beach-face outfall consists of a pipeline from the STP wastewater pump station to a pipe head structure located in the foredune at the centre of Merimbula beach, between the estuary entrances of Merimbula Lake in the north and Pambula Lake in the south. Treated wastewater is discharged just above the mean high-water mark and flows across the beach and into the ocean waters of Merimbula Bay (**Figure 1-2**). The beach-face outfall is used in preference to the dunal exfiltration ponds during the cooler winter periods of the year, when beach and swimming activities are reduced. The outfall is also used when the groundwater level around the dunal exfiltration ponds is high or being allowed to fall.

When the STP was built and commissioned in 1971, the pipeline originally extended into the wave zone but was damaged by storms in the early 1970s and was not reinstated to the original design (Elgin 2013). Approximately 160 ML of wastewater was disposed via the ocean outfall during the first year of operation in 1971. By 1980 the volume of wastewater discharged to the ocean had increased to approximately 400 ML/year, due to the rapid population growth in the 1970's. In 1980, wastewater reuse on the PMGC commenced helping to reduce the volume of wastewater disposed to the ocean from year to year. In 1991, the dunal exfiltration ponds were commissioned providing another disposal option. From wastewater monitoring data collected between 2009-2016, the volume of wastewater discharged to the beach-face outfall ranged between 280 and 660 ML/year.

For this assessment of marine ecology, it is important to note that treated wastewater has been disposed to the Merimbula Bay environment since 1971.

Figure 1-2 Existing beach-face outfall pipe terminating in the foredune (*left image*); treated wastewater is discharged to the beach and flows to the ocean as evidenced by scouring of beach sands (*right image*)

1.3 Description of Project (Future STP Operations)

The STP Upgrade and Ocean Outfall, the Project, includes the design, construction and operation of the Merimbula STP upgrade (to support ongoing treated wastewater reuse), and a new ocean outfall for disposal of any excess treated wastewater not able to be used as part of the existing beneficial re-use scheme - or future expansions thereof. The new ocean outfall would replace the current beach-face outfall and dunal exfiltration methods of excess treated wastewater disposal. The volume of wastewater disposed via the outfall in any one year would be dependent on total annual flows minus the volume of wastewater re-used. The STP current average dry weather flow is 2 ML/day. The strategy for managing treated wastewater currently and after the Project is complete is provided in **Table 1-1** (refer **EIS Chapter 2 Project Description**).

Table 1-1 Treated wastewater management strategy (from AECOM, 2019)

Phase	Inflow	Sludge treatment / disposal	Beneficial Reuse		Disposal
			PMGC	Oaklands	
Current average	2 ML/day	0.1 ML/day	0.4 ML/day	0.1 ML/day	1.4 ML day
Project completion projected average	2 ML/day	0.1 ML/day	0.4 ML/day	0.4 ML/day	1.1 ML day

1.3.1 Pipeline alignment options

Two potential pipeline alignments, a northern alignment and southern alignment, and four diffuser location options were considered by the project team and community working group (CWG) (**Figure 1-3).** Selection of the preferred alignment outfall option used a multi-criteria analysis approach that considered a range of criteria such as environmental constraints, constructability, as well stakeholder and community consultation.

Location 1, referred to as the 'North-Short' outfall option, was selected as the preferred option by the project team and Council in October 2019.

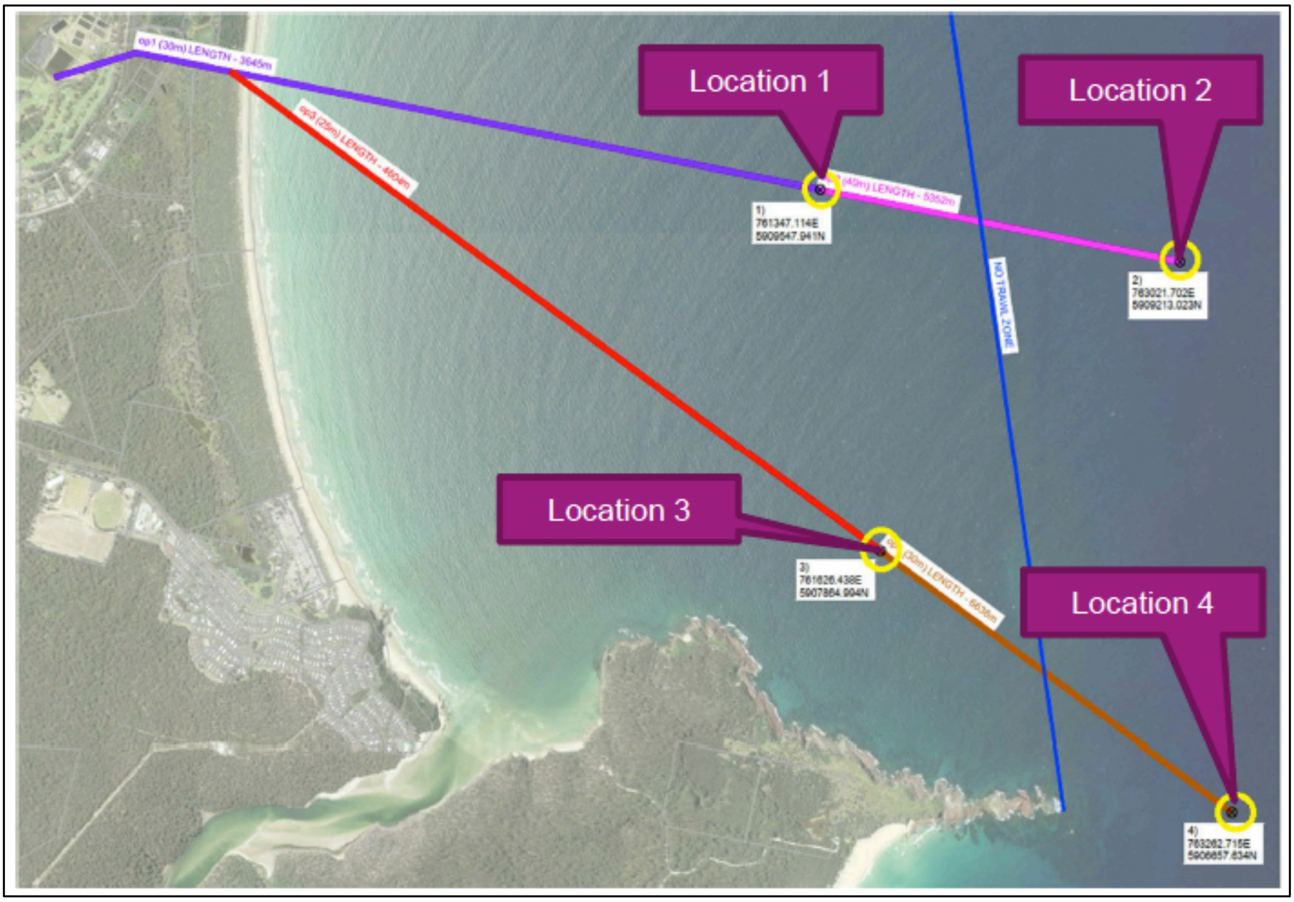


Figure 1-3 Ocean outfall pipeline alignment and diffuser location options (from AECOM 2019)

1.3.2 Preferred Pipeline Alignment – 'North-Short' outfall 30m depth

Based on the 30% Concept Design Report (AECOM, 2019), the preferred outfall pipeline alignment would travel from the STP in an east-south-easterly direction to a location approximately 2.7 kilometres offshore in Merimbula Bay, or 3.5 kilometres from the STP (**Figure 1-3**). The onshore component of the pipeline would be 0.8 kilometres and the offshore component would be 2.7 kilometres.

A brief summary of proposed Project key elements is provided in **Table 1-2.**

Table 1-2 Project Summary (AECOM, 2019)

Project element	Summary
STP upgrade	The STP upgrade would involve additional treatment processes incorporated into the existing STP site, including two stage poly aluminium chloride (PAC) dosing, ultraviolet (UV) disinfection, chlorine dosing and tertiary filtration (if required). The new treatment processes would be incorporated into the following existing STP phases (refer Chapter 2 Project description of the EIS for further information): *Phase two: secondary treatment* Addition of: • two stage PAC dosing for phosphorous removal. *Phase three: disinfection* A change to the existing disinfection (chlorine dosing) treatment, involving: • addition of ultraviolet (UV) treatment; • chlorine dosing, using chlorine gas, would continue to be applied to treated wastewater, however wastewater would be divided into two separate streams: - wastewater to be beneficially re-used would be dosed with chlorine; and - wastewater to be discharged via the ocean outfall would no longer be subject to chlorine dosing. • the chlorine dosing proposed would involve installation of a new chlorine dosing unit (including two 920 kg drum storage of chlorine, and a new pump system). The chlorine dosing unit would be stored at a dedicated storage facility within the STP (either the existing chlorine storage shed would be upgraded to house the increased volume of chlorine required for the Project, or a new shed would be built on or near to the site of the existing shed); and • tertiary filtration could also be installed (if required). The Project would also require the following within the existing STP site: • a new storage tank and new chlorine contact tank; • installation of up to four additional pump stations: - ocean outfall pump station – to pump treated wastewater through the outfall pipeline; - storage tank pump station – to pump treated wastewater to the new storage tank; - chemical sludge pump station (if tertiary filters required) – to pump sludge and treated wastewater; and - pump station - to pump from wet weather overflow back into the STP. • installation of ancillary infrastructure (including new sheds/structures to house new treatment processes, above-ground storage tanks, pipes, pits, power supply and additional low voltage (LV) connection (including transformer, cabling and distribution board), control kiosks, a retaining wall and internal access roads); and • relocation and upgrade of utilities to accommodate the additional features proposed.
Existing STP effluent storage pond	The existing 17 ML effluent storage pond within the STP site would be decommissioned, including dewatering and sediment/sludge removal.

Project element	Summary
New ocean outfall pipeline and effluent diffuser, and associated pump station	Phase four: Disposal and beneficial re-use New additions would involve: • installation of a 3.5 km outfall pipeline – the pipeline would travel from the STP in an east-south-easterly direction to a location approximately 2.7 km offshore in Merimbula Bay; • the pipeline would involve two construction methods for different sections of the pipeline as follows: - 'Section one' – STP to a location beyond surf zone: underground trenchless drilling method; and - 'Section two' – Location beyond surf zone to offshore pipeline termination point: laying of pipeline on sea floor and covering with rock or concrete mattresses. • Section one of the pipeline (the onshore component) would be about 0.8 km and below ground. installation of the underground section would be via a trenchless method (e.g. horizontal direction drilling or direct drive tunnelling), followed by pipeline insertion via pulling or pushing; • Section two (the above ground section of the pipeline) would be installed via direct placement on the sea floor in 600 m to 800 m pipe lengths. This would also involve progressive protection and stabilisation works for the pipeline (e.g. potentially using concrete or rock mattresses) held together with ropes/ slings/ cables; • the terrestrial component of the outfall pipeline would be laid between about -9.3 m and -19.5 m AHD, with greater depth largely depending on the nature of the overlying sand dunes; • a multi-port pipeline diffuser would be located at the end of the pipeline at a depth of approximately 30 m; the diffuser would be approximately 80 m in length; • the pipeline would have an outer diameter of up to 450 mm (366 mm internal diameter) and consist of pipeline lengths welded together; • a transition riser may be required to connect the underground pipeline with the above ground section of pipeline on the sea floor (if required, the riser would be located beyond the surf zone); and • the pipeline would contain valves along its length for mitigating against air entrapment.
Existing exfiltration ponds	The existing exfiltration ponds within the adjacent sand dunes (east of the STP site) would cease to be used under the Project.
Existing beach-face outfall	The existing public beach-face outfall pipeline would be decommissioned. The exposed end of the outfall pipeline would be removed, and the remainder of the pipeline would remain in-situ (i.e. would remain buried underground).
Water use	The STP would continue to use potable town water for kitchen and amenities on site. Apart from these water inputs, the Project would not require any other ongoing water source during operation.
Construction	
Construction footprint	The construction footprint includes temporary compound and laydown areas. The location of laydown areas would be confirmed during detailed design and would depend on the method and location/s proposed to be used for directional drilling by the construction contractor. Temporary construction laydown areas would be located: • within the STP site; • within a portion of the adjacent PMGC grounds; and

Project element	Summary
	• on Merimbula Beach (if required, for pipe stringing and potentially an intermediate drill rig site for directional drilling). A total of approximately 2,800 square metres (m^2) (or 0.28 hectares) of vegetation removal / trimming would be required in the following locations: • approximately 217 m^2 at the Pambula Beach access track; and • approximately 2,464 m^2 of regrowth scrub within the existing STP site and for construction access from the construction laydown area within the PMGC grounds; and 47m^2 at the existing beach-face outfall pipeline.
Construction timing, hours and workforce	Pending Project approval, it is proposed to commence construction in 2022, with construction anticipated to be undertaken over a period of 24 months. Construction would be staged and there would be times when some construction stages overlap. Works would typically be limited to standard daytime hours, which include: • 7:00 am to 6:00 pm Monday to Friday; • 8:00 am to 1:00 pm Saturday; and • No work on Sundays, public holidays. Certain works may need to occur outside standard construction hours for the safety of workers, in accordance with transport licence requirements, or for constructability reasons. Activities to be carried out during out of hours periods may include oversized load deliveries and pipeline pulling as part of the directional drilling (which would need to be undertaken continuously until completed, which may take up to 48 hours). Construction works in Merimbula Bay could occur seven days a week to maximise works during favourable offshore weather conditions. Approval from BVSC would be required for any out of hours work and the affected community would be notified. Construction of the Project would require a workforce of around 20 workers, with peak construction periods requiring up to 30 workers.
Traffic, construction vehicle types and workforce	Construction traffic would indicatively comprise: • 5 to 10 heavy vehicles per day (e.g. truck and dogs); and • 10 to 20 light vehicles per day. Vehicles transporting machinery or oversized materials such as prefabricated units may be required from time to time, and oversized vehicles would require escort to and from site. The largest truck expected as part of construction is the directional drilling rig truck (the exact size would be confirmed by the construction contractor). The construction phase of the Project would require construction vehicles to transport materials and equipment along the existing road network to the construction compound/laydown areas at the Merimbula STP and PMGC grounds and, if required, at the Merimbula Beach laydown area via Pambula Beach. In facilitating these construction activities, various plant and equipment would be required, including: • small, medium and large excavators (3-25 tonne) (tracked and wheeled); • compaction plant (e.g. roller/s, plate compactor); • grader; • bulldozer;

Project element	Summary
	• directional drilling rig truck and associated infrastructure (i.e. drilling fluid recovery and recovery unit); • pumps for dewatering (if required); • vacuum truck; • bobcat; • concrete trucks and pumps; • mobile cranes (e.g. franna crane, scissor lift, forklift); • semi-trailers and tipper truck; • telehandlers; • micro-piling rig (on barge); • water carts; • hand tools and welding equipment; • barges (e.g. 55 m and 73 m barges, jack-up barge) and tugs; • small, self-propelled vessel; • demolition saw, jackhammer, grinder; • generator/s, lighting tower; • light vehicles and light trucks; and • heavy vehicles. The size of vehicles used for haulage would be consistent with the access route constraints, safety and any worksite constraints. Some construction activities (such as the delivery of precast sections) may require truck and trailer combinations or semi-trailers.
Access	Construction vehicles would access/egress the STP site via the following accesses: • Arthur Kane Drive, via either the northern end of the STP site, and/or the existing main STP entrance. • Construction of the outfall pipeline would also utilise the following accesses: • Coraki Drive, Pambula (construction vehicles would enter the temporary beach access track from the end of Coraki Drive, before traversing the beach access track to the laydown area on Merimbula Beach); and • Port of Eden, Twofold Bay (barge/s would transport materials and equipment northward to the location of the proposed outfall pipeline alignment). Construction materials and equipment could also be delivered to the Port of Eden using shipping containers, with construction vehicles expected to haul these containers to the construction sites via the Princes Highway.

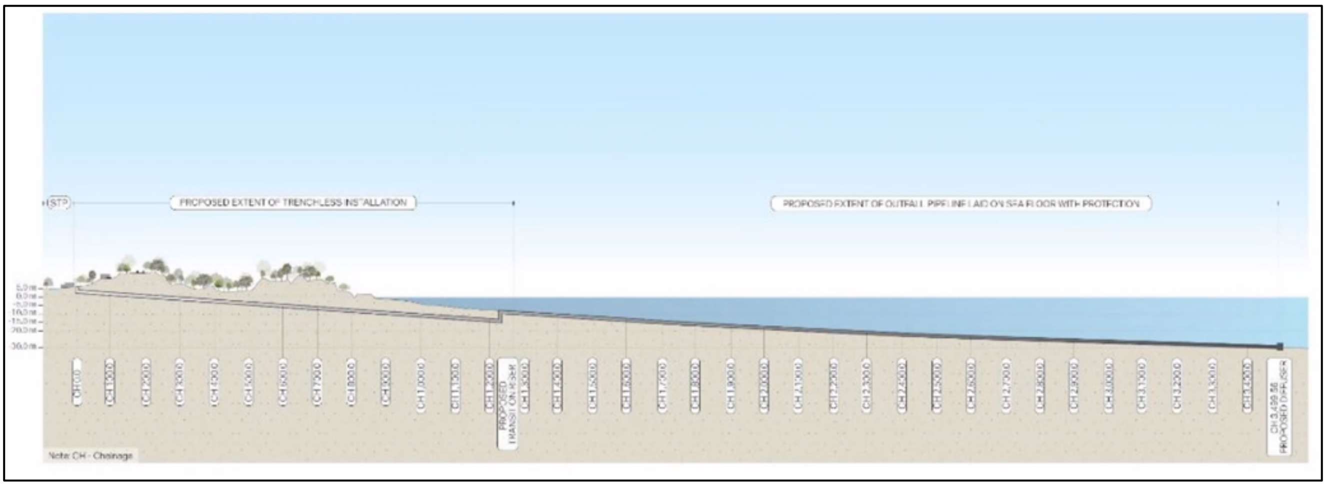


Figure 1-4 Conceptual cross section of pipeline alignment from STP to North-Short diffuser

1.4 Nature of the Wastewater Discharge

Once commissioned, the operation of the North-Short outfall would result in the discharge of treated wastewater to a diffuser located on the soft sediment habitat at 30 m depth. The volume of wastewater disposed via the outfall in any one year would be dependent on total annual flows minus the proportion of wastewater re-used. From wastewater monitoring data collected between 2009-2016, the volume of wastewater discharged to the beach-face outfall ranged between 280 and 660 ML/year.

Wastewater quality is currently monitored for a range of constituents including physico-chemical, microbiological, and metal parameters to assess compliance against environmental protection licence (EPL) limits, such that marine environmental values and beneficial uses are maintained and protected. A description of existing treated wastewater water quality (ETWWQ), background ambient ocean water quality (AWQ), EPL limits and marine water quality objectives (MWQOs) adopted for the Project are provided in the *Water Quality Technical Report* (Elgin, 2021), with summary in **Table 1-3**.

The adopted MWQOs are based on the lowest trigger values applicable for the maintenance and protection of all environmental values including aquatic ecosystem health, primary and secondary contact recreation, aquatic foods, and cultural and spiritual values. In some cases, the MWQO is lower than the aquatic ecosystem health trigger value. For the assessment of impacts to marine ecological values, the aquatic ecosystem health trigger values apply. For ETWWQ in **Table 1-3**, the adopted values represent the worse-case discharge scenario such as wet-weather flow. The values are based on the 100th percentile EPL discharge limits where applicable, otherwise the 90th percentile wastewater concentrations have been adopted

From the *Water Quality Technical Report* (Elgin, 2021), ETWWQ can be broadly described as:

- Freshwater, relatively low in salinity.
- Well oxygenated.
- Near neutral pH.
- Relatively low in suspended solids with intermittent higher suspended loads such as during wet weather flows.
- Containing levels of freshwater microalgae as represented by chlorophyll-a. Once discharged to the marine environment, freshwater microalgae in treated wastewater will not survive due to the saline environment.
- Containing elevated levels of nutrients that include ammonia, nitrate, oxides of nitrogen, total nitrogen,

total phosphorus and orthophosphate.

- Containing relatively low microbiological indicators of enterococci and faecal coliform counts with intermittent higher counts that exceed MWQOs such as during wet weather flow.
- Containing concentrations of metals that include instances of aluminium, copper, iron, selenium and zinc, reported above MWQOs.

The proposed STP upgrades are expected to result in improved wastewater quality that includes:

- Enhanced phosphorus removal, with an anticipated 90th percentile concentration reduction from current 12 mg/L to less than 1 mg/L.
- Improved heavy metal removal from tertiary filtration (if adopted).
- Potential to minimise impact of aluminium in final wastewater.
- Reduced load on downstream disinfection processes.
- Improved removal of virus, bacteria and pathogens.

It is understood that BVSC also has a long-term strategy to upgrade the reticulated water system that should result in reduction of copper and zinc concentrations in the wastewater stream.

Based on the physical properties of the wastewater (*i.e.* lower in salinity and less dense than seawater), it is expected that the wastewater would be buoyant upon discharge and rise upwards through the water column. Hydrodynamic processes would act to dilute and disperse the wastewater within zone of wastewater influence, referred to as the ‘mixing zone’.

