Merimbula Sewage Treatment Plant Upgrade and Ocean Outfall
Environmental Impact Statement
Bega Valley Shire Council
August 2021

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Merimbula STP Upgrade and Ocean Outfall

Client: Bega Valley Shire Council

ABN: 26 987 935 332

Prepared by

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Certification

This Environmental Impact Statement (EIS) for the Merimbula Sewage Treatment Plant and Ocean Outfall Project (Application Number SSI-7614) has been prepared in accordance with Part 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000.*

Environmental Impact Statement prepared by:

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The Applicant

Applicant name: Bega Valley Shire Council
Applicant address: Bega Valley Shire Council Administration Centre, Zingel Place Bega

Land to which this statement relates

The Project area and construction footprint is located over 14 parcels of land within the Bega Valley Shire Council Local Government Area, as shown on maps included in the EIS and is described as:

Lot 101 DP1201186 (BVSC), Lot 355 DP41837 (State of NSW Crown Land (leased to PMGC Ltd)), Lot 102 DP1201186 (BVSC), Lot 356 DP41837 (State of NSW Crown Land (leased to PMGC Ltd)), Lot 1 DP853245 (BVSC), Lot 2 DP853245 (BVSC), Lot 7307 DP1167035 (State of NSW Crown Land), Lot 7308 DP1167035 (State of NSW Crown Land), Lot 320 DP750227 (State of NSW Crown Land), Lot 7917 DP1187854, Lot 7318 DP 1167151 (State of NSW Crown Land), Lot 7019 DP1122193 (State of NSW Crown Land), Lot 1 and Lot 2 DP861737 (BVSC). The ocean outfall pipeline is to be located on land below the mean high water mark (State of NSW Crown Land), and Arthur Kain Drive would also fall within the footprint.

Description of the infrastructure to which this statement relates

The Project proposed in this EIS includes upgrading the existing STP with additional wastewater treatment processes as well as constructing and operating a new ocean outfall pipeline and diffuser in Merimbula Bay.

Environmental Impact Statement

This EIS assesses the environmental impacts of this Project and includes the matters referred to in Secretary's Environmental Assessment Requirements provided to the Applicant under Section 78A(8A) of the *Environmental Planning and Assessment Act 1979*.

Declaration

I certify that the contents of the EIS, to the best of my knowledge, has been prepared as follows:

- In accordance with Schedule 2 of the *Environmental Planning and Assessment Regulation 2000*
- In accordance with the requirements of the *Environmental Planning and Assessment Regulations 2000; and State Environmental Planning Policy (State and Regional Development) 2011;*
- The statement contains all available information that is relevant to the environmental assessment of the proposed development; and
- The information contained in this report is neither false nor misleading.

Signature: **Date: 17th August 2021**

Name: Catherine Brady

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Executive Summary

Overview

The existing Merimbula Sewage Treatment Plant (STP) is operated by Bega Valley Shire Council (BVSC) and services the communities of Merimbula, Pambula, South Pambula and Pambula Beach, on the Far South Coast of NSW. The STP is an intermittently decanted extended aeration (IDEA) activated sludge plant designed to serve 15,500 equivalent persons. The current process for managing treated wastewater from the STP involves a combination of beneficially re-using the treated wastewater (as irrigation water at offsite locations), as well as disposal to land and sea via nearby dunal exfiltration ponds and an existing beach-face outfall pipeline at Merimbula Beach.

The current use of the dunal exfiltration ponds and beach-face outfall does not meet community or regulatory agency expectations and presents risks to public health, the environment and the regional economy. Treated wastewater disposed from the beach-face outfall flows across the beach and impacts on near-shore water quality, local aesthetic and recreational values and perceptions of the area. Treated wastewater disposed via the dunal exfiltration ponds can impact on groundwater quality and may also influence water quality in the receiving environment. The exfiltration ponds are constructed within an Endangered Ecological Community (EEC), and within an area of Aboriginal cultural significance.

Following consultation with the NSW Environmental Protection Agency (EPA), other regulatory agencies and community stakeholders in 2013, BVSC committed to obtaining the necessary approvals to upgrade the STP to improve treated wastewater quality, and to construct and operate an ocean outfall pipeline for disposal of treated wastewater, in order to address the issues outlined above. This commitment was included in an amendment to the Environment Protection Licence (EPL) for the STP in 2014 and remains a condition of the current EPL which was recently amended in May 2020.

The Project proposed in this Environmental Impact Statement (EIS) includes upgrading the existing STP with additional wastewater treatment processes as well as constructing and operating a new ocean outfall pipeline and diffuser in Merimbula Bay.

BVSC is the Proponent for the Project. BVSC is responsible for the delivery of sewage services within the Bega Valley Shire local government area, including management and operation of the Merimbula STP.

On 26 July 2016 the Project was declared to be State Significant Infrastructure (SSI) under the *Environmental Planning and Assessment Act 1979* (EP&A Act) and the *State Environmental Planning Policy (State and Regional Development) 2011*. Accordingly, the Project requires the approval of the Minister for Planning and Public Spaces. The Secretary's environmental assessment requirements (SEARs) for the Project were first issued by the former Department of Planning and Environment in 2014, The SEARs were subsequently revised and re-issued by the Department of Planning, Industry and Environment (DPIE) on 4 February 2019, and re-issued again on 14 May 2021. The SEARs set out the technical requirements for the assessment of each potential key issue during preparation of the EIS for the Project.

The primary purpose of this EIS is to support an application for State Significant Infrastructure (SSI) approval under the EP&A Act. It has been prepared to help the community, public authorities and the decision-maker to understand the likely consequences of the Project and make informed submissions on the Project. This EIS addresses the SEARs for the Project, as well as other relevant NSW and Commonwealth legislative requirements.

The public exhibition of this EIS would provide further opportunity for the community, Government agencies and other interested parties to gain a better understanding of the Project and allow those parties to provide comment. BVSC would consider submissions provided during the exhibition period in the further development of the Project.

Next steps / Submission of the EIS and public exhibition

Following submission of the EIS, the DPIE will review the EIS to ensure that it has been prepared having regard to relevant requirements, including the guideline *Preparing an Environmental Impact Statement – Draft Environmental Impact Assessment Guidance Series June 2017* (Department of Planning and Environment, 2017) and the SEARs.

Following acceptance of the EIS, the Department will place the EIS on public exhibition for 30 days to seek submissions on the Project. Following public exhibition of the EIS, BVSC will prepare a response to submissions report addressing submissions received and documenting any changes to the Project following the consideration of submissions.

Assessment and determination

Following public exhibition, an assessment report will be prepared by the Planning Secretary of the DPIE and the submissions report will be made available to the public. The NSW Minister for Planning and Public Spaces (or delegate) will determine whether or not to approve the Project, and conditions will be attached to the determination, if approved.

Project description

Key features of the Project involve:

- upgrade of the STP to improve the quality of treated wastewater and recycled water;
- decommissioning the beach-face outfall;
- stopping use of the in-dune exfiltration ponds;
- supporting future increases in treated wastewater re-use;
- installation of a secondary disposal mechanism - an ocean outfall pipeline about 3.5 km in length to convey treated wastewater away from sensitive areas to a submerged diffuser;
- installation of upgraded pumps; and
- continuation of the beneficial re-use irrigation scheme at the Pambula Merimbula Golf Club (PMGC) grounds and nearby Oaklands agricultural area.

Upgrades to the STP and the ocean outfall would reduce the environmental and health impacts of current operations, by providing a higher level of treatment and a superior mode of discharge/ dispersion of the excess treated wastewater via an ocean outfall offshore in Merimbula Bay.

Construction of the Project is anticipated to be undertaken over a period of up to 24 months.

Following completion of the Project, the strategy for managing treated wastewater from the Merimbula STP would involve a combination of:

- beneficial re-use: re-use of treated wastewater to irrigate the adjacent PMGC grounds and 'Oaklands' agricultural area located on the Pambula River flats at South Pambula. BVSC would continue to investigate options for beneficial re-use into the future; and
- disposal: discharge of excess treated wastewater, via the new ocean outfall pipeline.

Project need and strategic context

The ongoing use of the existing Merimbula STP and beach-face outfall does not meet community or regulatory agency expectations and presents unacceptable risks to public health, the environment and the regional economy. The beach-face outfall presents a public health risk and a diminished aesthetic for recreational beach users. The dunal exfiltration ponds are located within an Endangered Ecological Community (EEC) and within an area of Aboriginal cultural significance. As such, the relinquishing of the dunal exfiltration ponds as part of the Project would also reducing existing risks to terrestrial ecology and Aboriginal heritage values.

The Project would improve the quality of treated wastewater being disposed of from the STP with an increased treatment regime. It would also cease disposal via the current beach-face outfall of excess treated wastewater that cannot be beneficially re-used (for example, during wet weather periods when the re-use schemes cannot irrigate) by introducing the ocean outfall pipeline and offshore discharge point. The Project is expected to contribute to the strengthening of the local economy by improving the recreational aesthetic value of the Merimbula Beach. Merimbula Bay and Merimbula Lake environs while at the same time reducing risks to public health, the environment, and the commercial fishing and oyster industries.

The Project aligns with the *State Infrastructure Strategy 2018-2038: Building Momentum* (Infrastructure NSW, 2018), and the *Safe and Secure Water Program - Program Guidelines* (Department of Planning, Industry and Environment, 2019). The Project is also important in the context of regional and Council policies, strategies and initiatives.

Project objectives

The Project aims to improve the quality of treated wastewater and minimise public health and environmental risks associated with disposing treated wastewater. The Project objectives are to:

- meet the conditions of amended environment protection licence (EPL) 1741 issued under the Protection of the Environment Operations Act 1997 (PoEO Act);
- address primary contact public health risk and related community concern associated with the current treated wastewater disposal practice;
- at a minimum meet the Marine Water Quality Objectives for NSW Ocean Waters – South Coast (DEC, 2005)[1];
- minimise environmental and heritage impacts associated with construction of the Project;
- account and provide for future population growth, community liveability expectations, and townships' economic stability;
- reduce risk to the nearby estuary-based oyster industry;
- provide a reliable method for disposing of excess treated wastewater during wet weather periods, when beneficial re-use schemes cannot irrigate;
- improve the aesthetic and recreational values of Merimbula Bay and surrounds, supporting the sustainability of the regional tourism industry and economy; and
- achieve a Project sustainability rating of Excellent under the Infrastructure Sustainability Council of Australia (ISCA)'s Infrastructure Sustainability Rating v1.2.

Project benefits

The Project would deliver the following benefits and opportunities:

- improve the quality of treated wastewater and minimise public health and environmental risks associated with using and disposing of treated wastewater;
- introduce additional beneficial re-use opportunities by improving treated wastewater quality (i.e. irrigation of playing fields);
- compared to other alternatives considered (refer to Chapter 4 Project development and alternatives), the Project would give rise to the least impacts during construction and operation; recognising the value the Merimbula community places on its beach and ocean front;
- provide a solution which is more socially, environmentally and economically sustainable in the long term (compared to the current operation);
- reduce the potential for water quality impacts on the local oyster industry; and
- reduce the potential for impact on tourism.

[1] As applied at the outer extent of the mixing zone around the ocean outfall pipeline diffuser

Project development and alternatives

Options for the beneficial re-use and disposal of effluent have been investigated for the Merimbula sewerage system for over 30 years. The common aim of investigations has been to resolve the problem of the beach-face ocean outfall and to improve environmental and social outcomes associated with disposing and re-using effluent produced at Merimbula STP.

In 2009, the NSW EPA directed BVSC to investigate and report on options for re-use and disposal of treated wastewater from the Merimbula STP. BVSC subsequently commissioned the *Merimbula Effluent Options Investigation (MEOI)* (AECOM, 2013a) to identify and rank solutions that would address the issues associated with the current beach-face outfall on Merimbula Beach, including meeting relevant water quality objectives. The study was undertaken from 2009-2013 and involved the evaluation of strategic alternatives by a community focus group and a multi-criteria analysis decision-making process.

The community focus group was established in 2010. It's role was to consult, guide, review and discuss the available information and recommend a preferred effluent management strategy to Council. The MEOI Focus Group consisted of consultants and representatives from the NSW Office of Water, NSW EPA, Merimbula and Pambula Lake Shellfish Quality Assurance Programs, Southern Rivers Catchment Management Authority, BVSC and a community representative.. The focus group considered 11 strategic alternatives for the Project as outlined in **Table E-1**, containing various re-use schemes and options for disposal (including reinstatement of an ocean outfall, dunal exfiltration, and deep alluvial aquifer well injection).

Table E-1 Strategic alternatives considered for wastewater disposal and re-use options

Option	Components
Continue existing re-use (Do nothing)	• PMGC and Oaklands agricultural irrigation
Re-use Scheme 1	• PMGC irrigation expansion • Oaklands Agricultural Irrigation
Re-use Scheme 2a	• PMGC irrigation • Oaklands agricultural irrigation • Pambula open space irrigation
Re-use Scheme 2b	• PMGC irrigation • Oaklands agricultural irrigation • South Pambula area agricultural irrigation
Re-use Scheme 2c	• PMGC irrigation • Oaklands agricultural irrigation • South Pambula area agricultural irrigation • Lochiel area agricultural irrigation
Re-use Scheme 3a	• PMGC irrigation • Oaklands agricultural irrigation • Millingandi area agricultural irrigation
Re-use Scheme 3b	• PMGC irrigation • Oaklands agricultural irrigation • Wolumla area agricultural irrigation
Re-use Scheme 4	• PMGC irrigation • Oaklands agricultural irrigation • Indirect potable re-use – Yellow Pinch Dam
Disposal Option 1	• Reinstated ocean outfall
Disposal Option 2	• Shallow dunal exfiltration via trench or well
Disposal Option 3	• Deep alluvial aquifer well injection

The focus group carried out a multi-criteria analysis and considered the life cycle performance, constraints and opportunities of each strategic alternative and determined a score for each option.

Based on the recommendations of the focus group, a preferred strategic alternative was selected comprising a combination of:

- continued existing treated wastewater re-use via irrigation of PMGC grounds and Oaklands agricultural area;
- disposal of excess treated wastewater via an ocean outfall ("Disposal Option 1"); and
- STP upgrades to improve effluent quality.

Water balance modelling was undertaken as part of the MEOI project for each re-use scheme discussed in **Table 4-3** of this EIS. The modelling showed that no scheme was capable of achieving 100% re-use due to land capacity constraints, physical storage size limitations and diminished returns from modelling theoretically large storages for wet weather and cooler times of the year when irrigation requirements are low or zero.

Project options

Review of preferred strategic alternative

The development of the concept design for the Project involved reviewing the alternative options identified in the MEOI project to confirm the validity of the resulting preferred strategy. The eight re-use schemes and three disposal systems identified in **Table E-1** were reviewed. The reviewers found that the preferred strategy provides a more reliable wastewater management method for disposing of excess treated wastewater, especially during wet weather periods, when treated wastewater re-use schemes cannot irrigate. Additional re-use schemes or storage would not remove the need for a sustainable disposal system at Merimbula for times when there is little demand for treated wastewater. This experience is reflected at the wastewater re-use schemes (Pambula Merimbula Golf Club grounds and Oaklands agricultural irrigation area) currently supplied by the Merimbula STP. The preferred strategy was confirmed as valid for the Project.

Detailed options considered

Following confirmation of the preferred strategic option, two treatment scheme options for the STP and four outfall alignment options were considered in the development of the concept design for the Project. Initial environmental investigations and hydrodynamic modelling were also commenced, which were used to inform the selection of the preferred option.

The alignment from the STP to shore was consistent across all options and was designed to avoid known environmental constraints found in the area. All options relied on successfully minimising construction impacts within the dunes.

Community Working Group multi-criteria analysis

In September 2017, BVSC resolved that 10 community members would form membership of a Community Working Group (CWG) to work through an assessment criteria analysis process to help select a preferred option for the Project, and provide recommendations to BVSC for the Project. As part of this process, both Project options as well as the results of environmental investigations, were considered by the CWG.

The two treatment options for the STP upgrade and four options for the ocean outfall alignment were shared with the CWG. Combinations of these options (a treatment option with each of four ocean discharge location options) resulted in eight options being scored against criteria developed by the CWG as part of the multi criteria analysis process.

The CWG preferred option was "Option 2 – North-Long" ocean outfall discharge location, with STP Upgrade "Option 2" (dual point chemical dosing for phosphorus removal, and a new additional filtration process).

The North-Long option was preferred as the longer option was perceived to present a lower environmental risk for Merimbula Bay. However, the CWG also indicated a general awareness of the cost implications of a longer outfall and was generally supportive of measures to reduce the length of the pipeline, providing the environment would not be compromised in the process.

Furthermore, the CWG understood that BVSC, in deciding on which option to select for design development and environmental assessment, would be informed by the technical Project team options assessment, concept design development, cost estimates for each of the options, community and stakeholder feedback and CWG recommendations (refer **Chapter 6 Engagement**).

Technical team multi-criteria analysis

Representatives from design and environment technical disciplines within the Project team participated in a technical multi criteria analysis in August 2019. As with the CWG multi criteria analysis, the two STP treatment options and four ocean outfall alignment options were combined to provide a total of eight options for analysis. Several non-cost criteria were developed and weighted, then the team scored the eight options against each criterion. Costs were not included in the multi criteria analysis in order to select the preferred option irrespective of cost. Scoring of options included consideration of:

- oceanographic modelling outcomes (available at time of scoring);
- treatment alternatives;
- discharge location options;
- recent specialist constructability advice;
- relevant background studies; and
- relevant community and stakeholder feedback.

The technical MCA found:

- discharge locations along the northern alignment (Option 1 – North-Short and Option 2 – North-Long) are preferred (regardless of associated treatment option); and
- treatment upgrade options that included the addition of a new STP filtration process (Option 2) generally scored higher compared to the options without such a new process (Option 1).

At the time, the STP Upgrade Option 2 was provisionally recommended pending further oceanographic modelling and an assessment of marine impacts. Additionally, it was recommended that the outfall alignment and diffuser location be optimised with consideration of costs and environmental impacts.

Preferred option (i.e. the Project)

A Value Engineering Workshop was held for the Project in September 2019 and was attended by BVSC representatives and members of the consultant Project team. The Value Engineering Workshop reviewed inputs from the technical multi criteria analysis, CWG multi criteria analysis, design development undertaken to date and cost estimates. The Value Engineering Workshop was structured to identify value adding opportunities with the aim of identifying a preferred option for both the STP and the ocean outfall.

Following consideration of the outcomes from the workshop, on 30 October 2019, BVSC resolved to adopt treatment Option 2, inclusive of dual-point phosphorous removal, tertiary filtration, and UV disinfection upgrade, together with ocean outfall Option 1 – North-Short (i.e. the Project).

Option 1 – North-Short was selected as the preferred option for the following reasons:

- the results of far field dispersion modelling found that the North-Short diffuser location achieves a desired level of water quality performance;
- the submerged reef is well outside the nominal 500 metre (m) radius described in the SEARs for Option 1 – North-Short diffuser location (30 m depth). However it is within about 250 m of Option 2 – North-Long (40 m depth). Avoiding the submerged reef is preferable for biodiversity and constructability reasons;

- construction at a depth of more than 30 m underwater requires a decompression chamber on the diving vessel, and would therefore require a larger vessel. Construction at a depth of more than 40 m underwater in open ocean is subject to a larger number of standby days where divers cannot operate; and costs for equipment and vessels on these days would still be incurred; and
- construction at depth poses a greater safety risk during construction and maintenance; and therefore Option 1 – North-Short therefore carries less risk to safety during construction and maintenance than Option 2 – North-Long.

Construction methodologies

Construction methodologies for the ocean outfall were also assessed against design, construction, environmental, community and relative cost considerations. The preferred construction methodologies include a trenchless method (i.e. directional drilling) from the STP site to the end of the surf zone to reduce surface disturbance. Two trenchless directional drilling options (Direct Drive Tunnelling (DDT) and Horizontal Directional Drilling (HDD)) are being considered. DDT requires a shorter pipe stringing operation than HDD, which can be confined to the STP and nearby laydown area if required). However, DDT is significantly more expensive that HDD.

From a location beyond the surf zone in Merimbula Bay to the offshore location of the pipeline diffuser, the pipeline would be laid on the sea floor with rock or concrete mattresses for stability and protection. The pipeline would be laid on the sea floor via trenchless installation, which is preferred for ease of construction with reduced risk of sediment plumes and seabed disturbance during construction, as well as ease of access for maintenance during operation.

Statutory context

Commonwealth approvals

Coastal Waters (State Powers) Act 1980

The *Coastal Waters (State Powers) Act 1980* conveys jurisdiction to the NSW Parliament to make any law in respect of the coastal waters of the State, being laws that the NSW Parliament is otherwise entitled to make on the land. The ocean outfall pipeline component of the Project would be located within coastal waters of the State of NSW, as defined by the *Coastal Waters (State Powers) Act 1980.* Works within coastal waters as part of the Project would be subject to assessment under the EP&A Act.

Environment Protection and Biodiversity Conservation Act 1999

Under the *Environment Protection and Biodiversity Conservation Act 1999(EPBC Act)*, a referral to the Commonwealth is required for proposed actions that have the potential to significantly impact matters of national environmental significance (MNES) or Commonwealth land. If the Project is declared a ‘controlled action’, approval from the Commonwealth Minister for the Environment would be required, in addition to the approval required from the NSW Minister for Planning and Public Spaces under Division 5.2 of the EP&A Act.

Based on the results of the environmental investigations carried out for this EIS, it is considered that MNES and the environment of Commonwealth land are not likely to be significantly impacted by the Project, and the Project would not be located on Commonwealth land. Accordingly, the Proponent has determined that the Project does not require referral to the Commonwealth Department of Agriculture, Water and Energy under the EPBC Act.

NSW approvals

Interpretation Act 1987

The jurisdiction of the State of NSW extends into the territorial waters of Australia. Section 59 of the *Interpretation Act 1987* provides that NSW State law applies to the coastal waters of the State and the sea-bed and subsoil beneath, and the airspace above the coastal waters of the State.

In accordance with the Commonwealth *Coastal Waters (State Powers) Act 1980*, the coastal waters of the State of NSW extend approximately 8.96 km seaward of the low water mark of Merimbula Bay. The Project including works that extend within coastal waters would be subject to assessment under the EP&A Act.

Environmental Planning and Assessment Act 1979

The Project has been declared SSI under Division 5.2, section 5.12 (2) of the EP&A Act, by reason of clause 3 of Schedule 4 of the *State Environmental Planning Policy (State and Regional Development) 2011*. This EIS has been prepared to support the SSI approval application in accordance with Part 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation).

Approval of a Project as SSI under Division 5.2 of the EP&A Act (Sections 5.23 and 5.24) means that certain other approvals are not required or must be applied consistently to an SSI approval.

Protection of the Environment Operations Act 1997

An amendment to the existing EPL for the Merimbula STP would be required under the POEO Act. In accordance with section 5.24 of the EP&A Act, such a licence cannot be refused for an approved SSI Project and is to be substantially consistent with the approval granted to the Project.

Consultation

Community and stakeholder consultation has been undertaken throughout development of the Project in accordance with a Community and Stakeholder Engagement Plan prepared for the Project.

Consultation prior to public exhibition of the EIS

Consultation for the EIS began in May 2017. Consultation was carried out with several stakeholders including the general community, community groups, Aboriginal stakeholders, commercial and industry representatives, and government. Broadly, the Project team used a ‘three-layer’ framework for engaging stakeholders and the community during the Project, including:

- first layer: communication tools;
- second layer: face-to-face engagement; and
- third layer: Community Working Group.

This consultation was carried out prior to and during preparation of the EIS to ensure feedback and issues raised by community members and stakeholders were considered in the EIS.

Communication tools

Communication tools included establishment of a dedicated 1800 phone number, postal address, email, and Project webpage, in addition to advertisements in the Merimbula News Weekly, and media releases, social media posts (including a video which was also posted on the Project webpage), a letter to the editor of Merimbula News Weekly, and Project signage erected in the local area.

Face-to-face engagement

Face-to-face engagement was carried out through 12 community information sessions held at locations in the Merimbula area and nearby towns. The information sessions were held over November 2017, March 2018 and March 2019. The information sessions were promoted via website/media release, social media and newspaper advertisement.

Face-to-face engagement also included briefing sessions held with various stakeholder groups. The briefing sessions were held at the Bega Valley Regional Learning Centre over November 2017 and March 2018. At the briefing sessions, stakeholders were provided with a Project overview and update on the environmental assessment process. Stakeholders had the opportunity to ask questions about the Project and have discussions with the Project team. In May 2019, a Project update email was also sent to stakeholders and community members. Other face-to-face consultation activities for stakeholders also occurred including a ‘lunch and learn’, media tour, surfers and board riders information session and tours of the Merimbula STP.

Questions and issues were raised by stakeholders and community members during the preparation of the EIS. These were captured at the stakeholder briefings, community information sessions and from phone calls received and emails sent to the Project team. These have been accounted for in the preparation of the EIS.

Community Working Group

Nine meetings were held with the CWG from December 2017 to August 2019 to assist in developing and confirming a preferred option.

Consultation during public display of the EIS

During the public display of this EIS, stakeholders and the community would be able to view and download electronic copies of the EIS from the DPIE Major Projects website (https://www.planningportal.nsw.gov.au/major-projects). Hard copies of the EIS would also be made available at local libraries (subject to COVID-19 restrictions).

BVSC would continue use of the contact points and information tools established for the Project to consult with stakeholders and the community to discuss the EIS. These would be available for all stakeholders to directly contact the Project team and request Project information.

Project collateral would be developed to inform stakeholders and the community about the EIS exhibition period, EIS display locations, provide instruction on how to make a submission and explain the EIS approval process. BVSC would:

- publish a media release;
- run advertisements on local newspapers and radio stations;
- update the Project webpage;
- provide Project updates via social media;
- provide a 1800 phone number to receive calls from the community regarding the Project; and
- send an email to stakeholders and community members registered on the stakeholder database.

Written submissions received during the EIS exhibition period would be forwarded from DPIE to BVSC for consideration and review. After reviewing the submissions, BVSC would prepare a Submissions Report documenting the submissions received and BVSC's response. This report would be made publicly available on the DPIE major projects website.

Future consultation after public exhibition of the EIS

Project to ensure stakeholders and the community are kept informed about the Project. This may include key milestone updates, notifications regarding upcoming works which may disrupt the community, and communication of the established complaints handling procedure (see below). This would also include publishing Project updates in the BVSC Council News newsletter.

Consultation during construction, particularly with regards to any community complaints, would be guided by a Construction Environmental Management Plan (CEMP), which would be developed in conjunction with a construction contractor should the Project be approved.

Once operational, any complaints received about the Project would typically be dealt with as per existing BVSC policy and procedures for the STP.

Environmental assessment

This EIS has been prepared in accordance with the provisions of Part 5.2 of the EP&A Act. It addresses the SEARs re-issued for the Project on 14 May 2021. Key environmental issues have been examined throughout the design and development process. Consultation has been carried out with stakeholders to identify key potential impacts. Where possible, potential impacts would be avoided or appropriate mitigation measures developed and implemented to minimise these impacts. Potential impacts would be largely temporary and confined to the construction period.

The Project would result in positive benefits, as it would improve the quality of treated wastewater released by the STP (either via disposal or beneficial re-use), and would also move the outfall disposal location offshore away from the beach-face which currently presents a number of issues.

The main impacts identified in the environmental assessment are described in the following sections.

Water quality, hydrology and flooding

Construction impacts

Potential impacts to surface waters may occur during the construction phase of the Project. However, the quality and quantity of the pollutants generated within the construction areas would be variable and subject to the soil profile, phase of works, extent of disturbance, construction activities and climatic influences (e.g. rainfall). Provided that appropriate erosion and sediment controls are implemented, pollutants are considered to pose a low risk.

Significant weather events and high levels of tidal flushing throughout the surrounding marine environment would result in greater transfer of common pollutants throughout the catchment area and therefore reduce the potential impacts of pollutant runoff during construction. Potential construction impacts on receiving water quality is therefore considered to be negligible.

The majority of the Project area (landside) is located outside of the 1% annual exceedance probability (AEP) and probable maximum flood (PMF) flood extents, with both flood extents affecting only a small portion of the construction laydown area on the PMGC grounds. No flooding impacts to adjacent property and land are anticipated, if adequate mitigation measures are put in place for the small portion of construction laydown area affected by relevant flood levels.

Construction of the Project is not expected to generate stormwater runoff or wastewater that would have any more than a negligible effect on natural hydrological attributes of receiving surface waters and on the capacity of existing systems.

Operational impacts

During operation, the Project would result in the following treated wastewater quality improvements:

- enhanced phosphorus removal, with an anticipated 90th percentile concentration reduction from the current 12 mg/L to less than 1 mg/L;
- improved heavy metal removal;
- potential to minimise impact of aluminium in treated wastewater;
- reduced load on downstream disinfection processes; and
- improved removal of virus, bacteria and pathogens.

Dispersion modelling was undertaken to understand the potential behaviour of treated wastewater plume dispersion from the ocean outfall discharge point. The assessment of water quality impacts adopted a conservative approach and was based on hydrodynamic modelling of existing treated wastewater quality (ETWWQ) (noting that the Project is designed to result in improved wastewater quality). The results of this modelling show that treated wastewater discharged at the proposed ocean outfall location would offer a substantial improvement in dispersion over the existing beach-face outfall. The results indicate that potential water quality impacts associated with discharged treated wastewater are most likely to be detected (99% of the time) within 25 m of the proposed offshore ocean outfall location (also referred to as the mixing zone). Detection of impacts beyond this 25 m mixing zone becomes less likely due to the high levels of dilution achieved over a relatively short distance, providing much improved water quality outcomes compared to the existing beach-face outfall, where water quality impacts would be contained within the surf zone close to the beach.

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 with an ocean outfall around 2.7 kilometres offshore in Merimbula Bay would increase the distance between the proposed discharge location and potential receptors such as Merimbula Lake, Pambula Lake and Merimbula and Pambula recreational beaches. Considering these distances alongside the 25 m mixing zone, it is considered the Project would also result in a lower risk of water quality impacts to Merimbula Lake, Pambula Lake and Merimbula and Pambula recreational beaches.

Operation of the Project is only expected to generate a small volume of additional stormwater runoff, which would have a minor impact on stormwater volume captured and discharged from the site via the existing stormwater drainage system.