Table 1-3 Existing treated wastewater quality (ETWWQ) of Merimbula STP compared to ambient marine water quality and regulatory limits for discharge to marine waters

Parameter	Units	90th %ile EPL limit [1]	100th %ile EPL limit [1]	MWQO [2]	Aquatic Ecosystem Health [3]	Ambient Marine WQ (AWQ) [4]	Existing Treated Wastewater Quality (ETWWQ) [5]
pH	pH units	-	6.5-8.5	8.0-8.4	8.0-8.4 [a]	8.17	6.5-8.5
Suspended Solids	mg/L	20	30	10	-	**12**	**30**
Turbidity	NTU	-	-	0.5	0.5 -10 [a]	0.3	-
Electrical Conductivity	µs/cm	-	-	n/a	-	53,408	874
Dissolved Oxygen	mg/L	-	-	>5	-	7.6	12.9
Dissolved Oxygen	% sat.	-	-	-	90-110% [a]	-	-
Total Nitrogen	mg/L	10	15	0.12	0.12 [a]	**0.12**	**15**
Oxides of Nitrogen NOx (as N)	mg/L	-	-	0.025	0.025 [a]	0.017	**8.06**
Nitrate	mg/L	-	-	0.7	0.7 [d]	0.017	**8.06**
Ammonia (as N)	mg/L	2	5	0.01	0.91 [b]	0.008	**5**
Total Phosphorus (as P)	mg/L	13	-	0.025	0.025 [a]	0.007	**13**
Ortho Phosphate (as P)	mg/L	-	-	0.01	0.01 [a]	0.004	**11**
Chlorophyll "a"	µg/L	-	-	1	1 [a]	**1.2**	**68.8**
Faecal Coliforms (2004-2016)	cfu/100mL	-	200	150	-	0.5	**200**
Faecal Coliforms (2014-2016)	cfu/100mL	-	200	150	-	0.5	**200**
Enterococci	cfu/100mL	-	-	35	-	0.5	**188**
Aluminium	ug/L	-	-	10	-	4.5	**74.6**
Antimony	ug/L	-	-	270	270 [d]	0.25	1.5
Arsenic (III)	ug/L	-	-	2.3	2.3 [d]	1.8	**3**
Arsenic (V)				4.5	4.5	-	-
Barium	ug/L	-	-	1000	-	5.9	10.2
Total Boron	ug/L	-	-	1000	-	**4295**	80
Cadmium	ug/L	-	-	0.7	0.7 [c]	0.1	0.025
Chromium (Total)	ug/L	-	-	20	-	0.25	1
Chromium (III)				27.4	27.4 [b]	-	-
Cobalt	ug/L	-	-	1	1 [b]	0.025	0.5
Copper	ug/L	-	-	1.3	1.3 [b]	0.2	**272**
Iron	ug/L	-	-	300	-	5	**706**
Lead	ug/L	-	-	4.4	4.4 [b]	0.1	**5.6**
Manganese	ug/L	-	-	100	-	0.25	54.2
Mercury	ug/L	-	-	0.1	0.1 [c]	0.05	0.05
Nickel	ug/L	-	-	7	70 [b]	0.25	3
Selenium	ug/L	-	-	3	3 [d]	1	**7.8**
Silver	ug/L	-	-	1.4	1.4 [b]	0.35	0.5
Zinc	ug/L	-	-	5	15 [b]	2.5	**140.4**

Note:

[1] Current 90th and 100th percentile concentration limit for discharge to ocean - EPL 1741 (NSW EPA 2014).

[2] Marine Water Quality Objective (MWQO) trigger values adopted for the Project based on all environmental values - Aquatic Ecosystem Health, Primary and Secondary Contact Recreation, Aquatic Foods (Table 2-2- in *Water Quality Technical Report*, Elgin 2020). In some cases, the adopted MWQO is lower than the Aquatic Ecosystem Health trigger value.

[3] Aquatic Ecosystem Health guideline values (ANZG 2018) relevant to the assessment of marine ecological values, and based on the following:

- [a] ANZECC (2000) Stressor guidelines for marine aquatic ecosystems, SE Australia – Tables 3.3.2 and 3.3.3. Also draft guideline values (DGVs) in ANZG (2018)
- [b] ANZECC (2000) Toxicant stressor guidelines for marine aquatic ecosystems – 95% protection – Table 3.4.1. Also draft guideline values (DGVs) in ANZG (2018).
- [c] ANZECC (2000) Toxicant stressor guidelines for marine aquatic ecosystems – 99% protection – Table 3.4.1. Also draft guideline values (DGVs) in ANZG (2018).
- [d] ANZECC (2000) Interim working level, Volume 2.

[4] Ambient marine water quality (from Table 3-3 in *Water Quality Technical Report, Elgin 2020*)

[5] Existing treated wastewater quality used for dispersion modelling - based on 100th percentile EPL discharge limits where applicable, otherwise 90th percentile concentrations adopted as worse-case discharge scenario such as wet-weather flow (Table 5-1- in *Water Quality Technical Report*, Elgin 2020)

Values in bold and shaded indicate exceedance of MWQO and or Aquatic Ecosystem Health guideline value

1.5 Wastewater Mixing Zone

The wastewater mixing zone is defined as an area around the discharge point where some, or all, marine water quality objectives (MWQOs) may not be met. The size of the mixing zone is determined by the distance required to achieve the necessary dilution to meet all MWQOs. Hydrodynamic modelling of the study area and treated wastewater discharge was provided in the *Merimbula Ocean Outfall Dispersion Modelling Report* (refer **Appendix Q** in this EIS) that describes the range of ocean current conditions expected at the ocean outfall location and the potential behaviour of treated wastewater plume dispersion subject to hydrodynamic processes (*i.e.* wind, waves and currents).

1.5.1 Target dilution

Dispersion modelling was based on worse case analyte dilution scenarios for the median and 90th percentile existing treated wastewater water quality (ETWWQ) to meet the required MWQOs. The worse-case analyte target dilutions for current ETWWQ are:

- For median ETWWQ a target dilution factor of 237 is required (based on oxides of nitrogen, NOx) to meet all MWQOs; and
- For 90th percentile ETWWQ, representing a worse-case wastewater quality that may be discharged a minor proportion of time such as during wet weather flows, a target dilution factor of 2,496 is required (based on ammonia and its licence discharge limit) to meet all MWQOs. This is a conservative scenario with modelling based on the licence discharge limit (5 mg/L) which is higher than the 90th (1.9 mg/L) and wet weather flow (4.1 mg/L) concentrations of actual treated wastewater.

Dispersion modelling outputs for median ETWWQ may be considered indicative of typical wastewater discharge conditions while 90th percentile ETWWQ represents atypical wastewater discharge that may occur a minor proportion of time such as during wet weather flow events.

1.5.2 Ocean Current Conditions

Modelling investigated wastewater plume behaviour and trajectory for a range of ambient current strengths expected at the preferred outfall location for both uniform and stratified conditions, as detailed in the *Dispersion Modelling Report* (refer **Appendix Q** in this EIS). The report noted that current speeds were varied from 0.05 m/s to 0.78 m/s representing the 10th percentile to 99th percentile range of currents from the Haycock Point mooring data (**Table 1-4**).

Table 1-4 Near-field model current scenarios (from *Merimbula Ocean Outfall Dispersion Modelling Report* (refer Appendix Q in this EIS)

Scenario	Current Speed (m/s)
10th percentile northward current	0.05
10th percentile southward current	0.15
90th percentile northward current	0.34
50th percentile southward current	0.40
90th percentile southward current	0.56
99th percentile southward current	0.78
Note: Both uniform and stratified conditions were run for each current speed. CORMIX does not differentiate between northward and southward current directions, so a range of current speeds were selected to encompass the current speeds measured at the mooring.	

Southward flowing current conditions

Statistical analysis of current data showed that southward flowing current conditions occurred 88% of the time and that southward flowing currents are stronger than the weaker northward flowing currents. Southward flowing current conditions can occur anytime through the year, but typically occur during the summer to autumn period when the influence of the Eastern Australian current (EAC) boundary current and its eddy field is strongest.

Worse-case 'extreme' current conditions

Modelling also considered extreme current conditions including zero current, conversely very strong currents and also stratified conditions that are expected to occur a very small proportion of time. Stratified conditions, defined as a temperature differential of ~6 ^{o}C between surface and bottom waters was characterised by a mid-depth pycnocline. Under stratified conditions, the treated wastewater plume has potential to become trapped and dispersion may not be as effective. Stratified conditions are most likely associated with the occurrence of upwelling events that can occur anytime of the year and represents a worse-case scenario for dispersion that may occur for a minor proportion of ambient conditions.

Based on the scenarios above, the data indicates that for either southward or northward flowing conditions, current speeds of 0.15m/s or less (as 10th percentiles) occur around 10% of the time.

1.5.3 Key Findings

The report found that upon release from the diffuser, the treated wastewater plume would mix rapidly with ambient seawater, rising upwards through the water column. From the *Merimbula Ocean Outfall Dispersion Modelling Report* (Refer **Appendix Q** of this EIS) are the following key findings:

- Dispersion modelling shows that treated wastewater discharged at the preferred ocean outfall location offers a significant improvement in dispersion over the existing beach-face outfall.
- Under typical conditions of median ETWWQ and a range of ocean current conditions, a mixing zone of 25 m is required to achieve necessary dilution to meet MWQOs based on a diffuser design 50 m long, with three ports, each with two risers and treated wastewater discharged at 80 L/s. This dispersion scenario would be expected to occur the majority of the time, estimated at 99% of the time. The extent of this mixing zone is shown in **Figure 1-5** below.
- Under worse-case conditions of treated wastewater discharge at EPL limits or 90th percentile concentrations and low current speeds with or without stratification, the mixing zone extends to within 200 m of the outfall location. This would be expected to occur a minor proportion of the time which is estimated at 1% of the time, based on 90th percentile ETWWQ (10%) combined with 10th percentile (10%) low current conditions (northward or southward). The extent of the 200 m mixing zone is shown on **Figure 1-5** below.

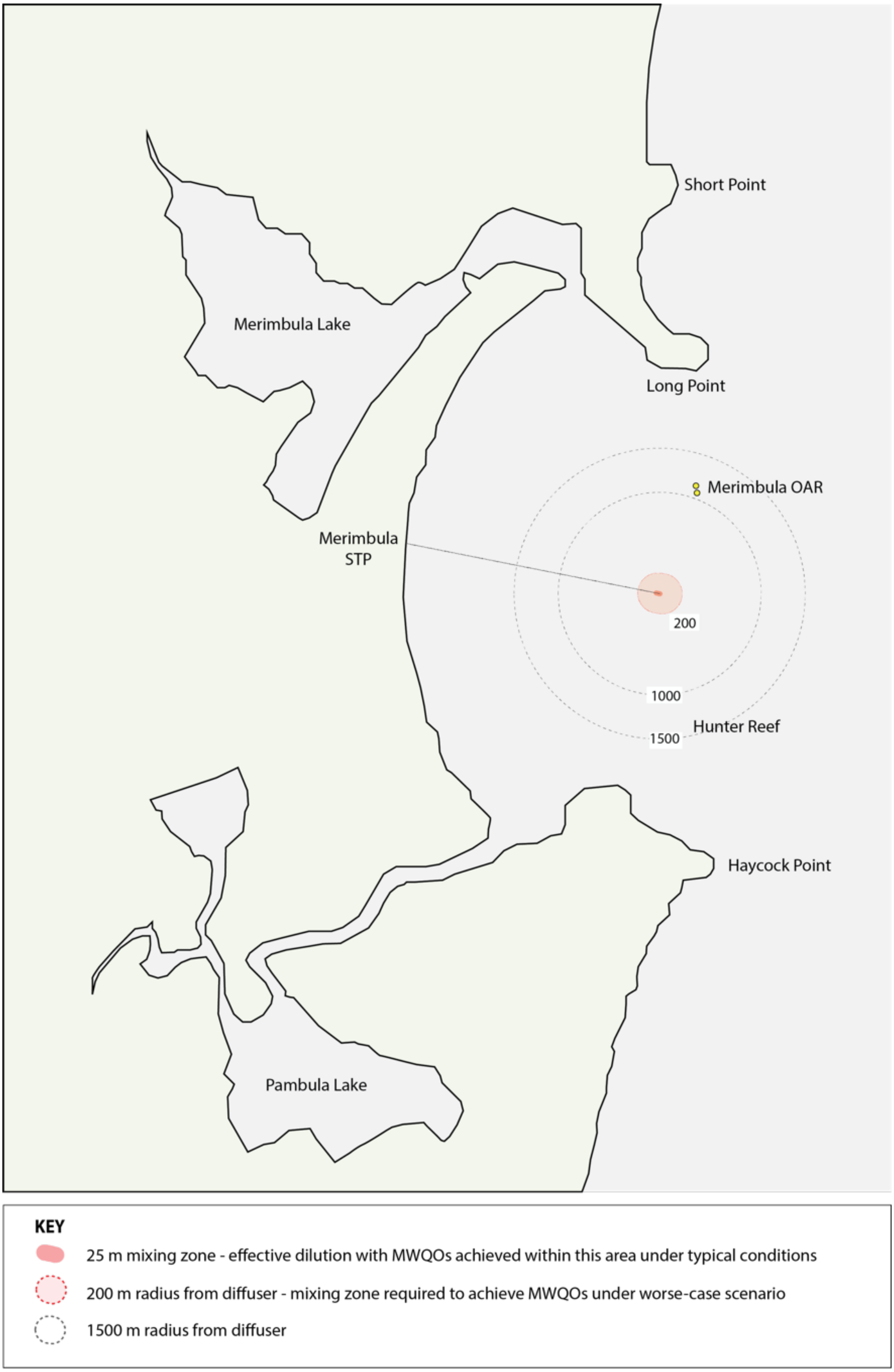


Figure 1-5 Modelled treated wastewater mixing zone (inferred from AECOM, 2020)

1.6 Potential Construction Phase Impacts to Marine Ecology

Construction phase activities include establishing the proposed pipeline in two sections:

- Section one - STP to a location beyond surf zone: underground trenchless drilling method.
- Section two - Location beyond surf zone to offshore pipeline termination point: laying of pipeline on seabed floor and covering with rock or concrete mattresses.

Construction of pipeline section one is not expected to cause impacts to marine ecological values and is not considered further in this report. Construction of pipeline section two would involve laying a 450mm diameter pipeline directly over the seabed and anchoring with either a cover of concrete mattress or rock armour.

Potential impacts of the proposed construction activities on marine communities include:

- Introduction of an invasive marine pest (IMP) via construction vessels and equipment.
- Disturbance and loss of Type 3 soft seabed habitat establishing the pipeline and diffuser infrastructure.
- Construction noise from vessels and equipment to marine fauna.
- Vessel or cable strike to cetaceans.
- Accidental spill from construction vessels and equipment causing water pollution.
- Disturbance of sediments resulting in a turbidity plume.
- Reduced opportunities for future marine waters aquaculture.

1.7 Potential Operational Phase Impacts to Marine Ecology

The potential impact to marine ecological values during the operational phase of the Project relate primarily to how the discharge of treated wastewater would impact the water quality of Merimbula Bay and the scale of that impact. An additional consideration is the potential impact of the completed infrastructure over the long-term to the quality of marine habitat.

The discharge of treated wastewater can potentially impact on marine habitats and biota via a number of ways that include:

- An increase in levels of suspended solids, nutrients, and toxicants some of which have potential to bioaccumulate.
- Release of freshwater causing reduced salinity in the mixing zone that can result in mortality or reduced fitness of stenohaline species.

Suspended solids may reduce light penetration and affect the photosynthetic activity of algae. Increased sediment load can also impact on benthic filter-feeding invertebrates through siltation and enrichment of sediments. Increased availability of dissolved nutrients can favour the growth of opportunistic algal species resulting in a shift in community structure, and a reduction in salinity can result in the mortality or reduced fitness of stenohaline species (those species able to tolerate only a narrow range of salinity).

The response of marine communities to treated wastewater depends on their degree of exposure to the dispersing wastewater gradient. Exposure of marine communities to dispersing wastewater depends on their distance to the outfall and the following general gradient trends may be expected:

- Species assemblages close to the discharge point (i.e within the mixing zone) can be expected to show a stronger response compared to those further away; and
- The magnitude of the response shown by a monitoring indicator - such as species abundance, species richness, or assemblage composition, would decrease with distance from the outfall.

The maximum exposure gradient in Merimbula Bay corresponds to the pathway/s along which the wastewater most commonly travels. This is considered to be the 25 m mixing zone around the diffuser, which is estimated to occur 99% of the time. Potential impacts to marine communities are most likely to be detected within the mixing zone and detection of impacts beyond this zone becomes less likely due to the high levels of dilution achieved over the relatively short distance. For the worse-case scenario where the mixing zone required to achieve all MWQOs is predicted to occur in a 200 m radius from the diffuser location, marine communities within this larger mixing zone would be exposed to dilute treated wastewater a minor proportion of time, estimated 1% of the time that worse case conditions may occur.

Construction of the pipeline infrastructure would constitute a change from Type 3 soft seabed habitat to hard substrate habitat, effectively resulting in the creation of an artificial reef. The pipeline and diffuser infrastructure may be colonised by a variety of sessile invertebrates and algae and over the long-term, result in a net increase in biodiversity in the central region of Merimbula Bay. The Project may have an indirect positive impact by creating Type 2 habitat recognised as being more valuable in terms of fish habitat.

1.7.1 Changes and Impacts to Marine Water Quality

Anticipated changes and impacts to marine water quality from the Project was assessed in the *Water Quality Technical Report* (Elgin, 2021), with the following water quality threats to aquatic ecosystem health identified:

- Discharge of nutrients and toxicants above MWQOs to the mixing zone that includes oxides of nitrogen (NOx), ammonia, total phosphorus, orthophosphate, faecal coliforms, enterococci, aluminium, arsenic, copper, iron, lead, selenium and zinc.
- Reduced salinity in the mixing zone due to freshwater discharge that can result in mortality or reduced fitness of stenohaline species.
- Discharge of suspended sediment load, organic particulate material, nutrients and toxicants settling to seabed zone around the diffuser and within the mixing zone.

As discussed In **Section 1.5**, the impact to marine water quality from the discharge of treated wastewater is expected to be limited to a localised 25 m mixing zone under typical conditions, the majority of time (estimated at 99%). Under this scenario, it is expected that there would be no measureable change to water quality beyond this 25 m mixing zone due to the rapid dilution and dispersion of the treated wastewater. Under worse-case conditions where treated wastewater is discharged at EPL limits or 90th percentile concentrations coincident with weak current conditions with or without stratification, modelling indicates the mixing zone would then extend to 200 m from the outfall diffuser. This scenario is modelled to occur a minor proportion of the time which is estimated at 1% of the time, based on 90th percentile ETWWQ (10%) combined with 10th percentile (10%) current conditions (northward or southward).

Ecological receptors within the predicted mixing zone under both typical and worse-case conditions is limited to soft sediment habitat and its epifauna and infauna communities. Fish, cetaceans and pinnipeds may be transient through this mixing zone on an intermittent basis. The nearest ecological receptors of subtidal and intertidal reef communities, Merimbula Offshore Artificial Reef (OAR), estuarine systems of Merimbula Lake and Pambula River estuary have the following distances from the proposed diffuser location:

  - Hunter Reef ~1400 m to the south-east.
  - Rocky reef shorelines of Haycock Point ~2,000 m to the south south-west.
  - Rocky reef shorelines of Long Point ~2,300 m to the north.
  - Merimbula Offshore Artificial Reef (OAR) ~1,000 m to the north-east;
  - Estuary entrances to Merimbula Lake and Pambula River ~2,700 m to 3, 000 m to the southwest, west and northwest.

The above receptors are located well beyond the modelled mixing zones, both for discharge under typical conditions expected for the majority of time (25 m), and at a modelled worse-case scenario expected a minority of time (200 m) such that there is likely to be no adverse impact to marine biota of those receptors.

1.8 Assessment Approach

This marine ecology assessment was undertaken in accordance with the *Policy of Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013) and *Aquatic Ecology in Envionmental Impact Assessment – EIA Guideline* (Lincoln Smith, 2003). Broadly the assessment approach included:

1. **Establishing the context.** Context included information about the marine environment of Merimbula Bay and Project activities.
    - **Identify marine ecological receptors and values** – providing detail regarding the extent and quality of marine ecological receptors (*i.e.* habitats and communities) within the study area and understanding the sensitivity of each receptor or value is necessary for assessment of potential impacts. Field surveys were undertaken to address data gaps where relevant.
    - **Identify project hazards or threats** – the potential effects of a project on the environment are specific to the local setting and conditions. Threats associated with proposed construction methodologies and operational phase activites can cause direct and indirect impacts via physical, chemical or biological effects.
2. **Evalution of risk of project hazards or threats to marine ecological receptors and values.** Assessment of potential impacts to marine ecological values from Project construction and operational phase activities was undertaken in two stages:
    - Stage 1 - Involved a preliminary risk analysis to identify sensitive ecological receptors that could be impacted by each project activity, the pathways by which potential impact could occur and the type of impact. A summary of the marine ecological values identified within the area of investigation and pathway(s) of potential impact by the project is provided in **Table 1-5** below.
    - Stage 2 - Potential impacts were considered in further detail in Stage 2 based on information provided in the Project 30% design report (AECOM, 2020) that describes the preferred pipeline alignment, diffuser design and anticipated construction methods; and findings from the dispersion modelling report (AECOM, 2020) that predicts the behaviour and dilution of the treated wastewater plume in the near-field and far field and the anticipated water quality impacts (Elgin, 2021).

    Discussion of potential project impacts to each identified marine ecological receptor or value is provided in the relevant report section.
3. **Identification of project key issues relevant to marine ecological receptors and values**. Potential impacts to marine ecological receptors and values were evaluated using a qualitative risk analysis framework (**Section 14**). Key issues were identified from this evaluation based on the level of risk, sensitivity of the receptor or value and scale of the potential impact.

    An overview of project impacts requiring mitigation measures is provided in **Section 14.**
4. **Environmental management measures** – identifying appropriate control measures to mitigate the risk of project hazards and threats where applicable (**Section 15**).

Table 1-5 Summary of marine ecological values and pathway(s) of potential impact

Marine Ecological Value	Project Phase	Pathway/s of Potential Impact
1. Soft sediment infauna and epifauna	Construction	Direct disturbance to soft sediment habitat during construction phase – establishment of Section 2 of pipeline and anchoring to seabed with concrete mattress or rock armour protection
	Construction	Spill of fuel, oil or other harmful substances from construction vessels, with harmful substances sinking to benthos and smothering benthic communities
	Construction	Establishment of outfall diffuser on seabed resulting in loss of soft sediment habitat direct below footprint of diffuser
	Operational	Altered water quality resulting in change in sediment chemistry - increased concentration of nutrients, carbon, altered pH
2. Phytoplankton assemblage	Construction	Increased turbidity during establishment of pipeline causing reduced light levels in water column
	Operational	Altered water quality - reduced salinity and increased nutrient levels
3. Fish assemblage including threatened fish species	Operational	Altered water quality - reduced salinity and increased nutrient levels above background. Ammonia is toxic to fish.
	Operational	Discharge of treated wastewater - toxic contaminants with potential to bioaccumulate
4. Shellfish (eg. mussels, abalone, oysters) at nearby rocky reef habitats Hunter Reef, Haycock Point, Long Point	Operational	Discharge of treated wastewater - toxic contaminants with potential to bioaccumulate
	Operational	Altered water quality - reduced salinity and increased nutrient levels
5. Deep reef - sessile filter feeder community (Sponges, Ascidians, Bryozoans, Cnidarians)	Construction	Increased turbidity establishment of pipeline - reduction in water clarity, potential smothering of deep reef communities such as sessile filter feeders
	Operational	Altered water quality - reduced salinity and increased nutrient levels
6. Shallow sub-tidal macroalgal assemblages at Hunter Reef	Operational	Altered water quality - reduced salinity and increased nutrient levels
7. Shallow sub-tidal macroalgal assemblages at Haycock Point	Operational	Altered water quality - reduced salinity and increased nutrient levels
8. Low shore intertidal macroalgal assemblage and herbivore community at Haycock Point	Operational	Altered water quality - reduced salinity and increased nutrient levels
9. Threatened species - Whales	Construction	Disturbance from construction noise and potential for vessel strike
10. Estuarine communities and aquaculture	Operational	Altered water quality - reduced salinity and increased nutrient levels
	Operational	Discharge of treated wastewater - toxic contaminants with potential to bioaccumulate in oysters and fish

1.8.1 Data review, stakeholder consultation and field surveys

The assessment was completed based on desktop review of existing datasets, agency and stakeholder consultation, and field surveys to collect data to address knowledge gaps. A summary of the assessment and field data collection is provided in **Table 1-6.**

A total of 50 fieldwork days have been undertaken in Stage 1 and Stage 2 for the Project also noting that a number of lost time days were encountered due to adverse weather conditions that resulted in cancellation of fieldwork prior to commencing or part days lost due to unsafe conditions for the continuation of the work tasks. Lost time days are not indicated in **Table 1-6** below.

At the time of this report, field surveys to complete the data collection for abalone, benthic infauna and sub-tidal rocky reef communities is ongoing.

Table 1-6 Summary of fieldwork completed for the marine ecology assessment

Marine Receptor or Value	Fieldwork Days	Fieldwork Dates	Datasets and stakeholder consultation
Threatened species	-	-	- Database searches for species listed under *Fisheries Management Act 1994, Biodiversity Conservaton Act 2016, Environment Protection and Biodiversity Conservation Act 1999* - Department of Planning Industry and Environment (DPIE) wildlife atlas - Department of Primary Industry - Fisheries records - Atlas of Living Australia
Marine habitats	10	2/11/2017 3/11/2017 4/11/2017 8/11/2017 9/11/2017 2/10/2019 11/10/2019 6/5/2020 8/5/2020 11/6/2020 21/11/2020	- Previous seabed mapping by DECCW - Bathymetry mapping by MES (2018) and Total Hydrographic (2018) for work undertaken in Stage 2 surveys - Seabed anomaly inspection (21/11/2020)
Sub-tidal reef community	8	5/11/2017 11/9/2020 14/10/2020 16/12/2020 17/12/2020 6/5/2020 11/7/2020 12/7/2020 21/11/2020 23/11/2020 18/1/2021 24/1/2021	*Monitoring for subtidal rocky reef communities is ongoing at the time of this report with final data analysis pending.*
Abalone population	3	7/1/2018 8/1/2018 9/1/2018	- DPI Fisheries - Abalone stakeholders
Fish assemblage	6	3/11/2017 4/11/2017 6/11/2017 8/11/2017/ 9/11/2017 10/10/2019	- DPI Fisheries - Reef life survey - Atlas of Living Australia
Bioaccumulation risk to fish and shellfish	3	29/9/2019 2/10/2019 24/4/2020	- Previous studies and datasets - Field survey to collect tissue samples of flathead, mussels, and abalone

Marine Receptor or Value	**Fieldwork Days**	**Dates**	**Datasets and stakeholder consultation**
Soft sediment infauna	9	9/11/2017 10/11/2017 3/10/2019 21/10/2019 22/10/2019 17/3/2020 15/4/2020 8/7/2020 10/7/2020 9/11/2020 14/11/2020	*Monitoring for soft sediment infauna is ongoing at the time of this report with final data analysis pending.*
Intertidal rocky shore community	2	7/12/2017 2/1/2018	
Phytoplankton	4	21/11/2017 1/10/2019 29/1/2020 7/4/2020	OEH algal bloom register NSW Food Authority Shellfish QAQC Program
Drift algae	2	9/1/2018 11/10/2019	Previous studies and datasets
Estuaries	-	-	Previous studies and datasets
Aquaculture	-	-	-
Reconnaisance inspections for Stage 2 reference sites	3	3/10/2019 14/10/2019 18/12/2019	-

1.9 SEARs

The EIS for the project needs to comply with the Secretary of Planning and Environment's Assessment Requirements (SEARs). A summary of the SEARs relevant to marine ecology is provided in **Table 1-7** below.

Table 1-7 SEARs relevant to Marine Ecology

Key Issue SEARs 4 - Biodiversity	Report section(s) where addressed
4. The Proponent must identify whether the project as a whole, or any component of the project, would be classified as a Key Threatening Process in accordance with the listings in the *Biodiversity Conservation Act 2016* (BC Act replaces the *Threatened Species Conservation Act 1995*), *Fisheries Management Act 1994* (FM Act) and *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).	13
5. The Proponent must undertake an assessment of significance as required by Part 7A of the FM Act for relevant threatened fish species according to NSW DPI Threatened Species Assessment Guidelines. This included (but not limited to) Grey Nurse Shark, southern Bluefin Tuna, White Shark, Black Rock Cod.	13, Appendix I
6. The Proponent include a description of benthic habitats along and adjacent to the full length of the proposed outfall pipe and for at least 500 m radius around the discharge point. Impacts to aquatic biodiversity (i.e. rocky reef, marine vegetation and benthic habitat, aquatic biota and fish assemblages) are to be assessed in accordance with the Policy and Guidelines for Fish Habitat Conservation and Management.	2, 5, 7
Key Issue SEARs 6 – Protected and Sensitive Lands	**Report section(s) where addressed**
The Proponent must assess the impacts of the project on environmentally sensitive land and processes (and the impact of processes on the project) including, but not limited to:	
h) The integrity and resilience of the biophysical, hydrological and ecological environment	14.5 (Cumulative Impact)
j) Water quality of the marine estate (within the meaning of the *Marine Estate Management Act 2014*)	Refer *Water Quality Technical Report* (Elgin, 2021)
k) Marine vegetation, rocky reefs and benthic habitats, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms	2, 3, 4, 5, 6, 7, 8, 9, 10, 11
o) Protected areas (including land and water) managed by OEH and/or DPI Fisheries under the *National Parks and Wildlife Act 1974* and the *Marine Estate Management Act 2014*	2
p) Key Fish Habitat as mapped and defined in accordance with the FM Act	2
r) Land or waters identified as Critical Habitat under the BC Act (replaces TSC Act), FM Act or EPBC Act	13

1.9.1 DPI Requirements and Other Issues

In addition to the Project SEARs, other requirements relating to marine ecology identified within the DPI submission letter to the SEARs (30/5/2016) and issues that arose during community and stakeholder consultation and required assessment included the following:

Additional DPI Requirement	Report section(s) where addressed
• A detailed description of construction methods, timing, duration and associated risks	1, 15
• An analysis of potential impacts upon, and risks from both construction and operational phases to commercial fishing (particularly ocean trawling, ocean beach hauling, abalone and lobster fisheries)	4, 5
• An analysis of potential impacts upon, and risks from both construction and operational phases to potential future marine waters aquaculture including risk of promotion of toxic algal blooms.	12
• An analysis of the potential benefits of the Project to recreational fishing along Merimbula Beach, in Merimbula and Pambula Lakes and the oyster industry in both lakes	5, 11, 12
• An outline of environmental protection measures that would be employed during the construction phase	15
Issue arising from community and stakeholder consultation	**Report section(s) where addressed**
• Risk of bioaccumulative metals discharged in treated wastewater to marine organisms such as fish and shellfish, with the potential for consumption by humans in commercial and/or recreational catches. Contaminants with bioaccumulative properties that may occur in STP wastewater include some metals (such as cadmium and mercury), organochlorine pesticides (such as DDT and dieldrin) and emerging contaminant per and poly-fluoro alkylated substances (PFAS).	6
• Risk to local abalone population stocks that are the basis of an important commercial fishery for a number of fishermen.	4

1.10 Scope of Work

The following scope of work was conducted to inform the marine ecology assessment:

- Desktop review of existing information such as previous studies, available datasets, biodiversity databases, fisheries catch data, existing mapping layers and species/habitat observations. Review of bio-accumulative contaminants in treated wastewater and potential risk to fish and shellfish.
- Assessment of threatened marine species and critical habitats listed under NSW and Commonwealth legislation.
- Consultation with DPI Fisheries and other stakeholders including commercial (ocean trawl, beach haul, abalone and lobster) and recreational fishers, oyster industry, and recreational divers.

- Field survey investigations conducted over Stage 1 and 2 including:
  - Broadscale survey of seabed within the study area using towed underwater video and remote operated video (ROV) to map and validate distribution of benthic habitats
  - Field surveys of aquatic biota and habitat types to describe community structure, compile species lists, and confirm presence of rare and/or threatened species (and their habitat).
  - Field sampling to establish baseline descriptions of aquatic biota - benthic infauna, fish assemblages, intertidal and sub-tidal communities and phytoplankton.
  - Diving surveys to provide an assessment of local abalone population at Haycock Point
  - Tissue sampling of flathead, mussels and abalone to provide a baseline dataset to address risk of bioaccumulative metals in local fish and shellfish resources
- Preparation of this marine ecology assessment report that conveys the findings of field investigations and provides an assessment of potential Project impacts from construction and operational phase activities to support the EIS.

1.11 Study Area

The marine ecology assessment considered the marine habitats, communities and environmental values present within the study area that includes:

- Department of Planning, Industry and Environment (DPIE) Project area of investigation;
- Broader Merimbula Bay environs including Haycock Point and Long Point; and
- Estuarine environments of Merimbula and Pambula Lake.

Stage 1 field investigations focused on the Project area of investigation and Haycock Point, with the geographic extent of field investigations expanded in Stage 2 to establish reference locations as part of the marine monitoring program (MMP). Reference locations include Tura Beach and Tura Head in the north to Quondolo and Lennards Island in the south (**Figure 1-6**).

Figure 1-6 Extent of study area for marine ecology assessment and monitoring

2 Overview of Marine Habitats and Communities in Study Area

This section presents an overview of the existing marine environment of Merimbula Bay, describes the habitats and communities present in the study area based on seabed validation surveys, and provides a summary of those habitats and associated communities potentially impacted by the Project construction and operational phase activities.

2.1 Merimbula Bay – Physical Setting

Merimbula Bay is located on the far south coast of New South Wales with the townships of Merimbula and Pambula situated on its northern and southern shoreline respectively. It is a large sandy embayment bounded by the rocky headlands of Long Point at the north and Haycock Point at the south. It is the receiving environment of the Merimbula and Pambula River estuaries whose ocean entrances are situated at the northern-most and southern-most extent respectively.

The embayment has an easterly aspect and bathymetric charts show seabed depth gradually increases with increasing distance from the shoreline. The seabed of Merimbula Bay is predominantly sand with extensive subtidal reefs extending from Long Point at the north and Haycock Point at the south. A large isolated subtidal reef that is surrounded by sand, known as Hunter Reef, exists approximately 500 m north of Haycock Point. The outer margins of Hunter Reef lie within the 35 to 40 m depth contours with the reef system rising to its shallowest point approximately 10 m below the surface with large, long period swells resulting in a breaking wave. The prominence and size of Hunter Reef is likely to exert local influence on hydrodynamics in the southern part of Merimbula Bay.

2.2 Marine Protected Areas and Sensitive Ecological Values

2.2.1 Biogeographical Setting - Marine Bioregion

The marine bioregions of Australia have been variously defined under a range of planning schemes that are designed to protect marine biodiversity and heritage values, while supporting the sustainable use of ocean resources by marine-based industries.

Under marine bioregional planning conducted in support of the *EPBC Act,* Merimbula Bay is situated within the *South-east Marine Region* of Australia (COA, 2015) which extends from Bermagui, NSW, around Tasmania and as far west as Kangaroo Island in South Australia (**Figure 2-1**). Compared to other marine regions, the *South-East Marine Region* is relatively low in nutrients and primary productivity, however, in some locations such as the far south coast region of NSW, the convergence of warm temperate and cool temperate waterbodies mix to create areas of relatively high biological productivity. A key ecological feature of the region is the *Upwelling east of Eden* (COA 2015).

The continental shelf waters offshore of Merimbula are dominated by the East Australlian current (EAC) and its eddy field. Near-shore effects of the EAC are also observed even when the main current is flowing well offshore, as intrusions of EAC onto the shelf are an important mechanism for driving upwellings of cold, nutrient-rich waters from the continental slope towards the coast (Cresswell, 2001). These episodic mixing and nutrient enrichment events drive phytoplankton blooms that are the basis of productive food chains including zooplankton, copepods, krill and small pelagic fish. In turn the upwelling supports fisheries and biodiversity, including top order predators, marine mammals and seabirds. The upwelling area is one of two feeding areas for blue whales and humpback whales when significant krill aggregations form.

According to the traditional marine biogeographic provinces of Bennett and Pope (1953), Merimbula Bay is located at the boundary of the warm temperate Peronian and the cool temperate Flindersian marine bioregions due to the influence of the eastward flowing Leeuwin current and southward flowing EAC (**Figure 2-2**). The overlap of these traditional marine provinces is now recognised as the *Twofold Shelf Bioregion* (Breen *et al.* 2005) under the Integrated Marine and Coastal Biogeographic Regionalisation of Australia (IMCRA) planning framework. The biodiversity of the *Twofold Shelf bioregion* is characterised by considerable overlap of warm and cool temperate species common to both NSW and eastern Victorian waters. Understanding the marine bioregional context of the Merimbula region is important when attempting to provide a description of existing ecosystems and communities, particularly when data is scarce at the local level.

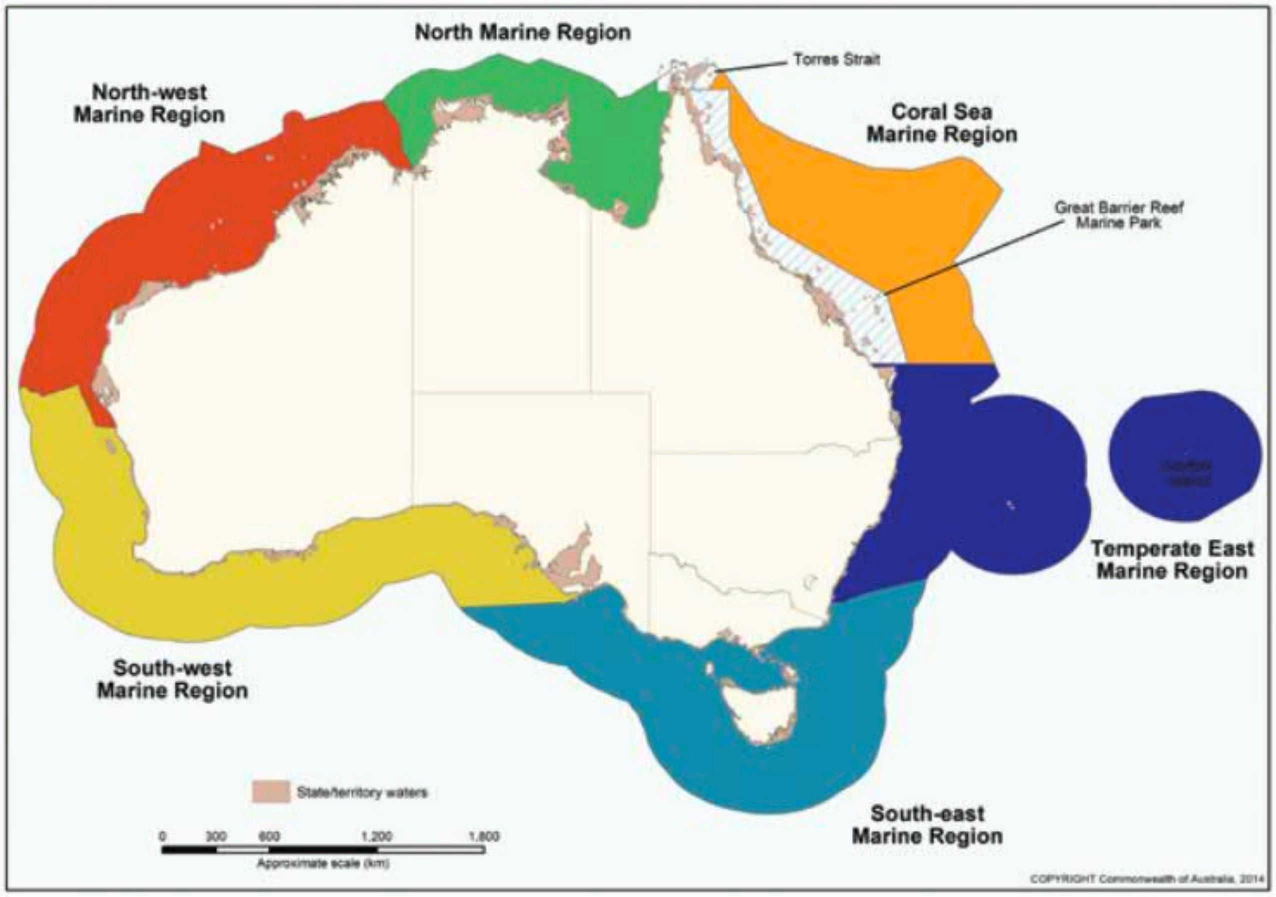


Figure 2-1 South-east Marine Region planning region (COA, 2015)

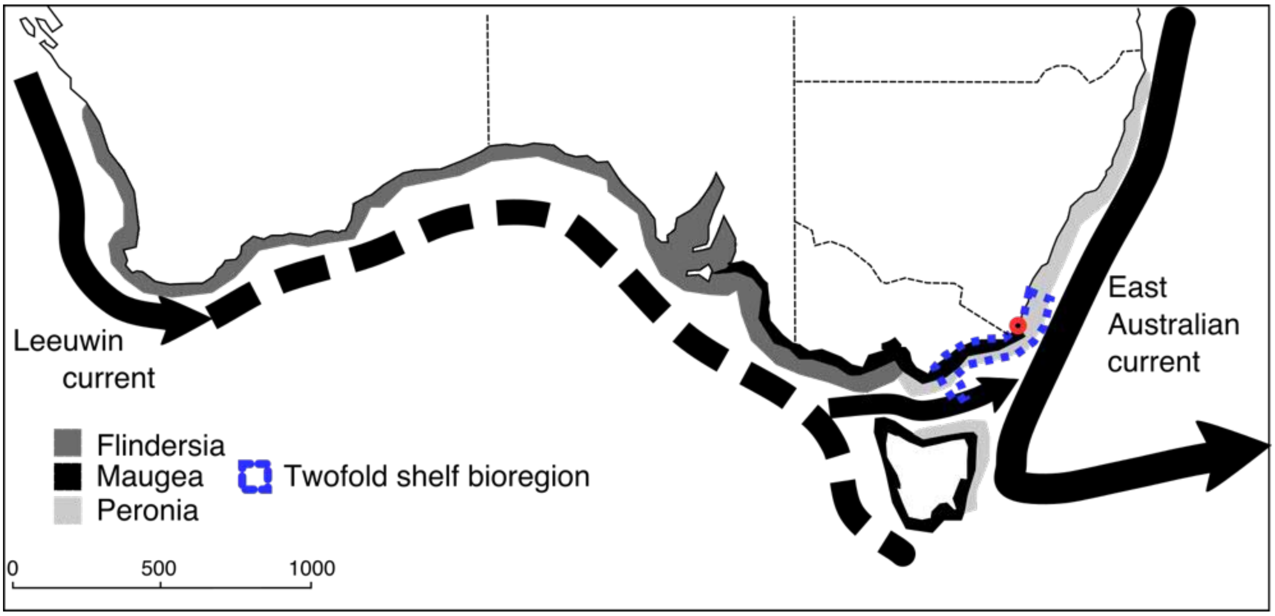


Figure 2-2 A map of temperate Australian waters showing the traditional biogeographic provinces of Bennett and Pope (1953), the IMCRA bioregion of Twofold Shelf, the major influencing boundary currents and the location of Merimbula (red point) – redrawn from Waters *et al.* (2010)

2.2.2 Conservation Areas and Important Wetlands

There are no marine protected areas or marine parks within the Twofold Shelf Bioregion.

Merimbula Lake and Pambula River estuary have significant natural and physical values and both are listed as a nationally important wetland (Environment Australia, 2017). Both estuaries support significant areas of sensitive Coastal Wetland identified under the SEPP (Coastal Management) 2018. Further information regarding estuarine values is provided in **Section 11 – Estuarine Communities**.

2.2.3 Critical Habitat

The only areas of Critical Habitat for aquatic / marine species identified under the EPBC Act are:

- Macquarie Island, Tasmania – Critical Habitat for wandering albatross (*Diomedea exulans*).
- Albatross Island, The Mewstone, Pedra Branca, Tasmania – Critical Habitat for shy albatross (*Thalassarche cauta*).
- Macquarie Island, Tasmania – Critical Habitat for grey-headed albatross (*Thalassarche chrysostoma*).

None of these islands are located near to Merimbula Bay and would not be impacted by the Project. As such, Critical Habitat under the EPBC Act 1999 is not discussed further in this assessment.

The FM Act 1994 also makes provision for the declaration of Critical Habitat by the Minister for Primary Industries. Critical Habitat is defined under the FM Act 1994 as 'the whole or any part of the habitat of an endangered species, population or ecological community that is critical to the survival of the species, population or ecological community'. Regulations can be developed to control specific activities in critical habitat areas. The Register of Critical Habitat under the FM Act 1994 includes:

- Grey Nurse Shark Critical Habitat – Various locations in NSW are listed with the closest to Twofold Bay being the Montague Island offshore of Narooma and approximately 80 km north of the study area.

Montague Island is not located near to Merimbula Bay and would not be impacted by the Project. As such, Critical Habitat under the FM Act 1994 is not discussed further in this assessment.

2.2.4 Key Fish Habitat

The habitats in the study area can be classified according to the *Policy and Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013). This requires consideration of the habitat 'sensitivity' (Type), which refers to the importance of the habitat to the survival of fish and its robustness (ability to withstand disturbance). This classification scheme is used within the policy and guidelines to differentiate between permissible and prohibited activities or developments and for determining value in the event offsetting is required. Key fish habitat sensitivity 'Types' relevant to the study area are provided in **Table 2-1** below.

The waterway 'Class' is also considered which is based on the functionality of the water as fish habitat and can be used to assess the impacts of certain activities on fish habitats in conjunction with the habitat sensitivity. The waterway 'Class' can also be used to make management recommendations to minimise impacts on different fish habitats (i.e. waterway crossings, if applicable).