Groundwater

Construction impacts

During construction, the risk of impacts to groundwater levels, quality, flow and existing groundwater users is considered to be low. The key risk to groundwater during construction is the potential impact to groundwater quality from drilling fluids, which can be managed by using inert and non-contaminating additives and by engaging a suitably qualified drilling fluid engineer to oversee the process. A groundwater management sub-plan would be developed for inclusion in the CEMP for the Project to manage impacts on groundwater and existing users.

Operational impacts

During operation and under reasonable worst-case conditions, the proposed ocean outfall pipeline is estimated to reduce groundwater flow by about 0.7 per cent. This level of change is well within the range of natural climactic variability and is therefore not considered to be a significant impact.

Under normal operating conditions, groundwater quality is not expected to be altered by the pipeline or the treated wastewater it would contain. Under a worst-case scenario involving a significant leak, groundwater is predicted to be locally altered and discharge at the low tide mark across a narrow zone where it would disperse at the beach. While a significant leak from the pipeline is unlikely, the likelihood would be minimised through design, materials selection and maintenance. Risks to off-site receptors such as nearby groundwater dependant ecosystems and existing groundwater bores to the south and to coastal groundwater discharges are considered to be low.

The decommissioning of the existing exfiltration ponds and diversion of treated wastewater to the new ocean outfall pipeline would cease the terrestrial disposal of treated wastewater at this location as well as any associated groundwater impacts by improving groundwater quality in this location.

Marine and coastal processes

Construction impacts

Construction of the offshore section of the ocean outfall would result in minor disturbances to marine sediment when the pipeline is being laid and during inspections/testing that follows, as well as installation of the diffuser. Any construction activity that results in mobilising marine sediments would be short-term and localised in extent. Further geotechnical sampling would be carried out during detailed design to identify the risk of clay lenses in the sediment and inform construction planning and identification of mitigation requirements to manage turbidity risks during marine construction. The construction methodology for pipeline directional drilling would be carefully planned and managed to minimise the risk of bentonite release and suspension in the water column. Mitigation measures would be detailed the CEMP for the Project.

Project construction activities may be at risk from short term coastal hazard events such as ‘storm bite’ erosion and coastal inundation. The risk of coastal hazards, particularly from storms, swell events and high and king tides would be considered in construction planning for the use of Merimbula Beach as well as when using floating barges. Mitigation and management measures related to these risks would also be incorporated into the Project.

Operational impacts

During operation, the pipeline would alter water flow which could result in changes to sediment transport around the pipeline. This can result in erosion (scour) around the pipeline with increased flow velocities or accretion (sedimentation/burial) with bed transport trapped by the pipeline, however the pipeline would be constructed to consider these factors and limit scouring.

The pipeline is not predicted to materially affect or change natural coastal processes in the area and accordingly is not expected to significantly exacerbate or change long-term coastal hazard trends predicted in the *Bega Valley Shire Coastal Processes and Hazards Definition Study*.

An assessment against the provisions of the *State Environmental Planning Policy (Coastal Protection) 2018* found that the Project is not located on any land mapped as 'coastal wetland', however a portion of the underground section of the pipeline would travel under an area mapped as coastal wetland, along the dunal area to the east of the STP site. As this section of the pipeline would be directionally drilled, there would be no direct surface impacts to the mapped wetland.

Marine ecology

Construction impacts

Potential impacts to marine ecological receptors and values from the proposed construction activities associated with establishing the ocean outfall pipeline in the marine environment 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; and
- reduced opportunities for future marine waters aquaculture.

Most of the potential threats 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 which is considered a medium risk. The potential introduction of a marine pest is also considered a medium risk.

Although construction of the pipeline and diffuser infrastructure would result in loss of Type 3 fish habitat, over the long-term there would be a gain of Type 2 fish habitat(sub-tidal rocky reef communities) which is 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.

Operational impacts

The potential impact to marine ecological values during the operational phase of the Project relate primarily to how the discharge of treated wastewater may impact the water quality of Merimbula Bay and the scale of that impact. The main risks identified include:

- discharge of nutrients and toxicants above Marine Water Quality Objectives (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 (i.e. marine species with low tolerance to variable salinity change).
- discharge of suspended sediment load, organic particulate material, nutrients and toxicants settling to the seabed zone around the diffuser and within the mixing zone.

Predicted water quality impacts would typically be confined to a 25 m near-field mixing zone most of the time, extending to 200 m under worse-case conditions that may occur a minor proportion of the 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 from the discharge of treated wastewater to 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 were considered minimal to low based on their distance to the mixing zone. These 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).

The marine ecology assessment found that the Project is not likely to have an adverse effect on threatened or protected species listed under the *Fisheries Management Act 1994*, and the Project as a whole is also not considered a Key Threating Process (KTP) under the Act. However, in relation to the recognised KTP - *introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales*, a potential risk exists for this KTP to occur during Project construction activities. Mitigation and management measures would be implemented to control this risk.

The Project is also not likely to have an adverse effect on threatened or protected species listed under the *Biodiversity Conservation Act 2016* or have a significant impact on a MNES and as a consequence a referral under the *EPBC Act 1999* is not required.

Mitigation and management measures to address impacts of the Project on marine ecology would be implemented as part of the Project.

Terrestrial ecology

Construction impacts

Construction of the Project has been designed to avoid important biodiversity values recorded within the Project area, and the need for vegetation clearance has been reduced as far as practicable. As a result, impacts on vegetation have been limited to 0.27 hectares of native vegetation, most of which is highly modified. With avoidance and mitigation measures proposed as part of the design and methodology of the Project, it is unlikely that any hollow bearing trees, or other potentially important habitats (e.g. Yellow-bellied Glider feed trees found in the area) would be removed or otherwise adversely affected. No threatened flora species are likely to be affected by the Project.

Although biodiversity impacts have been largely avoided in the design of the Project, some vegetation communities (Coast Banksia - Coast Wattle dune scrub of the Sydney Basin Bioregion and South East Corner Bioregion; and Coast Grey Box - Mountain Grey Gum - stringybark moist shrubby open forest in coastal gullies, southern South East Corner Bioregion), and fauna species (*Cercartetus nanus* (Eastern Pygmy-possum) and *Phascogale tapoatafa* (Brush-tailed Phascogale)) would still be impacted. These impacts would have implications for biodiversity offsetting, which would be required as part of the Project.

Mitigation measures to address potential impacts would be detailed in a Flora and Fauna Management Plan within the CEMP for the Project.

Operational impacts

Impacts to terrestrial ecology during operation of the Project would be limited to indirect impacts from noise, vibration and light spill from the STP site to the immediate surrounds. Periodic inspection and maintenance activities during operation may also bring about impacts, where movement around the area may have the potential to spread weeds or pathogens between infected areas and uninfected areas. Generally, these impacts would be relatively consistent with existing conditions at the STP site and would be unlikely to have a significant effect on ecological values within the area. Appropriate management measures would be implemented throughout operation.

Landform, geology and soils

Construction impacts

Construction of the Project could cause erosion and off-site sedimentation through vegetation clearance, bulk earthworks; excavation and stockpiling, vehicle and machinery operation within the Project area and underground directional drilling. Potential impacts are expected to be controlled by erosion and sediment mitigation and management measures, which would be implemented in and around areas of soil/ground disturbance, temporary stockpile sites (if required) and as required within the Project area. Measures would be developed in accordance with the *Managing Urban Stormwater:*

Soils and Construction Volume 1 (Landcom, 2004) and *Volume 2* (NSW Department of Environment and Climate Change (DECC), 2008) (the Blue Book).

The construction of the outfall pipeline between the STP and Merimbula Beach would occur through an area mapped as Class 2 and Class 4 acid sulfate soils. As the drilling methodology does not involve an open trench, it limits potential impacts from acid sulfate soils to the capturing of drilling spoil being returned to the drill rig site. The majority of drilling fluid would be recycled during the drilling process. Spent drilling spoil/fluid would be captured in an above ground tank and removed from site, which would eliminate potential impacts from acid sulfate soils to the receiving environment. Impacts related to water table drawdown and associated interactions with potential acid sulfate soils are not expected.

There are no known sources of contamination within the Project area. A procedure for dealing with unexpected finds of contamination would be included in the CEMP for the Project. The Project also has the potential to introduce sources of contamination, through use of fuels, oil and chemicals, and use of drilling fluids. Potential impacts from these sources of contamination would be adequately managed through mitigation and management measures.

The likelihood of salinity impacts from construction, including water table drawdown, is expected to be low and any impacts minor.

Operational impacts

Operation of the Project would not be expected to result in any significant impacts to landform, geology and soils.

Non-Aboriginal heritage

A total of six historic items were identified during an archaeological survey undertaken within and around the Project area. None of these items would be impacted by ground disturbance works for the Project.

In addition to the land survey conducted, a side scan sonar survey of Merimbula Bay was undertaken in 2018. Some anomalies (raised objects in the seabed) were identified in the survey, however are not expected to be impacted due to distance (more than 250 m from the proposed alignment). One anomaly was found closer to the proposed alignment (approximately 20 m to the north of the proposed alignment), however additional seabed investigations carried out in November 2020 did not identify any heritage remains (i.e. shipwreck or shipwreck related material present).

Impacts to non-Aboriginal heritage are not expected as a result of the Project during construction or operation. An unexpected finds procedure is included in the proposed mitigation and management measures to be included in the CEMP.

Aboriginal heritage

Construction impacts

A total of six Aboriginal archaeological sites are recognised within and immediately surrounding the Project area..

During construction, the Aboriginal archaeological sites would not be impacted by any primary ground disturbance works such as bulk earthworks for the Project. However, they may be impacted by ancillary ground disturbance activities such as light and/or heavy vehicle movements within and adjacent to the Project area. Installation of the underground section of the ocean outfall pipeline using trenchless construction techniques is considered to carry a negligible Aboriginal heritage impact risk. This assessment is made on the basis of drilling depths, which greatly exceed the probable depth of subsurface archaeological deposits in both contexts.

Measures to protect the known Aboriginal archaeological resource of the Project area would be detailed in an Aboriginal Cultural Heritage Management Plan, prepared in consultation with Registered Aboriginal Parties, the NSW Environment, Energy and Science and the DPIE. Measures for unexpected finds are also recommended.

Operational impacts

With the implementation of management measures to protect the existing Aboriginal sites identified, it is not anticipated that operational activities would result in ongoing or additional impacts to Aboriginal heritage.

Hazards and risk

A hazard analysis was carried out in accordance with the requirements of the *Hazardous and Offensive Development Application Guidelines, Applying SEPP 33* (Department of Planning, 2011). All hazardous chemicals were identified, assessed and a preliminary screening carried out. Two hazardous chemicals to be used in the Project were identified as dangerous goods, being liquefied chlorine gas and sodium hypochlorite. The assessment found that the hazards associated with the use of these chemicals in the STP upgrade in the quantities planned are not significant with respect to land use safety planning criteria. Appropriate safeguards have been proposed to prevent and mitigate the hazards and risks associated with these hazardous chemicals within the Project area.

Human health

Discharge of treated wastewater at the ocean outfall would provide substantial improvement in dispersion compared with the existing beach-face outfall, given that wastewater is no longer discharged directly on the beach and the quality of the wastewater being discharged would also be improved.

Human health risks were assessed for potential human contact pathways, including via beneficial re-use/irrigation (i.e. primary or secondary contact, incidental ingestion, including through spray drift, or surface runoff reaching watercourses), and primary or secondary contact through release from the ocean outfall. The hazard assessment included a review of existing toxicological information from a variety of appropriate sources to describe the capacity of a specific agent (ammonia, iron, copper, faecal coliforms, E.coli and enterococci) to produce adverse health effects. The human health risk of a hazardous event was found to be reduced from medium and high in the pre – upgrade scenario, to low with operation of the Project.

Traffic and transport

Construction impacts

The construction phase of the Project would require up to 10 heavy vehicles and up to 20 light vehicles each day. Heavy vehicles would generally follow established heavy vehicle routes in and around Pambula, Merimbula and the Port of Eden (Arthur Kaine Drive, Princes Highway and Imlay Street) to access the Project area and only use local roads where required to complete the trip. Coraki Drive (via Pambula Beach Road and Bullara Street) would be used to access Pambula Beach. Alternatively, construction vehicles would traverse the car parking facilities located at the end of Coraki Drive, down a temporary track and onto the beach.

An increase in vehicle movements from construction traffic would create minor traffic impacts along key local and regional access routes. Bus services along Arthur Kaine Drive would continue to operate during construction activities, however they may experience delays at times as a result of construction vehicle movements. The impacts of the Project on traffic and transport during construction are considered minor, and management and mitigation measures to manage traffic-related impacts would be included in the Construction Traffic Management Plan, as part of the CEMP for the Project.

The Project would not impact access to private properties near the Project or to the Port of Eden during the construction phase.

Operational impacts

Traffic and transport impacts during operation of the Project would be negligible, as the Project is not forecast to increase workforce numbers.

Property and land use

Construction impacts

The Project would temporarily occupy part of the PMGC grounds during construction. BVSC would work with the PMGC to minimise impacts on the activities and operation of the golf club. Land would be returned to its pre-construction use following construction or would be otherwise reinstated in consultation with the landowner. There may also be temporary and minor disruptions to the Pambula Surf Life Saving Club, given its close proximity to the proposed beach access route at Pambula Beach.

The Project may temporarily utilise a laydown area located on Merimbula Beach. The proposed construction access to this laydown area from Pambula Beach traverses Jiguma Beach, which is part of the Ben Boyd National Park. BVSC has consulted with the NSW National Parks and Wildlife Services about this access track. Approval for use from NSW National Parks and Wildlife Services would be secured prior to utilising this area. Some of the Project area is also located within Crown Land, and BVSC would consult with Crown Land NSW and secure the necessary authorisation from Crown Land NSW for construction and operation of the Project.

Operational impacts

The Project would not change the existing land use or impact on properties in the Project area during operation, with the exception of the dunal exfiltration ponds which would cease to be used. In the short term, the site of these ponds would continue to be maintained by BVSC for safety.

Airbourne noise and vibration

Construction impacts

The noise and vibration assessment undertaken for the Project found that there would be no construction noise exceedance for the majority of construction scenarios with the exception of the site establishment stage, where the construction noise levels at Pambula Beach Caravan Park may be exceeded as a consequence of heavy vehicle movements into the construction access at Pambula Beach. Specific mitigation and management measures for this stage of works would be implemented, including re-routing vehicles away from receivers during sensitive times of day and limiting speed of vehicles.

Construction vehicle movements outside of the Project area, are expected to have a minor impact on existing traffic noise in the area.

No vibration works are expected to be undertaken within the minimum working distance from heritage listed sites and no adverse impacts from vibration intensive works are likely in terms of human response or cosmetic damage.

Operational impacts

The predicted operational noise levels comply with the most stringent (evening time) operational noise criteria. Noise levels for sleep disturbance associated with the typical operation of the Project were found to be well under the Project sleep disturbance criteria.

Underwater noise and vibration

Construction impacts

Underwater noise emissions from the Project would be generated by offshore construction activities, including vessel movements, equipment noise, and laying and anchoring the pipeline and diffuser infrastructure on the seabed. Marine fauna exposed to underwater noise levels may experience physiological stress and / or injury if no mitigation measures are implemented.

During construction appropriate safety/exclusion zones for marine mammals have been determined to minimise the likelihood of hearing loss to occur. It is likely that an animal within the zone of potential responsiveness would demonstrate an avoidance reaction to the noise source, therefore reducing the potential for animals to enter the zone of potential hearing injury.

The zones of potential noise impact for auditory response are determined by reference to distance radii modelled from the source of noise at the end of the diffuser structure and include the following:

- an exclusion zone for the most sensitive hearing group, Low Frequency cetaceans (humpback and southern right whales) would be established during migration season. If a marine mammal is observed swimming towards or within the designated exclusion zone, work would immediately cease, until the animal has cleared the area. A distance of 170 m would be adopted by the Project as the exclusion zone; and

- a safety watch zone for Low Frequency cetaceans. If a marine mammal is observed swimming within the safety watch zone, it would be monitored and if seen swimming towards the exclusion zone work would be ceased. A zone of 2.3 km from the noise source would be adopted by the Project as the safety watch zone.

Operational impacts

Operation of the Project would not include any noise generating sources that are expected to generate underwater noise emissions.

Other issues

Air quality

Potential odour impacts may occur from the decommissioning of the effluent storage pond and potentially encountering acid sulfate soils during directional drilling. These impacts are expected to be minor. The Project would result in an overall reduction of odour concentrations due to the decommissioning of the effluent storage pond at the STP site, decommissioning of the beach-face outfall, and cessation of use of the dunal exfiltration ponds.

The potential for unmitigated impacts from dust emissions for soiling and human health risks were found to be low to negligible, whereas the potential unmitigated ecological risks from dust emissions were found to be negligible to medium. Adverse impacts from vehicle emissions are not expected for this Project due to the low number of vehicles expected.

Air quality impacts would be managed by implementation of a range of standard mitigation measures.

Social economic

Potential social and economic impacts during construction are likely to include:

- a minor increase in traffic volumes (and related impacts such as traffic delays, pedestrian/cyclist delays or increased safety risk;
- impacted beach access from the presence of construction laydown and access;
- the temporary use of a portion of the PMGC grounds;
- amenity impacts (i.e. from loss of vegetation, presence of construction vehicles/sites and noise and dust emissions); and
- temporary disruptions to local businesses in the immediate vicinity of the Project area.

Impacts would be short-medium term and construction works would be unlikely to affect business operations .

The Project would result in improvements in the quality of the treated wastewater being discharged into the environment and would also increase the distance of this discharge to approximately 2.7 km into the Merimbula Bay. This would result in overall positive impacts for recreational fishing, commercial fishing, the abalone fishery, aquaculture, the recreational value of the marine environment, as well as community environmental values.

Tourism, general recreational activities and business enterprises focussed on Merimbula Bay are major contributors to the local economy, with recreational fishing, commercial fishing and aquaculture being a significant contributor. The marine environment is therefore highly valuable to the community as a source of employment and income. The Project provides the local and wider area with much needed infrastructure, which is a significant improvement to the existing STP infrastructure, and which has a lifespan of approximately 100 years. The Project therefore has the capacity to serve the residents and visitors to the region for years to come, whilst also maintaining water quality and the integrity of the natural environment.

Sustainability

The Project is seeking an Infrastructure Sustainability (IS) design rating of "Excellent', under version 1.2 of the Infrastructure Sustainability Council of Australia's (ISCA) Infrastructure Sustainability Rating Tool, which is a widely recognised national benchmark. The sustainability of the Project would be guided by a Sustainability Management Plan that identifies overarching principles and objectives for the Project, as well as a framework to guide the delivery of sustainability outcomes during the design, construction and operation of the Project. In order to maintain the IS Rating, BVSC would be required to pursue an 'As Built' Rating, assessable during the construction period of the Project.

Climate change

Increased frequency and intensity of extreme weather events may interrupt the construction process. As there is a high level of uncertainty with regard to the timing and impact of extreme events, BVSC would incorporate contingency in both the schedule and budget to account for any potential delays in the program and/or construction.

A climate risk assessment conducted identified 43 climate change risk statements which may impact the operation of the Project. These include events such as extreme heat, bushfires, extreme rainfall/flooding and rising sea levels. Mitigation and management measures would be implemented to reduce the impact of climate change.

Waste

Waste generated by the Project would be regularly removed from site as required, to avoid potential issues associated with odour, visual amenity and creating environments that attract animals/pest species. Waste would be removed by licensed contractors and disposed of at licensed facilities (including facilities operated by BVSC). Waste generated on marine vessels (e.g. barge/s) would be contained onboard for management and disposal on land at licensed disposal facilities, except where the vessel is licensed to dispose of in marine waters.

A Waste Management Plan would be prepared as part of the CEMP for the Project to assist in managing construction waste and spoil management and would incorporate the waste management hierarchy, to avoid, re-use or recover waste where possible.

The Project is not expected to generate significant waste volumes during operation, and operational waste would be managed in accordance with mitigation and management measures proposed for this Project, and existing waste management procedures at the STP.

Cumulative impacts

A screening assessment was undertaken to identify other developments in the area with the potential to contribute to cumulative impacts in conjunction with the Project. No other developments were identified, and therefore the Project is not expected to contribute to cumulative impacts. The screening process would be undertaken again prior to construction of the Project, to confirm this remains the case.

Justification and conclusion

The Project has been justified in relation to its strategic need and its anticipated benefits, taking into account the objectives of the EP&A Act and matters of ecologically sustainable development. It best meets the Project objectives when compared to all other alternatives considered.

Key environmental issues have been examined throughout the design development process. Consultation has been carried out with affected stakeholders to identify key potential impacts at an early stage. With the implementation of mitigation and management measures specified in the EIS, the identified environmental impacts are considered to be acceptable and manageable. The Project would result in net positive outcomes to both the community and environment (including improvements to water quality, human health, recreation, environmental, heritage, and aesthetic values) compared to the existing beach-face outfall and dunal exfiltration ponds.

Acronyms, abbreviations and key terms

Term	Description
µg/L	Micrograms per litre
µPa2s	Unit of measurement for underwater noise
µs/cm	Microsiemens per centimetre
ABL	Assessment background level
ABS	Australian Bureau of Statistics
ACHAR	Aboriginal Cultural Heritage Assessment Report
ACHMP	Aboriginal Cultural Heritage Management Plan
ACTDG	Australian Code for the Transport of Dangerous Goods by Road and Rail
ADWF	Average dry weather flow
AECOM	AECOM Australia Pty Ltd
AEP	Annual exceedance possibility
Ag	Silver
AHD	Australian Height Datum
AHIMS	Aboriginal Heritage Information Management System
AHTS	Anchor handling tug supply
AIP	Aquifer Interference Policy
ALA	Atlas of Living Australia
ALR Act	Aboriginal Land Rights Act 1983 (NSW)
ALS	Australian Laboratory Services
AMBS	Australian Museum Business Services
ANSI	American National Standards Institute
ANZECC	Australian and New Zealand Environment and Conservation Council
ANZG	Australian and New Zealand Guidelines for Fresh and Marine Water Quality
AQIA	Air quality impact assessment
ARMCANZ	Agriculture and Resource Management Council of Australia and New Zealand
AS	Australian Standard
As	Arsenic
ASS	Acid sulphate soils
ASSMAC	Acid Sulfate Soils Management Advisory Committee
ATSIHP Act	Aboriginal and Torres Strait Islander Heritage Protection Act 1984 (Commonwealth)
AVTG	Assessing Vibration: A Technical Guideline
AWQ	Ambient water quality
AWS	Automatic Weather Station
B	Boron
BAR	Biodiversity Assessment Report

Term	Description
BBAM	Biobanking assessment methodology
BBCC	Biobanking credit calculator
BC Act	Biodiversity Conservation Act 2016
BDAR	Biodiversity Development Assessment Report
Be	Beryllium
Beach-face outfall	The existing beach-face outfall consists of a pipeline from the STP wastewater pumping station to a pipe head structure located in the hind dunes at the centre of Merimbula Beach between the estuary entrances of Merimbula Lake in the north and Pambula Lake in the south.
Bega Valley LEP 2013	Bega Valley Shire Council Local Environmental Plan 2013
BGL	Below ground level
BIAs	Biologically important areas
BOD	Biological oxygen demand
BoM or BOM	Bureau of Meteorology
BRUV	Baited remote underwater video
BVSC	Bega Valley Shire Council
CALMET	A diagnostic meteorological model that produces three-dimensional wind fields based on parameterized treatments of terrain effects such as slope flows and terrain blocking effects.
CALPUFF	A model designed to simulate the dispersion of buoyant, puff or continuous point and area pollution sources as well as the dispersion of buoyant, continuous line sources.
CAS No.	Chemical abstract number
CCRAA	Climate Change Risk and Adaption Assessment
Cd	Cadmium
CEMP	Construction Environmental Management Plan
CFU	Colony forming units
CHL	Commonwealth Heritage List
CLM Act	Contaminated Land Management Act 1997 (NSW)
CNVMP	Construction Noise and Vibration Management Plan
CNVS	Construction Noise and Vibration Strategy
Co	Cobalt
Coastal Management SEPP	State Environmental Planning Policy (Coastal Management) 2018
COC	Chain of custody
CoPC	Chemicals of potential concern
CPUE	Catch per unit effort
Cr	Chromium
CSEP	Community and Stakeholder Engagement Plan

Term	Description
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSM	Conceptual site model
CSP	Bega Valley Shire Council's Community Strategic Plan 2040
CTMP	Construction Traffic Management Plan
Cu	Copper
CWG	Community Working Group
CWMP	Construction Water Management Plan
dB(A)	An measure of the relative loudness of sounds in air as perceived by the human ear
DDT	Direct drive tunnelling
DEC	Department of Environment and Conservation
DECC	Department of Environment and Climate Change
DECCW	Department of Environment, Climate Change and Water
DEH	Department of Environment and Heritage
DGV	Default guideline values
DIWA	Directory of Important Wetlands in Australia
DLWC	Department of Land and Water Conservation
DO	Dissolved oxygen
DoP	Department of Planning
DOS	Degree of saturation
DPC	Department of the Premier and Cabinet
DPE	Department of Planning and Environment (now known as the Department of Planning, Infrastructure and Environment)
DPI	Department of Primary Industries
DPIE	Department of Planning, Infrastructure and Environment
EAC	East Australian Current
EAT	Extended aeration tank
EC	Electrical conductivity
EEC	Endangered Ecological Communities
EES	Environment, Energy and Science
EIS	Environmental Impact Statement
EP	Equivalent persons
EP&A Act	Environmental Planning and Assessment Act 1979 (NSW)
EP&A Regulation	Environmental Planning and Assessment Regulation 2000
EPA	Environment Protection Authority
EPBC Act	Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth)
EPL	Environment Protection Licence
ESD	Ecologically sustainable development

Term	Description
ETWWQ	Existing treated wastewater water quality
FBA	Framework for Biodiversity Assessment
FFDI	Forest Fire Danger Index
FM Act	Fisheries Management Act 1994
FPL	Flood planning level
FPRMS	Floodplain Risk Management Study
FRP	Orthophosphate
GDE	Groundwater dependent ecosystem
GHG	Greenhouse gas
GHS	Globally harmonised system
GIS	Geographic information system
GPS	Global positioning system
GREP	Government Resource Efficiency Policy
ha	Hectares
HAZOP	Hazard and operability
HDD	Horizontal directional drilling
HF	High frequency
Hg	Mercury
HHRA	Human Health Risk Assessment
IAIA	International Association for Impact Assessment
IAQM	Institute of Air Quality Management (UK)
IBC	Intermediate bulk container
IBRA	Interim Biogeographic Regionalisation for Australia
ICNG	Interim Construction Noise Guideline
IDEA	Intermittently decanted extended aeration
III	Arsenic
IMCRA	Interim Marine and Coastal Regionalisation of Australia
IMP	Introduced marine pest
IPCC	Intergovernmental Panel on Climate Change
IS	Infrastructure sustainability
ISCA	Infrastructure Sustainability Council of Australia
ISEPP	State Environmental Planning Policy (Infrastructure) 2007
ISQG	Interim Sediment Quality Guidelines
km	Kilometres
km/h	Kilometres per hour
KTP	Key Threatening Processes
LA90	The noise level exceeded for 90% of the measurement period

Term	Description
LACL	Local Aboriginal Land Council
LAeq	A-weighted equivalent continuous sound pressure level of noise from the source
LAeq,15min	A-weighted equivalent continuous sound pressure level of noise from the source, measured over a 15 minute period
LAFmax, dB(A)	The maximum Sound Level measured with 'A' frequency weighting during the measurement period.
LED	Light-emitting diode
LEP	Local Environmental Plan
LF	Low frequency
LGA	Local Government Area
LML	Legal minimum length
LOS	Level of service
LSPS	Local Strategic Planning Statement 2040
LV	Low voltage
m	Metres
mAHD	Metres Australian Height Datum
MCA	Multi-criteria analysis
MEOI	Merimbula Effluent Options Investigation (AECOM, 2013)
MER	Monitoring evaluation reporting
MES	Marine and earth sciences
MFO	Marine fauna observer
mg/L	Milligrams per litre
MHL	Manly Hydraulics Laboratory
MHWM	Mean high water mark
ML	Megalitres
ML / sec	Megalitres per second
MMP	Marine monitoring program
Mn	Manganese
MNES	Matters of National Environmental Significance
Mo	Molybdenum
MWQO	Marine Water Quality Objectives
MWSAS	NSW Marine Waters Sustainable Aquaculture Strategy 2018
NaOCl	Sodium hypochlorite
NASA	National Aeronautics and Space Administration
NCA	Noise catchment area
NEBA	Net environmental benefit analysis
NEMP	National environmental management plan
NH3	Ammonia

Term	Description
NH_4^+	Ammonium
NHL	National Heritage List
Ni	Nickel
NML	Noise management levels
NO_2	Nitrogen dioxide
NO_3-	Nitrate
NOx	Oxides of nitrogen
NPW Act	National Parks and Wildlife Act 1974 (NSW)
NPWS	National Parks and Wildlife Services
NSW	New South Wales
NSW EPA	NSW Environment Protection Authority
NSWSQAP	NSW Shellfish Quality Assurance Program
NT Act	Native Title Act 1993 (Commonwealth)
NTU	Nephelometric turbidity unit
NZS	New Zealand Standard
OAR	Offshore artificial reef
OC	Organochlorine
OCW	Other marine carnivores in water
OEH	Office of Environment and Heritage (now Department of Environment, Energy and Science))
OP	Organophosphate
ORRCA	Organisation for the Rescue and Research of Cetaceans in Australia
OU	EPA criterion for predicted 99th percentile odour concentration
PAC	Poly aluminium chloride
Pb	Lead
PCT	Plant community type
pcu	passenger car unit
pcu/h	passenger car unit per hour
PFAS	Per and poly-fluoro alkylated substances
PFC	Power factor correction
pH	A quantitative measure of the acidity or basicity of aqueous or other liquid solutions
PHA	Preliminary hazard analysis
PM10	Particulate matter 10 micrometers or less in diameter
PM2.5	Particulate matter 2.5 micrometers or less in diameter
PMF	Probable maximum flood
PMGC	Pambula Merimbula Golf Club
PO_4^3-	Phosphate

Term	Description
POEO Act	Protection of the Environment Operations Act 1997 (NSW)
POEO Waste Regulation	Protection of the Environment Operations (Waste) Regulation 2014
POM	Particulate organic material
PPE	Personal protective equipment
ppt	Parts per thousand
(the) Project	Proposed upgrades to the Merimbula Sewage Treatment Plant and ocean outfall
Project area	The footprint required for construction and operation of the Project
PSD	Particle size distribution
PTS	Permanent threshold shift
PV	Photovoltaic
Qa	Quaternary (Holocene) alluvial and aeolian deposits
QAQC	Quality assurance and quality control
RAPs	Registered Aboriginal parties
RBL	Rating background level
RLS	Reef life survey
RNP	Road Noise Policy
ROV	Remote operated video
RWC	Realistic worst case
RWMS	Recycled water management system
Sb	Antimony
SDGs	Sustainability Design Guidelines
Se	Selenium
SE	South East
SEARs	Secretary's Environmental Assessment Requirements
SEIA	Socio-economic impact assessment
SEL	Sound exposure levels
SEPP	State Environmental Planning Policy
SEPP 33	State Environment Planning Policy No. 33 – Hazardous and Offensive Development
SES	State Emergency Services
SHR	State Heritage Register
SIDRA	A computer-based modelling package designed for calculating isolated intersection performance
SILO	Scientific Information for Land Owners
Sn	Tin
SRES	Special Report on Emissions Scenarios
SRTM	Shuttle radar topography mission
SS	Suspended solids

Term	Description
SSI	State Significant Infrastructure
SSP	Sound speed profile
SSS	Side scan sonar
STP	Sewerage Treatment Plant
Surf zone	The area from the line of the outer most breaking waves to the limit of wave run up on the beach
SW	South-west
SWA	SafeWork Australia
SWAMP	Sustainable Water Action for Merimbula and Pambula
TAPM	The air pollution model
TCP	Traffic control plan
TECs	Threatened Ecological Communities
TfNSW	Transport for NSW
TKN	Total Kjeldahl nitrogen
TN	Total nitrogen
TOC	Total organic carbon
TP	Total phosphorus
Ts	Tertiary sediments (fluvial sands and lacustrine clays)
TSC Act	Threatened Species Conservation Act 1997 (now the Biosecurity Conservation Act 2016)
TSS	Total suspended solids
THI	Temporary hearing injury
TTS	Temporary threshold shift
TWWQ	Treated wastewater water quality
UV	Ultraviolet
VCR	Volume to capacity ratios
VDV	Vibration dose value
VENM	Virgin excavated natural material
VIS	Vegetation Information Systems
VM	Value management
VOC	Volatile organic compounds
WARR Act	Waste Avoidance and Resource Recovery Act 2001 (NSW)
WHL	World Heritage List
WM Act	Water Management Act 2000 (NSW)
WQO	Water quality objectives
WWF	Wet weather flow
Zn	Zinc

1.0 Introduction

This chapter provides the Project background and describes the purpose of this Environmental Impact Statement (EIS) and the EIS process.