Merimbula Bay would be considered as a *Class 1 waterway – Major Key Fish Habitat* on the basis that it is a marine waterway [i.e. a marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected species or 'critical habitat'].

Table 2-1 Key fish habitat sensitivity classification scheme (DPI, 2013)

Type	Characteristics of waterway 'Type'
Type 1 – highly sensitive key fish habitat	• *Posidonia australis* • *Zostera*, *Heterozostera*, *Halophila* and *Ruppia* species of seagrass beds >5 m^2 in area • Coastal saltmarsh >5 m^2 in area • Coastal Wetlands listed under SEPP (Coastal Wetland) 2018 and or Directory of Important Wetlands of Australia • Any known or expected protected or threatened species habitat or area of declared 'critical habitat' under the FM Act.
Type 2 – moderately sensitive key fish habitat	• *Zostera*, *Heterozostera*, *Halophila* and *Ruppia* species of seagrass beds <5 m^2 in area • Mangroves • Coastal saltmarsh >5 m^2 in area • Marine macroalgae such as *Ecklonia* and *Sargassum* species • Estuarine and marine rocky reefs • Stable intertidal sand/mud flats, coastal and estuarine sandy beaches with large populations of in-fauna
Type 3 – Minimally sensitive key fish habitat	• Unstable or unvegetated sand or mud substrate, coastal and estuarine sandy beaches with minimal or no infauna • Coastal and freshwater habitats not included in Types 1 or 2 • Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation

2.3 Seabed Validation Field Surveys

Broadscale surveys of the seabed were conducted during Stage 1 and Stage 2 marine ecology investigations which had the following objectives:

- Stage 1 objective - to identify the variety and extent of habitat types and marine communities present within the area of investigation (14.26 km^2) to inform potential pipeline alignment and outfall options.
- Stage 2 objective – to address Project SEARs and describe the benthic habitats along and adjacent to the full length of the proposed outfall pipeline and for at least 500 m radius around the discharge point.

2.3.1 Review of existing seabed habitat mapping

Preliminary habitat mapping layers from within the area of investigation (*i.e.* Geoscience Australia, NSW DPI, OzCoasts) were collated using GIS to identify physical features within the area of investigation. Existing mapping included nearshore sub-tidal reef systems and soft sediment mapping completed in 2002 and re-interpreted in 2010 (DECCW 2010). However, existing mapping was limited to minus 20 m depths and up to 1km offshore and none of the data had been ground-truthed, with substrates broadly classified as either 'reef' or 'sand'. Based on the available information it could be inferred that the majority of the substrate within the area of investigation (and Merimbula Bay more widely) was unconsolidated sediment (sand), with the exception of consolidated reef in nearshore areas of Haycock Point and Hunter Reef (**Figure 2-3**).

2.3.2 Merimbula Bay bathymetry

The bathymetry and seabed characteristics of Merimbula Bay have been resolved by two separate hydrographic surveys using acoustic multi-beam echosounder. The northern portion of Merimbula Bay was surveyed by Southern Divers - Total Hydrographic in 2017 for the Merimbula Offshore Artificial Reef

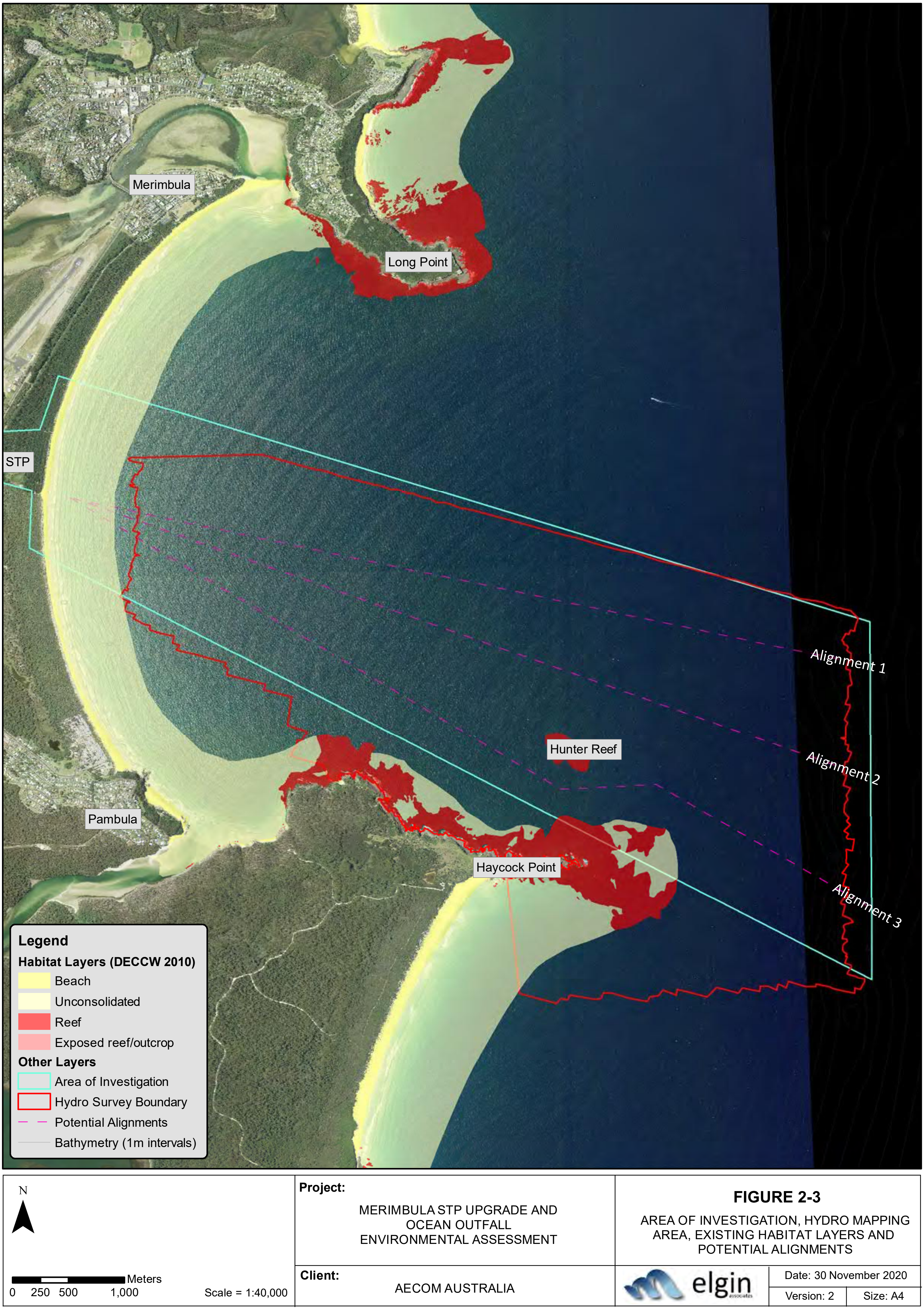
(Merimbula OAR) project, while the southern portion of Merimbula Bay was surveyed by Marine and Earth Sciences in 2018 as part of this Project. Data collected by both surveys has been utilised in the presentation of figures in this report.

2.3.3 Classification of Substrate and Benthic Habitats

Substrate types, terrain and benthic habitat (biological attributes) encountered within the survey area were classified using descriptions provided in the *NSW Continental Shelf Mapping Report* (**Table 2-2**; DECCW 2010). Primary and secondary substrate type and terrain were estimated at each point along the GPS track / transect and where present, types of biota were also recorded.

Table 2-2 Physical and habitat classes used in NSW seabed mapping (from Table 3.5 in DECCW 2010)

	Category	Class	Description
Physical attributes	Substrate type	Consolidated	Continuous bedrock or boulder reef
		Unconsolidated	Unconsolidated sediments
	Primary substrate type	Mud	Mud >75% (includes clay and silt)
		Muddy sand	Mud ~50% and sand ~50%
		Fine sand	Sand dominated by <2 millimetre grains
		Coarse sand	Sand with >2 millimetre grains and shell fragments
		Gravel	2–10 millimetres
		Pebbles	10–64 millimetres
		Cobbles	64–256 millimetres
		Boulders	>256 millimetres (dominant rock size)
		Reef	Reef
	Percentage primary cover	Percentage value	Percentage cover of primary seabed features
	Secondary substrate type		Same categories as for primary cover
	Percentage secondary cover	Percentage value	Percentage cover of secondary seabed features
	Terrain	Flat	<1 centimetre height
		Ripples	<10 centimetre height
		Waves	>10 centimetre height
		Boulders	Boulders
		Gutters	Gutters
Biological attributes	Macroalgae	Macroalgae	Macroalgae present
	Macroalgal type	Mixed	Mixed red/green/brown algae
		Brown algae	Brown algae present
		Green algae	Green algae present
		Red algae	Red algae present
	Ecklonia	*Ecklonia*	Kelp (*E. radiata*) present
	Percentage *Ecklonia* cover	Percentage value	Estimate of percentage cover of primary canopy
	Sponge	Sponge	Sponges present (morphology if possible)
	Sponge morphology	Mixed	More than one sponge morphology present
		Erect	Erect sponge present
		Encrusting	Encrusting sponge present
		Massive	Massive sponge present
		Branching	Branching sponge present
		Cup	Cup sponge present
	Ascidians	Ascidians	Ascidians present
	Sea whips	Sea whips	Sea whips present
	Gorgonians	Gorgonians	Gorgonians present
	Hard coral	Hard coral	Hard coral present
	Soft coral	Soft coral	Soft coral present
	Sea urchins	Sea urchins	Sea urchins present



Project:

MERIMBULA STP UPGRADE AND OCEAN OUTFALL ENVIRONMENTAL ASSESSMENT

Client:

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FIGURE 2-3

AREA OF INVESTIGATION, HYDRO MAPPING AREA, EXISTING HABITAT LAYERS AND POTENTIAL ALIGNMENTS

elgin associates

Date: 30 November 2020

Version: 2

Size: A4

2.4 Stage 1 Survey

2.4.1 Survey Area and Effort

Preparation and approach to Stage 1 surveys was based upon review of the following information:

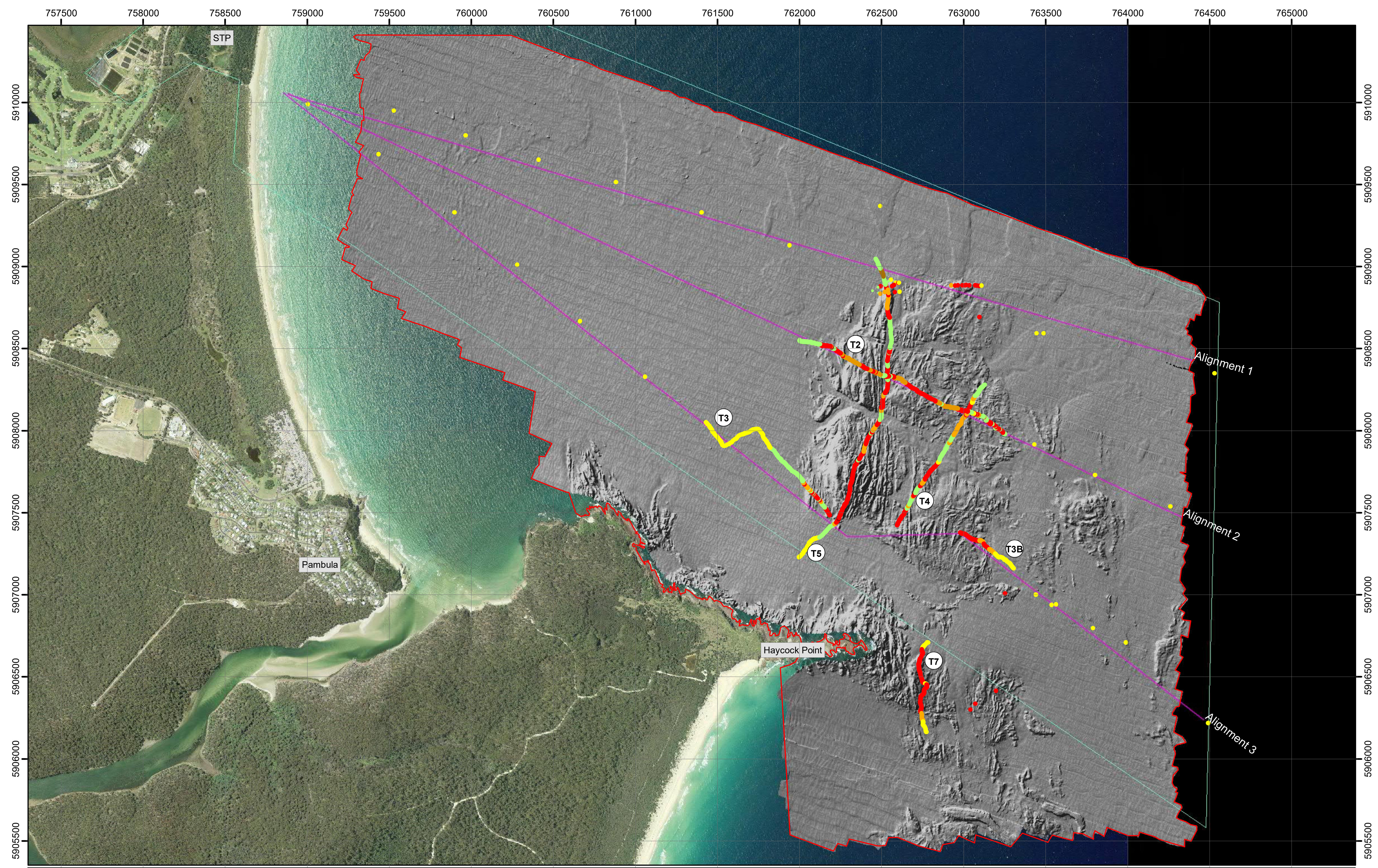
- Previous seabed habitat mapping layers (DECCW, 2010);
- Seabed mapping of northern sector of Merimbula Bay as part of the Offshore Artificial Reef (OAR) project (Southern Divers and Total Hydrographic 2017);
- Discussions with local DPI Fisheries (Eden office) regarding location of reef areas considered important to recreational and commercial fishing; and
- Discussions with AECOM regarding potential pipeline alignment options to assist in defining areas of field effort.

Stage 1 surveys were undertaken over five days between 3 November and 9 November 2017. Three potential pipeline alignments, each up to 4.5 km long, were surveyed. Local DPI Fisheries representatives (Matthew Proctor and Ian Merrington ex Eden office) provided on-water assistance on 9 November 2017 to locate reefs in 30 - 45 m depth that are considered productive for fishing and therefore worthy of inspection. A total of nine tow video transects (~7.3 km) were recorded in Stage 1 (**Table 2-3**). Video and still camera footage were also collected at various waypoints in addition to the nine transects and these contributed to the habitat mapping.

The field surveys were conducted from a 5.6 m work vessel in 2C survey. A Garmin 7408xsv chartplotter (GPS and Sounder) recorded a continual track of the vessel's geographic position and bottom depth during the survey. Segments of this track were extracted and aligned to the tow video footage to confirm the depth of habitats observed within the video footage. Video footage of benthic habitats was captured using a high-resolution tow video camera. Overlaying the video time, vessel position, depths, and hydrographic survey data in ArcGIS allowed detailed interpretation and classification of substrate type and habitat types along each tow video transect (**Figure 2-4)**. Images of the seabed were extracted from the video footage at regular intervals or where there was a clear transition between substrate types and terrain (i.e. reef to sand, low profile reef to high profile reef).

Table 2-3 Summary of tow video transects conducted during the Stage 1 seabed validation surveys

Transect	Date	Length (m)	Position / Feature	Direction	Validated Points
T1	8/11/17	245	Potential alignment 1	E to W	44
T2	8/11/17	1,600	Potential alignment 2	E to W	1197
T3	3&4 Nov 17	1,100	Potential alignment 3	E to W	613
T4	4/11/17	1,100	Hunter Reef	S to N	561
T5	4/11/17	2,100	Hunter Reef	S to N	1286
T6	9/11/17	365	North edge of Hunter Reef	Various	229
T7	3/11/17	625	East of Haycock Point (Hay20)	N to S	352
T8	5/11/17	80	East of Haycock Point (MHL1)	S to N	0
T9	3/11/17	140	Potential alignment 3 (MHL2)	W to E	0
WPs	Various		Waypoints	Various	90
	Stage 1 Total	*7,355*	-	-	*4,372*



Validated Substrate Type

- Coarse Sand
- Fine Sand
- Reef
- Boulders (>256mm)
- Cobbles (64-256mm)
- Gravel (2-10mm)

Other Layers

- Area Of Investigation
- Hydro Survey Boundary
- Potential Alignments
- T5 Tow video transect

Notes:

1. Elgin field survey conducted 3 - 9 November 2017
2. Bathymetry data collected and processed by Marine and Earth Sciences in October 2017

Project:

MERIMBULA STP UPGRADE AND OCEAN OUTFALL ENVIRONMENTAL ASSESSMENT

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FIGURE 2-4

OVERVIEW OF SEABED SUBSTRATA VALIDATED BY SURVEY

elgin

Date: 30 November 2020

Version: 3

Size: A3

2.4.2 Consolidated Reef Substrates

Various forms of consolidated reef were observed ranging in complexity from relatively flat 'low relief reef' through to 'high relief reef with overlying boulders', 'slab rock' or 'boulder field' (**Figure 2-5**). This reef provides structure and important habitat for a range of species, including sessile (sponges, bivalves, ascidians, sea whips) and mobile taxa (fish, crustacea, molluscs).

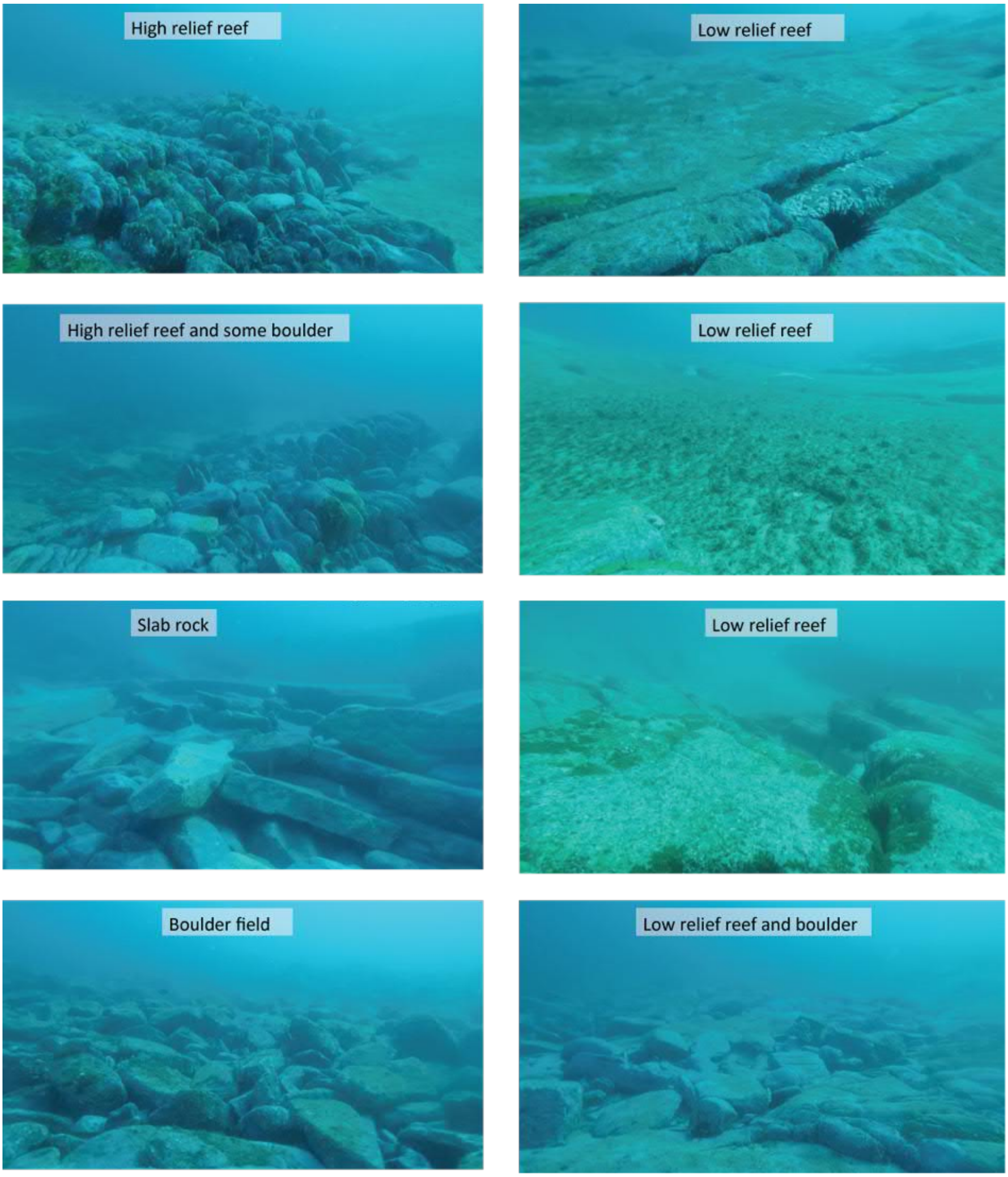


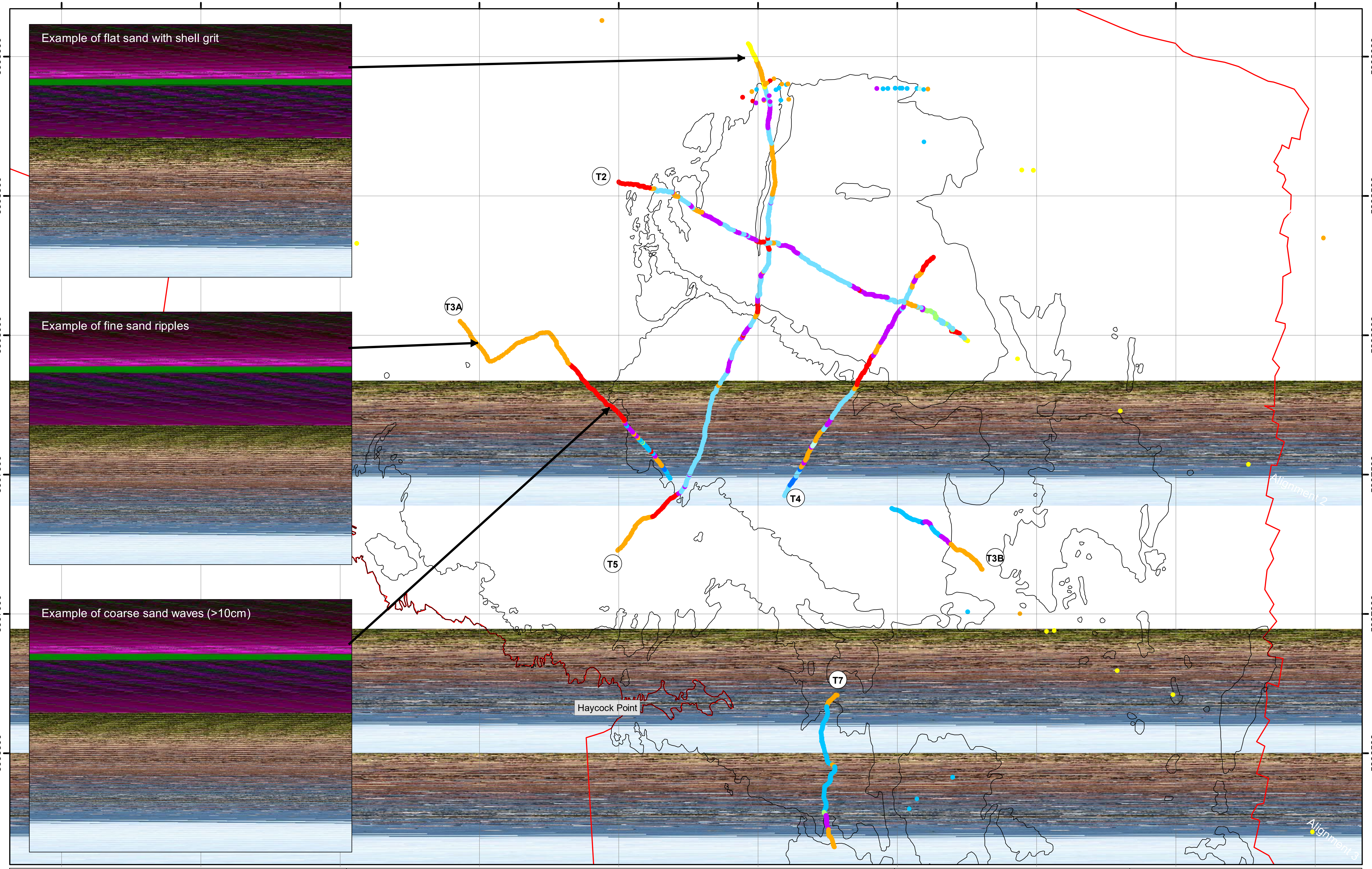
Figure 2-5 Examples of consolidated substrates in the vicinity of Hunter Reef

Consolidated reef was more extensive than previously mapped, particularly between Haycock Point and Hunter Reef, to the north of Hunter Reef, and extensive deep reefs to the east and southeast (**Figure 2-4**). The distribution of reef and sand was inferred from the 2018 bathymetry data (Marine and Earth, 2018) and a new 'inferred reef' layer mapped around all reef within the survey area. The extent of consolidated reef was estimated at 2.26 km^2 or 16% of the area of investigation.

The extent of reef around Hunter Reef was more widespread than the existing DECCW (2010) mapping layers indicated. The survey found that the Hunter Reef system covers an estimated area of 2.83 km^2 which is much more than the 0.08 km^2 feature previously mapped (DECCW, 2010). Depths associated with Hunter Reef ranged from 8.5 m on the top of the reef, to approximately 40 m on the north-eastern toe of the reef. The reef system is complex with ridges and gutters of varying lengths and depths oriented predominantly in north-south direction. One large gutter bisects Hunter Reef in a general east-west direction, with other smaller gutters also visible in this orientation. Gutter features were characterised by medium to coarse sands and shell fragments and sand wave terrain greater than 10 cm height (**Figure 2-6**), providing some indication of the high current flow in these gutters.

Haycock Point is a rock headland that represents the southern boundary of Merimbula Bay. It includes a monolith known as Haystack Rock, which rises up from the intertidal reef to make Haycock Point a prominent feature in the coastal landscape (**Figure 2-7**). The rocky shores are complex and convoluted, and these features are also represented in the underwater terrain. Generally, the underwater reefs around Haycock Point feature habitats that are commonly encountered along the south coast NSW, including shallow depths (0-10 m) dominated by *Ecklonia*, mixed algae, and urchin barrens (further detail provided in **Section 3 – Subtidal Communities**). Deeper reefs to the east and south-east of Haycock Point were generally of low relief, with ridges and gutters running in a general north-south direction (**Figure 2-6**).

Figure 2-7 Photo of Haycock Point looking east with examples of low relief reef, north-south alignment of gutters, boulders, and Haystack Rock



N

Scale = 1:12,000

Meters 0 250 500 1,000

Notes:
1. Elgin field survey conducted 3 - 9 November 2017
2. Bathymetry data collected and processed by Marine and Earth Sciences in October 2017

Terrain

- Flat (<1cm)
- Ripples (<10cm)
- Waves (>10cm)
- Gutters
- Slab rock
- Low relief reef
- High relief reef
- Boulders

Hydro Survey Boundary

Potential Alignments

T5 Tow video transect

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MERIMBULA STP UPGRADE AND OCEAN OUTFALL ENVIRONMENTAL ASSESSMENT

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FIGURE 2 - 6

SUBSTRATE AND TERRAIN TYPES

Date: 30 November 2020

Version: 3

Size: A3

2.4.3 Unconsolidated Substrates

The inner confines of Merimbula Bay were confirmed as unconsolidated sand using a series of drop camera checks (**Figure 2-4**). These locations were classified as primarily uniform fine sands with flat terrain (<1cm) to ripples (<10cm), indicative of the relatively low hydrodynamic forces acting on substrates in these areas of Merimbula Bay. Transects T2, T3, and T5 started and/or finished in unconsolidated sediments, or intersected sand at various locations along their length, which provided information on sand type and terrain around the edge of Hunter Reef (**Figure 2-6**).

Localised tides, waves and regional currents act on the unconsolidated substrates within Merimbula Bay, particularly around Hunter Reef and Haycock Point where seafloor channels re-direct and deflect current flow around reef and through gutters. Observations of sediment characteristics adjacent to Hunter Reef, and in gutters, confirm a substrate dominated by medium to coarse sands, and sand waves greater than 10 cm in height (**Figure 2-8**).

Overall the extent of unconsolidated sediments is estimated at approximately 12 km^2 or 84% of the area of investigation.

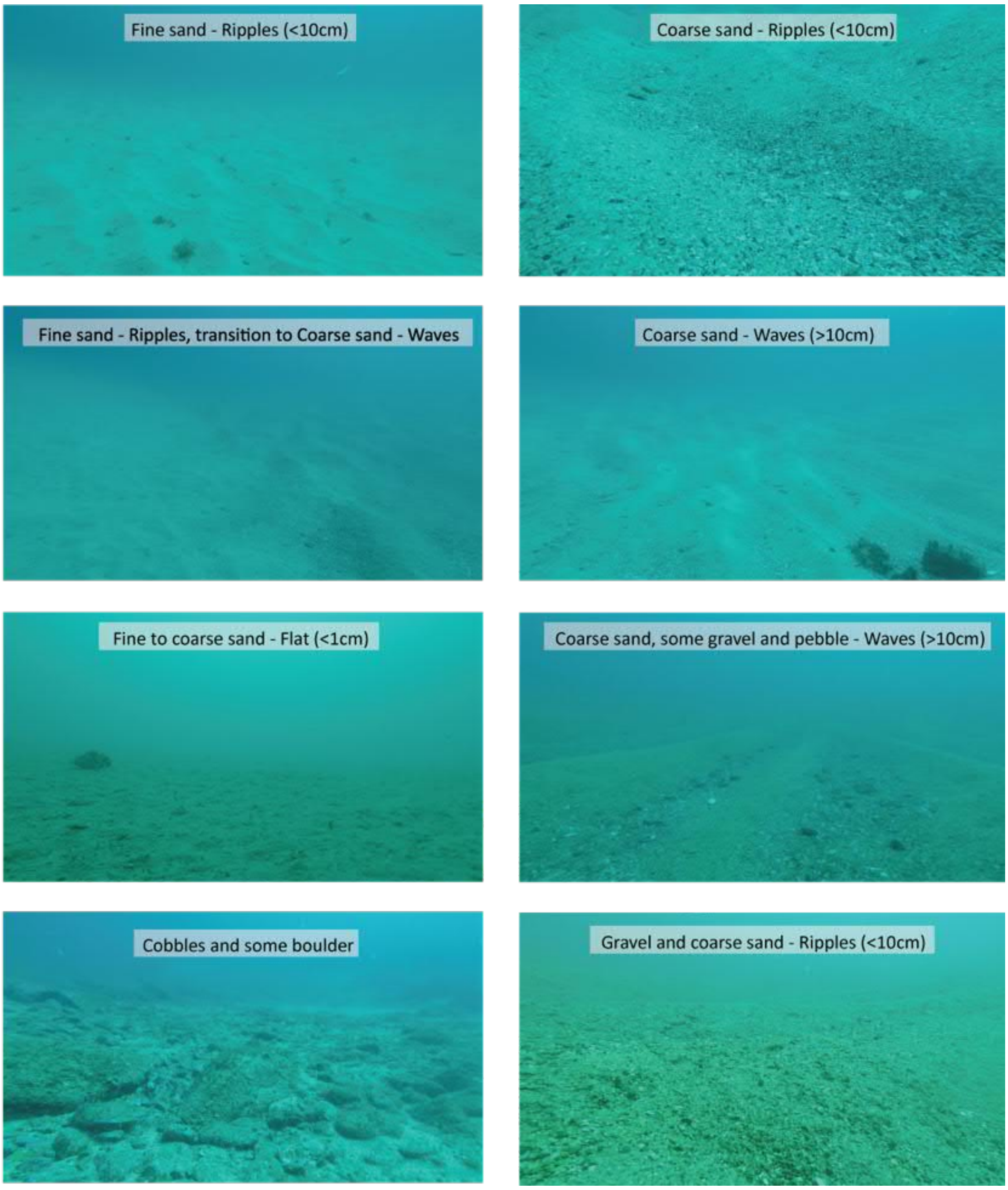


Figure 2-8 Examples of unconsolidated substrates within the study area

2.4.4 Benthic Reef Communities

A range of environmental factors influences the distribution and occurrence of benthic reef communities. Some of these factors include substrate availability, light levels, depth, water movement, predation and competition. For benthic communities observed at Hunter Reef, their occurrence follows a general trend associated with depth with distinct community types observed in waters up to 25 m depth, and a suite of different community types typically observed in deeper waters below 25 m depth. Discussion of benthic communities is presented by this relatively distinct zonation by depth. Those communities associated with unconsolidated sandy sediments are addressed in **Section 7 – Soft Sediment Infauna and Epifauna community**.

Benthic reef communities to 25 m depth

Benthic reef communities observed in water depths to 25 m included mussel beds, turf algal habitat and barrens habitat (**Figure 2-9**).

Mussels

Beds of blue mussels (*Mytilus galloprovincalis*) were observed over the shallowest areas of Hunter Reef between 8 to 10 m depths (**Figure 2-9)**. Aggregations of mussels also provide habitat for a range of smaller mobile invertebrates such as crustaceans and worms. Mussel beds were also observed growing on boulders on the north side of Haycock Point, although not to the same extent as the shallow areas of Hunter Reef.

Turf algae habitat

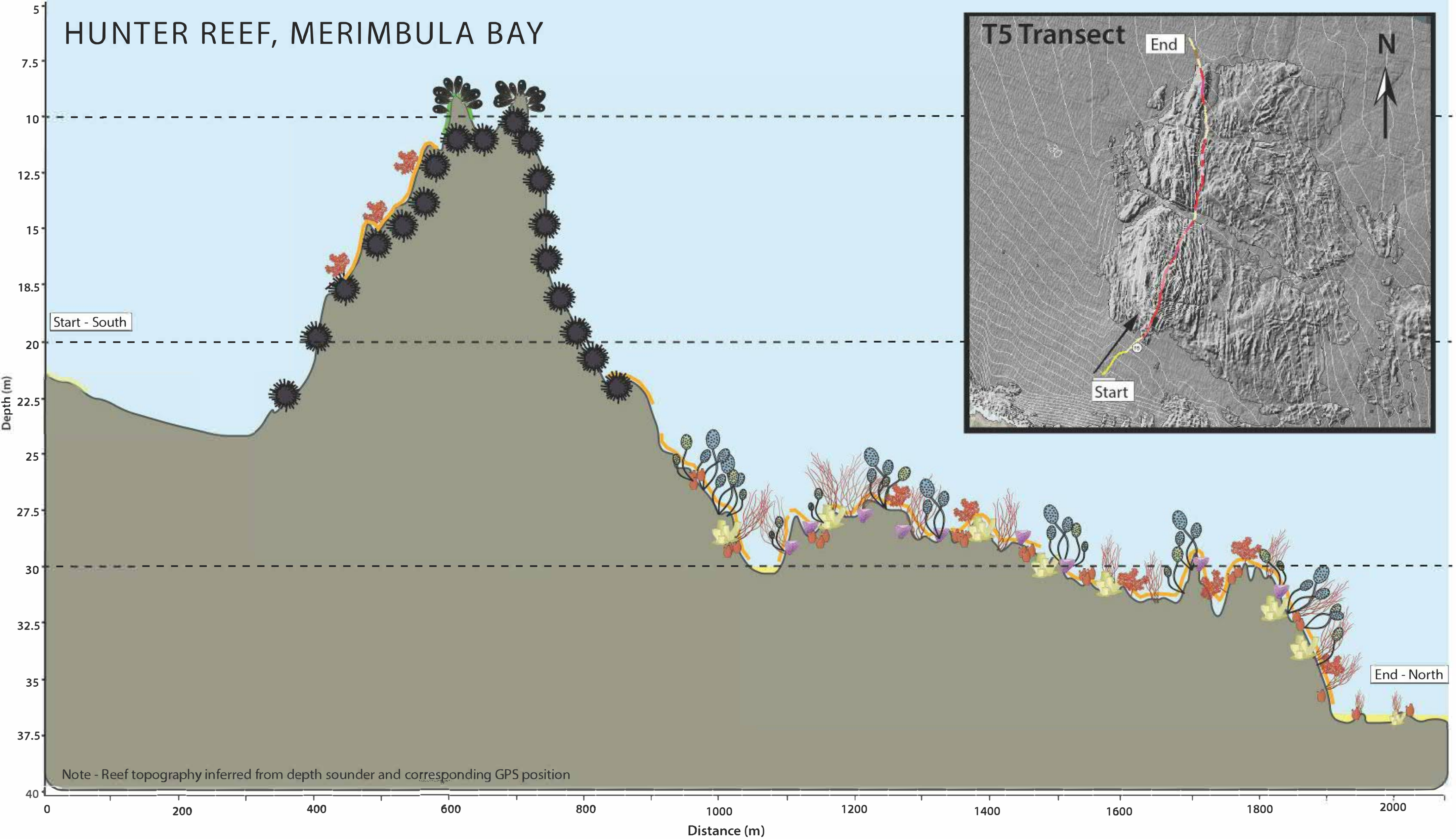
Turf algal habitat consists primarily of a range of small filamentous brown and red algae over areas of flat reef represented by members of the Sphacelariales and Ceramiales families (**Figure 2-9**). In shallower waters the turf algal habitat composition is dominated by coralline algae *Corallina officinalis* and *Amphiroa anceps*. Fish observed foraging over turf algal habitat in tow video included magpie perch, banded morwong, blue morwong, blue groper, luderick, zebra fish, and *Parma* spp.

Barrens habitat

Barrens habitat is characterised primarily by bare reef and high abundance of the black long-spined urchin (*Centrostephanus rodgersii*) (**Figure 2-9**). Encrusting non-geniculate coralline algae (appears as painted pink rock) is common in this community as its hard calcareous epidermis is resistant to grazing by urchins and a range of gastropods that include the tent shell (*Astralium tentoriiformis*), turban shell (*Lunella torquata*), and limpets (*i.e. Scutellastra chapmani, Cellana tramoserica*). A number of sessile invertebrates common to this community include encrusting sponge and bryozoan (*Watersipora* sp.) as well as occasional patch of sheet soft coral (*Erythropodium hicksonii*).

A conceptual model showing the depth zonation of these communities along T5 transect at Hunter Reef is provided in **Figure 2-10**.

Figure 2-9 Examples of benthic community types to 25 m depth



KEY:

Centrostephanus rodgersii

Mytilus galloprovincalis

Pyura spinifera

other ascidians

Turf algae

encrusting sponge

other sponges

sea whips

gorgonian sea fan and other soft corals

Project: MERIMBULA STP UPGRADE AND OCEAN OUTFALL ENVIRONMENTAL ASSESSMENT	**Figure 2 - 10** CONCEPTUAL MODEL OF HABITAT DISTRIBUTION ALONG T5 TRANSECT (STH to Nth) AT HUNTER REEF
Client: AECOM AUSTRALIA	elgin associates — Date: 30 November 2020 — Version 2 — A4

Benthic reef communities below 25 m depth

Benthic reef communities below 25 m depth fall into one broad category comprising all the sessile filter feeders that include sponges, ascidians, bryozoans and soft corals (**Figure 2-11**). Their occurrence is widespread across the reef in deeper waters as illustrated in a conceptual model of habitat distribution along T2 transect at Hunter Reef (**Figure 2-12**), and they are an important habitat for other animals such as fish. Sponges are also an important part of nutrient cycles in marine systems, filtering out particles and nutrients from the water as they feed (DPI 2018).

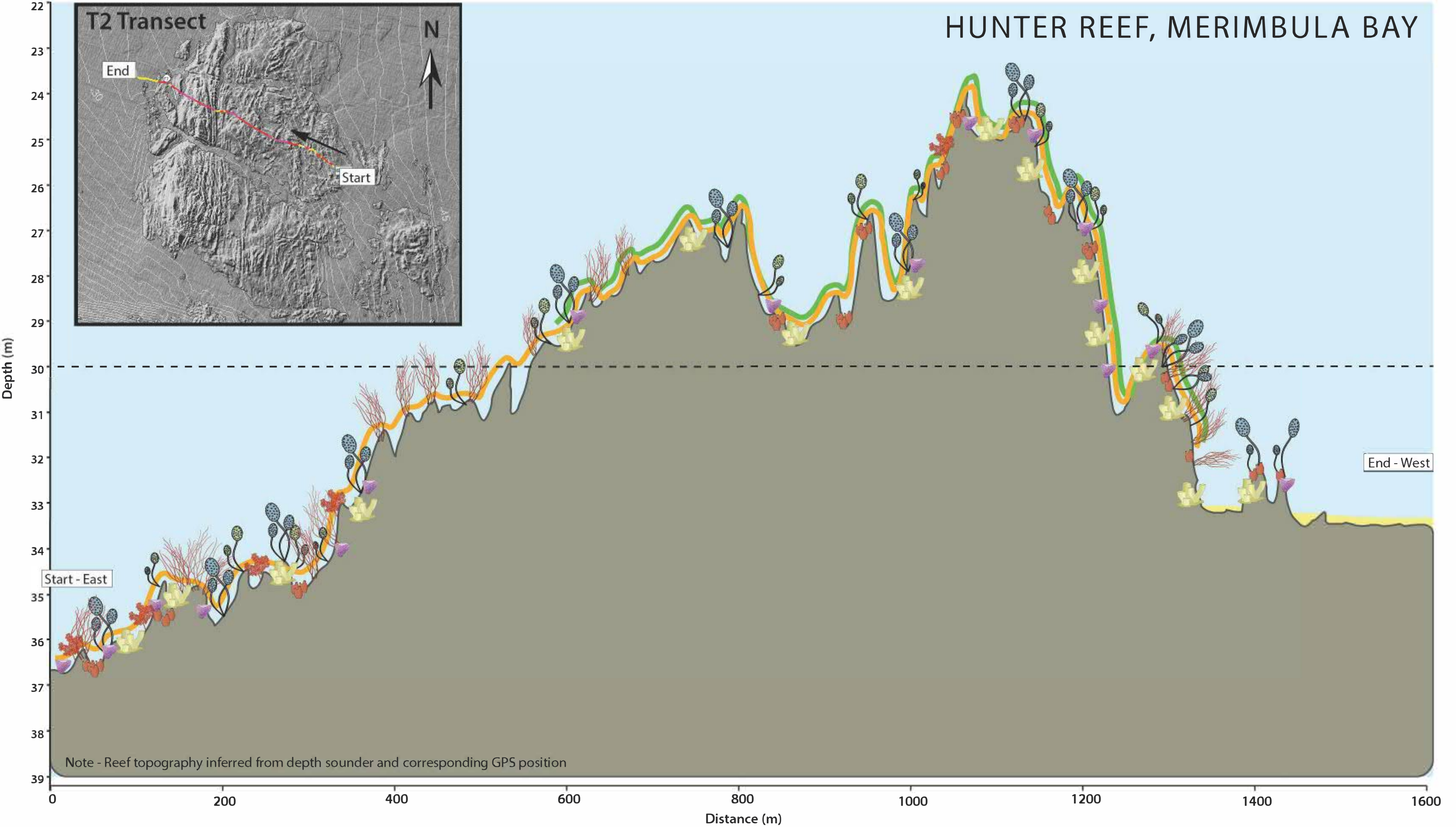
Sessile Filter Feeders

Communities of sessile filter feeding invertebrates are generally made up of delicate forms and many are slow to grow, some living for decades. These factors make this community susceptible to physically damaging processes such as storms and human activities such as trawling and dredging (DPI, 2018).

The community at Merimbula Bay is representative of the broader Twofold Shelf bioregion and included a wide range of sponge taxa of varying morphologies (erect, encrusting, and basket). Ascidians in the community include the conspicuous stalked *Pyura spinifera* and at its base *Cnemidocarpa pedata,* as well as *Herdmania* spp. Bryozoans include the black sieve bryozoan (*Adeona grisea*), filamentous bryozoan (*Orthoscuticella ventricosa*), and lace bryozoan (*Triphyllozoon moniliferum*). The encrusting bryozoan *Watersipora sp*. was observed on high relief reef, particularly on large boulders. Other species recorded included the soft corals southern sea fan (*Sphaerokodisis australis*), and sea whip (*Primnoella australasiae*).

The occurrence of the sessile filter feeding community within the study area is provided in **Figure 2-13**.