1.1 Background to the Project

The existing Merimbula Sewage Treatment Plant (STP) is operated by Bega Valley Shire Council (BVSC) and services the communities of Merimbula, Pambula, South Pambula and Pambula Beach, on the Far South Coast of NSW. The STP is an intermittently decanted extended aeration (IDEA) activated sludge plant designed to service 15,500 equivalent persons (EP).

The current process for managing treated wastewater from the STP involves a combination of beneficially re-using the treated wastewater as well as disposal to land/sea. On average, approximately a quarter of the current total annual volume of treated wastewater is beneficially re-used as irrigation water, at the adjacent Pambula Merimbula Golf Club course and a nearby farm at Oaklands. The balance of the treated wastewater is discharged to land/sea:

- via nearby dunal exfiltration ponds located within sand dunes east of the STP between the ocean and Merimbula Lake (approximately 25% of total annual volume on average); and
- via an existing beach-face outfall pipeline at Merimbula Beach (approximately 50% of total annual volume on average).

The current use of the dunal ponds and beach-face outfall does not meet community or regulatory agency expectations and presents risks to public health, the environment and the regional economy. Treated wastewater disposed from the beach-face outfall flows across the beach and impacts on near-shore water quality, local aesthetic, recreational value and perceptions of the area.

Treated wastewater disposed via the dunal exfiltration ponds can impact on groundwater quality and may also influence water quality in the receiving environment. The exfiltration ponds are constructed within an Endangered Ecological Community (EEC) and within an area of Aboriginal cultural significance.

Following consultation with the NSW Environmental Protection Agency (EPA), BVSC committed to obtaining the necessary approvals to upgrade the STP to improve treated wastewater quality, and to construct and operate an ocean outfall pipeline for disposal of treated wastewater, in order to address the issues outlined above. This commitment was included in an amendment to the Environment Protection Licence (EPL)) issued by the EPA for the STP in 2014, and remains a condition of the current EPL which was recently amended in May 2020.

The Project includes upgrading the existing STP with improved and additional treatment processes, including poly aluminium chloride (PAC) dosing, ultraviolet (UV) treatment, chlorine dosing, and tertiary filtration (if determined to be required during the detailed design, filtration is currently a project uncertainty). The Project also includes constructing and operating a 3.5 kilometre (km) ocean outfall pipeline from the STP to a location approximately 2.7 km offshore. The existing dunal exfiltration ponds would also cease to be used under the Project. The Project is described further in **Chapter 2 Project description**, and the need for the Project and strategic context are described further in **Chapter 3 Project need and strategic context**.

1.2 The Proponent

BVSC is the Proponent for the Project. BVSC is responsible for the delivery of sewage services including the management and operation of the Merimbula STP within the Bega Valley Shire Local Government Area (LGA), which includes the towns of Bega, Pambula, Merimbula, Eden, Bermagui, Tathra and several villages. The responsibilities of BVSC also include the development and implementation of land use planning schemes, managing public land, infrastructure management and regulating private activities within the Bega Valley Shire LGA.

1.3 Purpose of this EIS

On 26 July 2016 the Project was declared to be State Significant Infrastructure (SSI) under Division 5.2, section 5.12 (2) of the *Environmental Planning and Assessment Act 1979* (EP&A Act), by reason of clause 3 of Schedule 4 of the *State Environmental Planning Policy (State and Regional Development) 2011*. The Project requires the approval of the Minister for Planning and Public Spaces under section 5.14 of the EP&A Act.

The primary purpose of the EIS is to support an application for approval of the Project as SSI under the EP&A Act. The EIS has been prepared to help the community, public authorities and the decision-maker to understand the likely consequences of the Project and make informed submissions on the Project.

This EIS has been prepared in accordance with Part 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation). The EIS addresses the environmental assessment requirements of the Secretary of the Department of Planning, Industry and Environment (DPIE) (the 'Secretary's environmental assessment requirements' (SEARs), re-issued for the Project on 14 May 2021) (refer to **Appendix A** (SEARs Compliance Table) as well as other relevant NSW and Commonwealth legislative requirements. Further details on the assessment process for the Project are provided in **Chapter 5 Statutory context**.

The environmental assessments documented within this EIS focus on the environmental issues presented in the SEARs. Each assessment considers the areas directly and indirectly affected by construction and operation of the Project, as relevant to each technical assessment, as well as cumulative impacts.

The EIS also documents the range of consultation activities that BVSC has undertaken with the community and stakeholders about the Project. The public exhibition of this EIS will provide further opportunity for the community, Government agencies and other interested parties to gain a better understanding of the Project and allow those parties to provide comment. BVSC will consider submissions provided during the exhibition period in the further development of the Project.

1.4 EIS process

The EIS assessment and approval process under Division 5.2 of the EP&A Act is outlined below.

1.4.1 Preparing the EIS

The EIS has been prepared in consideration of the guidelines provided in *Preparing an Environmental Impact Statement - Draft Environmental Impact Assessment Guidance Series June 2017* (Department of Planning and Environment, 2017)[2] as well as the SEARs issued for the Project.

The activities carried out during the preparation of this EIS include:

- engaging with the community, including government agencies;
- assessing the impacts of the Project;
- making refinements to the design of the Project to avoid or mitigate impacts;
- developing effective mitigation and management measures to reduce identified impacts; and
- integrating the findings of community engagement and assessment of the impacts into an overall evaluation of the merits of the Project.

[2] At the time of EIS submission this guideline remained in draft form.

This EIS is structured in two volumes, as described below:

Volume 1:

- Introductory chapters:
  - **Chapter 1 Introduction:** introduction to this EIS and the EIS process;
  - **Chapter 2 Project description:** Project description, including definition of the Project area and proposed construction methodology;
  - **Chapter 3 Project need and strategic context:** overview of the Project need and strategic context with regard to its State significance and relevant government policy;
  - **Chapter 4 Project development and alternatives:** summary of the Project development and alternatives considered, including the options considered during design development and justification for the preferred option chosen;
  - **Chapter 5 Statutory context:** overview of the statutory context of the Project;
  - **Chapter 6 Consultation:** summary of community and stakeholder consultation undertaken and proposed for the Project;
  - **Chapter 7 Environmental scoping assessment:** preliminary assessment of environmental risks for the Project (pre-mitigation) and identification of key issues.
- Environmental assessment chapters:
  - **Chapters 8** to **27:** assessment of environmental issues undertaken in accordance with the SEARs, including information on the existing environment, assessment methodologies used, potential construction and operation impacts, and proposed mitigation and management measures.
- Conclusion:
  - **Chapter 28 Project synthesis and conclusion:** synthesis of the findings of the EIS and conclusion of the EIS.

Volume 2 of the EIS contains the appendices, which include a SEARs compliance table, plans and maps, as well as Technical reports prepared to inform the EIS.

1.4.2 Submission of the EIS and public exhibition

The EIS was lodged via the DPIE's Major Projects website:

https://www.planningportal.nsw.gov.au/major-projects.

Following acceptance of the EIS, DPIE placed the EIS on public exhibition from 23 August to 19 September 2021 to seek submissions on the Project. Following public exhibition of the EIS, BVSC will prepare a response to submissions report addressing submissions received and documenting any changes to the Project following the consideration of submissions.

1.4.3 Assessment and determination

Following public exhibition, an assessment report will be prepared by the Planning Secretary of the DPIE and the submissions report will be made available to the public. The NSW Minister for Planning and Public Spaces (or delegate) will determine whether or not to approve the Project, and if approved, conditions will be attached to the determination.

2.0 Project description

This chapter outlines the existing operations at the Merimbula Sewage Treatment Plant (STP) and describes the proposed upgrades to the STP and ocean outfall (the Project).

2.1 Existing operations

The existing Merimbula STP shown on **Figure 2-1**, is located between Merimbula and Pambula on Arthur Kaine Drive, approximately 3.5 kilometres (km) south of the Merimbula town centre and 2.5 km north of Pambula village.

The existing operations at the Merimbula STP consist of:

- sewage treatment at the Merimbula STP; and
- disposal of treated wastewater via:
  - a beach-face outfall;
  - dunal exfiltration ponds; and
  - a beneficial re-use scheme at the adjacent Pambula Merimbula Golf Club (PMGC), and at Oaklands agricultural area shown on **Figure 2-2**.

The STP is an intermittently decanted extended aeration (IDEA) activated sludge plant designed to serve an equivalent population of 15,500. The STP has a capacity to accommodate an average dry weather flow (ADWF) of up to 3.72 megalitres per day (ML/day) and a peak wet weather flow of seven times the ADWF, or 26 ML/day. It handles an average of 790 megalitres (ML) of treated wastewater per year[3].

The current strategy for managing treated wastewater from the Merimbula STP comprises a combination of:

- beneficial re-use (preferred disposal option): use of treated wastewater to irrigate the adjacent PMGC grounds and 'Oaklands' agricultural area, which is located on the Pambula River flats at South Pambula (approximately 25% of treated wastewater is directed to beneficial re-use at these two sites); and
- disposal: discharge 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 treated wastewater), or via the existing beach-face outfall east of the STP at Merimbula Beach (approximately 50% of annual treated wastewater).

2.1.1 Operation of STP

Operation of the STP comprises four phases:

- Phase one: screening;
- Phase two: secondary treatment;
- Phase three: disinfection; and
- Phase four: beneficial re-use and disposal.

Phase one: screening

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.).

[3] July 2009 – June 2016. Source: "Merimbula STP Flow Vol Data.xlsx" ,12 November 2016, BVSC. Includes wet weather flows.

Phase two: secondary treatment

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 process also reduces nitrogen levels by converting some of the nitrate/nitrite compounds into nitrogen gas.

Phase three: disinfection

Secondary wastewater is decanted from the IDEA tanks and flows to a catch pond for temporary storage. From the catch pond the effluent flows to a chlorine contact pipe and is dosed with chlorine to reduce the number of microorganisms in the effluent. Chlorinated effluent flows from the chlorine contact pipe to the STP effluent storage pond.

The STP effluent storage pond stores approximately 17 ML of treated wastewater, providing a residence time of between five and nine days, depending on inflow and outflow. A wet weather overflow pond is located next to the effluent storage pond and is kept empty to accept treated wastewater during extended wet weather events and enable more controlled discharge after the wet weather event has ended. The wet weather overflow pond has a capacity of approximately 20 ML.

Phase one through to phase three cycles about six to eight times per day.

Phase four: beneficial re-use and disposal

An effluent pump station is located at the end of the effluent storage pond and pumps wastewater to the beach-face ocean outfall and dunal exfiltration ponds. A smaller pump station pumps treated wastewater to a storage dam within the 'Oaklands' agricultural area. Treated wastewater is preferentially re-used as irrigation water on the adjacent PMGC grounds (a pump station at the golf club grounds draws treated wastewater directly from the effluent storage pond).

Sludge is dewatered and beneficially re-used on local farms by a commercial composting company. Where this cannot be achieved, any excess would be disposed of an appropriately licensed waste facility.

2.1.2 Existing treated wastewater management

The STP's current ADWF is approximately 2 ML/day. From this average daily inflow, the wastewater is treated and disposed of. The existing management strategy for treated wastewater can be summarised as follows:

- 0.1 ML/day (5% of inflow volume) undergoes sludge treatment and disposal (offsite for use on farms);
- 0.4 ML/day (20% of inflow volume) is beneficially re-used at the PMGC grounds;
- 0.1 ML/day (5% of inflow volume) is beneficially re-used at the Oaklands agricultural area; and
- 1.4 ML/day of treated wastewater (70% of inflow volume) is disposed of via the existing beach-face outfall and/or existing exfiltration ponds.

During wet weather flows, the volume of treated wastewater that can be beneficially re-used decreases (i.e. when the need and ability to beneficially re-use wastewater for irrigation decreases due to ground conditions being saturated from rainfall). In 2011/2012 (a high rainfall year) 12% of treated wastewater was beneficially re-used and again in 2015/2016 (a high rainfall year) 11% of treated wastewater was beneficially re-used.

Existing beach-face outfall

The existing beach-face outfall consists of a pipeline from the STP effluent pump station to a pipe head structure located on Merimbula Beach, between the estuary entrances of Merimbula Lake about 3.1 km to the north and Pambula Lake, about 3.1 km to the south. The pipeline length is approximately 1 km from the STP effluent pump station to the discharge point on the beach. The treated wastewater is discharged just above the mean high-water mark and flows across the beach and into the ocean waters of Merimbula Bay.

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. Discharges from the existing beach outfall only occur between the hours of 8:00pm and 6:00am. The existing rate of discharge varies in response to variations of the inflow to the STP, caused by fluctuations in rainfall and seasonal fluctuations in population.

Dunal exfiltration ponds

The existing dunal exfiltration system consists of two exfiltration ponds located east of the STP in a disused quarry in the sand dunes. Treated wastewater is pumped from the STP to the ponds and drains (exfiltrates) through the sand into the underlying groundwater aquifer. The ponds are used preferentially during summer to minimise treated wastewater disposal via the outfall when recreational beach use is highest. Groundwater level monitoring determines the timing to switch disposal from the ponds to the beach-face outfall and vice-versa.

Beneficial re-use

The Merimbula STP supplies treated wastewater to irrigate the adjacent PMGC and nearby ‘Oaklands’ agricultural area. Beneficial re-use is undertaken in accordance with BVSC’s Recycled Water Management System, which is based on industry guidelines.

FIGURE 2-1: PROJECT AREA

Legend

- Project area
- Project area (temporary construction area)

\\na.aecomnet.com\lfs\APAC\Sydney-AUSYD1\Secure\Projects\CPL1-AT-Proj-605x-new\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR083_02_A4P_F2-2_ReuseSites_210128.mxd Date Saved: 28/01/2021

FIGURE 2-2: LOCATION OF EXISTING BENEFICIAL REUSE SITES

N 0 500 1,000 m

Legend

- Project area
- Project area (temporary construction area)
- Beneficial reuse site
- Existing treated wastewater pipeline

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

2.2 Project overview

The Project would involve:

- upgrade of the STP to improve the quality of treated wastewater (including for beneficial re-use);
- decommissioning the beach-face outfall;
- stopping use of the in-dune exfiltration ponds;
- supporting future increases in beneficial re-use of treated wastewater;
- installation of a secondary disposal mechanism - an ocean outfall pipeline about 3.5 km in length to convey treated wastewater away from sensitive areas to a submerged diffuser;
- installation of upgraded pumps; and
- continuation of the beneficial re-use irrigation scheme at the PMGC grounds and nearby Oaklands agricultural area.

Upgrades to the STP and the ocean outfall would reduce the environmental and health impacts of current operations, by providing a higher level of treatment and a superior mode of discharge/ dispersion of the treated wastewater via an ocean outfall offshore in Merimbula Bay.

2.2.1 Project elements

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

This EIS is based on a concept design for the Project, which is described in this chapter and shown on **Figure 2-3, Figure 2-4** and **Figure 2-5**. An indicative process flow diagram demonstrating how the Project would operate is provided in **Section 2.7**. It is noted that during subsequent design stages, and subsequent to a design and construction contractor(s) being engaged, details of the Project may change or be refined (e.g. specific locations of some elements or infrastructure within the existing STP site; materials to be used in plant construction and technology). The technology provider would be required to meet performance specifications so that the STP upgrade and ocean outfall pipeline are designed, constructed and operated using proven technology. In addition, a suite of environmental mitigation and management measures would also be implemented, including those presented in this EIS. Procurement for the Project would be subject to sustainability considerations (refer **Chapter 24 Sustainability**).

Table 2-1 Project elements

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 indicative physical layout of the proposed STP upgrade is shown in **Figure 2-3**. The new treatment processes would be incorporated into the following STP phases: *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 - wet weather overflow return pump station – to pump from wet weather overflow back into the STP treatment train; • 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 access roads); and • relocation and upgrade of utilities to accommodate the additional features proposed.
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
Ocean outfall pipeline, effluent diffuser, and associated pump stations	*<u>Phase four: Disposal and beneficial re-use</u>* 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 onshore component of the pipeline would be about 0.8 km. The pipeline would likely have an outer diameter of up to 450 mm (366 mm internal diameter) and consist of pipeline lengths welded together. 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 (**Figure 2-4**); 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 (**Figure 2-5**). The terrestrial component of the outfall pipeline would be laid between -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 50 m to 80 m in length. 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. 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 be capped and remain in-situ (buried underground).

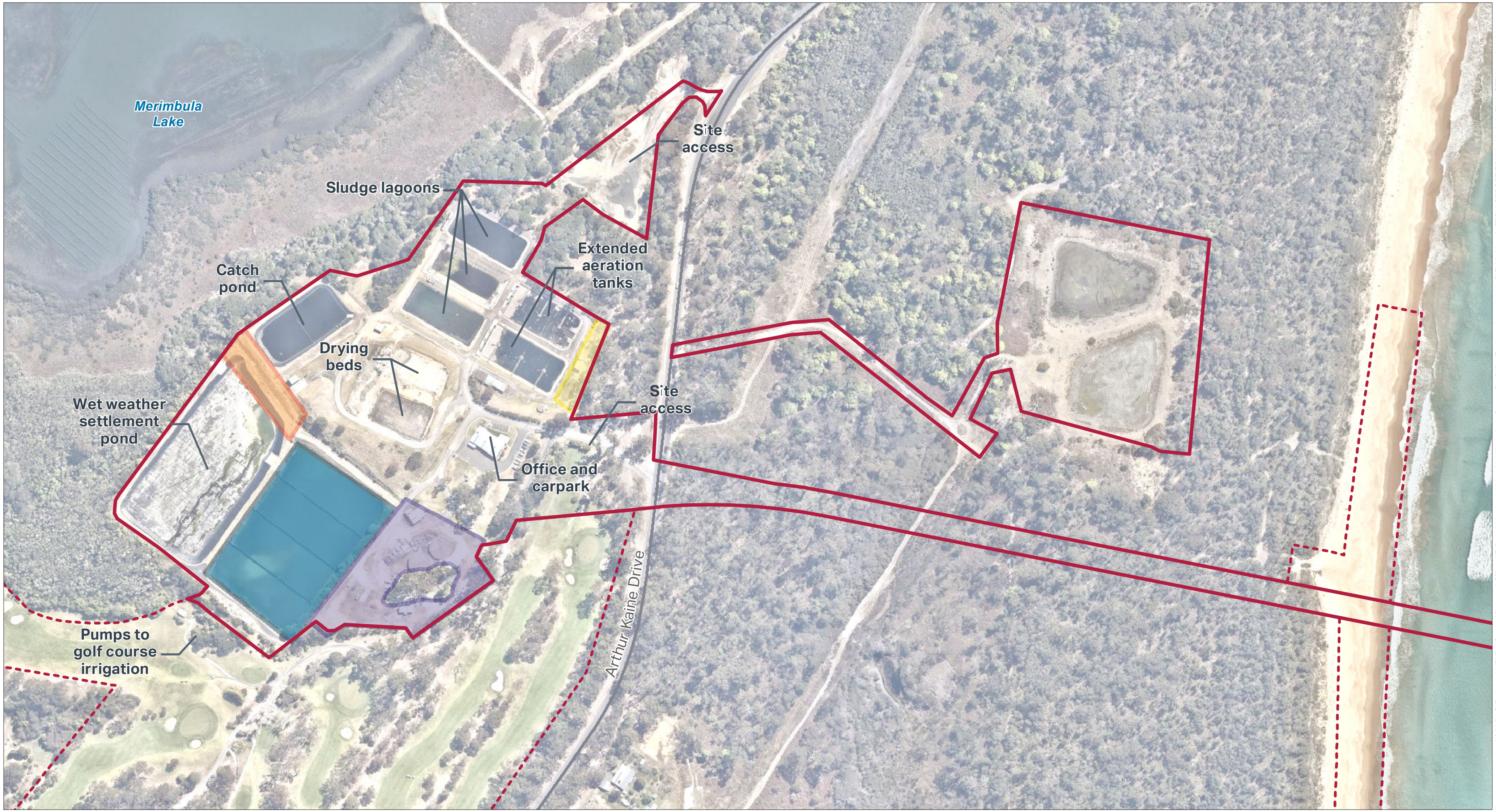

FIGURE 2-3: PROPOSED STP LAYOUT (INDICATIVE)

N

0 50 100 m

AECOM

Source: Nearmap, 2019

Legend

- Project area
- Project area (temporary construction area)

Proposed Project Upgrades

- PAC dosing, UV disinfection, tertiary treatment
- Pump stations, storage, chlorine disinfection
- PAC dosing (second unit)
- Effluent storage pond to be decommissioned

Proposed treated wastewater management Following completion of the Project, the strategy for managing treated wastewater from the STP would involve a combination of:

- beneficial re-use (preferred disposal option): use of treated wastewater to irrigate the adjacent PMGC grounds and nearby 'Oaklands' agricultural area; and
- disposal: discharge of excess treated wastewater to the environment, via the new ocean outfall pipeline.

The existing ADWF rate and disposal rates described in **Section 2.1.2** are not expected to change under the Project, with 1.4 ML/day of treated wastewater to be disposed of via the new ocean outfall pipeline (instead of the existing beach-face outfall and/or existing exfiltration ponds).

As per the existing situation, the volume of treated wastewater that can be beneficially re-used would decrease during wet-weather flows (i.e. when the need and ability to beneficially re-use wastewater for irrigation decreases due to ground conditions being saturated from rainfall). However the addition of the ocean outfall would provide a reliable method for disposing of excess treated wastewater during wet weather periods (refer **Chapter 3 Project need and statutory context**).

2.2.2 Water use

At present, the operation of the STP utilises a daily average of about 1.2 kL of potable town water per day for kitchen and amenities on site. Water use is not expected to change during operation of the Project.

2.3 Project layout and design

New STP elements would be installed within the existing, cleared STP site. Indicative images of the STP infrastructure to be installed are provided in **Table 2-2** below. The indicative physical layout of the proposed STP upgrade is shown in **Figure 2-3**.

The proposed outfall pipeline is described in two sections, Section one (below ground) and Section two (above ground) shown on **Figure 2-4** and **Figure 2-5**. A longitudinal section of the pipeline is on **Figure 2-6**.

Table 2-2 Indicative images of STP infrastructure to be installed

STP element proposed	Indicative image
PAC/Chlorine dosing unit	 

STP element proposed	Indicative image
UV disinfection unit	
Pump station and kiosk (indicative images - for the Project, the dry well which would house the pumps would be square, rather than linear as shown in the example)	
Above ground storage tank	

STP element proposed	Indicative image
Continuous sand filtration units (if required or chosen as the tertiary filtration type to be installed)	

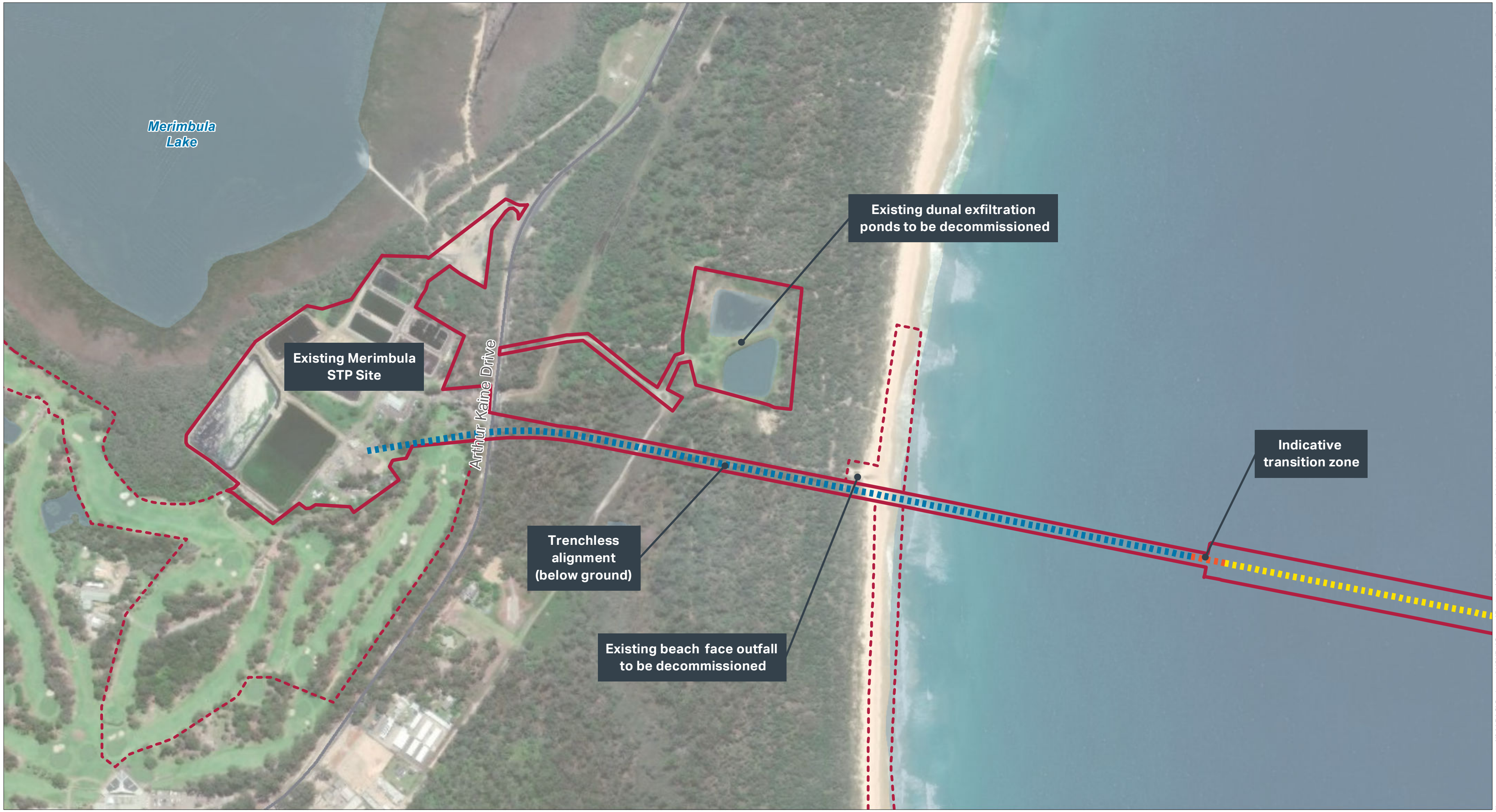

FIGURE 2-4: OCEAN OUTFALL PIPELINE - SECTION 1 (BELOW GROUND)

Legend

- Project area
- Project area (temporary construction area)
- Outfall pipeline – Section 1 (below ground)
- Transition Zone
- Outfall pipeline – Section 2 (above seafloor)