Figure 2-11 Examples of benthic community types below 25 m depth



KEY:

- *Pyura spinifera*
- other ascidians
- Turf algae
- encrusting sponge
- other sponges
- sea whips
- gorgonian sea fan and other soft corals

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MERIMBULA STP UPGRADE AND OCEAN OUTFALL ENVIRONMENTAL ASSESSMENT

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Figure 2 - 12

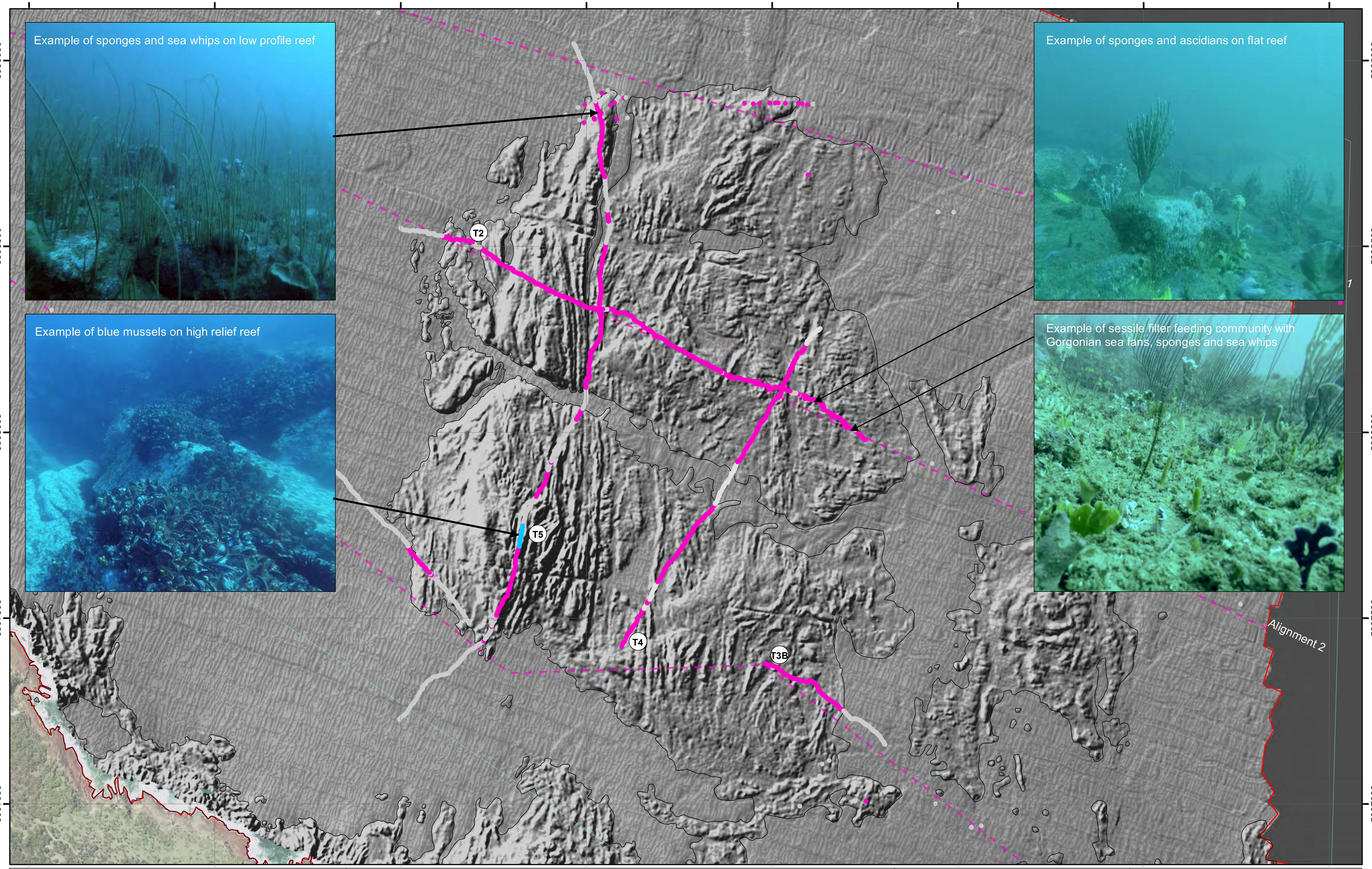
CONCEPTUAL MODEL OF HABITAT DISTRIBUTION ALONG T2 TRANSECT (East to West) AT HUNTER REEF

elgin associates

Date: 30 November 2020

Version 1

Size A4



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Notes:
1. Elgin field survey conducted 3 - 9 November 2017
2. Bathymetry data collected and processed by Marine and Earth Sciences in October 2017

0 125 250 500 Meters

Scale = 1:9,000

Habitat / Community
- Mussels
- Sessile filter feeder community
- Other

T5 Tow video transect

Other Layers
- Area Of Investigation
- Potential Alignments
- Hydro Survey Boundary
- Inferred Reef Boundary

Project:
MERIMBULA STP UPGRADE AND OCEAN OUTFALL ENVIRONMENTAL ASSESSMENT

Client: AECOM AUSTRALIA

FIGURE 2 - 13
OBSERVED OCCURRENCE OF MUSSEL AND SESSILE FILTER FEEDER COMMUNITIES

elgin

Date: 30 November 2020
Version: 2
Size: A3

2.4.5 Seagrass

Extensive seagrass meadows are present in both Merimbula and Pambula estuaries which include the three species - *Zostera muelleri* subsp. *capricorni*, *Halophila ovalis* and *Posidonia australis.* Significantly, Merimbula and Pambula estuaries are two of only four locations within the Bega Valley Shire that support meadows of *Posidonia australis* seagrass. The species also occurs in the Bermagui River and at Twofold Bay. *Posidonia* prefers marine waters whereas *Zostera* and *Halophila* may tolerate increasingly brackish conditions and intermittent periods of exposure during low tides. Further detailed discussion regarding seagrass and other estuarine habitats is provided in **Section 11 – Estuarine Communities**.

Review of previous nearshore coastal habitat mapping (DECCW, 2010) indicates that seagrass is absent from Merimbula Bay. Marine survey work undertaken for this Project between October 2017 and October 2020 supported that finding. However, in November 2020, a small patch of *Zostera* seagrass was detected during a tow video survey of a seabed anomaly in the central region of Merimbula Bay and within the area of investigation for the Project.

Seagrass in the Area of Investigation

Several small patches of *Zostera* segrass were observed at 14 m depth within the area of investigation (**Figure 2-14**). Collectively, the total area of segrass is estimated at less than ~3 m^2. The seagrass is sparsely distributed and at 14 m depth is the likely reason it has not previously been detected in aerial mapping surveys of nearshore marine habitats in Merimbula Bay. It is possible that more occurrences of *Zostera*, as yet undetected, exist within Merimbula Bay.

The seagrass in its current condition is considered to be of low value in terms of potential fish habitat and as the area of seagrass is less than 5 m^2, it is considered Type 2 moderately sensitive fish habitat.

Figure 2-14 Sparse patches of *Zostera* seagrass observed at 14 m depth

2.4.6 Key Fish Habitat Classification

According to the NSW DPI *Policy and Guidelines for Fish Habitat Conservation and Management* (DPI, 2013), the waterway of Merimbula Bay is considered a Class 1 – Major Key Fish Habitat, i.e. *"a marine or estuarine waterway or permanently flowing or flooded freshwater waterway (eg. river or major creek), habitat of a threatened or protected species or critical habitat"*.

Given the attributes of the substrate types and marine habitats observed, the marine area of investigation including the beach and sub-tidal zones, can be classified as the following key fish habitat types:

Type 2 – Moderately Sensitive Key Fish Habitat

- Several small, isolated and sparse patches of *Zostera* seagrass occur at 14 m depth. The total estimated area of seagrass is less than ~3 m^2 equivalent to 0.000003 km^2. The seagrass is sparse and in its current condition is considered to be of low value in terms of fish habitat. As the total estimated area is less than 5m^2, it is considered Type 2 habitat.
- The intertidal beach zone (0.015 km^2) is considered *Moderately Sensitive Key Fish Habitat* as it is a coastal beach and likely to support large populations of in-fauna.
- The sub-tidal reef area (2.26 km^2) is also considered *Moderately Sensitive Key Fish Habitat* as it contains marine macroalgae or other reef communities. Overall, Type 2 habitat represents an estimated 16% of the total area of investigation.

Type 3 – Minimally Sensitive Key Fish Habitat

- The upper littoral beach zone (0.030 km^2) and sub-tidal sandy seabed (12.0 km^2) would be considered *Minimally Sensitive Key Fish Habitat* as it consists of unvegetated sandy substrate (DPI, 2013). Type 3 habitat represents an estimated 84% of the total area of investigation.

A summary of the proportion of key fish habitat types within the area of investigation is provided in **Table 2-4** and shown in **Figure 2-15.** *Type 1 highly sensitive fish habitat* that includes seagrasses, marine park or aquatic reserve, or declared critical habitat under the FM Act does not occur within the area of investigation. The nearest known occurrence of Type 1 habitat comprising extensive seagrass meadows and saltmarsh within the estuaries of Pambula River and Merimbula Lake.

Table 2-4 Key fish habitat types within the area of investigation

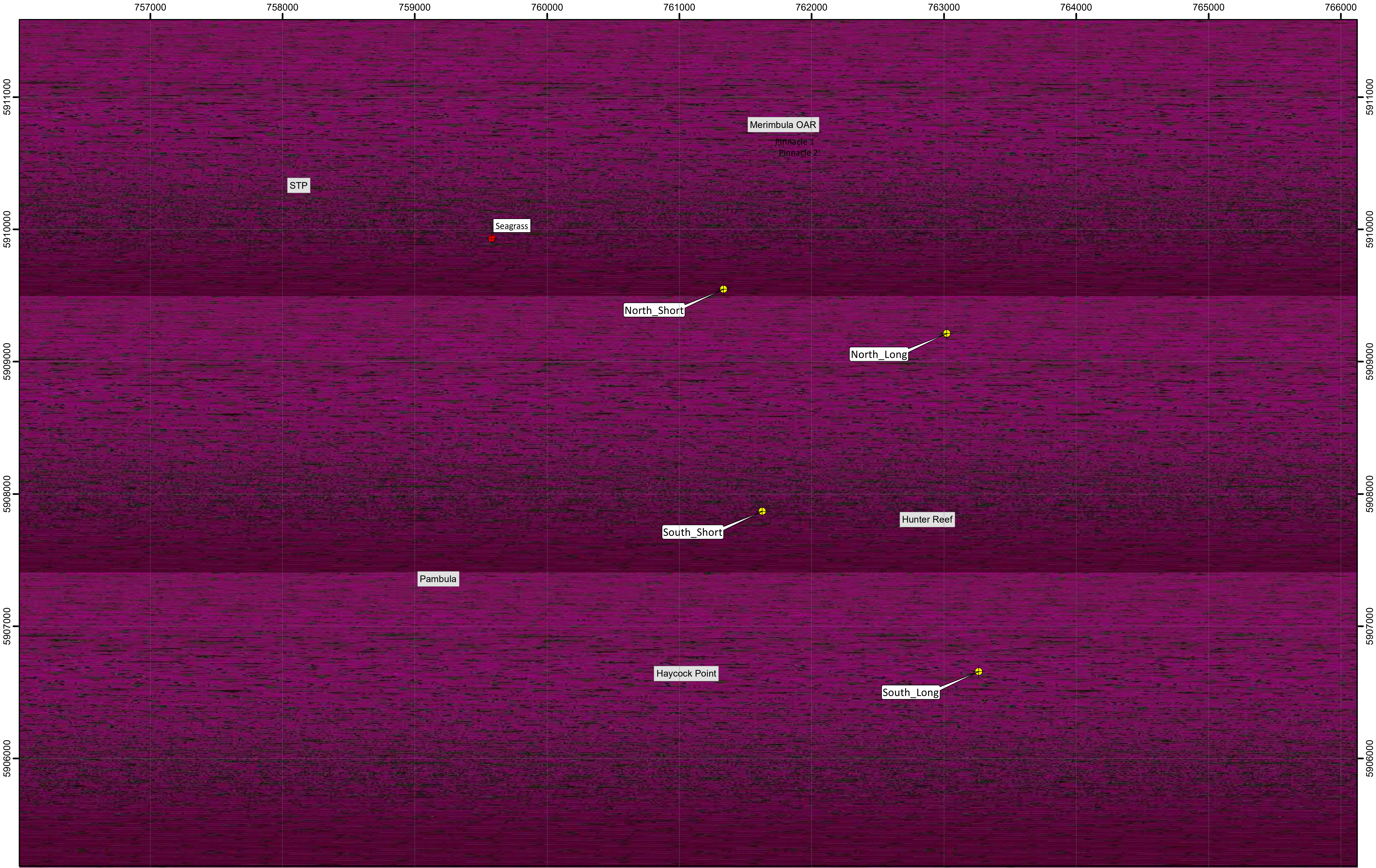
Area	Type 1 Highly sensitive key fish habitat	Type 2 Moderately sensitive key fish habitat	Type 3 Minimally sensitive key fish habitat
Upper littoral beach zone	-	-	0.030 km^2
Intertidal unconsolidated beach zone	-	0.015 km^2	-
Sub-tidal consolidated reef	-	2.26 km^2	-
Sub-tidal unconsolidated sandy seabed	-	-	12.0 km^2
Zostera seagrass	-	0.000003 km^2	**-**
Total Area	**-**	**2.275003 km^2**	**12.03 km^2**
Proportion of Area of Investigation	**0%**	**16%**	**84%**

Note: Based on key fish habitat types classification scheme (DPI, 2013)

2.5 Stage 1 Key Findings

Key findings from the Stage 1 seabed validation survey included:

- Unconsolidated sediments comprise approximately 84% of the area of investigation (12 km^2) varying from fine to coarse sands, and terrain varying from flat (<1 cm high), to ripples (<10 cm high), to waves (>10 cm high). Areas of sand waves are indicative of high current flow and typically comprised coarse-grained sands with a high proportion of shell and pebble sized particles. Large sand waves and coarse sediment was observed at various locations around the edge of Hunter Reef, and in gutters that traverse the reef. Flat areas and sand ripples were typically found within the inner confines of Merimbula Bay and dominated by fine to medium grained sands that are likely indicative of lower current flow.
- Consolidated reef substrates comprise approximately 16% of the area of investigation (2.26 km^2) with the majority of reef associated with Hunter Reef. The reef system occurs primarily between the 25 to 40 m depth contours. A small proportion of the reef occurs above depths of 25 m rising to 8 m below the ocean surface at its shallowest point. Waves break over the reef during large swells events. Reef substrates are highly varied including low relief to high relief bedrock and boulder fields.
- Six benthic communities were identified within the area of investigation including:
  - Infauna and epifauna of the unconsolidated sediments;
  - Mussel beds on shallow areas of Hunter Reef;
  - Turf algal community on shallow areas of Hunter Reef;
  - Sea urchins, invertebrates and fish fauna associated with barrens habitat on Hunter Reef;
  - Sessile filter feeding invertebrate community (sponges, ascidians, bryozoans and soft coral dominated) on deep areas of Hunter reef typically occurring below 25 m depth; and
  - Isolated and small patch of *Zostera* seagrass in 14 m depth.
- In terms of key fish habitat classification (DPI, 2013), the area of investigation comprises:
  - 16% of *Type 2 - moderately sensitive fish habitat* that includes the areas of rocky reef supporting assemblages of macroalgae and sessile filter feeding invertebrates, and an isolated patch of *Zostera* seagrass estimated at less than 5 m^2 in area.
  - 84% of *Type 3 - minimally sensitive fish habitat* that includes the areas of unconsolidated sediments.
  - Type 1 highly sensitive fish habitat that includes seagrasses (greater than 5 m^2 in area), marine park or aquatic rreserve, or declared critical habitat under the FM Act does not occur within the area of investigation.
  - The distribution and extent of key fish habitat types is shown in **Figure 2-15.**



Preferred Alignment
- Pipeline Alignment
- Below Ground
- Diffuser
- AECOM Diffuser Options Sept19

- Seagrass Patch (3 m2)
- Reef - Investigation Area
- Sand - Investigation Area
- Other Reef Area
- Bathymetry (1m intervals)

Meters
0 250 500 1,000

Scale = 1:24,000

Notes:
1. Elgin field survey conducted 3 - 9 November 2017
2. Bathymetry data reported by Marine and Earth Sciences in October 2017
3. Northern bathymetry data reported by Southern Divers and Total Hydrographic in 2017

Area of Investigation - Marine Area = 14.26 km2
Area of Investigation - Reef = 2.26 km2
Area of Investigation - Sand = 12km2

Type 2 = Moderately Sensitive (Reef)

Type 3 = Minimally Sensitive (Sand)

Project:
MERIMBULA STP UPGRADE AND OCEAN OUTFALL ENVIRONMENTAL ASSESSMENT

Client:
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FIGURE 2-15

KEY FISH HABITATS

Date: 06 October 2020
Version: 1
Size: A3

Document Path: D:\Elgin Associates Dropbox\Elgin_GIS\New_South_Wales\BVSC GIS Data\Merimbula EIS\1. MXD Mapping Files\Habitat Mapping\Figure_2-15_Key Fish Habitats_04Dec2020.mxd

2.6 Stage 2 Survey

2.6.1 SEARs requirement – constraint for pipeline alignment option

One of the requirements of DPI in its submission to the SEARs (letter dated 30/5/2016) is for the project to demonstrate that important benthic habitats such as rocky reef have been avoided as much as possible in considering potential pipeline alignment options, and once a preferred alignment option is selected to:

- *Describe the benthic habitats along and adjacent to the full length of the proposed outfall pipeline and for at least 500m radius around the discharge point*.

Following the findings of the Stage 1 seabed validation surveys, two potential pipeline alignments, a northern alignment and southern alignment, and four diffuser location options were considered by the project team and CWG (**Figure 1-3).** The proposed southern alignment would pass closer to rocky reef habitat than does the proposed northern alignment. Selection of the preferred alignment outfall option used a multi-criteria analysis approach that considered a range of criteria such as constructability, as well as the outcomes of a community engagement and stakeholder consultation process.

Location 1, referred to as the 'North-Short' outfall option, was selected as the preferred option by the project team in October 2019. To fulfil the above SEARs objective, further surveys were conducted in Stage 2 marine ecology investigations to inspect the seabed along entire length of the preferred pipeline alignment and 500 m radius around the diffuser location.

2.6.2 Survey Effort

Seabed validation surveys were undertaken over four days commencing on 2 October 2019 once it was understood that the northern alignment was the preferred option for the pipeline. At that time, a decision had not been resolved regarding the preferred outfall option, 'North-Short' at 30 m depth or 'North-Long' at 40m depth had not yet been decided on 2 October 2019. Hence, transect T10 surveyed the seabed between the North-Short and North-Long options. Following selection of the preferred outfall option North-Short at 30m depth, surveys resumed on 6 May 2020 and concluded on 11 June 2020.

A subsequent survey was completed on 21 November 2020 to inspect a seabed anomaly identified in the non-Aboriginal heritage assessment (refer Chapter 15 of the EIS) adjacent to the preferred pipeline alignment.

A total of ten tow video transects were recorded in Stage 2 to validate seabed characteristics along the preferred pipeline alignment, 500 m radius buffer around the proposed outfall diffuser and also at the site 2 anomaly (**Table 2-5**). Location of tow video transects is provided in **Figure 2-16**.

Table 2-5 Summary of tow video transects conducted during Stage 2 seabed validation surveys

Transect	Date	Length (m)	Position / Feature	Direction	Validated Points
T10	2/10/19	1,000	500m radius buffer for NLS-Mid	NE to SW	1,068
T11	2/10/19	1,150	Diffuser 500 m radius buffer	SE to NW	397
T12	6/5/20	1,210	Diffuser 500 m radius buffer	E to W	1,094
T13	11/6/20	2,500	Preferred pipeline alignment	W to E	1,593
T14	11/6/20	1,100	Diffuser 500 m radius buffer	SE to NW	876
T15	11/6/20	1,120	Diffuser 500 m radius buffer	SE to NW	649
T16	21/11/20	95	Site 2 anomaly	SW to NE	98

Transect	Date	Length (m)	Position / Feature	Direction	Validated Points
T17	21/11/20	98	Site 2 anomaly	W to E	59
T18	21/11/20	95	Site 2 anomaly	NW to SE	116
T19	21/11/20	190	Site 2 anomaly	SW to NE	155
Stage 2 Total		*8,558*	-	-	*6,105*

Note - Refer to **Figure 2-16** for location of transects.

2.6.3 Site 2 Anomaly

An anomaly on the seabed approximately 20 m to the north of the proposed pipeline alignment was identified in the non-Aboriginal heritage assessment by AECOM (Chapter 15 of the EIS) following analysis of the geophysical data collected for the study area (Marine and Earth, 2018). The anomaly is located approximately 900 m from shore (**Figure 2-17**) and is described by AECOM as:

The anomaly site appears as a raised object on the seabed. The anomaly is located between the stitching of two separate survey runs. The visible part of the anomaly is 9 m long and approximately 4 m wide. The shadowing on the eastern (right) side of the image depicts possible height associated with the anomaly.

According to historical records, the shipwreck of the *Margaret* was wrecked in Merimbula Bay in 1853 but has never been located. Newspaper reports at the time indicated it was lost 'on shore' and a 'complete wreck'. Another report states that it was lost in the surf zone. Either way it was lost somewhere close to the shore at Merimbula. The vessel was a brig, which included two large masts, and a large jib. At 26 m long with 6 m beam and draft of 4 m , this was not a small vessel (*in lit.* Chris Lewczak, AECOM, 5 May 2020, https://www.environment.nsw.gov.au/maritimeheritageapp/ViewSiteDetail.aspx?siteid=1069). A rudder was pulled up in a net in the 1970s that was covered in muntz metal, and the timber test revealed the rudder was made of northern hemisphere oak. With no other information on the snagging of the rudder, it is likely that it was pulled up further out into the bay (*in lit.* Chris Lewczak, AECOM, 5 May 2020).

As the anomaly is close to the pipeline alignment an underwater inspection using tow video was requested by Council (2 November 2020) to confirm the nature of the seabed at that location and whether evidence exists at the surface of a potential shipwreck.