0 100 200 m

AECOM

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

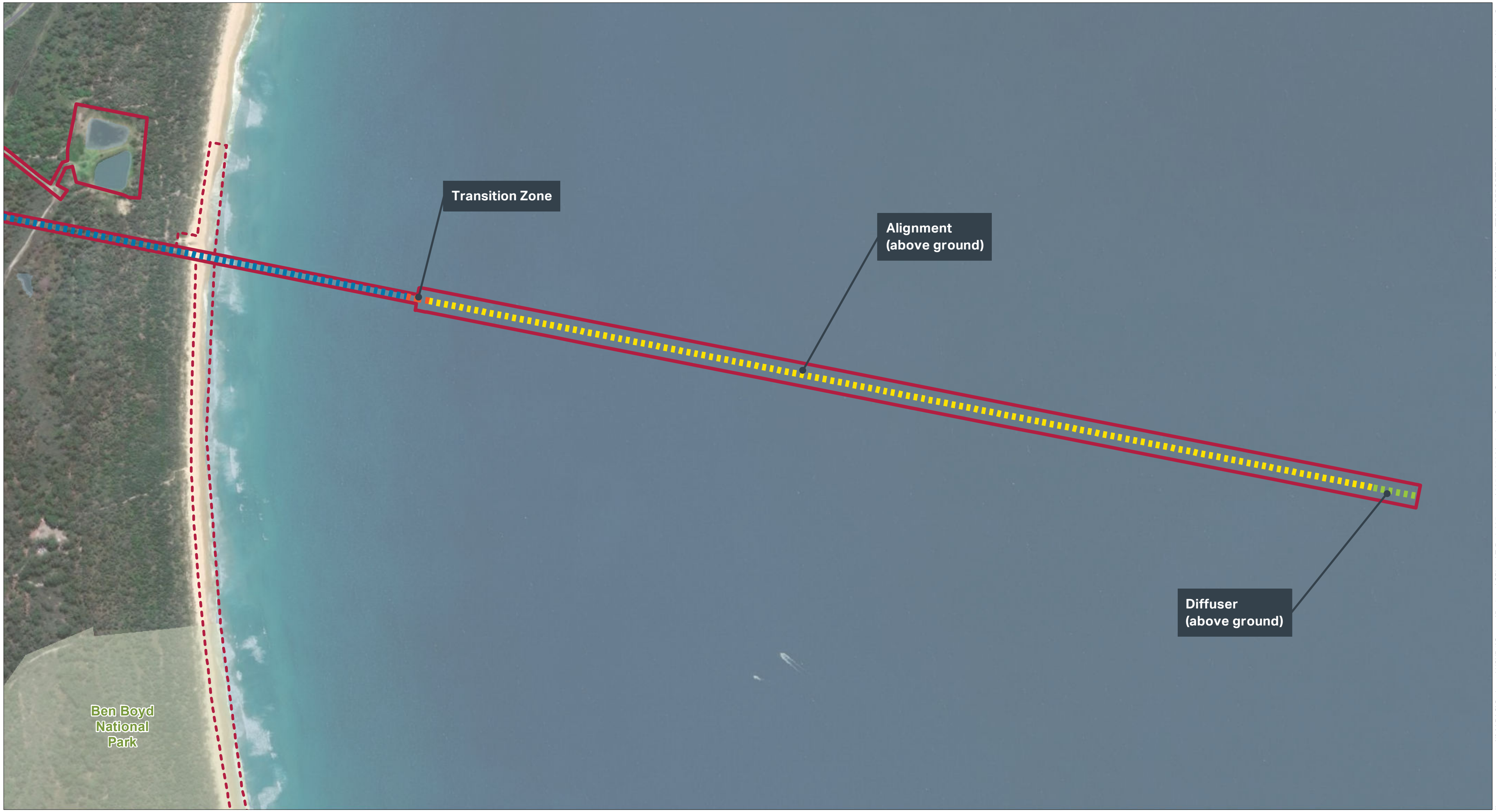

FIGURE 2-5: OCEAN OUTFALL PIPELINE – SECTION 2 (ABOVE SEAFLOOR)

0 200 400 m

AECOM

Legend

- Project area
- Project area (temporary construction area)
- Outfall pipeline – Section 1 (below ground)
- Transition Zone
- Outfall pipeline – Section 2 (above seafloor)
- Diffuser (above seafloor)

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

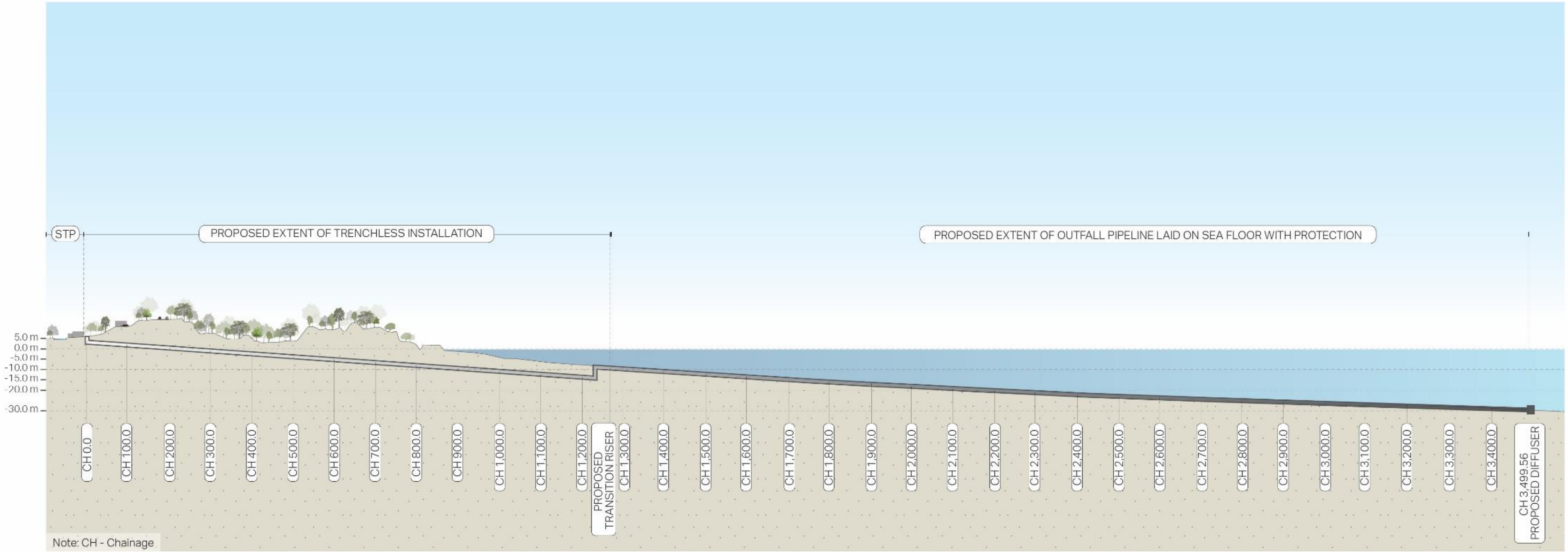

Figure 2-6 Outfall pipeline longitudinal section (indicative)

2.4 Construction

The indicative construction methodology, including construction areas required, construction activities, stages, work hours and other details are described below. The construction methodology would be further developed during subsequent design stages of the Project by the nominated construction contractor in consultation with BVSC.

2.4.1 Construction area

The construction footprint includes temporary compound and laydown areas, construction parking areas and access tracks. The construction footprint is shown in **Figure 2-7** and **Figure 2-8**.

FIGURE 2-7: CONSTRUCTION COMPOUND/LAYDOWN AREAS

N

0 300 600 m

Legend

- Project area
- Project area (temporary construction area)
- Construction access
- Construction compound/laydown area
- Construction laydown area and potential intermediate drilling site
- Construction laydown area at Pambula-Merimbula Golf Club

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

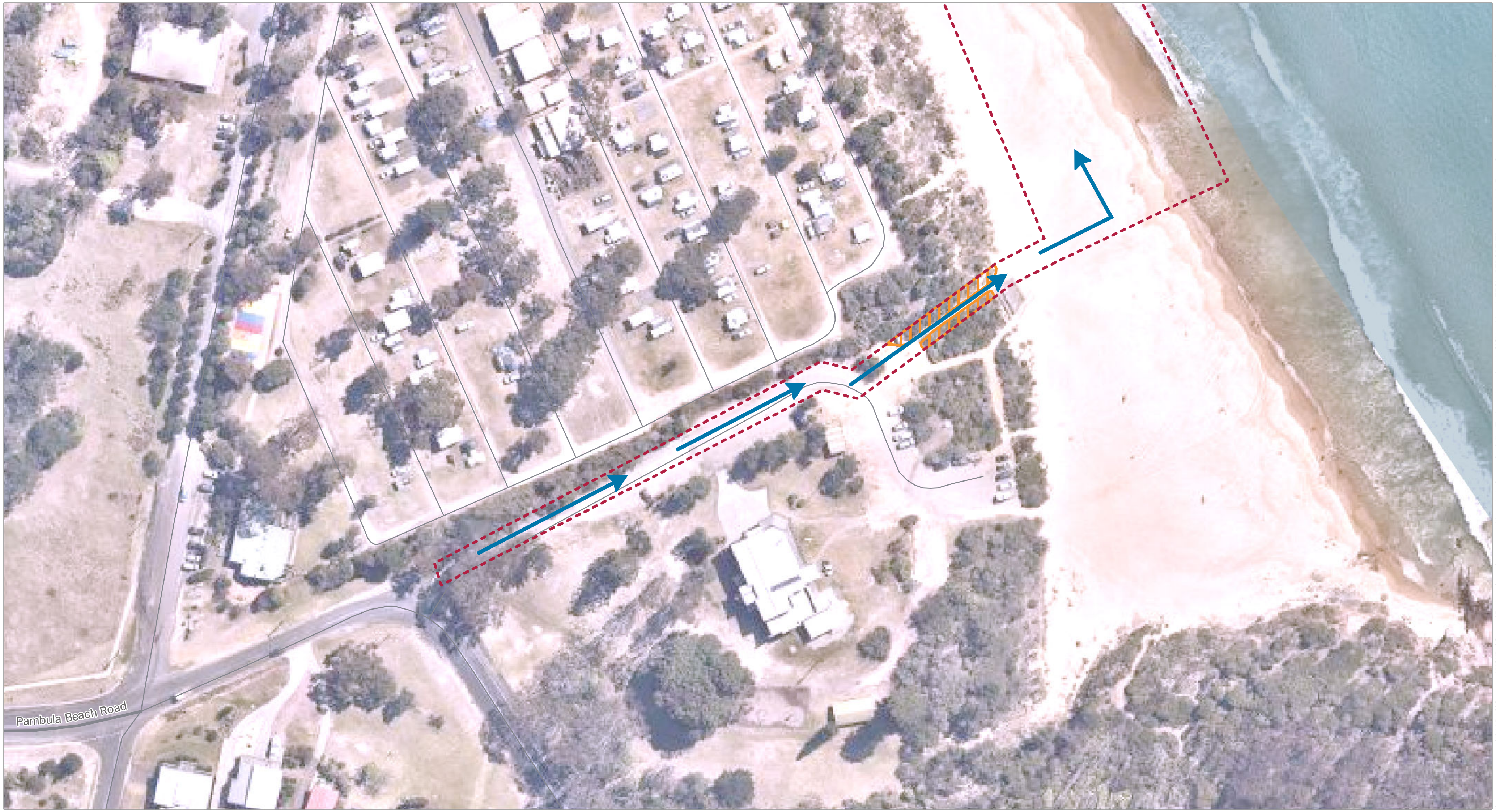

FIGURE 2-8: PAMBULA BEACH CONSTRUCTION ACCESS

Legend

- Project area
- Project area (temporary construction area)
- Vegetation to be removed
- Construction Access

Source: Nearmap, 2019

2.4.2 Construction activities

The activities that would be carried out during construction are described below.

- construction of the STP upgrade including:
  - establishment of site construction areas, including compound areas, laydown areas, parking areas and access tracks;
  - decommissioning of the existing beach-face outfall pipeline. The exposed end of the outfall pipeline would be removed, and the remainder of the pipeline would be capped and remain in-situ (buried underground);
  - installation of erosion and sediment controls, and establishment of other no-go areas (e.g. flagging vegetation to be retained);
  - mobilisation of machinery and delivery of materials, equipment, and process units to site;
  - identification, relocation and upgrade of utilities;
  - bulk earthworks and importing of fill and decommissioning of effluent storage pond; including dewatering, mechanical removal of sludge/sediment into truck/s or alternatively left to dry out, and further excavation;
  - construction and installation of STP infrastructure, including buildings, treatment process upgrades and new pumping stations (involving laying foundations/concrete slabs, installation of process units, placement and joining of pumping station equipment, erection of buildings and pumping station buildings);
  - installation of pipes, switches, valves and connections throughout plant; and
  - installation of electrical and control infrastructure.
- construction of ocean outfall pipeline, including:
  - establishment of site construction areas, including compound areas (including parking areas), laydown areas and access tracks;
  - transport of pipeline lengths and construction materials to site and laydown;
  - pipeline stringing and welding;
  - establishment of drill rig pad and entry point, drill rig and recycling unit/tank to collect drilling fluids (where soil cuttings are separated from the fluid for removal offsite to a licensed facility), and re-use of the fluid for drilling (where appropriate). Excess fluid at the conclusion of drilling would also be removed offsite. The final location/s of the drill rig would be confirmed by the drilling contractor during detailed design and in the finalisation of the drilling plan. There are three possible locations for the drill rig to be set up, including a drill pad site at the STP site; a drill rig in the temporary laydown area on Merimbula Beach, or a drill rig located offshore on a barge (and drilling westward). The hole may be drilled in one length or require two lengths to be drilled and therefore require two drill rig locations. These scenarios have been addressed in the environmental assessments carried out as part of this EIS where necessary;
  - installation of underground section (Section one) via trenchless method (e.g. horizontal direction drilling or direct drive tunnelling), following by pipeline insertion via pulling or pushing;
  - installation of a transition riser, beyond the surf zone, if required. The riser would be installed using micro-piling and would consist of a precast concrete structure approximately 5 m by 3 m and would be installed in sections via an excavation created by simple airlifts. Alternatively, the riser may consist of a section of pipe specifically fabricated to match the ends of the underground pipeline (Section one) and the start of the section above the sea floor (Section two);
  - installation of the above ground section (Section two) via direct placement on sea floor in 600 m to 800 m lengths. This would also involve progressive covering, protection and

stabilisation works for the pipeline (e.g. potentially using concrete or rock mattresses) held together with ropes/ slings/ cables;

- installation of a temporary barrier such as silt curtains to minimise mobilisation of sediment and pollutants into adjacent areas;
- installation of fittings including access points and intermediate air valves. Access points may be required at the upstream end (e.g. at outfall pumping station) and the downstream end (e.g. at the diffuser) of the outfall pipeline for maintenance. Air valves would be required if a transition riser is incorporated; and
- installation of multi-port diffuser (approximately 80 metres in length) and risers (up to three) at the downstream end of the pipeline, including rock or concrete protection.

2.4.3 Construction staging

Construction staging is outlined in **Table 2-4**. Staging is indicative and would be determined by the construction contractor as part of the Project works methodology. As a consequence, the sequencing of construction stages may not be linear as presented in the table below.

Table 2-3 Construction stages

Stage	Description of activities	Duration	Timing[1]
Stage 1A - Utility works/ relocations	• identify existing services; • excavate and relocate where required; and • identify mains to exfiltration ponds as well as beach-face outfall pipeline alignment, in order to avoid them (i.e. no excavation work required).	1 month	Standard construction hours
Stage 1B - Site establishment	• mobilisation of machinery and equipment needed for site establishment; • clearing of ancillary facility/construction areas/pipeline stringing area and levelling where required; • clearing of vegetation; • laying down of gravel; • installation of site offices, amenity blocks and utility connections, and parking areas within the ancillary facility areas; • erection of hoarding, fencing and flagging; • installation of temporary erosion and sediment controls; and • clearing and establishment of access tracks to STP site and beach access.	0.5 month	Standard construction hours
Stage 3 - STP upgrade works within STP site	• heavy and light vehicles arriving/departing site each day; • bulk earthworks and excavation (for pipes, new infrastructure); • importing of fill; • decommissioning of existing effluent storage pond within the STP, including dewatering and removal of sludge/clean out and removal of pipes/pits and connections;	10 months	Standard construction hours

Stage	Description of activities	Duration	Timing[1]
	• further relocation and upgrade of utilities; • construction of STP infrastructure, including buildings, dosing facilities, filtration units, and a new pump station - this would involve laying foundations/concrete slabs, installation of process units, placement and joining of pump station equipment, erection of buildings and pump station building; • installation of storage tank and chlorine contact tank; • installation of pipes, switches, valves and connections throughout plant; and • installation of electrical and control infrastructure.		
Stage 4 - Pipeline butt welding and stringing Note there are 2 options for Stage 4[2]	• mobilisation of pipe to laydown area and unloading pipe; • inserting temporary ballast into pipe strings for directional drilled section; • attaching permanent concrete weights to offshore section of pipe and diffuser; • pipeline butt welding and stringing; and • moving pipe around within laydown area and to drilling site.	3 months	Standard construction hours
Stage 5 – Ocean outfall pipeline construction – directional drilling and pulling	• establishment of drill pad and compound (about 40 m x 20 m), including site shed/s; • mobilisation of drill rig and equipment/machinery to site, including drilling fluid recycling unit set up (for separating spoil out, and re-using drilling fluids); • directional drilling using a drill rig - note there are four options for the drill rig location[3]. Directional drilling would be by either horizontal directional drilling (HDD) or direct drive tunnelling (DDT) methods; • pipeline pulling (i.e. the pipeline would be pulled through the hole, either incrementally as it is drilled, or after it has been drilled); pipe lengths that have been 'strung' together by welding would be pulled through from a laydown area; and • trucking drilling spoil/waste away.	2.5 months, up to 4.5 months depending on drilling method/ locations used	Standard construction hours, plus out of hours work (evening and night-time work) for directional drilling, and pipe pulling (i.e. 48 hours continuous for pulling)

Stage	Description of activities	Duration	Timing[1]
Stage 6A - Offshore Pipeline riser/exit works	• direct barge to offshore location • install pipeline riser in sea floor (at end of directional drilling location) using micro-piling (works needed for the riser may include an exit casing and/or exit pit or a temporary exit mound on the sea floor to prevent drilling fluid blow out).	3 months	Standard construction hours and out of hours work (evening and night-time works)
Stage 6C - Lay pipe strings for above ground offshore section[4]	Float out and progressively sink pipe strings for above ground (above sea floor) offshore section, including: • loading pipe lengths onto 73 m barge at Port of Eden or beach laydown area; • tow out to installation location; and • progressively lower pipe strings to sea floor (and potentially adhere and install connection pups by divers).	1 month	24 hours
Stage 6D - Cover above-ground offshore pipeline[4]	• use barges to lower rock or concrete mattresses to cover pipeline; and • an anchored vessel such as a small barge would act as the target vessel for the rock barges to tie up alongside and dump rock into a chute fixed to the target vessel.	1 month	24 hours
Stage 6E - Diffuser works[4]	• float diffuser out to offshore location, sink it; and • connect diffuser to offshore pipeline, cover/protect it.	<1 month	24 hours
Stage 7 - Commissioning (all new components)	• operating pump stations; • operating new STP components; • pipeline pigging; and • barge operation.	2 to 5 months	Standard construction hours

Notes:

*1: Certain works may need to occur outside standard daytime hours (refer **Table 2-4**).*

2: Option A includes pipeline welding/stringing within the PMGC laydown area and the STP site. Option B includes pipeline welding/stringing at Merimbula Beach intermediate site/compound area.

3: Option A involves the drill rig located within the temporary construction laydown on Merimbula Beach and pipe strings also located on the beach/floated out by ship/barge to beyond surf zone. Option B involves the drill rig located in the temporary laydown on Merimbula Beach and pipe strings located in the laydown at the PMGC laydown area/STP site. Option C involves the drill rig located at the STP drill pad site (drilling eastbound) and pipes located at the temporary laydown on Merimbula Beach. Option D involves the drill rig located offshore (on a barge) drilling westward, with pipe strings located in the temporary laydown on Merimbula Beach or at the PMGC laydown.

4: Marine work in Stages 6C, 6D and 6E may require extended hours and weekend work to take advantage of favourable conditions.

The timing of some construction of stages may overlap, including the following:

- Stages 3 and 6A;
- Stages 3, 4B, 5A and 5C;
- Stages 4A, 4B, 5A and 5B;
- Stages 4B, 5A and 5C;

- Stages 4B and 5C; and
- Stages 6C and 6D.

It is noted that these overlapping stage scenarios are considered conservative, as for example, if two of the Stage 5 options are required during construction (i.e. two different directional drilling sites are required), it is unlikely that both of the drilling sites would be operating at the same time.

2.4.4 Construction details

Further details of construction of the Project are provided in **Table 2-4**.

Table 2-4 Construction details

Construction element	Description
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. 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.
Plant and equipment	An indicative list of construction plant and equipment includes: • small, medium and large excavators (3 tonne to 25 tonne) (tracked and wheeled); • compaction plant (e.g. roller/s, plate compactor); • grader; • bulldozer; • directional drilling rig truck and associated infrastructure (i.e. drilling fluid recovery and recycling unit); • pump/s for dewatering; • vacuum truck; • bobcat; • concrete trucks and concrete pumps; • mobile cranes (e.g. franna crane, scissor lift); • semi-trailers and tipper truck; • telehandlers; • barges (e.g. 55 m and 73 m barges, jack-up barge) and tugs; • micro-piling rig (on barge);

Construction element	Description
	• small, self-propelled vessel; • water carts; • demolition saw, jackhammer, grinder; • generator/s; • forklift; • lighting tower; • light vehicles and light trucks; • heavy vehicles; and • hand tools and welding equipment.
Construction traffic	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 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).
Construction 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 (see **Figure 2-3**) 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) (**Figure 2-8**); and • Port of Eden, Twofold Bay (barge/s would transport materials and equipment northward to the location of the proposed outfall pipeline alignment). Further information and assessment of construction accesses is provided in **Chapter 18 Traffic and Transport.**
Imported fill and spoil material generated	Imported fill and spoil generated during construction would include the following: • directional drilling spoil would be approximately 700 cubic metres (m^3); • approximately 13,125 m^3 of spoil/sludge may be required to be removed from site (as a worst case) from the decommissioning of the effluent storage pond on site (alternatively, after dewatering the pond may be left to dry out); • approximately 2,750 m^3 of spoil would be removed following excavation works for new STP infrastructure (including internal pipelines, pumping stations, storage tanks and other components); and • approximately 25,600 m^3 of fill material may be imported (or re-used where possible from excavations within the STP site) to infill the existing effluent storage pond if infilling is required.

Construction element	Description
Construction waste	The main construction waste types generated would include: • spoil from STP excavations and spoil from directional drilling (contaminated with drilling fluid/mud); • spoil/sludge from decommissioning the effluent storage pond; • concrete waste, timber, scrap metal, steel, electrical and pipe fittings/cut-offs, plasterboard, cable and packaging material; • cement wash-out waste; • contaminated materials (e.g. oil/lubricant waste); • adhesives, lubricants, waste fuels and oils, solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials; • sediment-laden and/or potentially contaminated wastewater, sewage and grey water; • adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses, solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials, and spent spill kit absorbent materials used to clean up accidental spills during maintenance; • drained oil filters (mechanically crushed), rags and oil-absorbent materials that do not contain free liquids; • paper, cardboard, plastics, glass and printer cartridges • putrescibles; and • green waste (from vegetation removal). Waste expected to be generated and waste management is described further in **Chapter 26 Waste**
Vegetation removal/trimming	Approximately 2,800 square metres (m^2) (or 0.28 hectares) of vegetation removal / trimming would be required in the following locations (and as shown on **Figure 12.5** in **Chapter 12 Terrestrial biodiversity**): • approximately 217 m^2 at the Pambula Beach access track; • approximately 47 m^2 at the existing beach-face outfall pipeline (to be decommissioned); 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 Note that 0.28ha is a rounded up figure in accordance with the calculation of biodiversity offset credits contained in **Appendix H** (Biodiversity Assessment Report). In addition to the above, the removal and replacement of the plantings on the roundabout at the Princes Highway / Toallo Street intersection may be undertaken, if required to allow for the passage of oversized construction vehicles (such as the drill rig truck). Any removal and replacement of these plantings would be undertaken in consultation with Transport for NSW (and relevant stakeholders).

2.5 Commissioning activities

Commissioning activities for the STP upgrade would include:

- testing of all new components and structures of the new treatment trains (including hydraulic testing, electrical testing and functional testing); and
- influent and treated wastewater quality testing.

Commissioning of the ocean outfall pipeline would include:

- pipeline flushing and pigging;
- hydrostatic testing (pre- and post- installation);
- testing of other structural components; and
- removal of waste generated during commissioning.

2.6 Operational activities

The upgraded STP would be operated with the additional treatment processes which would improve the quality of the treated wastewater. Levels of total phosphorus, total suspended solids, biological oxygen demand, virus, bacteria and other pathogens would be managed to be within discharge limits.

Upgrades to the four phases of operation are described below and shown on **Figure 2-3** and **Figure 2-9**.

This section also described the proposed maintenance activities that would be required during the operation of the Project.

2.6.1 Phase one: screening (primary treatment)

There would be no upgrade required to the existing screening process.

2.6.2 Phase two: secondary treatment

As shown in the process flow diagram in **Figure 2-9**, the Project includes additional treatment processes to bolster the secondary treatment. Phase two would now involve two stage PAC dosing. The two stage PAC dosing would comprise:

- PAC dosing – first dosing point: PAC would be dosed to the incoming sewage after primary treatment to remove phosphorous. The dosing rate would depend on the volume of flow; and
- PAC dosing – second dosing point: PAC dosing would occur after aeration in the extended aeration tanks (EAT) and be mixed via an in-line static mixer. The PAC dosing would be flow-paced with the operator choosing the set-point based on on-site testing.

The two stage PAC dosing is expected to reduce total phosphorus levels in the treated wastewater to below 1mg/l. The introduction of PAC dosing would result in additional sludge being produced, resulting in nearly a 20% increase in overall solids to be handled. Sludge would continue to be treated by being dewatered and beneficially re-used on local farms by a commercial composting company or other beneficial re-use accordance with State Government guidelines. Occasionally, where necessary, sludge would be disposed to landfill.

It is noted that another key function of the Phase two infrastructure is to provide wet weather flow management. This function is described in more detail in **Section 2.6.5**.

2.6.3 Phase three: filtration / disinfection (tertiary treatment)

Additional treatment processes to bolster Phase three: This includes UV disinfection and tertiary filtration (if required). These phase three components are described below.

Disinfection

All effluent up to flow of 3.7 ML/d would enter an above ground inline pressure UV system, comprising two UV disinfection units. Flow would gravitate through the UV reactors and into the pump station feeding the onsite storage. The UV plant would be capable of running continuously and automatically.

Flows above 3.7ML/d (wet weather flows) would be diverted to the wet weather overflow pond and then would be pumped back to the catch pond after peak wet weather flows have passed to ensure that all flows receive UV disinfection before leaving the plant.

Treated wastewater that is to be re-used would undergo further disinfection using chlorine. This is to ensure that any treated wastewater that is being used for irrigation would meet the log removal requirements for effluent re-use.

Tertiary filtration

If required and included in the Project, tertiary filtration would also be incorporated into the treatment process. Decanted effluent from the secondary treatment phase would be passed through a filter system. There are a number of filtration processes and systems available which may be considered during subsequent design stages.

2.6.4 Phase four: Disposal and beneficial re-use

Disposal and beneficial re-use

Treated wastewater would be tested for quality prior to discharge via the ocean outfall pipeline or via beneficial re-use offsite (to existing land application areas at the Oaklands agricultural area or the adjacent PMGC grounds).

In future BVSC may seek to beneficially re-use treated wastewater at other sites; this would be subject to separate approval process/es and agreement/s with relevant landholders.

2.6.5 Wet weather flow management

Management of wet weather flows would be adjusted from the existing approach as follows:

- the IDEA tanks would retain a wet weather function to enable processing of higher flows at reduced treatment;
- treated wastewater stored in the wet weather overflow pond would be returned to the catch pond when there is capacity within the catch pond (refer to **Figure 2-9)**; and
- the upgrade would allow greater throughput in a wet weather event plus the existing 20 ML storage providing added capacity in extended periods of wet weather.

2.6.6 Maintenance activities

New maintenance activities at the STP site would include:

- calibrating new dosing equipment, mechanical and electrical repairs of new STP elements as required;
- maintenance of UV disinfection units (including chemical cleaning, replacing lamps, ballast and other parts as required, periodic calibration of the units, and adjustment of alarm levels);
- handling and management of additional waste (as a result of additional treatment processes), including waste sludge (aluminium/hydrated aluminium precipitate), solids capture from filters;
- storage and handling of chemicals including:
  - chlorine (approximately 1,840 kg stored in tank/s on site, replaced approximately every 28 days);
  - PAC (47m^3 stored in tank/s on site, replaced approximately every 14 days); and
  - maintenance of new plant and equipment, including flushing pipes, inspecting connections, mechanical and electrical maintenance of pumps and pumping stations (including replacing filters, grease, oil and other fluids.

Maintenance activities for the ocean outfall pipeline would include:

- monitoring, inspections, cleaning and repairs as required, including:
  - measurement and recording pipeline flow and hydraulic head;
  - underwater visual inspections by divers and/or remote operated vehicles (ROV) periodically and as required (e.g. annually);

  - cleaning accumulated sediment/grease and/or other impediments by periodically flushing (increasing flow through the pipeline) and/or pigging, and/or physically removing marine organisms growing/accumulating around the diffuser (e.g. barnacles);
  - corrosion repairs by divers (e.g. physically removing corrosion/strengthening or replacing any components subject to corrosion such as fasteners, joints, fittings or anchors);
- disposal of maintenance waste material including sediment/grease/impediments and contaminants, structural repair waste (e.g. cement waste, steel/wire offcuts).

The exfiltration ponds site would also continue to be maintained by Council (e.g. for safety reasons), even though treated wastewater would cease to be pumped to these ponds under the Project. Council would determine the best use of this site in future, and any works proposed may be subject to a separate approvals process.

Maintenance of the STP upgrades and pipeline would continue until the STP is decommissioned or further upgraded in the future.

2.6.7 Decommissioning

The ocean outfall pipeline is designed to have a life of 100 years. Decommissioning of the pipeline is likely to involve removing the pipeline and anchoring mattresses from the sea floor (for Section two of the pipeline) and leaving the remainder of the pipeline (Section one) in situ by removing the end sections and filling the pipe with grout. Other associated valves and access points associated with the pipeline would also be removed. Components of the STP plant would remain in operation until they are either upgraded or become redundant.

Prior to decommissioning, a net environmental benefit analysis (NEBA) would be undertaken to determine the most appropriate approach to decommissioning, which would also allow for future re-uses. This assessment would likely consider the environmental impacts of removal of the pipeline and anchoring mattresses from the sea floor versus the potential benefits of leaving the structure in-situ (due to habitat created over the life of the pipeline).

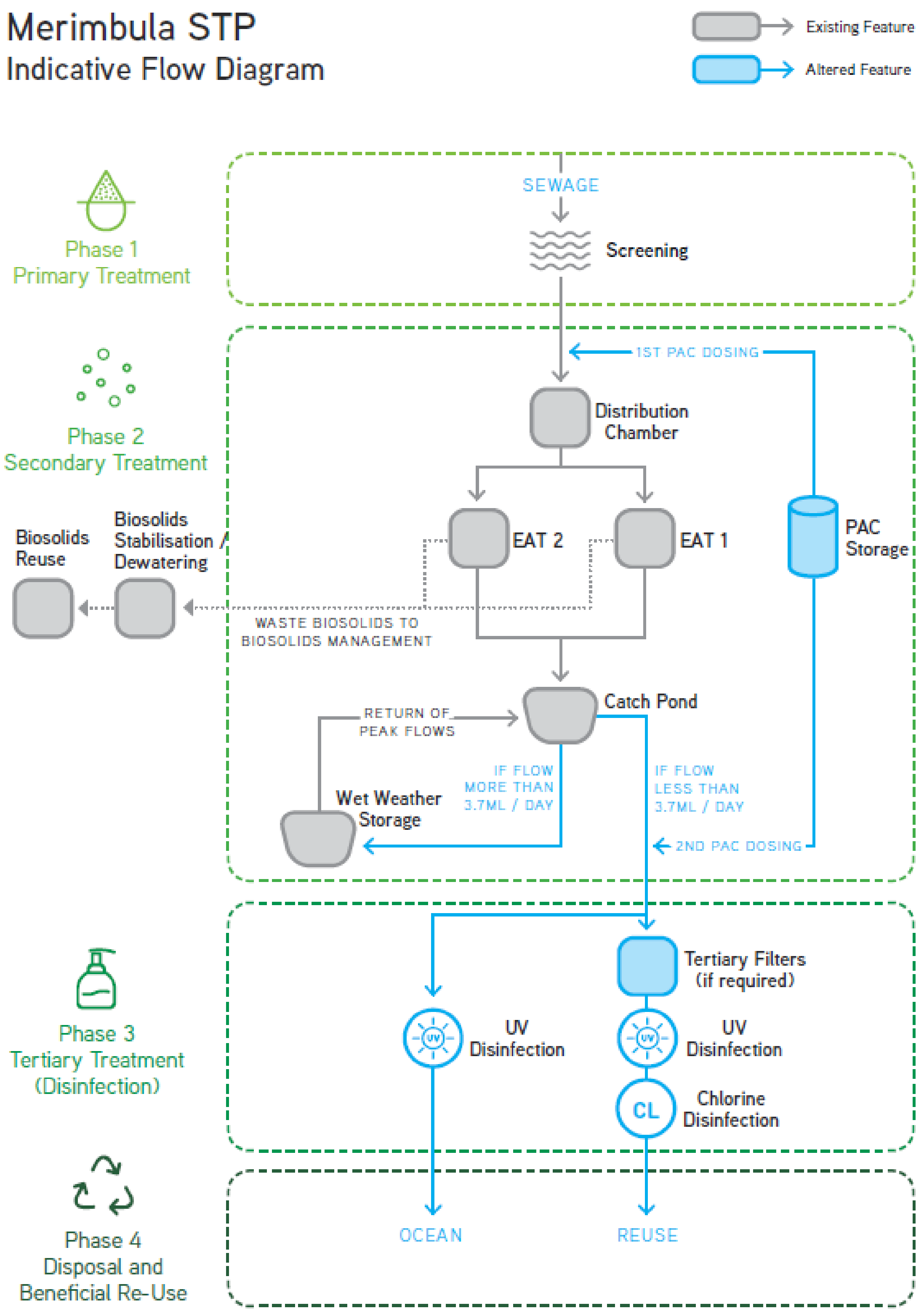

Figure 2-9 STP upgrade – Indicative process flow diagram

2.7 Project uncertainties

The Project, as described in this chapter is based on a concept design and may be subject to change during the subsequent design stages. Design changes that would have a material impact on the assessments within this EIS would require re-assessment.

The following uncertainties have been captured by this EIS and supporting technical studies:

- Tertiary filtration: the requirement for tertiary filtration and the type of tertiary filtration that may be installed is to be determined. Tertiary filtration involves a large upfront cost, increased pumping, chemical and energy use, and operator and maintenance time and spend. The benefits to the receiving environment may be low and not offset the additional cost, chemical and carbon requirements. This uncertainty would be resolved in a subsequent design stage with consideration to projected performance against water quality objectives for the Project design as well as consideration of whether tertiary filtration provides a material benefit or additional security should it be included;
- Use of the site of the 17 ML effluent storage pond that would be decommissioned: following decommissioning the effluent storage pond, the site may be re-purposed as wet weather detention storage, a smaller storage pond, or backfilled completely. This uncertainty would be resolved in the detailed design to determine the optimum volume of wet weather or re-use storage / flow balancing required. The decision would be determined by long term operational needs and/or costs;
- Directional drilling method:
  - the pipeline construction method between the STP and a location beyond the surf zone would involve directional drilling, however the specific method is to be confirmed, and may consist of horizontal directional drilling (HDD) or direct drive tunnelling (DDT). This would be determined by the construction contractor chosen (in coordination with BVSC) and may be considered in terms of methods available to the contractor, engineering/terrain constraints, constructability constraints and/or cost;
  - need for an intermediate pipeline drilling location: an intermediate pipeline drilling location may be required on Merimbula Beach (east of the STP) if the whole pipeline length cannot be drilled in one length. The intermediate drilling location (if required) would include establishing a construction compound of around 40 m by 20 m and operation of a drill rig; as well as an excavation where the separate sections of pipe would join. The requirement for an intermediate drilling location would depend on the final directional drilling plan (method, locations used, direction to drill from, etc.), which would be determined by the construction contractor in coordination with BVSC; and
  - pipe laydown and stringing location: pipe stringing for the trenchless installation of the underground portion of the outfall pipeline would require temporary use of an area/s to lay down and string the lengths of pipe to be installed. Potential areas to lay out and string the pipe include within the STP site, on a portion of the adjacent PMGC grounds and/or within an area on Merimbula Beach. The location of these 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. The use of laydown areas would be considered in consultation with relevant landowners.
- Transition riser: a permanent riser structure may be required to connect the underground pipeline with the above-ground offshore pipeline section laid on the sea floor. If required, the riser would be located within the "transition zone" shown on **Figure 2-4** and **Figure 2-5.** A permanent riser structure may be required if the underground portion of the pipeline is at considerable depth below the seafloor, or if recovery of directional drilling equipment is required. The requirement for a transition riser would be determined by the construction contractor during detailed design and construction planning;

- Location of new elements within the STP site: the exact location of new STP elements proposed (e.g. upgraded chlorine storage shed) would be confirmed during detailed design, in consultation with the design and construction contractor(s), based on engineering and constructability requirements. Final locations would be within areas of the existing STP site that are currently cleared of vegetation, or where the EIS has accounted for clearing within the STP site (refer **Chapter 12 Terrestrial Ecology**); and

Clearing of the vegetation on the roundabout at the Princes Highway/Toallo Street intersection may be required to accommodate the passage of oversized construction vehicles (such as the drill rig truck). Any removal of vegetation at the Princes Highway/Toallo Street intersection would be undertaken in consultation with relevant stakeholders. Following the completion of construction, all disturbed areas at the roundabout would be restored to a pre-construction condition, or better.

3.0 Project need and strategic context

This chapter outlines the need for the Project, the Project objectives and discusses the context of the Project within State and local strategic planning and policy documents.

3.1 Project need

The ongoing use of the Merimbula STP and beach-face outfall does not meet community expectations and presents unacceptable risks to public health, the environment and the regional economy, as follows:

- the current operation does not meet the *Marine Water Quality Objectives for NSW Ocean Waters – South Coast* (DEC, 2005);
- the treated wastewater quality at the existing STP discharge locations has been recorded to contain elevated levels of numerous nutrients and metals, as well as intermittently higher counts of enterococci and faecal coliforms, which could be improved under an increased treatment regime;
- disposal via the current beach-face outfall of excess treated wastewater that cannot be beneficially re-used (for example, during wet weather periods when the re-use schemes cannot irrigate) presents a public health risk and a diminished aesthetic for recreational beach users;
- the quality of the current treated wastewater is affected by re-contamination in the STP ponds prior to re-use and disposal;
- continued disposal of treated wastewater to the existing dunal exfiltration ponds (which have limited capacity) adversely impacting groundwater quality, nearby Aboriginal cultural heritage sites, and surrounding ecology (the ponds are located within vegetation mapped as an endangered ecological community (i.e. Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions)); and
- the economic stability of the area and future growth potential (including for tourism and industry) may be threatened by inadequate water and wastewater treatment infrastructure.

As discussed in **Section 1.1**, the EPA on 22 May 2020 updated the conditions of the Environment Protection Licence (EP)L for the Merimbula STP requiring BVSC to obtain the necessary planning approvals to construct and commission an ocean outfall for the disposal of treated wastewater from the plant. The current EPL includes the following condition:

> *U1 Effluent management strategy for Merimbula STP*
>
> *U1.1 The licensee must, by 31 March 2021:*
>
> *a) Have completed than* (sic) *Environmental Impact Statement (EIS) and Concept Design for a deep water ocean outfall and STP upgrade for the disposal of treated effluent from the premises.*
>
> *U1.2 The licensee must, by 31 March 2023:*
>
> *a) Have obtained the necessary approvals, constructed and commissioned a deep water ocean outfall for the disposal of treated effluent from the premises; and*
>
> *b) Have obtained the necessary approvals, constructed and commissioned upgrades to the STP to ensure that the treated effluent quality is commensurate with the standards required in condition 'a)' above.*

The Project would address the above requirements by improving the quality of treated wastewater being disposed of from the STP and address the issues associated with the beach-face outfall by introducing an ocean outfall pipeline with an offshore discharge point. The Project is expected to contribute to the strengthening of the local economy by improving the recreational aesthetic of the Merimbula Beach and Merimbula Bay environs while at the same time reducing risks to public health, the environment, and commercial industry.

3.2 Project objectives

The Project aims to improve the quality of treated wastewater and minimise public health and environmental risks associated with disposing treated wastewater.

The Project objectives are to:

- meet the conditions of the amended EPL 1741 issued under the *Protection of the Environment Operations Act 1997* (POEO Act);
- address primary contact public health risk and related community concern associated with the current treated wastewater disposal practice;
- meet the *Marine Water Quality Objectives for NSW Ocean Waters – South Coast* (DEC, 2005)[4];
- minimise existing environmental and heritage impacts, as well as those which may be associated with construction of the Project;
- account and provide for future population growth, community liveability expectations, and townships' economic stability;
- reduce risk to the nearby estuary-based oyster industry;
- provide a reliable method for disposing of excess treated wastewater during wet weather periods, when beneficial re-use schemes cannot irrigate;
- improve the aesthetic and recreational values of Merimbula Bay and surrounds, supporting the sustainability of the regional tourism industry and economy; and
- achieve a Project sustainability rating of Excellent under the Infrastructure Sustainability Council of Australia (ISCA)'s Infrastructure Sustainability Rating v1.2.

3.3 Strategic context

The Project was declared State Significant Infrastructure (SSI) on 26 July 2016 and requires assessment and approval under Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act) (refer **Chapter 5 Statutory context** for further information). This section describes the strategic context of the Project and importance to the State with regard to NSW Government, regional and BVSC policies, strategies and initiatives.

3.3.1 State Infrastructure Strategy 2018-2038

The strategic objective for regional New South Wales as identified in the *State Infrastructure Strategy 2018-2038: Building Momentum* (Infrastructure NSW, 2018) is "adopt an area-based approach to infrastructure planning and investment decisions". This approach recognises that "infrastructure networks, such as transport, energy and water, are the foundation of a successful economy". Infrastructure NSW's response to this approach is to ensure adequate water supply and wastewater treatment to enable growth. The Project would align with this response as it would improve the treated wastewater quality and existing disposal regime and thereby cater for existing and future population and land use in the area.

3.3.2 Safe and Secure Water Program

The *Safe and Secure Water Program - Program Guidelines* (Department of Planning, Industry and Environment, 2019) supports one of the key strategic objectives of the NSW Government, as highlighted in the State Infrastructure Strategy, namely to support the critical needs of regional NSW through improvements to public health, water security, environmental outcomes and/or social benefits. The Project directly aligns with the purpose of the Safe and Secure Water Program. Key Safe and Secure Water Program criteria include:

- prioritise projects that address the highest risks and issues for regional NSW water;

[4] As applied at the outer extent of the mixing zone around the ocean outfall pipeline diffuser

- achieve an appropriate level of service in smaller towns where the cost of critical infrastructure can outweigh the economic benefits provided; and
- provide more flexibility by including non-infrastructure options, where this is cost-effective.

3.3.3 Marine water quality objectives

Marine Water Quality Objectives for NSW Ocean Waters is a series of four publications developed in 2005 by the (then) Department of Environment and Conservation. The four publications cover the following regions: Sydney Metropolitan and Hawkesbury-Nepean; Hunter and Central Coast; North Coast; and South Coast.

Marine Water Quality Objectives for NSW Ocean Waters – South Coast (DEC, 2005) (South Coast WQOs) encompasses the Council areas of Wollongong, Shellharbour, Kiama, Shoalhaven, Eurobodalla and Bega Valley and applies to the Project area.

The publications outline marine water quality objectives based on the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC Guidelines) (ANZECC, 2000), and apply to ocean waters that adjoin the NSW coast and extend three nautical miles from the shore. The four publications include region based water quality objectives for: aquatic ecosystems (i.e. aquatic ecosystem health), primary contact recreation (i.e. swimming, surfing), secondary contact recreation (i.e. boating, wading), visual amenity (i.e. aesthetic qualities of waters), and aquatic foods (i.e. water suitable for growing seafood).

The South Coast WQOs are not a statutory requirement but are nonetheless considered applicable guidelines for the Project. The current operations do not meet the South Coast WQOs. An objective of the Project is to improve wastewater quality so that operations meet these WQOs and in doing so, improve the environmental and public health outcomes of the area.

3.3.4 Regional and local policies

South East and Tablelands Regional Plan 2036

The *South East and Tablelands Regional Plan 2036* (Department of Planning and Environment, 2017) is part of the NSW Government's commitment to deliver a whole of Government, integrated strategic plan for land use, transport and infrastructure investment. The plan identifies the Government's immediate priorities for the South East and Tablelands region. These will complement both the existing long term strategies for the region including the *South Coast Regional Strategy* (Department of Planning, 2007) and the community strategic plans of individual local government authorities in the region. The plan suggests actions to protect the coast such as updating coastal/estuary management plans and preparing new coastal management programs to identify areas affected by coastal hazards. The Project would introduce a new built element into the coastal zone. The EIS has included assessment of the Project with consideration of potential impacts on coastal processes and hazards (including those affected by climate change) consistent with BVSC's existing Coastal Zone Program (BVSC, 2020) (which covers the management of the shire's coastal assets, estuaries and response to coastal hazards). This is discussed further in **Chapter 10 Marine and coastal processes**, and **Chapter 25 Climate change risk**.

South Coast Regional Strategy 2006-31

The *South Coast Regional Strategy 2006-31* (Department of Planning, 2007) identifies challenges facing the South Coast region including the management of groundwater resources, climate change/sea level rise, population growth and management of water and waste services. The strategy acknowledges that during seasonal holiday periods, some of the region's towns would experience increasing demands on infrastructure and services and these demands could increase the risk of pollution on sensitive ecosystems. The Project would align with a key outcome of the strategy by providing for existing and planned water, wastewater and waste infrastructure and services for both current and future customers in an efficient and cost effective manner. The Project would thereby support the growth of the area.

Bega Valley Community Strategic Plan 2040

The *Bega Valley Community Strategic Plan 2040* (BVSC, 2017) outlines the community's priorities and aspirations for the future. The plan establishes six key outcomes for the Bega Valley community:

active and healthy communities, employment and learning opportunities, sustainable living, liveable places, connected communications and strong, consultative leadership. The plan establishes goals and strategies under each key outcome. The Project underpins BVSC's long-term visionary plan for the community to "build a stronger and better Bega Valley Shire" (BVSC, 2017).

The Project aligns with the two key outcomes of sustainable living and liveable places, which were identified as important to the community during community consultation undertaken for the plan. The goals under each of these key outcomes that are relevant to the Project are outlined in **Table 3-1**.

Table 3-1 Relevant outcomes, goals and strategies from the Bega Valley Community Strategic Plan 2040

Outcomes	Goals	Relevant strategies	How the Project aligns
Outcome 3 – Sustainable living	Goal 5 - Our air and water is pristine and our natural environment and rural landscapes are protected.	Ensure land use planning and resource use protects the quality of the natural environment, the existing character of rural landscapes and the high value agricultural land.	The Project is consistent with the strategies of land use planning to protect the natural environment of the area and adopt sustainable design principles, as it would involve the upgrade of an essential service to improve the existing manner in which wastewater is being managed and disposed of. This would improve environmental, public health and aesthetic outcomes.
	Goal 6 - We are leaders in sustainable living and support innovative approaches to resource recovery and the production of renewable energy and food.	Adopt sustainable design principles in the planning of our urban areas and infrastructure provision, and encourage sustainable buildings and lifestyles.	
Outcome 4 – Liveable places	Goal 8 - Our places retain their character and scale, development is well planned, and a range of goods and services are available within our Shire that meet local needs.	Provide infrastructure and services to meet the ranging needs of residents in our towns, villages and rural areas.	By upgrading an essential service to improve environmental, public health and aesthetic outcomes, the Project would provide for existing and future needs (while maintaining the area's existing character). It would also support local economic, social and environmental outcomes.

3.4 Project benefits

The Project would deliver the following benefits and opportunities:

- improve the quality of treated wastewater and minimise public health and environmental risks associated with using and disposing of treated wastewater;
- introduce additional beneficial re-use opportunities (i.e. irrigation of playing fields) through enhanced treatment processes;
- remove the capacity of the existing dunal exfiltration ponds to adversely impact environmental values; give rise to the least impacts during construction and operation compared to other alternatives considered (refer to **Chapter 4 Project development and alternatives**);
- recognise the value the Merimbula community places on its beach and ocean front;
- provide a solution which is more socially, environmentally and economically sustainable in the long term (compared to the current operation);

- reduce the potential for water quality impacts on the local oyster industry; and
- reduce the potential for impact on tourism.

4.0 Project development and alternatives

This chapter describes the alternatives to the Project, as well as options considered as part of the design development process. It explains how and why the Project was selected as the preferred option for assessment in this EIS.

4.1 Project background

The original ocean outfall that conveyed and discharged treated wastewater from the Merimbula STP was destroyed during a storm in the late 1970s and never replaced. Disposal of excess treated wastewater from the STP has since been via a beach-face outfall on Merimbula Beach.

An irrigation system on the Pambula Merimbula Golf Club (PMGC) grounds was connected to the STP in the 1970’s. This connection enabled some of the treated wastewater produced at the STP to be beneficially re-used. The PMGC grounds irrigation system has been augmented and upgraded in the years since and currently an automated system utilises treated wastewater for irrigating approximately 37 hectares of the PMGC grounds.

A second re-use scheme at Oaklands agricultural area on the Pambula River flats at South Pambula was commissioned in February 2013. A pump station, pipeline and a 20 megalitre storage dam was constructed for treated wastewater transfer, storage and irrigation of farmland over approximately 32 hectares at start-up.

Treated wastewater surplus to re-use requirements continues to be discharged from the STP to the beach face outfall or dunal exfiltration ponds.

The dunal exfiltration ponds are located east of the STP in a disused quarry in the sand dunes. They were commissioned in 1991 and are used preferentially during higher beach use periods (e.g. tourist seasons, summertime), thereby avoiding use of the beach-face outfall during these times. The dunal exfiltration ponds have a limited capacity and are only used for treated wastewater disposal when groundwater level in the dunes is below a prescribed threshold level.

The existing operation is described in **Section 2.1** of this EIS.

The Merimbula STP is licenced by the NSW Environment Protection Authority (EPA) via an Environmental Protection Licence (EPL) issued under the *Protection of the Environment Operations Act 1997*. Under instruction from the NSW EPA and due to a number of environmental challenges associated with treated wastewater disposal, BVSC began a process of re-investigating options and solutions for treated wastewater disposal and beneficial re-use in 2009. Some of the environmental constraints, challenges and drivers for the work that followed included:

- the disposal of treated wastewater via the beach face outfall does not meet the *Marine Water Quality Objectives for NSW Ocean Waters – South Coast* (DEC, 2005);
- STP treated wastewater quality is not wholly compliant with the current EPL;
- the volume of treated wastewater able to be beneficially re-used is determined by the watering requirements of the PMGC grounds and Oaklands agricultural area, which is much less than the total volume of treated wastewater produced at the STP, especially during wet weather and in winter;
- disposal of treated wastewater via the beach-face outfall presents a public health risk as well as diminished aesthetic values for recreational beach users;
- disposal of excess treated wastewater to the existing dunal exfiltration ponds (which have limited capacity) impacting groundwater quality, nearby Aboriginal cultural heritage sites, and surrounding ecology (the ponds are located within vegetation mapped as an endangered ecological community (i.e. Bangalay Sand Forest of the Sydney Basin and South East Corner bioregions, refer **Chapter 12 Terrestrial ecology**);
- the dunes in which the exfiltration ponds are located contain potential habitat for protected migratory bird species; and

- Merimbula Lake is listed on the Commonwealth Directory of Important Wetlands in Australia as a nationally important marine and coastal zone wetland.

4.2 Project development

4.2.1 Timeline

A timeline of the investigations leading up to and including the Project is provided in **Table 4-1**.

Table 4-1 Project development timeline

Year	Development
1987-2008	• various studies and investigations on options for effluent* disposal and re-use from Merimbula STP (see **Table 4-2**) were carried out.
2008-2009	• NSW EPA included a Pollution Studies and Reduction Program condition in the Merimbula STP EPL, requiring BVSC to submit a report in relation to the re-use and disposal of effluent from Merimbula STP.
2010-2013	• Merimbula Effluent Options Investigation (MEOI) project undertaken to investigate options for effluent disposal and re-use in accordance with the EPL condition; and • a Focus Group comprising of agency, industry, community and BVSC representatives formed to consider and assess options and recommend a preferred option.
2013	• a preferred strategic option recommended by the MEOI Focus Group for ongoing beneficial re-use on the PMGC grounds and Oaklands agricultural area, STP upgrades to improve effluent quality and disposal of excess effluent via a new ocean outfall; and • effluent re-use at Oaklands agricultural area began.
2014	• Council adoption of the MEOI Focus Group recommendation for an effluent management strategy consisting of STP upgrades and the construction of an ocean outfall; and • NSW EPA amended the EPL for the Merimbula STP to include a requirement to upgrade the STP and construct an ocean outfall.
2014-2016	• the Project is declared State Significant Infrastructure (SSI) under Division 5.2, section 5.12(2) of the Environmental Planning and Assessment Act 1979 and an initial set of SEARs issued by the Department of Planning, Industry and Environment (DPIE) (formerly the Department of Planning and Industry).
2017	• development of a concept design and commencement of the EIS for STP upgrades and an ocean outfall; and • Community Working Group (CWG) established to inform a multi-criteria assessment process, select a preferred option and provide recommendations to BVSC for the Project.
2017-2019	• environmental assessments commenced and progressed; • DPIE issued revised SEARs for the Project on 4 February 2019; • two STP upgrade options and four ocean outfall alignment options considered by the Project team and the CWG; and • preferred option confirmed for the Project by BVSC.
2020	• amendment to the EPL for the Merimbula STP requiring BVSC to obtain the necessary planning approvals to construct and commission an ocean outfall for the disposal of treated wastewater from the STP.

Year	Development
1987-2008	• various studies and investigations on options for effluent* disposal and re-use from Merimbula STP (see **Table 4-2**) were carried out.
2021	• DPIE re-issued the SEARs for the Project on 14 May 2021 • completion of the EIS based on the preferred option (the Project); and • lodgement of the EIS with DPIE.

Note: The term 'effluent' means the same as 'treated wastewater'.

4.2.2 Historic investigation reports

Options for the beneficial re-use and disposal of treated wastewater have been investigated for the Merimbula sewerage system over the past 30 or more years. The common aim of investigations has been to resolve the problem of the beach-face ocean outfall and to improve environmental and social outcomes associated with disposing and re-using treated wastewater produced at Merimbula STP. A summary of investigation and reporting carried out between 1987-2013 and key recommendations from each report is provided in **Table 4-2.** These reports were referenced during the development of the MEOI project (AECOM, 2013) and informed the long-list of options assessed.

Table 4-2 Previous investigations and reports

Report	Brief Summary of Report / Options Considered	Recommendations/Key Findings
1987, Mackie Martin & Associates: *Appraisal of Sand Seepage Capacity and Conceptual Design of Infiltration Systems*	• field studies, drilling, hydraulic testing & survey. • Seven options considered to augment the previous effluent disposal regime of near shore discharge	Combined option of two exfiltration ponds in old sand quarry (stage 1) and spearpoint dewatering system (stage 2) to spread water along dunes.
1987, Binnie & Partners: *Merimbula Sewage Augmentation Effluent Disposal Report*	• investigated options including: - ocean disposal (upgrade outfall & Merimbula Point) - disposal to surface waters (Merimbula and Pambula Lake) - land application (sports complex Pambula Beach and dairy farm Pambula River flats) - dune disposal	Dunal disposal (option 4 or 5 of Mackie Martin report). Included required works, staging, costings and Review of Environmental Factors.
1994, DPWS: *Merimbula Sewerage Effluent Management Strategy Study Report*	• investigated options including: - dunal discharge - ocean discharge - land application - ebb tide river discharge - non-potable urban re-use (dual supply) - potable re-use	New exfiltration pond system to north of existing ponds, taking flow direct from catch pond and further investigations.
1995, OWRU: *Effluent Irrigation Study, Bermagui, Tathra and Merimbula*	• investigated sites available for irrigation, potential of each site with respect to application rates and the impact of nutrients. • soils investigations, water balances, storage	Oaklands agricultural area for irrigation, Pambula River flats.
1996, OWRU: *Effluent Irrigation Study, Pambula Merimbula and Tura Beach*		

Report	Brief Summary of Report / Options Considered	Recommendations/Key Findings
1997, OWRU: *Effluent Irrigation Study, Merimbula Sewerage Scheme Irrigation Options*	requirements and nutrient budgets.	
1998, DPWS: *Merimbula Sewerage Augmentation – Reclaimed Water Management Preliminary Options Report* 2000, DPWS: *Merimbula Sewerage Augmentation – Reclaimed Water Management Final Options Report*	• investigated and costed options including: - offshore ocean discharge; - Pambula River discharge; - urban re-use; - agriculture and recreational irrigation; and - dunal exfiltration	Irrigation at Oaklands agricultural area and upgrade of dune exfiltration. Need for community consultation, final re-use study, groundwater study and EIS
2000, PPK: *Merimbula Effluent Exfiltration Scheme - Preliminary Assessment of Performance*	• assessment of the performance of the existing dunal exfiltration pond	Concluded that the existing system does not have the hydraulic capacity to accept large volumes of effluent on a continued basis without causing unacceptable rises in groundwater levels
2002, PPK: *Assessment of Groundwater Conditions and Dune Disposal Options for Merimbula STP*	• field investigations, drilling of new monitoring boreholes, hydraulic testing, water level and quality monitoring, discussion of groundwater conditions, travel times etc.	Investigate potential for deep disposal and groundwater modelling of potential new exfiltration site
2004, PB: *Investigation of the Shallow Disposal Option for Reclaimed Water from Merimbula STP – Draft Report*	• investigation of the shallow exfiltration of treated effluent into upper sands in the area north of the disused exfiltration ponds.	Exfiltration trench approximately 750m long with a disposal capacity of up to 20ML/d.
2004, PB: *Investigation of the Deep Disposal Option for Reclaimed Water from Merimbula STP Stages 1 and 2 – Draft Report*	• investigation of deep disposal of effluent into a deep confined aquifer.	Deep disposal feasible, requires further investigation and testing
2004, PB, Agsol and Lansci: *Effluent Re-use Investigations*	*Document unavailable / not on BVSC file.*	*Document unavailable / not on BVSC file*
2004, IGGC: *Merimbula STP Exfiltration Ponds, Assessment of Potential Impacts from Short Term Exfiltration* 2005a, IGGC: *Merimbula Exfiltration Ponds – Baseline Monitoring Program* 2005c, IGGC: *Exfiltration Ponds Monitoring Program*	• assessment of potential impacts from short-term exfiltration; and • development of an operational philosophy and monitoring program.	Established operational program and monitoring program for exfiltration ponds use.

Report	Brief Summary of Report / Options Considered	Recommendations/Key Findings
2005b, IGGC: *Merimbula/Pambula Re-use Scheme – Monitoring Bore Installation and Baseline Monitoring Program*	• supervision of installation of monitoring bores at the PMGC grounds and Oaklands agricultural area; and • collection of baseline monitoring data	Found relatively low risk to water quality in surface water receptors from reclaimed water re-use Recommended monitoring regime
2005, ERM: *Merimbula Sewerage Scheme Augmentation Part A, Environmental Impact Statement*	• assessment of likely environmental impacts associated with Bega Valley Sewerage Program Part A: expansion of irrigation scheme to Oakland Pambula River flats and increased storage and improved disinfection at the STP; and • part B, to provide a sustainable disposal option for effluent unable to be beneficially used, not part of EIS.	Suggests implementation of Part A will increase percentage of recycled water able to be beneficially re-used.
2005, Agsol Pty Ltd: *Pambula Merimbula Investigations of options for the re-use of reclaimed water – Final Report –* [Merimbula Sewerage Scheme Augmentation Part A, Annex D – Options for the Re-use of Reclaimed Water]	• investigated alternative re-use locations for reclaimed water from Merimbula STP.	Oaklands agricultural area for irrigation, continued supply of reclaimed water to the PMGC grounds
2006, IGGC: *Merimbula Reclaimed Water Management Scheme – Review of Options for Disposal of Excess Water*	• investigated capacity of existing exfiltration ponds, exfiltration trench review, disposal by shallow wells, deep well injection.	Further investigations into frontal dune area for exfiltration trench or well points; further investigations into deep groundwater disposal; assessment of potential impact on water quality in receiving waters including an assessment of travel times and potential pathogen transport and nutrient loads and expected attenuation processes etc.
2006, CMJA: *Peer Review – Hydrogeological Investigations in relation to the Disposal of Excess Effluent from the Merimbula Sewage Treatment Plant*	• investigated the feasibility of disposing excess effluent into a coastal sand aquifer.	Future extraction for re-use, further investigation required.