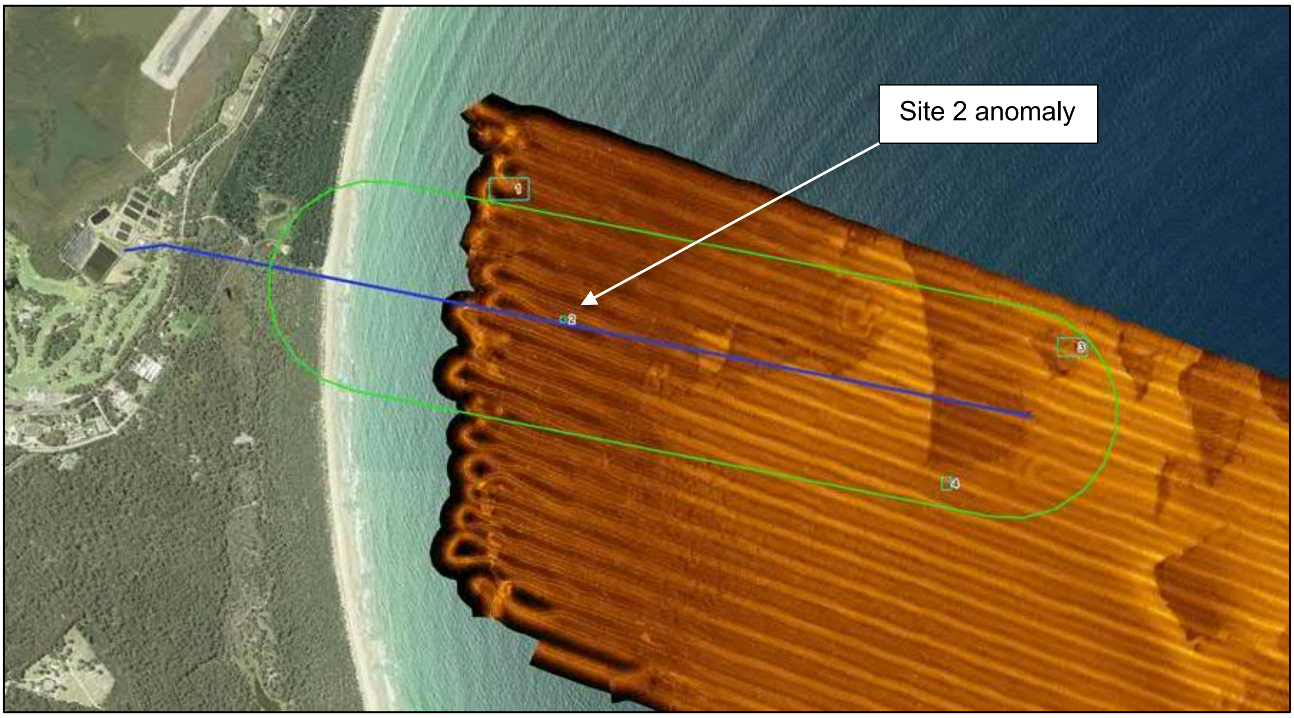


Figure 2-17 Location of Site 2 anomaly (Chapter 15 of the EIS)

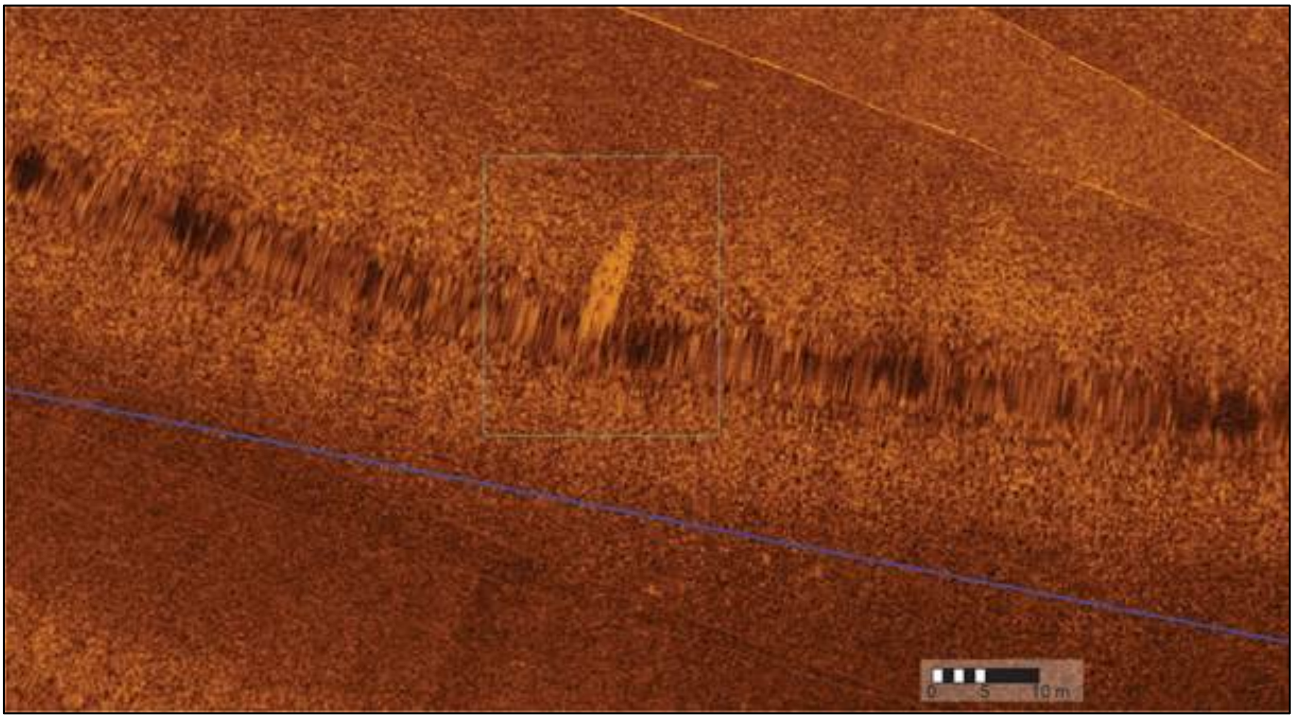


Figure 2-18 Close-up of Site 2 anomaly from geophysical data (Chapter 15 of the EIS)

2.6.4 Classification of substrate and benthic habitat

Substrate type, terrain and benthic habitat (biological attributes) were classified using descriptions provided in the NSW Continental Shelf Mapping Report (**Table 2-2**; DECCW, 2010) as per approaches applied in earlier Stage 1 Marine Ecology investigations (Elgin, 2018).

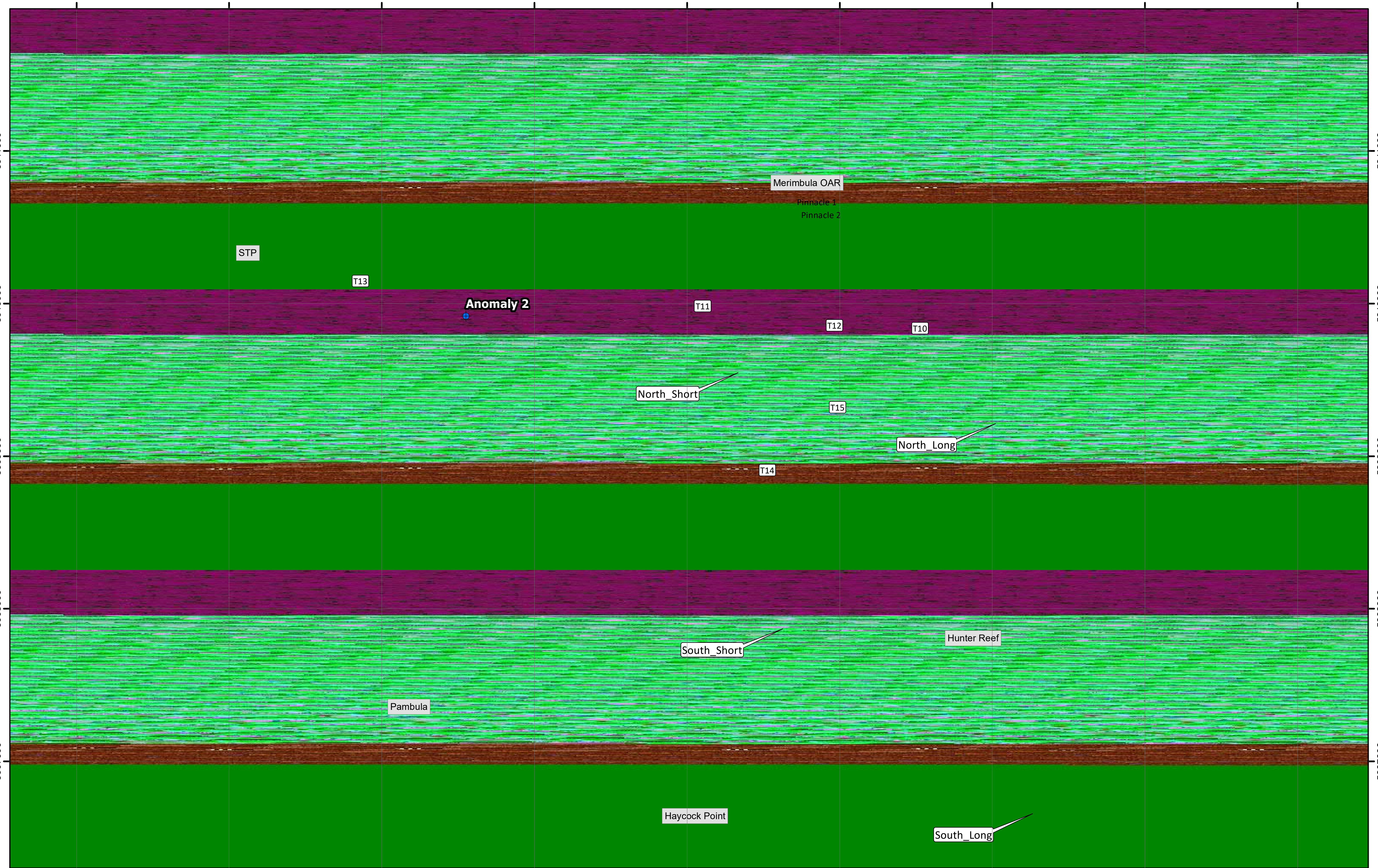
Primary and secondary substrate type and terrain were estimated at each point along the GPS transect. Where present, types of biota were also recorded as shown in **Table 2-2**.

2.6.5 Results and Discussion

Pipeline alignment

The seabed along the entire length of the preferred pipeline alignment is characterised by Type 3 unconsolidated sandy sediments. Terrain along the pipeline alignment varies from sand ripples (<10 cm high) to areas of sand waves (>10 cm high) indicating the variable sediment grain size and hydrodynamic conditions occurring at various depths along the alignment. Sand ripple terrain was recorded from the start of transect 13 (T13) at 6 m depth and continues for 1.3 km to 22 m depth where there is a clear transition to sand waves for approximately 150 m. Multiple transitions between sand ripple to sand wave terrain occur over the remainder of the pipeline alignment in depths between 22 m and 30 m (**Figure 2-16**).

The occurrence of sand wave terrain along the pipeline alignment (**Figure 2-19**) appears to correspond to the subtle, yet observable, sediment gutter features that were resolved by the bathymetry surveys of Merimbula Bay (Marine and Earth Sciences [2018], Southern Divers and Total Hydrographic [2017]). Images of the seabed substrate and terrain types from selected locations along the pipeline alignment are provided in **Figure 2-20** below**.**



N

Scale = 1:22,000

0 250 500 1,000 Meters

Preferred Alignment

- Pipeline Alignment
- Below Ground
- Diffuser
- AECOM Diffuser Options Sept19
- SEARs 500m bufffer from diffuser

Terrain

- Sand (Ripples <10cm)
- Sand (Waves >10cm)
- Bathymetry (1m intervals)
- Site 2 Anomaly

Notes:

1. Elgin field surveys conducted 2 October 2019, 5 June 2020 & 11 June 2020
2. Southern bathymetry data reported by Marine and Earth Sciences in 2017
3. Northern bathymetry data reported by Southern Divers and Total Hydrographic in 2017

Project:

MERIMBULA STP UPGRADE AND OCEAN OUTFALL ENVIRONMENTAL ASSESSMENT

Client:

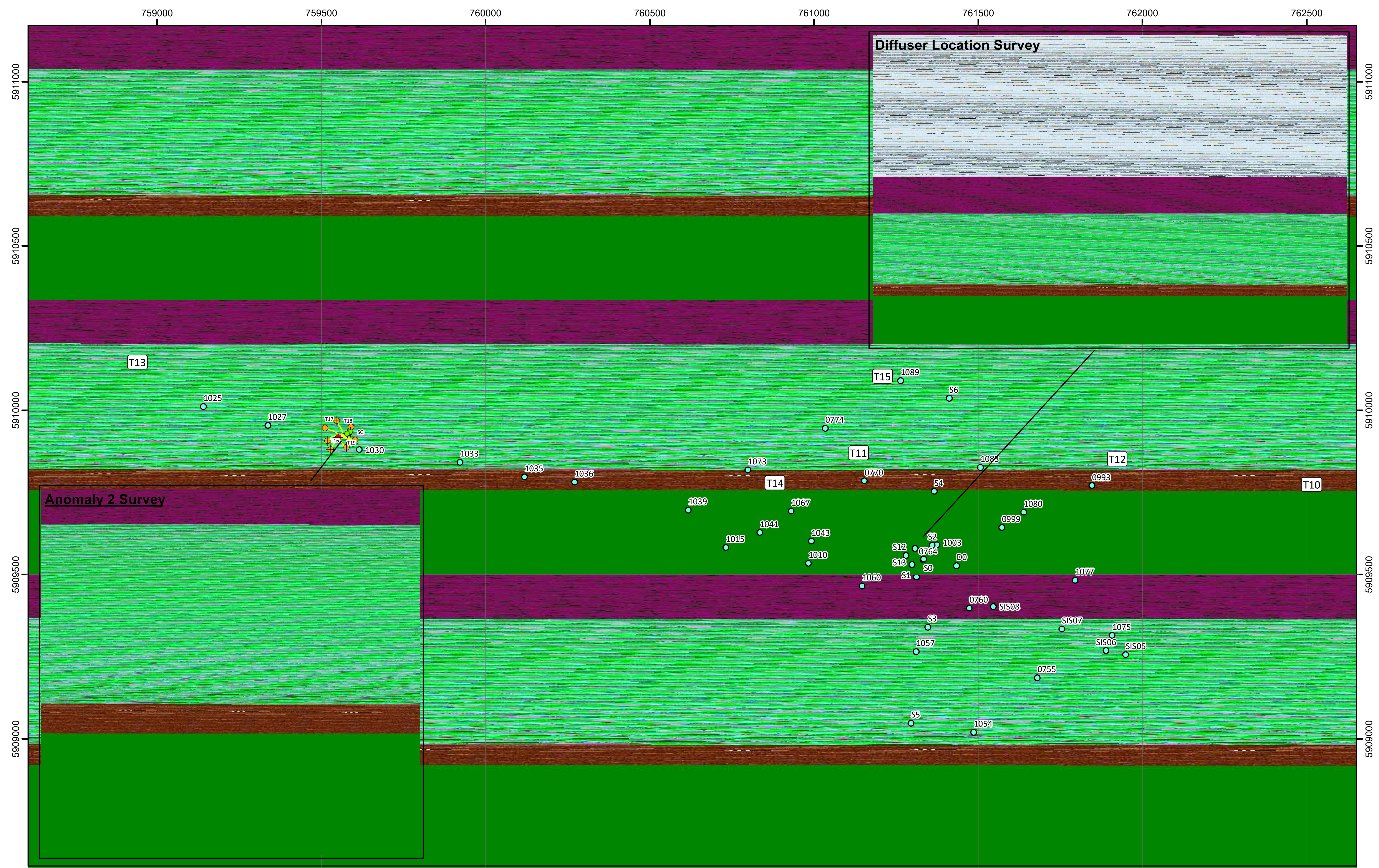
AECOM AUSTRALIA

FIGURE 2-16

SEABED VALIDATION ALONG THE PREFERRED OUTFALL ALIGNMENT

Date: 04 December 2020	
Version: 1	Size: A3

Document Path: D:\Elgin Associates Dropbox\Elgin_GIS\New_South_Wales\BVSC GIS Data\Merimbula EIS\1. MXD Mapping Files\2020_Habitat_Mapping\Figure_2-16_Alignment_Groundtruthing_04Dec2020.mxd



N

Scale = 1:10,000

0 100 200 400 Meters

- Pipeline Alignment
- Below Ground
- Diffuser
- Seabed Validation Photos
- SEARs 500m bufffer from diffuser
- Sand (Ripples <10cm)
- Sand (Waves >10cm)
- Transect Start/End
- Anomaly 2
- Seagrass (<3m2)
- Bathymetry (1m intervals)

Notes:
1. Elgin field surveys conducted 2 October 2019, 5 June 2020 & 11 June 2020
2. Southern bathymetry data reported by Marine and Earth Sciences in 2017
3. Northern bathymetry data reported by Southern Divers and Total Hydrographic in 2017

Project:
MERIMBULA STP UPGRADE AND OCEAN OUTFALL ENVIRONMENTAL ASSESSMENT

Client:
AECOM AUSTRALIA

FIGURE 2-19
SELECTED SEABED VALIDATION PHOTOPOINTS

Date: 07 December 2020
Version: 2
Size: A3

Document Path: D:\Elgin Associates Dropbox\Elgin_GIS\New_South_Wales\BVSC GIS Data\Merimbula EIS\1. MXD Mapping Files\2020_Habitat_Mapping\Figure_2-19_Validation_photos_v2_07Dec2020.mxd

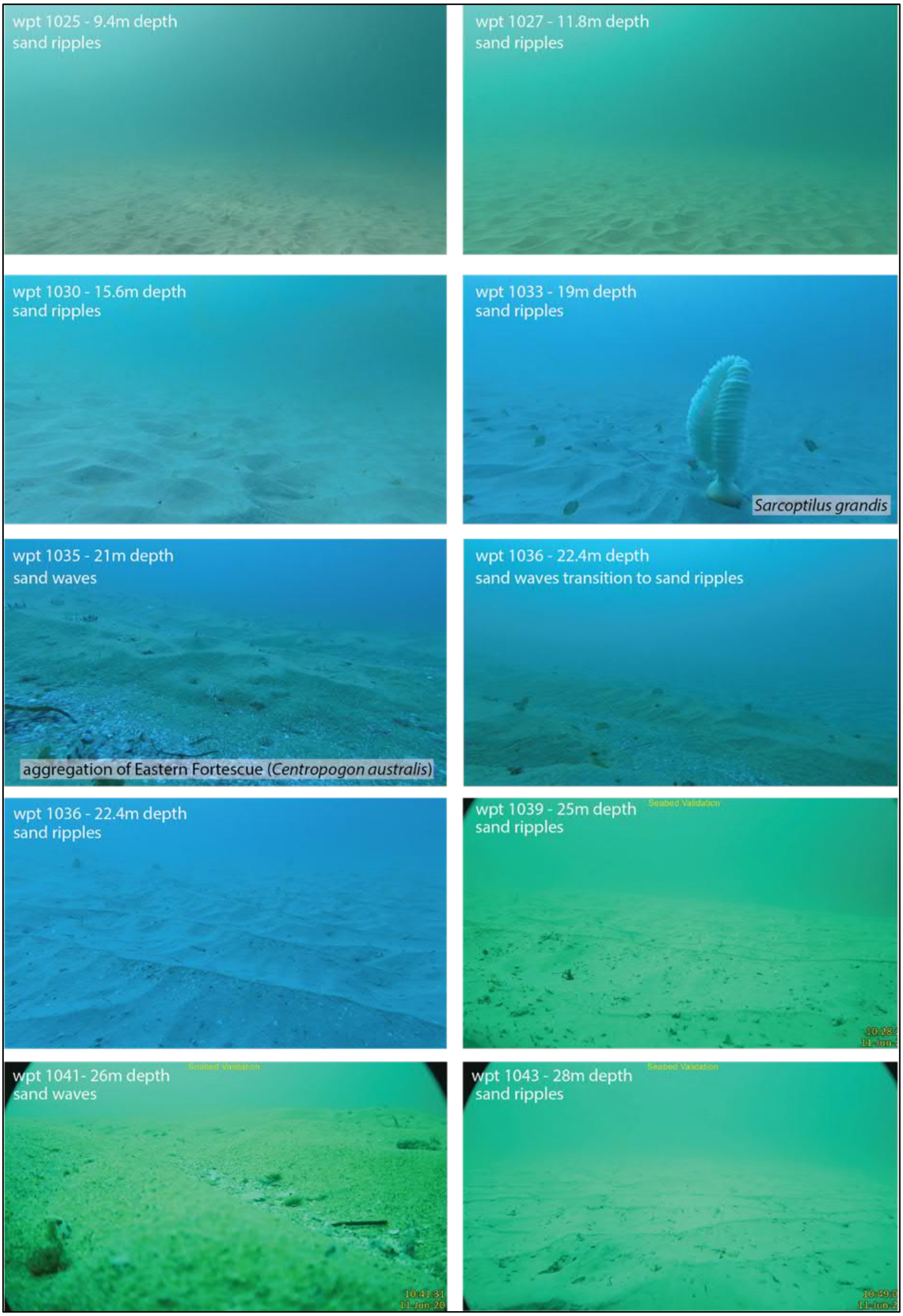


Figure 2-20 Selected seabed validation photo-points captured along preferred pipeline alignment

North-Short outfall diffuser

The seabed at the proposed location for the North-Short outfall diffuser is unconsolidated sediment, described as medium to coarse grain sands with trace fines. Terrain is a combination of sand ripples and waves as shown in **Figure 2-21**.