Report	Brief Summary of Report / Options Considered	Recommendations/Key Findings
2010, AECOM: *Pilot Water Quality Model Final Report Merimbula Effluent Outfall*	• pilot hydrodynamic and water quality model developed to provide an indication of the effects of proposed ocean outfall locations; and • water quality objectives, mixing zone, tidal planes, currents and hydrodynamic and water quality input data were used for scenario modelling of effluent discharges at three depths of –20m, -30m and –40m.	The specified water quality objectives can be achieved with no alteration to the existing STP process for most water quality parameters; for some parameters the water quality objectives were exceeded; further modelling and detailed design of the STP and outfall would address these issues
2013, Elgin: *Merimbula Bay Algal Bloom Study*	• EPA and BVSC collaborative study to investigate the effects of effluent discharge from Merimbula STP on the occurrence of periodic algal blooms in Merimbula Bay; and • analytical approach of using nitrogen stable isotopes to determine whether the nitrogen present in drifting macroalgae is derived from sewage effluent, typically isotopically enriched in 15N	The dominant bloom forming alga in Merimbula Bay during 2008-12 study period was the filamentous brown alga *Hinksia sordida; H. sordida* has a clear competitive advantage over other algae in an environment where nitrogen inputs are continuous or regularly pulsed; the origin of *H. sordia* blooms is unclear*;* dataset for *H. sordida* isotopically enriched with ^{15}N was limited by inadequate spatial and temporal sampling; the ^{15}N signature was highly variable; data from 2008 suggested effluent had negligible influence; data from 2011-12 suggested effluent derived nitrogen was assimilated by the algae; anecdotal accounts from several long-term Merimbula residents indicate macroalgal blooms have been a regular occurrence since the 1950's, before the STP and outfall were built

Report	Brief Summary of Report / Options Considered	Recommendations/Key Findings
2013, IGGC: *Disposal of Effluent from Merimbula Sewage Treatment Plant by Dunal Exfiltration – Investigation and Assessment of Impacts on Groundwater Levels and Water Quality of Merimbula Lake and Bay*	• project implementation of further investigations recommended in the 2006 reports; • drilling of additional monitoring wells, test production wells, test pumping and numerical modelling and assessment for simulation of exfiltration for each of the three potential discharge areas; and • assessment of potential mechanisms of discharge, travel times and potential for increased nutrient fluxes to the lake and ocean and the benthic zone sediments through which discharge occurs	All three areas investigated are viable for disposal of excess effluent from a hydraulic loading perspective; preferred method could be a trench or wells; detailed design and management plan required; remaining uncertainties include groundwater chemistry for nitrate and phosphorous removal and ultimate nutrient flux of these nutrients to Merimbula Lake and ocean.
2013, AECOM: Ecological Assessment of the Potential Impacts on Merimbula Lake from Shallow Dunal Exfiltration of Effluent	• identification of aquatic habitats and protected ecological area in Merimbula Lake; • review and interpretation of nutrient flux data for comparison against background data provided by the EPA and literature; • identification of potential impacts associated with modelled nutrient fluxes on the receiving environment; and • identification of likely approvals pathways associated with the shallow dunal exfiltration option	Two of the four scenarios modelled (IGGC, 2013) show all of the phosphorous (P) and nitrogen (N) is absorbed and denitrified in the groundwater system before it reaches the lake; one scenario shows both P and N would be discharged and potentially lead to enhanced production of micro-algae in the sediments and more visible macro-algae in the vicinity of the discharge location; one scenario would have potential impacts on saltmarsh, seagrass and mangrove vegetation.

4.3 Strategic alternatives

This section outlines the strategic alternatives considered for the Project and the approach taken to select the preferred strategic alternative for the Project.

The MEOI project (AECOM, 2013) was commissioned to identify and assess options for effluent disposal and re-use and recommend a preferred strategy for Council consideration. It was initiated following NSW EPA inclusion of a condition in Merimbula STP Licence for this to occur. The project was undertaken from 2009-2013 and involved considering a long-list of options from previous work, identifying information gaps, initiating further studies, collating and interpreting data and information, developing a short-list of options, developing re-use schemes and forming a Focus Group to assess the options and schemes by multi-criteria analysis (MCA). Further studies undertaken included 2010 AECOM, 2013 IGGC and 2013 AECOM documented in **Table 4-2**.

Eight re-use options and three disposal options were formulated, as described in **Table 4-3**.

The MEOI Focus Group's role was to consult, guide, review and discuss the available information and recommend a preferred effluent management strategy to Council. The MEOI Focus Group consisted of consultants and representatives from the NSW Office of Water, NSW EPA, Merimbula and Pambula Lake Shellfish Quality Assurance Programs, Southern Rivers Catchment Management Authority, BVSC and a community representative. The MEOI Focus Group considered the strategic alternatives described in **Table 4-3**.

Fact Sheets were developed by AECOM and BVSC as part of the MEOI project to summarise relevant project information for existing and future scheme options described in **Table 4-3**, including;

- Descriptions of re-use and treatment options;
- infrastructure requirements;
- operational requirements;
- potential for effluent re-use/disposal;
- reliability of option;
- social and environmental impacts, including greenhouse gas emissions;
- life cycle costs; and
- key opportunities and constraints.

The fact sheets (*"Fact Sheets 1 -16 Merimbula Effluent Options Investigation (BVSC & AECOM 2013).pdf")* can be found on BVSC's website at the following address: https://begavalley.nsw.gov.au/cp_themes/default/page.asp?p=DOC-DKK-80-42-24. Key opportunities and constraints identified at the time of writing the fact sheets are included in **Table 4-3**.

Table 4-3 Merimbula Effluent Options Investigation (MEOI) Project (AECOM, 2013a) Options Considered for Effluent Disposal and Re-use

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
Continue existing re-use (Do nothing)	• PMGC grounds • Oaklands agricultural area irrigation	Existing re-use arrangements.	• approved scheme and operational; • utilises existing PMGC grounds irrigation infrastructure and Oaklands irrigation infrastructure financed by the users; • community and golfers benefit by providing reliable irrigation water to PMGC; • supports local agriculture by providing reliable irrigation water to Oaklands agricultural area; • substitutes historical use of river water at Oaklands agricultural area to reduce stress on natural water resources; and • relatively small carbon footprint through operation and relatively low operational cost.	• ongoing management controls for the PMGC grounds and Oaklands agricultural area are required in accordance with the Merimbula Sewerage Scheme Operational Environmental Management Plan to minimise the potential risk to receiving environments and public health (i.e. ongoing Council resourcing required); and • reliant on a private operator with financial capacity to purchase, install and operate an efficient and suitable irrigation system in an appropriate manner.

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
Re-use Scheme 1	• PMGC irrigation expansion • Oaklands agricultural irrigation	Re-use Scheme 1 includes an expansion of the irrigation of treated wastewater on the PMGC grounds, the construction of an on-site wastewater storage dam on the PMGC and the continued irrigation of Oaklands agricultural area on the Pambula River flats. It also includes STP upgrades that would be undertaken as a minimum as part of future treated wastewater management upgrades.	• upgrades existing PMGC irrigation system infrastructure, which is aging, with a more efficient system able to be controlled and operated more effectively; • moderate increase in 2025 potential re-use potential (~9%) and decease in the volume of effluent for disposal; • improved playing amenity and appearance of the golf course with potential social benefits through increased visitation; • less BVSC management controls and oversight is required because professional greenkeeper staff operate the system efficiently; • community appreciation of increased effluent re-use and water recycling practices; • relatively small carbon footprint through operation and relatively low operational cost; and • others as identified for the Existing Re-use Scheme.	• relatively high construction cost, particularly for the 70 ML effluent storage dam (AECOM estimated construction costs are $1.5M higher than previous estimates); • existing PMGC system is old and total replacement may be required, potentially further increasing the capital cost • minor works anticipated in road verge of Arthur Kaine Drive and truck movements for storage earthworks and construction may impact on local traffic; • minimal remnant vegetation removal for effluent storage, however environmental footprint is relatively high in comparison to other beneficial re-use options; and • others as identified for the Existing Re-use Scheme.

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
Re-use Scheme 2a	• PMGC grounds irrigation • Oaklands agricultural area irrigation • Pambula open space irrigation	Re-use Scheme 2a includes the supply of treated wastewater for use at the open space areas of Pambula Sports Complex, Pambula Recreation Ground and Pambula Cemetery. It also includes the existing treated wastewater re-use scheme at the PMGC grounds and Oaklands agricultural area and the treatment plant upgrades that would be undertaken as a minimum as part of future wastewater management upgrades	• upgrades existing irrigation system infrastructure with more efficient systems able to be controlled and operated more effectively; • improved playing amenity and appearance of the playing fields with social benefits through increased visitation and enjoyment; • reduced town water usage and cost of using town water for irrigation of playing fields and cemetery; • community appreciation of increased effluent re-use and water recycling practices; • environmental footprint is relatively low in comparison to other re-use options; and • others as identified for the Existing Re-use Scheme.	• relatively small increase in 2025 potential re-use percentage (~2%) and decrease in the volume of effluent for disposal; • relatively high construction cost for the benefit achieved in terms of percentage reduction of effluent disposal; • minor works anticipated in road verge of Pambula Beach Road may impact on local traffic; • reliant on Council operations staff and/or volunteer management committees to operate Pambula Open Space area irrigation systems in an appropriate manner; • new management controls for Pambula Open Space areas will need to be developed, implemented and added to the existing management controls for the PMGC grounds and Oaklands agricultural area in accordance with an updated Merimbula Sewerage Scheme Operational Environmental Management Plan to minimise the potential risk to receiving environments and public health (i.e. increased Council resourcing required); and • others as identified for the Existing Re-use Scheme.

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
Re-use Scheme 2b	• PMGC irrigation • Oaklands agricultural irrigation • South Pambula area agricultural irrigation	Re-use Scheme 2b includes the supply of treated wastewater for irrigation of agricultural land at South Pambula on the Pambula River flats. It also includes the existing wastewater re-use scheme at the PMGC grounds and Oaklands and the treatment plant upgrades that would be undertaken as a minimum as part of future wastewater management upgrades.	• supports local agricultural by providing reliable irrigation water • substitutes historical use of river water at South Pambula to reduce stress on natural water resources; • scheme has potential for staged expansion to Lochiel; • community appreciation of increased effluent re-use and water recycling practices; • relatively small carbon footprint through operation and relatively low operational cost; • environmental footprint is relatively low in comparison to other re-use options; and • others as identified for the Existing Re-use Scheme	• relatively small increase in 2025 potential re-use percentage (~2.5%) and decrease in the volume of effluent for disposal; • Pambula Lake oyster farmers have expressed opposition to increased effluent irrigation in the Pambula River catchment; • major works in road verge along Pacific Highway and Pambula River bridge crossing, requiring traffic management and possibly night works; • minor works in road verge along Northview Drive and Mount Darragh Road possibly impacting on local traffic; • a number of watercourse crossings and the bridged crossing of Pambula River, increasing pipeline installation costs; • new management controls for South Pambula areas will need to be developed, implemented and added to the existing management controls for the PMGC grounds and Oaklands agricultural area in accordance with an updated Merimbula Sewerage Scheme Operational Environmental Management Plan to minimise the potential risk to receiving environments and public health (i.e. increased Council resourcing required); • reliant on two new private landholders with the capability and willingness to operate an efficient and suitable effluent irrigation system in an appropriate manner; and • others as identified for the Existing Re-use Scheme.
Re-use Scheme 2c	• PMGC irrigation	Re-use Scheme 2c includes the supply of wastewater for irrigation	• relatively large increase in 2025 potential re-use percentage (~18%)	• relatively high capital and operational costs, with relatively high carbon footprint through operation;

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
	• Oaklands agricultural irrigation • South Pambula area agricultural irrigation • Lochiel area agricultural irrigation	of agricultural land at Lochiel and South Pambula. It also includes the existing treated wastewater re-use scheme at the PMGC grounds and Oaklands and the treatment plant upgrades that would be undertaken as a minimum as part of future wastewater management upgrades	and decrease in the volume of effluent for disposal; • scheme has potential for further staged expansion and connection to other properties with land suitable for irrigation; • supports local agricultural by providing reliable irrigation water • substitutes historical use of river water to reduce stress on natural water resources; • community appreciation of increased effluent re-use and water recycling practices; • environmental footprint is relatively low in comparison to other beneficial re-use options; and • others as identified for the Existing Re-use Scheme.	• Pambula Lake oyster farmers have expressed opposition to increased effluent irrigation in the Pambula River catchment; • major works in road verge along Pacific Highway and Pambula River bridge crossing, requiring traffic management and possibly night works with minor works in road verge along Northview Drive and Mount Darragh Road potentially impacting on local traffic; • a number of watercourse crossings and the bridged crossing of Pambula River, increasing pipeline installation costs; • new management controls for Lochiel area will need to be developed, implemented and added to the existing management controls for South Pambula, the PMGC grounds and Oaklands agricultural area in accordance with an updated Merimbula Sewerage Scheme Operational Environmental Management Plan to minimise the potential risk to receiving environments and public health (i.e. increased Council resourcing required) • reliant on three new private landholders with the capability and willingness to operate an efficient and suitable effluent irrigation system in an appropriate manner; and • others as identified for the Existing Re-use Scheme.
Re-use Scheme 3a	• PMGC irrigation • Oaklands agricultural irrigation	Re-use Scheme 3a builds on the existing treated wastewater re-use schemes at the PMGC grounds and the Oaklands agricultural	• relatively large increase in the 2025 percentage re-use (~17%) and decrease in the volume of effluent for disposal;	• relatively high capital and operational costs, with relatively high carbon footprint through operation; • reliant on a new private landholder with the capability and willingness to operate an efficient

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
	• Millingandi area agricultural irrigation	land on the Pambula River flats, with the additional supply of treated wastewater for the irrigation of agricultural areas around Millingandi. The scheme also includes a number of STP upgrades which have been committed as a part of BVSC's future wastewater management strategy.	• landholder has expressed keen interest in an effluent re-use scheme on the property identified; • irrigation areas are further from water courses than those for Schemes 2b and c; • scheme has some potential for further staged expansion and connection to other properties with land suitable for irrigation; • supports local agriculture by providing reliable irrigation water; • community appreciation of increased effluent re-use and water recycling practices; • subject to condition assessment, there is a potential opportunity to utilise up to 3.5 km of an existing 225 mm cast iron cement lined Tantawanglo pipeline with an estimated cost saving of up to $600K; and • others as identified for the Existing Re-use Scheme.	and suitable effluent irrigation system in an appropriate manner; • Merimbula Lake oyster farmers may oppose increased effluent irrigation in the Merimbula Lake catchment; • should the Tantawanglo pipeline be utilised, there is large amount of uncertainty around its integrity and cross connection with duplicate water supply mains running in parallel would need to be eliminated; • major works in road verge along Princes Highway requiring traffic management and possibly night works; • a number of watercourse crossings and up to 1km of pipe installation through siltstone, increasing pipeline installation cost by up to $180,000; • construction footprint >50,000 m2 is relatively large in comparison to other re-use options (reduced by up to 40% if the Tantawangalo pipeline can be utilised); • new management controls for Millingandi will need to be developed, implemented and added to the existing management controls for the PMGC grounds and Oaklands agricultural area in accordance with an updated Merimbula Sewerage Scheme Operational Environmental Management Plan to minimise the potential risk to receiving environments and public health (i.e. increased Council resourcing required); and • others as identified for the Existing Re-use Scheme.

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
Re-use Scheme 3b	• PMGC irrigation • Oaklands agricultural irrigation • Wolumla area agricultural irrigation	Re-use Scheme 3b includes the supply of treated wastewater for irrigation of agricultural land north of Wolumla near Wanatta Lane. It also includes the existing treated wastewater re-use scheme at the PMGC grounds and Oaklands and the STP upgrades that will be undertaken as a minimum as part of future wastewater management upgrades.	• very large increase in 2025 potential re-use percentage (~53%) achieved, decreasing significantly the effluent volume for disposal • irrigation areas are located outside of the Pambula Lake and Merimbula Lake catchment areas • supports local agriculture by providing reliable irrigation water • community appreciation of increased effluent re-use and water recycling practices • subject to condition assessment, there is a potential opportunity to utilise up to 12.3 km of an existing 225 mm cast iron cement lined Tantawanglo pipeline with an estimated cost saving of up to $4 M • others as identified for the Existing Re-use Scheme	• very high capital and operational costs, with very high carbon footprint through operation; • potential for community misperception that Wolumla is a strategic disposal site for the shires solid and liquid wastes; • reliant on Council and at least three new private landholders with the capability and willingness to operate an efficient and suitable effluent irrigation system in an appropriate manner; • should the Tantawanglo pipeline be utilised, there is large amount of uncertainty around its integrity, friction losses would be higher (with less flow transferred) and cross connection with duplicate water supply mains running in parallel would need to be eliminated; • major works in road verge along Princes Highway requiring traffic management and possibly night works • minor works in road verge along Wanatta Lane and Millingandi Road may impact on local traffic; • a large number of watercourse crossings and up to 6 km of pipe installation through siltstone, increasing pipeline installation cost by up to $1.35 M (significantly reduced if Tantawanglo pipeline can be utilised); • construction footprint >140,000 m2 is relatively high in comparison to other re-use options; • new management controls for Wolumla will need to be developed, implemented and added to the existing management controls for the PMGC grounds and Oaklands agricultural area in accordance with an updated Merimbula Sewerage Scheme Operational Environmental Management Plan to minimise the potential risk

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
				to receiving environments and public health (i.e. increased Council resourcing required); and • others as identified for the Existing Re-use Scheme
Re-use Scheme 4	• PMGC irrigation • Oaklands agricultural irrigation • indirect potable re-use – Yellow Pinch Dam	Re-use Scheme 4 includes the supply of high-quality treated wastewater to the drinking water storage of Yellow Pinch Dam for indirect potable re-use. It also includes existing treated wastewater re-use schemes at the PMGC grounds and Oaklands agricultural area and the STP upgrades that will be undertaken as a minimum as part of future wastewater management upgrades.	• very large increase in 2025 potential re-use percentage (~56%) achieved, decreasing significantly the effluent volume for disposal; • subject to condition assessment, there is a potential opportunity to utilise up to 12.3 km of the existing 225 mm cast iron cement lined Tantawanglo pipeline, with an estimated cost saving of up to $4 M; • reduces extraction of river water from Tantawanglo Creek and the Bega River; and • others as identified for the Existing Re-use Scheme.	• community objection to drinking recycled water; • there is no immediate need to supplement the supply of water to Yellow Pinch Dam since the 2012; commissioning of the Bega to Yellow Pinch Dam pipeline • advanced water treatment facility carries extremely high capital and operational costs; • should the Tantawanglo pipeline be utilised, there is large amount of uncertainty around its integrity, friction losses will be higher (with less flow transferred) and cross connection with duplicate water supply mains running in parallel would need to be eliminated; • major works in road verge along Princes Highway, requiring traffic management and possibly night works • minor works in road verge along Millingandi Road may impact on local traffic; • a number of watercourse crossings and up to 5km of pipe installation through siltstone, increasing pipeline installation cost by up to $0.975 M (significantly reduced if Tantawanglo pipeline can be utilised); • construction footprint >90,000 m2 is relatively high in comparison to other re-use options; and • others as identified for the Existing Re-use Scheme.

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
Disposal Option 1	• reinstated ocean outfall	A new ocean outfall disposal option requires a new transfer pipeline and a submerged diffuser outlet located some distance (up to five kilometres) offshore and an upgrade of the existing pumping capacity to transfer treated wastewater to the point of discharge. Construction of the pipeline would require a combination of trenching and horizontal directional drilling, commencing from a point east of the STP behind the foredunes of the Pambula-Merimbula dunal system, and exiting approximately one kilometre away beyond the zone of wave influence, before adopting a dredge and lay construction methodology for several kilometres offshore to a favoured depth of about 40 metres below the water surface.	• full capacity to dispose all effluent discharged for the STP including wet weather flows; • proven technology; • potential to meet relevant environmental objectives, particularly if built to the 40 metre depth distance offshore; • does not impact on Merimbula Beach shoreline or sensitive receptors such as Merimbula and Pambula Lakes, if built to the 40 metre depth distance offshore (subsequently modelled this can be reduced); and • relatively low landward construction footprint.	• higher construction and operational costs than dunal exfiltration or deep aquifer injection systems; • difficult construction conditions with a risk of unsuitable geological materials for drilling and dredging; • potentially high pipeline construction impacts, including disruption of marine environments flora and fauna, depending on construction methodology used; and • community opposition is likely to be high.

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
Disposal Option 2	• shallow dunal exfiltration via trench or well	Disposal Option 2 (shallow dunal exfiltration trench) involves the construction of a new exfiltration system within the Merimbula-Pambula dunal system north of the existing exfiltration ponds. Treated wastewater would be pumped to the exfiltration system, or subsurface “trench” (or “wells”) and allowed to exfiltrate and flow in groundwater towards Merimbula Bay and Merimbula Lake.	• relatively small capital and construction cost compared to other disposal system options; • proven technology; • subject of numerous investigations confirming the dune system has the hydraulic capacity for future disposal of volumes during wet and dry weather; • potential to combine with deep alluvial aquifer injection system, constructed wetland or aquifer recharge and recovery system; • majority of effluent disposed would flow east in groundwater to Merimbula Bay; and • groundwater migration provides long residence times for pathogen die-off and nutrient concentration reduction, particularly the proportion that would flow west towards Merimbula Lake.	• a number of statutory approvals will require consideration through consultation with respective agencies under the Commonwealth and State legislation; • construction footprint of >10,000m2 , including the clearing of native dune vegetation which may result in the potential for dune destabilisation and impact on Bangalay Sand Forest EEC; • the potential for Aboriginal heritage sites to exist within the proposed footprint and surrounds; • the potential for clogging of the system by algae and suspended solids in the effluent; • sea level and lake level rise would impact negatively on the system; • the potential for attenuation for phosphate and inorganic nitrogen in the sand aquifer may be limited over time; and • a proportion of the effluent would flow in groundwater towards Merimbula Lake.
Disposal Option 3	• deep alluvial aquifer well injection	Deep alluvial aquifer injection is a disposal option involving the pumping of treated wastewater into the deep confined alluvial sequence associated with the former Pambula River. Deep wells would be constructed by drilling bore holes to the required depth	• unlikely to affect sensitive receptors such as Merimbula and Pambula Lakes.	• deep aquifer hydraulic conductivity, chemistry, flow paths and capacity for injection of effluent into the deep alluvial aquifer are not well understood; • limited potential to accommodate wet weather flows, therefore requiring use in combination with another disposal system; • higher construction and operational costs than shallow dunal exfiltration options; • relatively high ongoing pumping requirements and associated greenhouse gas emissions;

Option	Components	Description	Key opportunities identified (MEOI, 2013)	Key Constraints identified (MEOI, 2013)
		(estimated 60 metres or more) and pumping treated wastewater into the deep alluvial sequence. Deep disposal was previously recognised as a potentially promising option for treated wastewater disposal on the assumption that sensitive receptors (such as Merimbula Lake and Pambula Lake) would not be affected. The treated wastewater would instead likely discharge to the ocean at some distance offshore where the Pambula River paleo-channel intersects with the seabed.		• increased maintenance requirements due to susceptibility of deep bores fouling; • the potential for Aboriginal heritage sites to exist within the proposed footprint and surrounds; and • the potential for clogging of the paleochannel strata by biofilms.

The Fact Sheets, reports and other information enabled AECOM and the MEOI Focus Group to develop a multi-criteria analysis (MCA) process to compare the options for disposal systems, re-use schemes and treatment plant upgrades. This was done in a series of workshops in March, April and May 2013.The MCA process addressed the following considerations:

- reliability;
- operation and maintenance;
- constructability;
- public health;
- regional economy;
- aesthetic and recreational amenity;
- Aboriginal heritage;
- natural water resources;
- construction impact;
- greenhouse gas emissions;
- receiving water quality and aquatic ecology; and
- disposal capital cost.

During the final meeting, the MEOI Focus Group selected a preferred strategic alternative for the Project and recommended that:

- an ocean outfall was the favoured effluent disposal option offering the greatest relative environmental and public health benefits;
- BVSC should pursue this disposal option and ways to fund a possible capital funding shortfall exceeding ten million dollars over and above that allowed in BVSC's current long-term financial plan for Merimbula/Pambula STP upgrades and wastewater disposal;
- as a minimum, the Merimbula STP should be upgraded to reduce phosphorus concentrations and improve disinfection; and
- BVSC should defer the expansion of effluent re-use beyond the existing schemes until an outfall is built.

The MEOI Focus Group favoured Re-use Scheme 1 (PMGC irrigation expansion and Oaklands agricultural irrigation) and Re-use Scheme 2a (PMGC, Oaklands agricultural irrigation and Pambula open space irrigation) over other effluent re-use schemes.

The ocean outfall option (Disposal Option 1) was assessed to be the most expensive disposal system to construct. However, the MEOI Focus Group concluded that the ocean outfall offers the greatest relative benefit through improving receiving water quality and ecology, providing the least construction impacts, greatest preservation of Aboriginal heritage, improving aesthetic and recreational amenity, enhancing the regional economy, protecting public health and providing the greatest system reliability.

Water balance modelling was undertaken for the MEOI project for each re-use scheme discussed in **Table 4-3**. The modelling showed that no scheme was capable of achieving 100% re-use due to land capacity constraints, physical storage size limitations and diminished returns from modelling theoretically large storages for wet weather and cooler times of the year when irrigation requirements are low or zero.

Effluent re-use was defined as the volume of effluent applied to meet vegetation growth needs without exceeding the soil infiltration rate or water holding capacity of the soil. This definition was considered an important preventative risk management measure for protecting the health of both the public and environment. It was necessary to distinguish land-based beneficial effluent re-use from land-based effluent disposal. It enabled the per cent re-use estimates to be reliably and consistently estimated and compared for each re-use scheme.

Figure 4-1 illustrates the land constraints surrounding the Merimbula STP. Land sloping less than 10% is suited to irrigating and land sloping >15% should not be irrigated with treated wastewater.

FIGURE 4-1: CONSTRAINTS MAP - MERIMBULA EFFLUENT MANAGMENT
Created by BVSC GIS
14/3/2019

Note that the Project area has been updated from what is shown - refer to Figure 2-1

Created by: Best, Chris
Map Projection: Transverse Mercator
Horizontal Datum: GDA 1994
MGA zone 55, EPSG:28355

Source: Bega Valley Shire Council, 2021; Land and Property Information NSW, 2021

Following the conclusion of the MCA process, Council resolved to proceed with a preferred strategic alternative that would comprise a combination of:

- continued existing effluent re-use via irrigation of PMGC grounds and Oaklands agricultural area;
- Disposal Option 1: disposal of excess effluent via an ocean outfall; and
- STP upgrades to improve effluent quality.

Council also resolved to investigate new effluent re-use schemes including at Pambula Sporting Complex and more broadly in the Shire, although such schemes are not part of the scope of this EIS and are not included in the Project. Similarly, any additional effluent storages or other infrastructure associated with enhancement of the existing re-use schemes (at the PMGC grounds and Oaklands agricultural area) are not included in the scope of this EIS.

As a result of the MEOI project, the Focus Group's findings and Council's adopted strategy, the NSW EPA modified the EPL (No. 1714) for the STP site to require the completion of a concept design and EIS for an ocean outfall and STP upgrade, and to subsequently obtain the necessary approvals, and construct and commission such a project (refer **Chapter 3 Project need and strategic context** for further details).

The memorandum summarising the MEOI Focus Group MCA results and interpretation dated 24 May 2013 can be found in **Appendix B** (Community consultation plan).

4.3.1 Review of preferred strategic alternative

The development of the concept design for the Project involved reviewing the alternative options identified in the MEOI project to confirm the validity of the resulting preferred strategy (i.e. STP upgrade and ocean outfall). The eight re-use schemes and three disposal systems described in **Table 4-3** the MEOI were reviewed. The preferred strategic direction was confirmed as valid for the Project.

4.4 Detailed options considered

Subsequent to re-confirming the preferred strategic direction, a number of detailed options were considered for upgrading the STP, as well as for the alignment of the ocean outfall and depth for the diffuser. These options were developed in parallel to the commencement of early environmental investigations, which were used to inform the selection of the preferred detailed option. These investigations included the formulation of a complex oceanographic model (and validation of its calibration by an independent third party), geotechnical assessments, archaeological assessments (investigating both Aboriginal and non-Aboriginal heritage potential) and terrestrial and marine ecology studies.

This section describes the options for STP treatment processes and ocean outfall alignment and diffuser depth, how they were analysed and how the preferred option (i.e. the Project) was selected.

4.4.1 Options for STP treatment

The treatment options outlined in **Table 4-4** were considered as they best met the Project objectives, specified in **Section 3.2** in **Chapter 3.0 Project need and strategic context** of this EIS.

Table 4-4 STP upgrade options

Option	Option description	Advantages	Disadvantages
Option 1	• Phosphorus removal with Poly Aluminium Chloride (PAC), dosing before Intermittently Decanted Extended Aeration (IDEA) tanks • ultraviolet (UV) treatment • Chlorine dosing	• lower capital expenditure and operational expenditure.	• Aluminium contamination of biosolids; and • potential increase in Aluminium in final wastewater.
Option 2	• Phosphorus removal with PAC, dosing before and after IDEA tanks • UV treatment • Chlorine dosing • tertiary filtration.	• improved quality of treated wastewater via: - enhanced Phosphorus removal – 1 mg/L - improved heavy metal removal – tertiary filtration - potential to minimise impact of Aluminium in final treated wastewater • reduced load on downstream disinfection processes.	• higher capital expenditure and operational expenditure; • additional waste streams; • Aluminium contamination of biosolids; • increased Aluminium sludge production compared to Option 1B; and • increased pumping requirements – filters.

4.4.2 Options for ocean outfall alignment (from shore to pipeline diffuser location)

Four alignment options for the ocean outfall were considered during development of the concept design for the Project, as summarised in **Table 4-5**. The assessment of outfall alignment options was supported by initial hydrodynamic modelling based on existing treated wastewater quality discharged at the potential outfall diffuser locations.