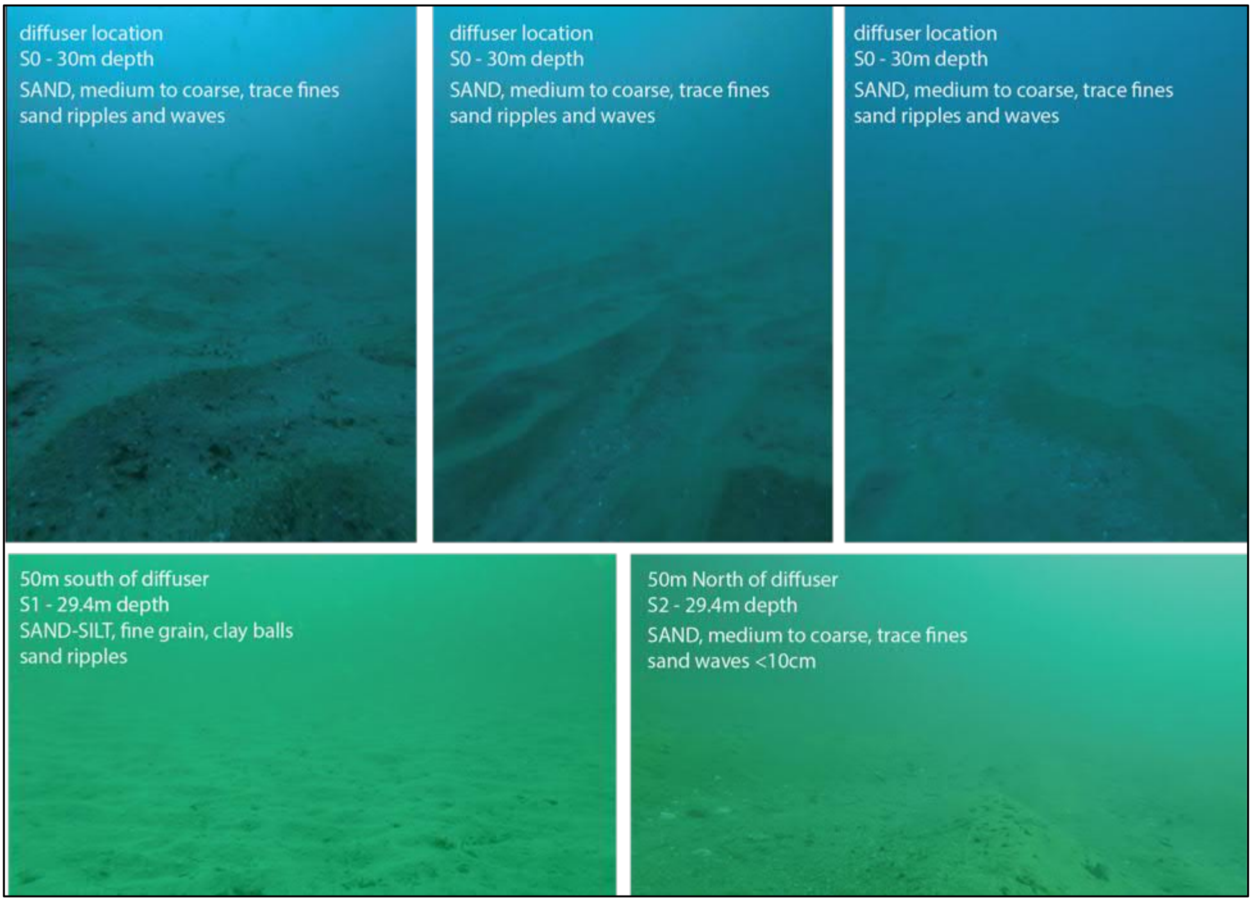


Figure 2-21 Selected seabed validation photo-points captured at and around the North-Short outfall diffuser

500m radius buffer around the North-Short outfall diffuser

Four tow video transects were recorded over the North-Short diffuser 500 m radius buffer (**Figure 2-16**). The seabed within this buffer area is characterised by unconsolidated sandy sediments. Terrain varies from sand ripples (<10cm high) to areas of sand waves (>10cm high), with the latter appearing more dominant over the areas surveyed. Images of the seabed substrate and terrain types from selected locations along the transects (**Figure 2-19**) are provided in **Figure 2-22** below**.**

The mapping of sand wave terrain (**Figure 2-16)** across the survey area corresponds well with subtle yet observable irregularity of seabed level, inferred to be sediment gutters, resolved by the bathymetry surveys of Merimbula Bay (Marine and Earth Sciences [2018], Southern Divers and Total Hydrographic [2017]). Several of these sediment gutter-like features extend from Long Point in a south to southwest direction towards the central bay region. These features are expected to be related to lobes of mobile sands that provide some indication of overall dominant current flow direction over bed sediments.

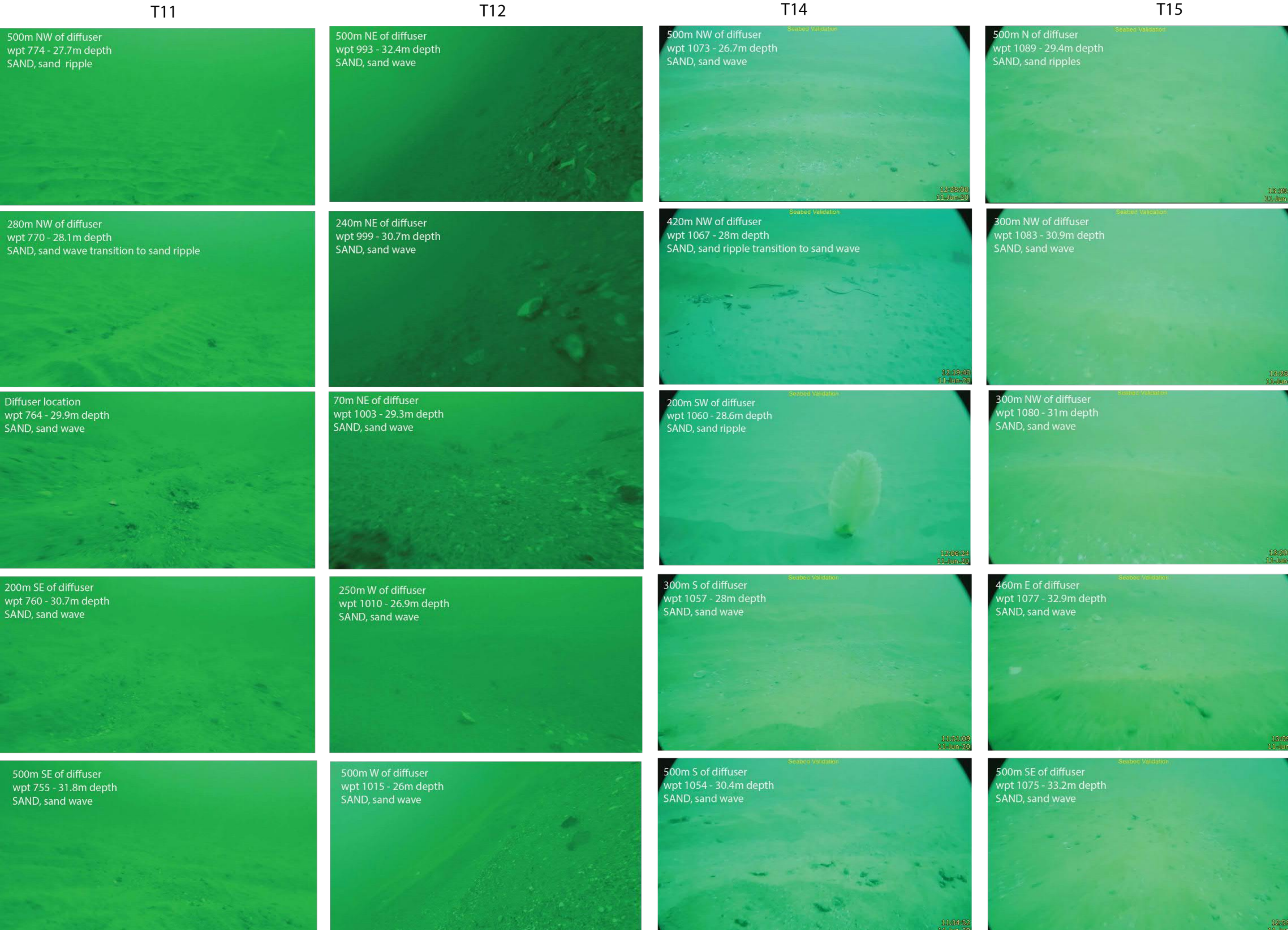


FIGURE 3 - 20. Selected seabed validation photo-points captured along transects of the diffuser 500m radius buffer.

Site 2 Anomaly

A weighted marker buoy was dropped at the anomaly location in 14 m depth (**Figure 2-23**) and four tow video transects recorded across the area (**Figure 2-16**). The seabed was found to be uniform across the area characterised by sand ripples with no evidence of a height difference in the seabed to indicate a potentially buried structure, nor was there any evidence of a potential structure protruding from the seabed surface.

Fauna and flora observations recorded during the anomaly inspection included a few individuals of the comb sand star (*Astropecten vappa*) that is common in Merimbula Bay and several sparse patches of *Zostera* seagrass (**Figure 2-14**). Collectively, the total area of seagrass was estimated at less than ~3 m^2 and is 30 to 40 m to the north of the proposed pipeline alignment.

Figure 2-23 Seabed characteristics at the Site 2 anomaly location

2.6.6 Flora and fauna of the central region of Merimbula Bay

The flora community of the central region of Merimbula Bay is limited to the microphytobenthos and intermittent drift wrack. Microphytobenthos is the assemblage of microalgae that inhabit the bed sediments, whereas drift wrack includes the fragments of macroalgae and seagrass that have detached from their point of origin (*i.e.* adjacent estuaries and rocky reef habitat) and drift around the embayment according to prevailing current conditions. Merimbula Bay is well-known for episodes of large aggregations of drift wrack that occasionally wash ashore. Accumulations of drift wrack are often present in deeper waters within the embayment but do not wash ashore.

Noteworthy fauna observations along the pipeline alignment included an aggregation of the small scorpionfish, Eastern fortesque (*Centropogon australis*), in sand wave terrain at 22 m depth (**Figure 2-23**). Eastern fortesque is a fish species known to form large aggregations (Bray and Gormon, 2020), and at Merimbula Bay the species appears to prefer the coarse grain sand and shell fragment habitat that occurs in the troughs between sand waves. Eastern fortesque are commonly observed throughout Merimbula Bay and the wider far south coast region of NSW.

A number of individuals of the great sea pen (*Sarcoptilus grandis*), the largest sea pen in southern Australian waters, were also observed during surveys (**Figure 2-20**). Sea pens were typically solitary and their density across the survey area is considered very low, conservatively estimated at one individual for every 10,000 m^2 in water depths between 19 m to 30 m that were surveyed.

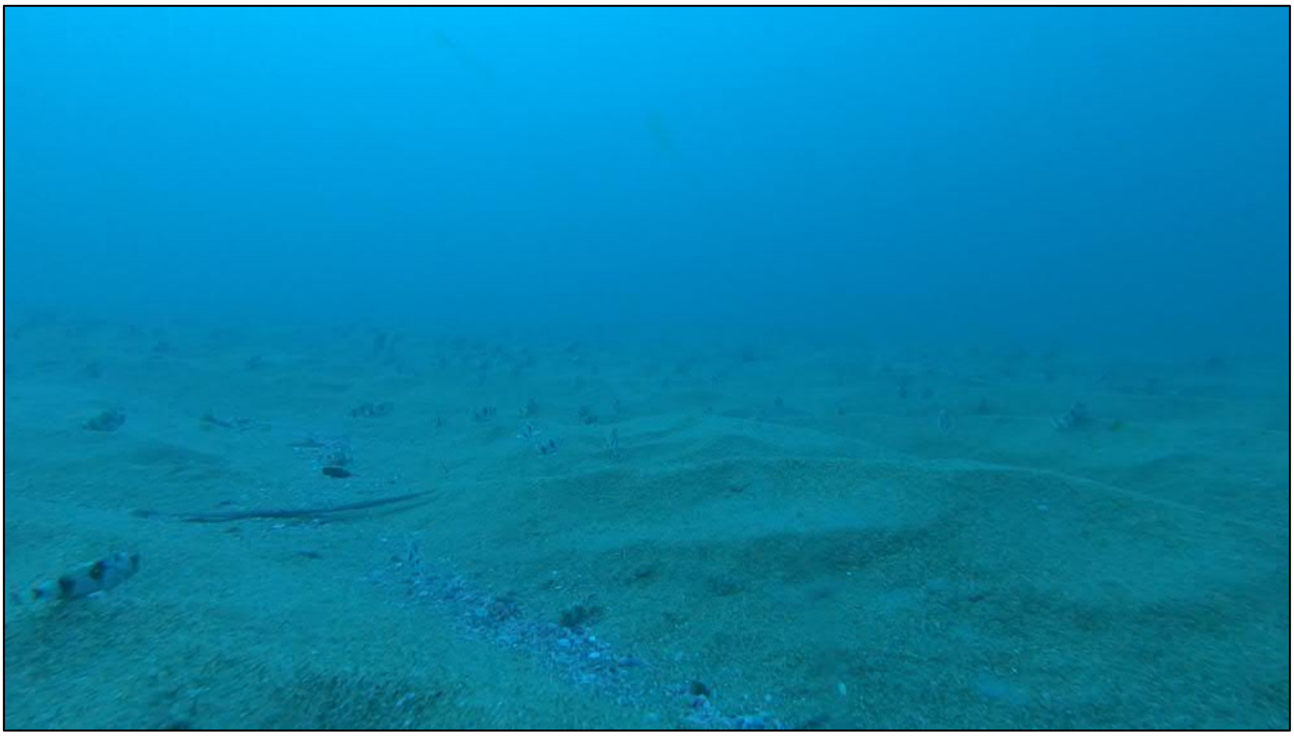


Figure 2-24 Fauna observations along the pipeline alignment included an aggregation of Eastern Fortesque at 22 m depth

In addition to the fauna observations recorded during seabed validation surveys, separate studies of the soft sediment infauna and epifauna community and demersal fish assemblage of sand habitat have been undertaken as part of the broader marine ecology studies for the EIS. Findings from those studies are provided in report sections below.

2.6.7 Nearest rocky reef habitat to the preferred North-Short outfall diffuser

Based on seabed validation surveys it can be concluded that the seabed of the pipeline alignment and the North-Short diffuser 500 m radius buffer is characterised by unconsolidated sandy sediments. In selecting the North-Short outfall option, sensitive communities associated with rocky reef habitat has been avoided altogether with the nearest rocky reef habitat located at:

- Hunter Reef ~1,400m to the south-east;
- Rocky reef shorelines from Pambula Lake entrance to Haycock Point ~2,000m to the south; and
- Rocky reef shorelines from Merimbula Lake entrance to Long Point ~2,300m to the north.

2.7 Stage 2 Key Findings

- Seabed validation surveys of the preferred pipeline alignment and diffuser option were undertaken over four days. Surveys included ten tow-video transects over approximately 8km of seabed that included the length of the pipeline alignment, the North-Short diffuser 500 m radius buffer, and site 2 anomaly.
- The seabed of the pipeline alignment and the North-Short diffuser 500 m radius buffer is characterised by Type 3 unconsolidated sandy sediments comprised primarily of medium to coarse grain size particles.
- Terrain along the pipeline alignment and within the North-Short diffuser 500 m radius buffer varies from

sand ripples (<10 cm high) to areas of sand waves (>10 cm high) indicating the variable sediment grain size and hydrodynamic conditions occurring at various depths within the survey area.

- The mapping of sand wave terrain across the survey area corresponds well with subtle, yet observable irregularity of seabed level, inferred to be sediment gutters resolved by the bathymetry surveys of Merimbula Bay (Marine and Earth Sciences [2018], Southern Divers and Total Hydrographic [2017]). Several of these sediment gutter-like features extend from Long Point in a south to southwest direction towards the central bay region. These features are expected to be related to lobes of mobile sands that provide some indication of overall dominant current flow direction over bed sediments.
- A small patch of sparse *Zostera* seagrass was recorded at 14 m depth adjacent to the site 2 anomaly. The patch in its current condition is considered to be of low value in terms of fish habitat and as the total estimated area is less than 5m^2, it is considered Type 2 habitat.
- In selecting the North-Short outfall option, Type 2 rocky reef habitat has been avoided altogether with the nearest rocky reef habitat located at Hunter Reef, is approximately 1,400 m to the south-east.

2.8 Construction Phase Impact

Construction phase activities include establishing the pipeline in two sections:

- Section one – From the STP to a location beyond surf zone using underground trenchless drilling method.
- Section two – From the location beyond surf zone to offshore pipeline termination point that will involve laying of pipeline on seabed floor and covering with rock and or concrete mattresses.
- Construction activities include the mobilisation of vessels and barges

Construction of pipeline section one is not expected to cause impact or material change to the seabed of Merimbula Bay. Construction of pipeline section two would involve laying a 450 mm diameter pipeline directly over the seabed and anchoring with either a cover of concrete mattress and or rock armour. This would result in the loss of sandy habitat (Type 3 fish habitat) but also the creation of new hard, rocky substrate habitat that would eventually become colonised by a range of sessile invertebrates and algae in an otherwise sandy environment. Over the long-term the pipeline infrastructure representing effectively an artificial reef, may provide opportunities for increased biodiversity value and and would then be classified as Type 2 fish habitat.

2.8.1 Disturbance and loss of Type 3 soft sediment habitat

Section 2 pipeline construction would involve laying the proposed 450 mm diameter pipeline directly on the seafloor and anchoring with a protective cover of concrete mattress and or rock armour along its 2.7 km length. The construction footprint over the seabed is conservatively estimated at 1.6 m wide by 2,700 m long, or 4,320 m^2. This would result in the direct disturbance and loss of 0.00432 km^2 of Type 3 unconsolidated sand habitat, considered minimally sensitive with regard to fish habitat. Based on estimate of 12 km^2 of sand habitat within the study area (Refer **Figure 2-15**), this represents a 0.04% loss of Type 3 soft sediment habitat mapped within the study area. The scale of the sand habitat loss (as a result of the Project) would be minor and is unlikely to have a long-term negative effect on the faunal assemblages that rely on sand habitat within Merimbula Bay in terms of their diversity and abundance.

Establishing the pipeline infrastructure would result in the smothering of soft sediment infauna and epifauna that occur directly below the pipeline footprint. The impact on infauna is expected to be minimal as infauna are highly mobile and can move to adjacent habitat. Epifauna such as the sessile great sea pen (*Sarcoptilus grandis)* or mobile comb sand star (*Astopecten vappa*) present along the pipeline alignment could be lost due to direct physical damage during the placemnt of rock armour over the pipeline. Few individuals of the great sea pen were noted during surveys, conservatively estimated at one per 10,000 m^2, and the potential loss of a few individuals is not expected to have an adverse effect on the local population. Similarly, the comb sand star is distributed throughout Merimbula Bay and while a few individuals may be lost during construction of the pipeline, that loss would not have an adverse effect on the local population.

2.9 Operational Phase Impact

Potential impacts from the Project operational phase considers how the discharge of treated wastewater at the diffuser may affect the quality of the marine habitat and communities, as well as the impacts of the completed infrastructure over the long-term.

2.9.1 Discharge of treated wastewater to mixing zone

The disposal of treated wastewater to the proposed North-Short outfall would result in a freshwater discharge containing elevated levels of nutrients and concentrations of metals that exceed MWQOs. Under most conditions and for the majority of time, a mixing zone of 25 m is required to achieve necessary dilution to meet MWQOs. Potential impacts associated with treated wastewater discharge on marine communities are most likely to be detected within the predicted mixing zone of 25 m. Detection of impacts beyond this zone becomes less likely due to the high levels of dilution achieved over the relatively short distance. Ecological receptors within this mixing zone area is primarily the epifauna and infauna community of the Type 3 sandy seabed habitat. Cetaceans and majority of fish would typically transit through this mixing zone and their exposure to dilute treated wastewater would be infrequent and not be considered detrimental or harmful. However, there may be some fish species that are attracted to the mixing zone due to localised increase in food availability and structure provided by the pipeline and diffuser.

Fish that utilise sand habitats in the mixing zone are demersal species such as flathead, whiting and rays (Refer **Section 5** - **Fish Assemblage)**. Those fish that transit the 25 m mixing zone would be exposed to treated wastewater intermittently, and but are unlikely to be affected as the treated wastewater, being less dense than seawater, would rise upwards through the water column away from the seabed. The fish most likely to be exposed to the dilute treated wastewater plume are pelagic or mid-water species such as the yellowtail horse mackerel, or demersal species that may show high fidelity to substrates and habitat within the 25 m mixing zone. A study by Fetterplace *et al.* (2016) showed that flathead in Jervis Bay can show strong site attachment for periods of at least 60 days (duration of the study) and it is this type of fish behaviour that would increase the likelihood of exposure to treated wastewater if occurring within the 25 m mixing zone. Under this scenario there is risk that fish may be exposed to metals in treated wastewater with potential for bioaccumulation of metals due to foraging upon prey within the mixing zone. Metals are a physiological stressor for marine organisms with reported effects in some fish that can include changes to growth and reproduction, and abnormal courtship and aggressive behaviours (McCallum *et al.*, 2019). Potential impact of metals to fish would be dependent of exposure levels and some fish may be more tolerant than others. Futher discussion of the potential impacts to fish from the discharge of treated wastewater is provided in **Section 5 – Fish Assemblage** and **Section 6 – Bioaccumulation Risk to Fish and Shellfish**.

There would be instances where treated wastewater may discharge at higher concentrations, such as during wet weather flows or at licence discharge limits that may also coincide with weak ocean current conditions. Under this modelled worse-case scenario, the mixing zone required to achieve all MWQOs is predicted to occur in a 200 m radius from the diffuser location. Ecological receptors in this larger mixing zone is also limited to epifauna and infauna community of Type 3 soft seabed habitat. Risk analysis of Project impacts to epifauna and infauna community is provided in **Section 7 – Soft Sediment Infauna and Epifauna Community**.

2.9.2 Creation of Type 2 rocky habitat

Construction of the pipeline infrastructure with concrete mattress and or rock armour protection along its length constitutes a change from soft seabed habitat to hard substrate habitat, effectively resulting in the creation of an artificial reef. Any available hard substrate placed in the marine environment provides habitat opportunity in the short-term for a wide range of colonising sessile invertebrates such as ascidians, bryozoans, sponges, barnacles, oysters and mussels.

The pipeline and diffuser are also likely to be colonised by various macroalgae. In effect, by laying the pipeline on the seabed rather than trenching and burial, the Project is creating an artificial reef that after some period of colonisation by various invertebrates and algae would be considered Type 2 fish habitat. Over the long-term, or for some periods, the pipeline may become buried by sand. Intermittent sand burial and sand scour of hard substrates is a naturally occurring process in the marine environment that can contribute to increased species diversity due to the intermediate disturbance that provides both early and late successional species an opportunity to establish.

Construction of the pipeline and diffuser infrastructure would result in loss of Type 3 fish habitat but over the long-term result in a gain of Type 2 fish habitat, the latter recognised as being more valuable in terms of fish habitat. The Project may result in a net positive effect on the fish assemblage with increased diversity and abundance in the central region of Merimbula Bay. The potential attraction of fish to the pipeline structure may also result in improved recreational fishing opportunities within the vicinity of the pipeline. Overall there would be no net loss of fish habitat and as such no biodiversity offset under the *Policy of Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013) is required.