Table 4-5 Pipeline alignment options

Option	Length from STP (metres)	Diffuser depth (metres)	Advantages	Disadvantages
1 – North-Short	3,500 m	30 m	• shortest length – lower construction costs • shortest length – reducing the distance in which water-based construction would be required, in turn reducing the safety and maintenance risks associated with this as far as practicable; • unlikely to encounter shallow buried rock; • would not cross any known rocky reef habitat; • unlikely to require intermediate construction site within dunes; • depth does not require specialist divers to construct/maintain; and • greater protection from trawler vessels.	• centrally located in Merimbula Bay – less desirable for community stakeholders; and • slower dispersion than long options.
2 – North-Long	5,220 m	40 m	• unlikely to encounter shallow rock within embayment; • unlikely to require intermediate construction site within dunes; • deep location would have greater dilution; and • faster dispersion than short options.	• long length – higher construction costs/risks; • increased construction and maintenance risks/costs due to depth; • crosses shallow rock outcrop beyond embayment, and closer to rocky reef habitat around Hunter Rock than Option 1 – North Short; and • less protection from trawler vessels.

Option	Length from STP (metres)	Diffuser depth (metres)	Advantages	Disadvantages
3 – South-Short	4,470 m	25 m	• short length – lower construction costs; • unlikely to encounter shallow rock within embayment; • depth does not require specialist divers to construct/maintain; and • greater protection from trawler vessels.	• some construction likely in rock – higher construction risks/costs than Option 1 – North-Short; • location is closer to sensitive ecology around Hunter Rock and reef than northern options; • proximity to Hunter Rock/reef is less desirable for community stakeholders; • higher likelihood of intermediate construction site within dunes due to pipe curvature; and • slower dispersion than long options.
4 – South-Long	6,500 m	30 m	• good dilution and dispersion east of Haycock Point; and • faster dispersion than short options.	• largest construction footprint required, resulting in higher risks, costs and environmental impacts; • location is closest to sensitive ecology around Hunter Rock and reef than northern options; • proximity to Hunter Rock/reef is least desirable for community stakeholders; • higher likelihood of intermediate construction site within dunes due to pipe curvature; and • less protection from trawler vessels.

4.4.3 Pipeline alignment option from STP to shore

The alignment from the STP to shore was consistent across all options and has been designed to avoid known environmental constraints found in the area. All options currently rely on successfully minimising construction impacts within the dunes. Known environmental constraints include:

- threatened vegetation communities including Endangered Ecological Communities (EEC) (refer **Chapter 12 Terrestrial ecology**); and
- recorded Aboriginal cultural heritage items/sites in close proximity to the existing dunal exfiltration ponds (refer **Chapter 14 Aboriginal heritage**).

4.4.4 Community Working Group multi-criteria analysis

In 2017, a CWG was established to work through an MCA process to help select a preferred option and provide recommendations to BVSC for the Project. Project options were considered by the CWG, as well as the results of environmental investigations. More information about the CWG and its assessment process is provided in **Chapter 6.0 Consultation**.

During several meetings held between December 2017 and August 2019, the CWG:

- developed a preliminary list of criteria for use in evaluating the options for the Project;
- confirmed and agreed upon the relative importance of each criterion; and
- scored options against these criteria, thus identifying a CWG preferred option.

All options involve an effluent management strategy consistent with that adopted by BVSC in 2014, namely upgrades to the Merimbula STP to improve effluent quality and the construction of an ocean outfall (as outlined in **Section 4.5**).

The CWG criteria and respective rankings are outlined in **Table 4-6** below.

Table 4-6 CWG criteria and weighting

Category	Criterion	Description	Weighting	Rank
Environmental	Ecology	Terrestrial and/or aquatic impacts/benefits (with respect to any threatened species, threatened habitat or endangered ecological communities, wetlands, marine life). Potential impacts/benefits to threatened aquatic species, populations, habitat and communities – e.g. wetlands, benthic habitats, rocky reefs, disturbance of the seabed, bioaccumulation risk, noise and vibration impacts on marine mammals.	28%	1st
Environmental	Water quality	Potential impacts/benefits to water quality (groundwater, estuarine and marine) with consideration of: • water chemistry – disinfection chemicals (e.g. chlorine) and by-products, nutrients (nitrogen, phosphorus), heavy metals, microplastics; • treated wastewater plumes and zones of influence – including during rainfall events, risk of long-shore drift/circulation/flow-back to beaches or estuaries, potential algal blooms; and • human health risk (via marine contact pathways, or future re-use opportunity pathways – e.g. sporting field irrigation).	19%	Equal 2nd
Environmental	Sustainability and climate change	Resilience to climate change (e.g. rainfall variance, extreme weather, sea level rise), greenhouse gas production (in construction, operation, and/or renewal work); including: • ability to adapt to suit changing conditions – rainfall variance, extreme weather/storm impacts (e.g. east coast low pressure systems), sea level rise, capacity for ecosystem migration; • greenhouse gases; • embodied CO_2 for construction, operation/maintenance, and renewal; • adaptability to technology change – including ability to continue to maximise land-based re-use, minimise ocean disposal; and • ability to meet the proposed Infrastructure Sustainability Council of Australia (ISCA) target rating.	19%	Equal 2nd

Category	Criterion	Description	Weighting	Rank
Economic	Local and regional economy	Impacts/benefits to tourism, tourism-related industries, business-in-general, employment (including long-term – e.g. employment, ‘clean’ reputation) in areas such as: • aquaculture; • oyster, abalone, commercial fishing industries; • agriculture; • tourism - during construction; seasonal impacts (e.g. during school holidays); • PMGC; and • restrictions on vessels in Merimbula Bay.	19%	Equal 2nd
Social	Recreation	Impacts/benefits to recreational amenity including: • fishing –impacts/benefits to proposed artificial reef; • diving; • swimming, surfing, beach use/beach walking/beach health; • recreational boating; • visual amenity – aesthetics (of constructed project infrastructure); and • noise/traffic generated during construction.	10%	Equal 5th
Environmental	Heritage	Aboriginal and European heritage impacts/benefits (during construction or operation) such as those to scarred trees, middens, rock art sites, burial sites, buildings, historical sites, sensitive landscapes, Empire Gladstone shipwreck off Haycock Point.	5%	Equal 5th
Environmental	Odour	Odour impacts/benefits (e.g. from the operation of a wastewater treatment process (including any associated lagoons/pondage), wastewater flow discharge, sewer vent or pump station).	0%	7th

The two treatment options for the STP upgrade and four options for the ocean outfall alignment (outlined in **Table 4-4** and **Table 4-5**) were shared with the CWG. Combinations of these options (a treatment option with each of the four ocean discharge location options) resulted in eight options. These eight options were scored through an MCA using the CWG criteria.

Based on the information available, the CWG recommended that BVSC select the option most protective of the environment of Merimbula Bay which was judged to be:

- the higher wastewater quality treatment option of the two treatment options offered; and
- the outfall discharge location that takes advantage of oceanographic conditions that minimise the potential for dispersed treated wastewater to impact the environment of Merimbula Bay.

The results of the CWG MCA showed that the four options that include the addition of a new STP filtration (treatment) process generally scored higher compared to the four options without such a new treatment process.

In summary, the CWG preferred option was Option 2 – North-Long ocean outfall discharge location, with STP Upgrade Option 2 (dual point chemical dosing for phosphorus removal, and a new additional filtration process).

The North-Long option was preferred by the CWG because the longer option was perceived to present a lower environmental risk for Merimbula Bay. However, the CWG also indicated a general awareness of the cost implications of a longer outfall and was generally supportive of measures to reduce the length of the pipeline, provided the environment would not be compromised in the process. Furthermore, the CWG understood that BVSC, in deciding which option to select for design development and environmental assessment, would be informed by the technical Project team options assessment, concept design development, cost estimates for each of the options, community and stakeholder feedback (refer **Chapter 6.0 Consultation**) and CWG recommendations.

Further detail on the CWG assessment and subsequent recommendations is provided in a memorandum from the CWG to BVSC dated 18 Sept 2019, which is included in **Appendix B** (Community consultation plan).

4.4.5 Technical team multi-criteria analysis

Representatives from design and environment technical disciplines within the Project team participated in a technical MCA on 30 August 2019. As with the CWG MCA, the two STP treatment options and four ocean outfall alignment option s were combined to provide a total of eight options for analysis. Several non-cost criteria were developed and weighted, then the team scored the eight options against each criterion. Costs were not included in the MCA in order to select the most preferred option irrespective of cost.

Project team members were selected to participate in the scoring of options against weighted non-cost criteria. Team members were selected for their technical expertise, understanding or deeper knowledge in the areas of each criterion.

Scoring of options included consideration of:

- oceanographic modelling outcomes (available at time of scoring);
- treatment options;
- discharge location options;
- recent specialist constructability advice;
- relevant background studies; and
- relevant community and stakeholder feedback.

The criteria developed by the technical team and their respective weightings are presented in **Table 4-7**. The rankings from the technical MCA were similar to the rankings from the CWG MCA (with only the weighting for each criterion differing).

Table 4-7 Technical MCA criteria and weighting

Category	Criterion	Description	Weighting	Rank
Environmental	Ecology	Terrestrial and/or aquatic impacts/benefits (in particular, with respect to any threatened species, threatened habitat or endangered ecological communities, wetlands, marine life): • terrestrial - potential impacts/benefits to terrestrial threatened species and populations, habitat and endangered ecological communities (e.g. through the removal of or damage to vegetation and habitat); and • aquatic - potential impacts/benefits to threatened aquatic species, populations, habitat and communities (e.g. wetlands, benthic habitats, rocky reefs, disturbance of the seabed, bioaccumulation risk, noise and vibration impacts on marine mammals).	29%	1st
Environmental	Water quality	Potential impacts/benefits to water quality (groundwater, estuarine and marine) with consideration of: • water chemistry - disinfection chemicals (e.g. chlorine) and by-products, nutrients (nitrogen, phosphorus), heavy metals, micro-plastics; • treated wastewater plumes and zones of influence - including during rainfall events; risk of long-shore drift/circulation/flow-back to beaches or estuaries, potential algal blooms; and • human health risk (via marine contact pathways, or future re-use opportunity pathways – e.g. sporting field irrigation).	24%	2nd
Environmental	Sustainability and climate change	Resilience to climate change (e.g. rainfall variance, extreme weather, sea level rise), greenhouse gas production (in construction, operation, and/or renewal work): • resilience to climate change - ability to adapt to suit changing conditions (rainfall variance, extreme weather/storm; impacts (e.g. east coast lows), sea level rise, capacity for ecosystem migration) • greenhouse gases - embodied CO_2 for construction, operation/maintenance, and renewal; • adaptability to technology change - including ability to continue to maximise land-based re-use, minimise ocean disposal; and • ability to meet ISCA target rating.	19%	3rd

Category	Criterion	Description	Weighting	Rank
Economic	Local and regional economy	Impacts/benefits to tourism, tourism-related industries, business-in-general, employment, including long-term (e.g. having a 'clean' reputation) in areas such as: • aquaculture: oyster, abalone, commercial fishing industries; • agriculture; • tourism: during construction; seasonal impacts – e.g. during school holidays; • PMGC; and • restrictions on vessels in Merimbula Bay.	14%	4th
Social	Recreation	Impacts/benefits to recreational amenity (e.g. boating, swimming, fishing, bushwalking, and other recreational pursuits): • fishing - including impacts/benefits to proposed artificial reef; • diving; • swimming, surfing, beach use/beach walking/beach health; • recreational boating; • visual amenity - aesthetics (of constructed project infrastructure); and • noise/traffic during construction.	7%	Equal 5th
Environmental	Heritage	Aboriginal and European heritage impacts/benefits (during construction or operation) such as scarred trees, middens, rock art sites, burial sites, buildings, historical sites, sensitive landscapes, and Empire Gladstone shipwreck off Haycock Point.	7%	Equal 5th
Environmental	Odour	Odour impacts/benefits (e.g. from the operation of a wastewater treatment process (including any associated lagoons/pondage), a wastewater flow discharge, sewer vent or pump station).	0%	7th

The technical MCA found:

- discharge locations along the northern alignment (Option 1 – North-Short and Option 2 – North-Long) are preferred (regardless of associated treatment option); and
- treatment upgrade options that included the addition of a new STP filtration process (Option 2) generally scored higher compared to the options without such a new process (Option 1).

At the time, the STP Upgrade Option 2 was provisionally recommended pending further oceanographic modelling and an assessment of marine impacts. Additionally, it was recommended that the outfall alignment and diffuser location be optimised with consideration of costs and environmental impacts.

4.4.6 Preferred option (i.e. the Project)

A Value Engineering Workshop was held for the Project on 26 September 2019 and was attended by BVSC representatives and members of the consultant project team, including engineers and environmental specialists. The Value Engineering Workshop reviewed inputs from the technical MCA, CWG MCA, design development undertaken to date and cost estimates. The Value Engineering Workshop was structured to identify value adding opportunities with the aim of identifying a preferred option for both the STP and the ocean outfall.

Key outcomes from the workshop were:

- STP upgrades:
  - BVSC expressed its preference to decommission the existing wastewater storage ponds, which could be left as a dry pond or backfilled as required; and
  - BVSC expressed its preference for chlorine gas disinfection over sodium hypochlorite for consistency across other plants.
- ocean outfall:
  - southern alignments were deemed less favourable than northern alignments due to proximity to Hunter Rock which would increase the risk of environmental impacts, and construction costs; and
  - the North-Long alignment was deemed to be marginally more favourable than the North-Short alignment, however it had increased cost and construction/maintenance risks due to extended length and increased depth.

As a result of the outcomes from the Value Engineering Workshop, on 30 October 2019, BVSC resolved to adopt the treatment Option 2, inclusive of dual-point phosphorous removal, a tertiary filtration device (if required), and UV disinfection upgrade, together with ocean outfall Option 1 – North-Short (i.e. the Project).

Option 1 – North-Short was selected as the preferred option because:

- the results of far field dispersion modelling found that the North-Short diffuser location achieves a desired level of water quality performance;
- the submerged reef is well outside the nominal 500 metre radius described in the SEARs for Option 1 – North-Short diffuser location (30 metres depth). However, it is within about 250 metres of Option 2 – North-Long (40 metres depth). Avoiding the submerged reef is preferable for biodiversity and constructability reasons. Construction at a depth of more than 30 metres underwater requires a decompression chamber on the diving vessel, and would therefore require a larger vessel. Construction at a depth of more than 40 metres underwater in open ocean is also subject to a larger number of standby days where divers cannot operate; and costs for equipment and vessels on these days would still be incurred; and
- construction at depth poses a greater safety risk during construction and maintenance; and therefore Option 1 – North-Short carries less risk to safety during construction and maintenance than Option 2 – North-Long.

During design development, a number of iterations for the diffuser configuration were considered before the configuration chosen for the 30% concept design was settled upon. The primary criterion for the design of the diffuser assembly was that it should achieve the amount of dispersion required against the performance criteria and to minimise the size of the mixing zone. Other (secondary) factors were that the design was simplified as far as possible to reduce cost and improve maintainability once the performance had been verified, and multiple risers (i.e. three) were also needed in CORMIX's multiport module. A multiport design was also noted to add some redundancy in the event a diffuser riser is damaged or clogged. The final diffuser configuration is subject to subsequent design development and will continue to be subject to environment and cost considerations.

The Project provides a more reliable method for disposing of excess treated wastewater during wet weather periods, when treated wastewater re-use schemes cannot irrigate. Additional re-use schemes or storage would not remove the need for such a sustainable disposal system at Merimbula for times when there is little demand for treated wastewater.

The Project description is provided in **Chapter 2.0 Project description**.

4.5 Construction methodologies

Construction methodologies and technologies for the ocean outfall were developed based on geotechnical and environmental constraints, as well as feasibility and cost efficiency.

Several potential options for construction access have been considered for the Project. Initially, access routes off Arthur Kaine Drive, east of the STP, were considered. However, these were not chosen due to the risk of impacting known Aboriginal sites and ecological values. Access routes at various points at the northern end of Merimbula Beach were also considered but were likewise not pursued due to inadequate access for construction vehicles and/or impacts to public facilities and vegetation. Temporary construction beach access from Pambula Beach to the laydown area on Merimbula Beach has been selected to avoid these issues, primarily potential impacts to Aboriginal sites within the foredune and backbarrier flat components of the Merimbula Barrier sand mass, as well as potential ecological impacts.

Construction methodologies were assessed against design, construction, environmental, community and relative cost considerations to determine overall preferred options.

The constructability of the ocean outfall pipeline has been considered in three sections:

- STP to surf zone;
- surf zone to offshore zone; and
- offshore zone.

The methodologies for each section and their respective impacts are outlined in **Table 4-8** below.

Table 4-8 Comparison of ocean outfall construction methodologies

Outfall section	Construction methodology	Notes	Ranking
STP to surf zone	Trenching	• major visual, heritage and ecological disturbance.	Not preferred
	Trenchless – Horizontal Directional drilling	• either confined to STP site and beach (transport through dune area) or sited near beach in dune area and in PMGC.	Preferred
	Trenchless – Direct-drive tunnelling	• confined to STP and small portion of PMGC and small area near beach in dune area.	Preferred
Surf zone to offshore zone	Trenching – Temporary Jetty	• major visual and ecological disturbance.	Not preferred
	Trenchless – Horizontal Directional drilling	• sited near beach in dune area and on beach.	Preferred
	Trenchless –Direct-drive tunnelling	• confined to area near beach in dune area.	Preferred
Offshore zone	Transition Riser	• a transition riser would be required for any construction method selected; and • minimal impact.	Preferred
	Trenching – blasting	• considerable underwater work; • turbidity, noise; and • high relative cost.	Not preferred
	Trenching – jetting	• considerable underwater work; • turbidity, noise; and • high relative cost.	Not preferred
	Trenching – dredging	• high relative cost.	Not preferred
	Trenching – ploughing	• considerable underwater work; • turbidity, noise; and • high relative cost.	Not preferred

Outfall section	Construction methodology	Notes	Ranking
	No trench	• lower turbidity issues; • relative ease of construction; and • preferable for ongoing maintenance accessibility.	Preferred

The initial constructability assessment concluded that:

- open trench options have the potential for visual, ecological and heritage disturbance;
- for both the ‘STP to surf zone’ section and within the surf zone, trenchless options (HDD and DDT) are the most viable options;
- unless geotechnical conditions determine otherwise, these two zones should be combined as one installation operation with no onshore interim transition pit; and
- for the offshore section, the ocean outfall pipeline should be laid on the seabed (non-burial option) and appropriately protected from the wave climate and trawler activity.

The proposed construction methods for each of the three outfall sections were subsequently developed further based on the initial constructability assessment, further design development and analysis of costs, and are outlined below:

- STP to surf zone:
  - trenchless method preferred (DDT requires a shorter pipe stringing operation than HDD, which can be confined to the STP and PMGC (if required); however, DDT is significantly more expensive than HDD (approximately $20 million more expensive);
  - a transition riser would be required regardless of the construction method selected;
- Surf zone to offshore zone:
  - trenchless method preferred;
  - combine with upstream section to avoid intermediate construction site and air valve;
  - detailed design to accurately determine the extent of the surf zone;
- Offshore zone (surf zone to diffuser):
  - no-trench installation (i.e. pipeline laid on seabed) preferred for ease of construction, reduced risk of sediment plumes and seabed disturbance during construction, and ongoing maintenance accessibility;
  - rock or concrete mats required to provide stability and protection.

The construction methodology for the Project is described in more detail in **Chapter 2.0 Project description**.

5.0 Statutory context

This chapter describes the relevant statutory planning and approval process for the Project.

5.1 Commonwealth legislation

5.1.1 Coastal Waters (State Powers) Act 1980

The *Coastal Waters (State Powers) Act 1980* conveys jurisdiction to the NSW Parliament to make any law in respect of the coastal waters of the State, being laws that the NSW Parliament is otherwise entitled to make on the land. The ocean outfall pipeline component of the Project would be located within coastal waters of the State of NSW, as defined by the *Coastal Waters (State Powers) Act 1980.* Works within coastal waters as part of the Project would be subject to assessment under the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act).

5.1.2 Environment Protection and Biodiversity Conservation Act 1999

The *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) provides a framework to protect and manage matters of national environmental significance (MNES) and impacts on Commonwealth land. The Act identifies the following as MNES:

- World Heritage properties;
- National Heritage places;
- wetlands of international importance (including Ramsar Wetlands);
- listed threatened species and ecological communities;
- listed migratory species protected under international agreements;
- Commonwealth marine areas;
- the Great Barrier Reef Marine Park;
- nuclear actions (including uranium mines); and
- water resources, in relation to coal seam gas development and large coal mining development.

Under the EPBC Act, a referral to the Commonwealth is required for proposed actions that have the potential to significantly impact MNES or Commonwealth land. If the Project is declared a 'controlled action', approval from the Commonwealth Minister for the Environment and Energy would be required, in addition to the approval required from the NSW Minister for Planning and Public Spaces under Division 5.2 of the EP&A Act.

Based on the results of the environmental investigations carried out for this EIS, it is considered that MNES and the environment of Commonwealth land are not likely to be significantly impacted by the Project, and the Project would not be located on Commonwealth land. Accordingly, the Proponent has determined that no referral is required at this stage.

5.1.3 Environment Protection (Sea Dumping) Act 1981

Australia regulates the loading and dumping of waste at sea under the *Environment Protection (Sea Dumping) Act 1981* (the Sea Dumping Act). This Act helps to minimise marine pollution by controlling waste and other matter being disposed or discarded in Commonwealth waters. Under the Sea Dumping Act, the Commonwealth Government aims to minimise pollution threats by:

- prohibiting ocean disposal of waste considered too harmful to be released in the marine environment; and
- regulating permitted waste disposal to ensure environmental impacts are minimised.

The Sea Dumping Act applies to all vessels, aircraft and platforms in Australian waters and to all Australian vessels and aircrafts in any part of the sea. The Project does not involve dredging, and a sea dumping permit is not required for the Project.

5.2 NSW legislation

The jurisdiction of the State of NSW extends into the territorial waters of Australia. Section 59 of the *Interpretation Act 1987* provides that NSW State law applies to the coastal waters of the State and the seabed and subsoil beneath, and the airspace above the coastal waters of the State.

In accordance with the Commonwealth *Coastal Waters (State Powers) Act 1980*, the coastal waters of the State of NSW extend approximately 8.96 kilometres (km) seaward of the low water mark of Merimbula Bay. The Project including works that extend within coastal waters would be subject to assessment under the EP&A Act.

The Project has been declared State Significant Infrastructure (SSI) under Division 5.2, section 5.12 (2) of the EP&A Act, by reason of clause 3 of Schedule 4 of the *State Environmental Planning Policy (State and Regional Development) 2011*. This EIS has been prepared to support the SSI approval application in accordance with Part 3 of Schedule 2 of the *Environmental Planning and Assessment Regulation 2000* (EP&A Regulation).

Approval of a Project as SSI under Division 5.2 of the EP&A Act (Sections 5.23 and 5.24) means that certain other approvals are not required or must be applied consistently to an SSI approval. The potential impacts anticipated by those approvals have nevertheless been assessed as part of this EIS.

The project does **NOT** require the following approvals as it is classified as SSI (refer section 5.23 and 5.24 of the EP&A Act):

- permits under sections 201, 205 and 219 of the *Fisheries Management Act 1994* (FM Act) to carry out dredging and reclamation works, to harm marine vegetation in a protected area or to block fish passage (refer to **Chapter 11 Marine ecology**);
- approvals under Part 4 (to disturb or excavate a place, building, work, relic, moveable object, precinct or land to which an interim heritage order or listing on the State Heritage Register applies) and excavation permits under section 139 of the *Heritage Act 1977* (refer to **Chapter 15 Non-Aboriginal heritage**);
- Aboriginal heritage impact permits under section 90 of the *National Parks and Wildlife Act 1974* (NPW Act) to harm an Aboriginal object or place (refer to **Chapter 14 Aboriginal heritage**);
- a bush fire safety authority under section 100B of the *Rural Fires Act 1997*;
- consent from the relevant roads authority under section 138 of the *Roads Act 1993,* including to carry out work in, on or over a public road, dig up or disturb the public surface of a public road or connect a road to a classified road. The Project may involve works in a portion of Arthur Kaine Drive road reserve, for which BVSC is the relevant roads authority. However, clause 5 of Schedule 2 of the *Roads Act 1993*, exempts public authorities (such as BVSC) from the need to obtain approval under section 138 when exercising its functions in, on or over an unclassified road other than a Crown road. As Arthur Kaine Drive road reserve is not Crown road, the requirement for consent under section 138 does not apply subject to the exemptions in clause 5 of schedule 2 of the *Roads Act 1993;*
- an application to the National Heavy Vehicle Regulator (NHVR) for an access permit during subsequent design stages prior to the commencement of the construction works;
- various approvals under the *Water Management Act 2000*, namely water use approvals under section 89, water management work approvals under section 90, and activity approvals (other than aquifer interference approvals) under section 91; and
- a licence under the *Pipelines Act 1967*. This Act states that a person is not able "to commence or continue the construction of a pipeline or alter or reconstruct a pipeline unless the person is, or is acting on behalf of, the registered holder of a licence and the activity is in pursuance of the licence." However, relevant to the Project, section 5 of the Act identifies that nothing in the Act requires a person to hold a licence in respect of:

a. a pipeline constructed or to be constructed under, or under an approval or other authority granted under, any Act, other than this Act or the *EP&A Act*;

b. a pipeline constructed or to be constructed by a public authority;

d. a pipeline constructed or to be constructed for the purpose of the supply of water (including for irrigation), the drainage of land or the conveyance of wastewater, mine water, aqueous slurries of minerals, mineral concentrates or mineral tailings.

As such, given that the Project is a pipeline for wastewater and would be constructed under the EP&A Act by a public authority, a licence is not required under the *Pipelines Act 1967*.

Approvals under other NSW legislation that **ARE** required for the Project include the following:

- an amendment to the existing Environment Protection Licence (EPL) for the Merimbula STP under the *Protection of the Environment Operations Act 1997* (POEO Act).. In accordance with section 5.24 of the EP&A Act, such a licence cannot be refused for an approved SSI Project and is to be substantially consistent with the approval granted to the Project; and
- as described in **Table 5-1**, part of the Project used for construction vehicle access, would be located on land managed by NSW National Parks and Wildlife Service. Under Clause 9(2) of the *National Parks and Wildlife Regulation, 2019*, the Park Authority (or Area Manager) has the jurisdiction to provide a consent to allow vehicles to be used in an area of park that is not an existing road leading into or traversing the park. BVSC will secure approval from the Park Authority to permit construction vehicle access prior to the construction of the Project.

Other NSW legislation that would apply to the Project includes:

- the *Contaminated Land Management Act 1997*, which outlines the circumstances in which notification to the NSW Environment Protection Authority (EPA) is required in relation to contamination of land. The EPA would be notified in writing of any contamination identified within the Project area during construction activities, in accordance with the requirements of section 60 of the Act. This is discussed further in **Chapter 13 Landform, geology and soils**;
- the *Biodiversity Conservation Act 2016* (BC Act) identifies threatened species, ecological communities and key threatening processes and establishes a framework to avoid, minimise and offset the impacts of proposed development and land use change on biodiversity. Under section 7.9 of the BC Act, any State Significant Infrastructure application is to be accompanied by a Biodiversity Development Assessment Report (BDAR), unless it is determined by the Department of Planning, Industry and Environment (DPIE) that the proposed development is not likely to have any significant impact on of biodiversity values. **Appendix I** (Marine Ecology Assessment) provides a detailed assessment of the potential biodiversity impact in the marine environment as a result of the Project. A BDAR has been prepared and is provided in **Appendix H** (Biodiversity Assessment Report). A summary of the potential biodiversity impacts of the Project are provided in **Chapter 11 Marine ecology** and **Chapter 12 Terrestrial ecology**;
- the *Marine Estate Management Act 2014* provides for strategic and integrated management of the whole marine estate – marine waters, coasts and estuaries. The Project is not located within any declared aquatic reserves or marine parks and is located approximately 60 km south of the boundary of the nearest NSW marine park (i.e. Batemans Marine Park). Notwithstanding, impacts to marine ecology, marine land uses and coastal processes have been assessed in **Chapter 8 Water quality, hydrology and flooding**, **Chapter 10 Marine and coastal processes, Chapter 11 Marine ecology**, and **Chapter 19 Property and land use.** As Merimbula Bay is part of the marine estate, consideration has been given to the *Marine Estate Management Act 2014* (refer to **Chapter 10 Marine and coastal processes** and **Chapter 11 Marine ecology**), as it provides for the management of the marine estate of NSW consistent with the principles of ecologically sustainable development. This includes assessment of economic opportunities for regional communities, and assessment of cultural, social and recreational use of the marine estate within **Chapter 23 Social and economic**;
- permits under sections 201, 205 and 219 of the FM Act (relating to dredging or reclamation, harming marine vegetation or blocking fish passage respectively) would not be required for the Project (as per section 5.23 of the EP&A Act); and

- Crown land in NSW is managed for development and conservation by the State Government. Part of the Project (including at Pambula Merimbula Golf Club and at Merimbula Beach) would be located within Crown land (including land located below the mean high water mark (MHWM) which is within State of NSW (Crown Land) and as such, the Project would impact Crown land (refer to Chapter 19 Property and land use). Council would engage with Crown Land in regard to access arrangements required for the Project, noting that previously a licence under the *Crown Land Management Act 2016* has been issued in relation to the Project (Licence Number RN 596274). Approval under the *Crown Land Management Act 2016* would be required to allow occupation of Crown land, which Council would confirm in consultation with Crown Land. Prior to the commencement of construction, the Project would seek to obtain a temporary licence for construction of the Project under clause 5.21 of the *Crown Land Management Act 2016* . A formal easement under clause 5.50 would be sought for the operational outfall pipeline. An existing easement currently in place for the existing pipeline (proposed to be decommissioned) would either be relocated to accommodate the new pipeline or be extinguished to reduce the encumbrance on Crown land;
- It is noted that there is an active Aboriginal Lands claim on lots 7308, 320 and 7307 which are included in the Project area. The Project (and need for associated easement/ access) are to be documented in the Land Acquisition Schedules associated with this claim. The *Aboriginal Land Rights Act 1983* provides the legal mechanism through which the NSW Aboriginal Land Council and Local Aboriginal Land Councils may make an Aboriginal Lands claim upon claimable Crown land. Claimable Crown lands are defined under Section 36(1) of the *Aboriginal Land Rights Act 1983*. The responsibility for determining Aboriginal land claims lies with the Minister administering the *Crown Land Management Act 2016*. In April 2018, BVSC representatives met with the relevant LALC to discuss the Project including the key Project objective of avoiding ongoing impacts to the dunes. The existing land claim was also discussed during this meeting. In good faith, BVSC has not lodged any objections to the Aboriginal Land Claim so as to not impede its progress for the LALC. Council has also undergone formal consultation with the relevant LALC through the Aboriginal Cultural Heritage Assessment Report (ACHAR) process. Consultation undertaken as part of the ACHAR process is provided in detail in Appendix I (Aboriginal Cultural Heritage Assessment Report). Consultation with Crown Land and the LALC would continue in due course as part of the land claim process;
- the *Biosecurity Act 2015* provides a framework for the prevention, elimination and minimisation of biosecurity risks posed by a biosecurity matter. Under Part 3 of the *Biosecurity Act 2015*, all persons are required to minimise biosecurity risks including through the control of noxious weeds on their land. The approach to managing weeds during construction is provided in **Chapter 12 Terrestrial ecology** of this EIS;
- the *Ben Boyd National Park and Bell Bird Creek Nature Reserve Plan of Management 2010* outlines the scheme of operations for Ben Boyd National Park, as well as actions to protect it. This plan of management has been considered during the development of this Project;
- the *Waste Avoidance and Resource Recovery Act 2001* encourages the most efficient use of resources in order to reduce environmental harm. Waste resulting from the Project would be managed in accordance with the requirements of this Act. Waste would be classified in accordance with the *Waste Classification Guidelines 2014* (NSW EPA), 2014a). Further details of waste management are provided in **Chapter 26 Waste** of this EIS; and
- the *Protection of the Environment Operations (Waste) Regulation 2014* (POEO Waste Regulation) regulates matters such as the obligations of consignors (producers and agents), transporters, and receivers of waste, in relation to waste transport licensing and tracking requirements within NSW. Waste transport associated with the Project would be managed in accordance with the requirements of this Act as outlined in **Chapter 26 Waste**.

As the Project has been declared to be SSI, section 5.23(2) of the EP&A Act precludes the following directions, orders or notices being made to prevent or interfere with the carrying out of the Project once approved:

- an order restricting harm to buildings, works, relics or places that are not the subject of an interim heritage order or listing under the State Heritage Register under Division 8 of Part 6 of the *Heritage Act 1977*.

5.3 Environmental planning instruments

In general, section 5.22(2) of the EP&A Act excludes the application of environmental planning instruments to SSI Projects (except as those instruments apply to the declaration of SSI or critical SSI – refer **Section 5.3.1** and **Section 5.3.2**). Notwithstanding this, the provisions of the following State Environmental Planning Policies (SEPPs), deemed SEPPs and Local Environmental Plan (LEP) have been considered consistent with good environmental assessment practice.

5.3.1 State Environmental Planning Policies

State Environmental Planning Policy (State and Regional Development) 2011

Clause 15 of the *State Environmental Planning Policy (State and Regional Development) 2011* (State and Regional Development SEPP) declares development to be SSI if the development is a type of development specified in Schedule 4 of the State and Regional Development SEPP. Clause 3 of Schedule 4 of the State and Regional Development SEPP relates to development for the purposes of the Merimbula Sewage Treatment Plant Upgrade and Ocean Outfall. As such the Project is classified as SSI for the purposes of the State and Regional Development SEPP and Division 5.2 of the EP&A Act.

State Environmental Planning Policy (Infrastructure) 2007

The component of the Project that comprises the ocean outfall pipeline and submerged diffuser is defined in clause 105 of the *State Environmental Planning Policy (Infrastructure)* 2007 (ISEPP) as a sewage reticulation system[5]. Development for the purposes of a sewage reticulation system may be carried out on any land without development consent if it is carried out by or on behalf of a public authority. As BVSC is a public authority, this component of the Project is classified as permissible without development consent under clause 106(3)(B) of the ISEPP.

The remainder of the Project meets the definition of a sewage treatment plant under clause 105 of the ISEPP and the *Standard Instrument (Local Environmental Plans) Order 2006 (*meaning *a "building or place used for the treatment and disposal of sewage, whether or not the facility supplies recycled water for use as an alternative water supply"*). Under clause 106(2) of ISEPP development for the purpose of sewage treatment plants may be carried out without consent on land in a prescribed zone by a public authority. The Project would be carried out by BVSC (a public authority) and is located on land zoned SP2 Infrastructure (Sewerage System) under the *Bega Valley LEP 2013*, which is a prescribed zone for the purposes of clauses 105-106 of the ISEPP. As such, this component of the Project is classified as permissible without development consent under clause 106(2) of ISEPP.

Accordingly, the Project is permissible without obtaining development consent under Part 4 of the EP&A Act. Nevertheless, section 15.12(2) of the EP&A Act provides that a SEPP may declare any development or class of development to be SSI, which requires approval from the NSW Minister for Planning under Division 5.2, section 5.14 of the EP&A Act. As identified above, the Project is classified as SSI under the State and Regional Development SEPP and requires approval under Division 5.2 of the EP&A Act.

State Environmental Planning Policy (Coastal Management) 2018

The *State Environmental Planning Policy (Coastal Management) 2018* (Coastal Management SEPP) establishes a strategic land use planning framework for coastal management. The aim of the Coastal Management SEPP is *"to promote an integrated and coordinated approach to land use planning in the coastal zone".*

[5] Sewage reticulation system means a *"building or place used for the collection and transfer of sewage to a sewage treatment plant or water recycling facility for treatment, or transfer of the treated water for use or disposal, including associated (a) pipelines and tunnels, (b) pumping stations, (c) dosing facilities, (d) odour control works, (e) sewage overflow structures, and (f) vent stacks"* (Clause 105 of ISEPP and the *Standard Instrument (Local Environmental Plans) Order 2006*).

The Coastal Management SEPP defines the following coastal management areas (which together forms the 'coastal zone'):

- the coastal wetlands and littoral rainforests area;
- land in proximity to coastal wetlands or littoral rainforest
- the coastal vulnerability area;
- the coastal environment area; and
- the coastal use area.

Division 1 to 4 to the Coastal Management SEPP identifies specific development controls applying to development requiring consent within each management area, whilst Division 5 identifies general development controls applying to the coastal zone, as a whole.

In accordance with clause 8 of the Coastal Management SEPP, land classified under each management area is mapped under the NSW Planning Portal (e-spatial viewer). The e-spatial viewer does not currently include a mapping layer for the coastal vulnerability area (yet to be mapped/released by the NSW Govt.). The Project would traverse land covered by the Coastal management SEPP, as shown in **Chapter 10 Marine and coastal processes**, comprising:

- coastal wetland - a portion of the underground section of the pipeline would travel under an area mapped as coastal wetland;
- land in proximity to coastal wetlands;
- coastal environment area; and
- coastal use area.

The Project is SSI and is permissible without consent. As a consequence,, development under Divisions 1-5 of the SEPP is not applicable once the Project is approved by the Minister for Planning and Public Spaces. Notwithstanding, as required by the SEARs, consistency of the Project against the development controls identified in Divisions 1-5 of the SEPP for the various 'coastal management areas' have been considered in detail in **Chapter 10 Marine and coastal processes** (Refer **Table 10-7**).

State Environmental Planning Policy No. 55 – Remediation of Land

State Environmental Planning Policy No. 55 – Remediation of Land (SEPP 55) provides a State-wide approach to the remediation of contaminated land for the purpose of minimising the risk of harm to the health of humans and the environment. In accordance with Clause 7(1) of SEPP 55, a consent authority must not consent to the carrying out of development on any land unless:

a. it has considered whether the land is contaminated;
b. if the land is contaminated, it is satisfied that the land is suitable in its contaminated state (or would be suitable, after remediation) for the purpose for which the development is proposed to be carried out; and
c. if the land requires remediation to be made suitable for the purpose for which the development is proposed to be carried out, it is satisfied that the land would be remediated before the land is used for that purpose.

Consent is not required for the Project under SEPP 55 as it would be assessed under Division 5.2 of the EP&A Act, however the potential for contaminated land to be present within the Project area and control measures that would be put in place during construction have been considered in **Chapter 16 Hazard and risk**.

State Environmental Planning Policy (Vegetation in Non-Rural Areas) 2017

State Environmental Planning Policy (Vegetation in Non-Rural Areas) aims to protect the biodiversity values of trees and other vegetation in non-rural areas and to preserve the amenity of non-rural areas through preservation of trees and other vegetation. While the Project would result in the removal of some trees and vegetation, an authority to clear vegetation under this SEPP is not required as the Project is subject to assessment under Division 5.2 of the EP&A Act.

Potential impacts to biodiversity, including trees and vegetation, are considered in **Chapter 12 Terrestrial ecology**.

State Environmental Planning Policy (Koala Habitat Protection) 2019

The aim of the *State Environmental Planning Policy (Koala Habitat Protection) 2019* is to encourage the conservation and management of areas of natural vegetation that provide habitat for koalas to support a permanent free-living population over their present range and reverse the current trend of koala population decline. The Bega Valley local government area (LGA) is listed under Schedule 1 of this SEPP, indicating that koala habitat may be present in the Project area. However, the Project area is not located within an area identified in the Koala Development Application Map (Department of Planning, Industry and Environment, 2020), and a koala management plan under the SEPP is not in place for the area. Further, the SSI designation of the Project means that the provisions of the SEPP relating to the development assessment process do not apply.

The land-based portion of the ocean outfall pipeline would be primarily underground (installed via trenchless drilling), and the majority of the remainder of the Project would occur within the existing STP site. Significant impacts to vegetation that provides habitat for koalas are not anticipated. Potential impacts to terrestrial ecology are assessed in **Chapter 12 Terrestrial ecology**.

5.3.2 Local Environmental Plan (LEP)

LEPs do not apply to SSI Projects. Notwithstanding, the provisions of the Bega Valley LEP 2013 have been considered below as relevant to the Project (refer also to **Chapter 19 Property and land use** for further details). The STP is located on land zoned SP2 Infrastructure (Sewerage System) under Bega Valley LEP 2013. The land-based portion of the ocean outfall pipeline (i.e. Section one) would be located on land zoned E2 Environmental Conservation and RE1 Public Recreation. Part of the pipeline that is located on the seaward side of the mean high-water mark (i.e. Section two) is outside the Bega Valley LGA (i.e. within Crown land) and would not be subject to the Bega Valley LEP 2013.

Table 5-1 provides an outline of the current land zonings and land uses within the Project area. Land parcels within the Project area are shown in **Figure 19-1** and **Figure 19-2**, respectively in **Chapter 19 Property and land use**. The Project does not seek to change any of these land zonings or uses. The permissibility of the Project is established under the provisions of the ISEPP as described above.

Table 5-1 Land zonings and land uses within the Project area

Land parcel within Project area	Existing land zoning under the Bega Valley LEP 2013	Landowner
Lot 102 on DP1201186	This Lot is zoned as SP2 Infrastructure and contains the golf course at PMGC.	BVSC
Lot 101 on DP1201186	This Lot is zoned as SP2 Infrastructure - Sewerage System and contains the existing STP site.	BVSC
Lots 1 and 2 on DP853245	These Lots are zoned as SP2 Infrastructure - Sewerage System. This land contains the existing dunal exfiltration ponds and existing underground pipeline.	BVSC
Lots 1 and 2 on DP861737	This Lot is zoned SP2 Infrastructure – Sewerage System. This land contains the existing dunal exfiltration ponds and coastal vegetation.	BVSC
Lot 355 on DP41837	This Lot is zoned RE1 Public Recreation. This land is currently part of the Pambula Merimbula Golf Club.	State of NSW (Leased to Pambula Merimbula Golf Club Ltd)

Land parcel within Project area	Existing land zoning under the Bega Valley LEP 2013	Landowner
Lot 7308 on DP1167035	This Lot is zoned E2 Environmental Conservation. This land is located east of the existing dunal exfiltration ponds and consists of coastal vegetation.	State of NSW
Lot 320 on DP750227	This Lot is zoned E2 Environmental Conservation. This land is located south of the existing dunal exfiltration ponds and consists of coastal vegetation.	State of NSW
Lot 7307 on DP1167035	This Lot is zoned E2 Environmental Conservation. This land surrounds the existing dunal exfiltration ponds and consists of coastal vegetation.	State of NSW
Portion of Arthur Kaine Drive Road Reserve	This Lot is a Road reserve (classified Regional Road), zoned E2 Environmental Conservation.	BVSC
Land below the MHWM	N/A - This area of coastal waters is not subject to the Bega Valley LEP 2013, and forms part of Merimbula Bay.	Crown in the Right of NSW (Crown land)
Lot 7917 on DP1187854	This Lot is zoned E1 National Parks and Nature Reserves.	Partially located on Crown land (seaward most portion of the lot). The remainder of the lot is located on land managed by NSW National Parks and Wildlife Service.
Lot 7318 on DP1167151	This Lot is zoned E2 National Parks and Nature Reserves.	Crown land
Lot 7019 on DP1122193.	This Lot is zoned RE1 Public Recreation.	Crown land

The Bega Valley LEP 2013 establishes the framework for future development within the LGA. The aims of the Bega Valley LEP 2013 are:

a. to protect and improve the economic, natural and social resources of Bega Valley through the principles of ecologically sustainable development, including conservation of biodiversity, energy efficiency and taking into account projected changes as a result of climate change;

b. to provide employment opportunities and strengthen the local economic base by encouraging a range of enterprises, including tourism, that respond to lifestyle choices, emerging markets and changes in technology;

c. to conserve and enhance environmental assets, including estuaries, rivers, wetlands, remnant native vegetation, soils and wildlife corridors;

d. to encourage compact and efficient urban settlement;

e. to ensure that development contributes to the natural landscape and built form environments that make up the character of Bega Valley;

f. to provide opportunities for a range of housing choice in locations that have good access to public transport, community facilities and services, retail and commercial services and employment opportunities;

g. to protect agricultural lands by preventing land fragmentation and adverse impacts from non-agricultural land uses;

h. to identify and conserve the Aboriginal and European cultural heritage of Bega Valley;

i. to restrict development on land that is subject to natural hazards;

j. to ensure that development has minimal impact on water quality and environmental flows of receiving waters.

The Project is considered to be consistent with the aims of the Bega Valley LEP 2013 as it would involve an upgrade of essential services to facilitate improved water quality, environmental and public health standards. The Project would also improve the aesthetic and recreational values of Merimbula Bay and surrounds, supporting the sustainability of the regional tourism industry and economic base of the area.

6.0 Consultation

Community and stakeholder consultation has been undertaken throughout development of the Project in accordance with the *Community and Stakeholder Engagement Plan* (CSEP) (AECOM, 2017) prepared for the Project. This chapter provides an overview of the consultation activities for the Project, described in the following three phases:

- consultation before public exhibition of the EIS, including consultation during design development, between November 2017 and May 2021;
- consultation during public exhibition of the EIS (23 August to 19 September 2021), including preparation of a submissions report and a preferred infrastructure report (if required); and
- consultation after the public exhibition of the EIS and post determination (should the Project be approved), including proposed consultation activities during construction of the Project.

Table 6-1 sets out the SEARs relevant to consultation and where the requirements have been addressed in this EIS.

Table 6-1 SEARs – consultation

Ref.	Assessment requirements	Where addressed
4.1	The Project must be informed by consultation, including with relevant government agencies, infrastructure and service providers, special interest groups, affected landowners, businesses, recreational fishers, commercial fishers, the aquaculture industry and the community. The consultation process must be undertaken in accordance with the current guidelines.	**Section 6.2**
4.2	The Proponent must document the consultation process and demonstrate how the Project has responded to the inputs received.	**Section 6.2**
4.3	The Proponent must describe the timing and type of community consultation proposed during the design and delivery of the Project, the mechanisms for community feedback, the mechanisms for keeping the community informed, and procedures for complaints handling and resolution.	**Section 6.2, Section 6.3** and **Section 6.4**

6.1 Consultation objectives and approach

The CSEP for the Project outlines a communication approach focused on:

- **actively involving** the community and stakeholders in the Project design;
- **providing consistent, relevant, jargon-free and up to date information** on the Project through accessible, tailored communication channels adapted to different stakeholders depending on their needs;
- **responding appropriately and in a timely manner** to issues, concerns or questions raised by the community and stakeholders over the life of the Project to demonstrate how issues are being addressed and managed;
- **facilitating information flow** to the Project team to ensure stakeholder and community input is appropriately incorporated into the Project's development and delivery;
- **creating Project advocates** by working with trusted voices in the community and actively engaging with the community to understand their issues;
- **building trust and rapport** with stakeholders and the community through transparency, inclusivity and responsiveness;
- **taking a risk management focus** by pre-empting, planning for and proactively managing stakeholder issues as they arise to ensure limited impact on the Project;

- **managing expectations** by closing the feedback loop through sharing results, Project updates, and thank you communications; and
- **accurately capturing, analysing and reporting feedback** received throughout the Project so it can inform the Project development and subsequent application process.

These consultation objectives are designed to meet the requirements of the SEARs issued for the Project and outlined in **Table 6-1**. Consultation for this Project has also been undertaken in accordance with Department of Planning, Industry and Environment (DPIE) guidelines for Community and Stakeholder Engagement: *Draft Environmental Impact Assessment Guidance Series June 2017*.

6.1.1 Stakeholders

Stakeholders for the Project are listed in **Table 6-2** below.

Table 6-2 Stakeholders

Stakeholder group	Stakeholders
Internal stakeholders	• BVSC executive staff • BVSC Project team • BVSC staff (not Project related) • sub-consultants • AECOM Project team.
Government agencies	• DPIE • Office of Environment and Heritage (now DPIE) • NSW Environment Protection Authority • NSW Department of Primary Industries – Water • NSW Department of Primary Industries – Fisheries • NSW Health • NSW National Parks • NSW Food Authority (Merimbula and Pambula Lake Shellfish Quality Assurance Program) • Local Land Services South East (formerly Southern Rivers Catchment Management Authority) • Crown Land.
Political stakeholders	• BVSC Councillors • Federal Member for Eden Monaro • State Member for Bega.
Infrastructure and service providers	• Transport for NSW (formerly Roads and Maritime Services) • Fire and Rescue NSW Merimbula • NSW Police Merimbula • Ambulance Service of NSW.

Stakeholder group	Stakeholders
Recreation/commercial fishing groups	• NSW Recreational Fishing Alliance • Merimbula Oyster Farmers • Merimbula Lake Shellfish Association • Pambula Lake Shellfish Association • Sapphire Coast Wilderness Oysters • Merimbula Lake & Big Game Fishing Club • Professional Fishers Association • Wild Caught Fishers Coalition • Abalone Association NSW • Merimbula Marina • Reel Affair Fishing Charters • Rathlan Fishing Charters • Fishpen Charters Merimbula • Headland Fishing Charter • Merimbula Big Game and Lakes Angling Club Inc.
Aboriginal stakeholders	• Eden Local Aboriginal Land Council (refer to **Chapter 14 Aboriginal heritage** for more detail on consultation with Aboriginal stakeholders).
Environmental interest groups	• Panboola Wetlands Trust • Pambula Beach LandCare • Marine Discovery Centre Eden • Bournda Environmental Education Centre.
Recreational users of beach and lake	• Merimbula Divers Club • Pambula Surf Life Saving Club • Sapphire Coast Boardriders • Merimbula Sailboard Club.
Affected landowners	• Merimbula Airport • Pambula Merimbula Golf Club • Oaklands Barn Farm • Crown Land.
Businesses/tourism stakeholders and community groups	• Bega Valley Shire Residents and Ratepayers Association Inc. • Merimbula Imlay Historical Society • Pambula-Merimbula Lions Club • Rotary Merimbula • Merimbula View Club • Merimbula Scout Group • Merimbula Aquarium • Merimbula Chamber of Commerce • Merimbula Visitor Information Centre • Sapphire Coast Tourist Association • Top Lake Boat Hire & Sunset Kiosk • Merimbula Stand Up Paddle Lessons & Tours • Coastlife Adventures • Merimbula Lake Holiday Park • South Coast Holiday Parks Pambula • Discovery Parks Pambula Beach • Best Western Fairway Motor Inn • Acacia Ponds by Gateway Lifestyle • From Little Things Parklands.
Action groups	• Merimbula/Pambula Wastewater Alternatives/Sustainable Water Action for Merimbula and Pambula (SWAMP)

Stakeholder group	Stakeholders
Media	• Merimbula News Weekly • Bega District News • Power FM Bega Bay • Sapphire FM Community Radio • ABC South East NSW.
Wider community	• Residents and visitors to the Merimbula Pambula area • Residents and visitors to the wider BVSC Local Government Area.

6.2 Consultation before public exhibition of the Environmental Impact Statement

Consultation for the Project and the EIS began in May 2017. Consultation has been carried out with each of the stakeholder groups outlined in **Table 6-1**. Feedback received during this consultation has informed the EIS, as outlined in **Section 6.2.4**.

Broadly, the Project team used a 'three-layer' framework for engaging stakeholders and the community during the Project. This included communication tools as the first layer, face-to-face engagement as the second layer, and a Community Working Group as the third layer. This consultation was carried out prior to and during preparation of the EIS to ensure feedback and issues raised by community members and stakeholders were considered in the EIS. The three-layered engagement approach is shown in **Figure 6-1**.

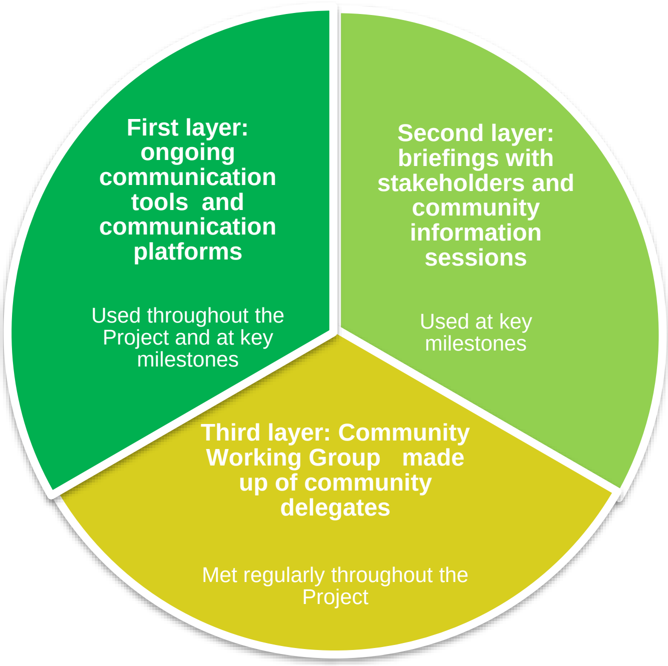

Figure 6-1 Three layered engagement approach

6.2.1 First layer: communication tools

Communication tools have been established to provide Project information and two-way communication opportunities for stakeholders and the community for the duration of the Project. Other communication tools were used to publish Project information to the wider community. **Table 6-3** below describes these tools.

Table 6-3 Ongoing communication tools and communication platforms

Communication tools	Description
1800 phone number	To ensure that Project information was easily accessible, a dedicated 1800 phone number, postal address, email address and webpage were established in October 2017 and maintained for the duration of Project design development and the drafting of this EIS through to May 2021 . Details of any calls and emails received during this time period were recorded in a stakeholder database where issues raised were categorised. The Project webpage can be found here: https://www.begavalley.nsw.gov.au/cp_themes/default/page.asp?p=DOC-ONG-54-47-20
Postal address	
Email	
Webpage	
Advertisements	Advertisements in Merimbula News Weekly were used to inform the community about the Project and upcoming community information sessions. Advertisements were placed on the following dates: • 1 November 2017 • 8 November 2017 • 14 February 2018 • 28 February 2018 • 6 March 2019 • 8 May 2019.
Media releases	Media releases were published on the Project webpage to inform the community about Project progress, environmental assessments and key milestones: • August 2017 • September 2017 • October 2017 • November 2017 • February 2018 • December 2018 • March 2019 • May 2019 • August 2019.
Social media posts	Regular social media posts (over 30) were published on BVSC's Facebook and Instagram sites during the development of the EIS to inform the community about Project progress, community information sessions and key milestones.
Video	A video titled *Merimbula STP and Ocean Outfall*, was released on the Project webpage and BVSC social media accounts on 1 April 2019. The video explains the Project need and benefits through voiceover and contains footage of former BVSC Mayor, Kristy McBain speaking about the Project.
Letter to the editor	A letter to the editor was published in the Merimbula News Weekly on 5 March 2019. Former Mayor, KristyMcBain wrote to the wider community with information about the Project need and benefits.
Project signage	Large corflute signs were displayed at the entrances to nearby Mitchies Jetty, Merimbula Beach and Pambula Beach to provide information to community members about the Project. The signs were installed in May 2019.

6.2.2 Second layer: face-to-face engagement

Community information sessions

Project updates and general Project information were provided at staffed community information sessions held at several different locations in the Merimbula area and nearby towns. The information sessions were promoted via website/media release, social media and newspaper advertisement.

Table 6-4 Community information sessions

Date	Location	Number of attendees
Wednesday 8 November 2017	Bega Valley Regional Learning Centre, Merimbula	3
Thursday 9 November 2017		3
Saturday 11 November 2017		1
Saturday 17 March 2018	Bar Beach, Merimbula	15
Saturday 17 March 2018	Hylands Corner, Merimbula	5
Sunday 18 March 2018	Merimbula Seaside Markets	30
Saturday 9 March 2019	Bar Beach, Merimbula	25
Sunday 10 March 2019	Pambula Markets	50
Saturday 16 March 2019	Bar Beach, Merimbula	6
Sunday 17 March 2019	Merimbula Seaside Markets	40
Sunday 12 May 2019	Pambula Markets	40
Sunday 19 May 2019	Merimbula Markets	34

A total of 249 community members attended the 12 community information sessions. At the information sessions:

- communication material available included posters displaying the current and future STP treatment processes, aerial maps and Project update newsletters;
- community members were encouraged to complete a feedback form or sign up to the stakeholder database to receive Project updates;
- Project team members took notes of issues raised by community members; and
- sample jars of wastewater in various stages of treatment and biosolids were displayed at the 2019 sessions, to educate community members about the effectiveness of the current and future treatment processes proposed.

Stakeholder consultation

Targeted stakeholder briefing sessions were held with various stakeholder groups.

In 2017, 56 people representing all stakeholder groups identified were invited to briefing sessions. Of those invited, 17 people attended briefing sessions, three were unable to make it after indicating they would attend, and three asked for information to be sent to them instead of attending. The remainder did not attend.

In 2018, 56 people representing all identified stakeholder groups were invited to briefing sessions. Of those invited, eight attended briefing sessions. The remainder did not attend.

In both instances, invitations were sent out by email and post to a key contact from each of the stakeholder groups. Follow up phone calls and emails were sent to those who had not responded to make sure they were aware of the sessions. The sessions were all held at the Bega Valley Regional Learning Centre on the dates and times displayed in **Table 6-5**.

Table 6-5 Stakeholder briefing schedule

Date	Time	Stakeholder groups
Monday 6 November 2017	9:00 am to 12:00 pm	• Businesses/tourism stakeholders
	1:00 pm to 4:00 pm	• Aboriginal stakeholders: Eden Local Aboriginal Land Council
Tuesday 7 November 2017	9:00 am to 12:00 pm	• Environmental interest groups
Wednesday 8 November 2017	9:00 am to 12:00 pm	• Government agencies
	1:00 pm to 4:00 pm	• Recreational/commercial fishing groups
Thursday 9 November 2017	9:00 am to 12:00 pm	• Affected landowners
Friday 10 November 2017	9:00 am to 12:00 pm	• Infrastructure and service providers
	1:00 pm to 4:00 pm	• Community groups • Recreational users of beach and lake
Wednesday 14 March 2018	4:00 pm to 5:00 pm	• Affected landowners
Thursday 15 March 2018	9:00 am to 12:30 pm	• Government agencies • Infrastructure and service providers
	1:30 pm to 3:30 pm	• Recreation/commercial fishing groups • Environmental interest groups
	4:00 pm to 6:00 pm	• Community groups • Businesses and tourism stakeholders • Recreational users of beach and lake
Friday 16 March 2018	11:30 am to 3:00 pm	• Aboriginal stakeholders: Eden Local Aboriginal Land Council (this session was cancelled as the stakeholder was unable to attend)

At the briefing sessions, stakeholders were provided with a Project overview and update on the environmental assessment process. Stakeholders had the opportunity to ask questions about the Project and have discussions with the Project team. Notes were taken by the Project team to capture issues raised by stakeholders.

Other consultation activities for stakeholders included:

- an internal 'lunch and learn' held for BVSC staff on 7 March 2019. About 80 staff members were briefed about the Project to ensure consistent Project information was made available to staff members;
- a media tour held at the Merimbula STP on 8 March 2019 for local print and radio media outlets. Local media were provided information about Project background, timeline, need and benefits;
- a surfers and board riders information session held on 11 April 2019 at the Bega Valley Regional Learning Centre, Merimbula, with 12 attendees. The information session covered Project background, Project timeline, current and future treated wastewater re-use and disposal, investigation work to inform EIS;
- two tours of the Merimbula STP held during an open day (12:00 pm and 2:00 pm on 25 May 2019). The purpose of the tours was to educate stakeholders and the community on the current

and future operations of the STP and the Project. This activity was accompanied by an email invite, social media posts and newspaper advertisements; and

- email and letter correspondence with action group SWAMP during the development of this EIS.

Further consultation with NSW Crown Lands occurred in July 2020 via letter correspondence. The letter notified of the Crown Land containing the Project area and construction footprint.

Issues raised by stakeholders during these activities are detailed in **Section 6.2.4**.

6.2.3 Third layer: Community Working Group

In September 2017, BVSC resolved that 10 community members would form membership of a CWG to work through an assessment criteria analysis process to assist in selecting a preferred option for the Project and provide recommendations to BVSC for the Project.

AECOM's Project team aimed to select, from a pool of applications, ten members who would closely match the Australian Bureau of Statistics (2016) profile of the region. Despite advertising in the Merimbula News Weekly, a limited number of applications were received (12), and matching the regional profile was not able to be achieved. The Project team therefore offered membership to all 12 applicants, with eventual acceptances totalling ten members.

Over nine meetings, from 4 December 2017 to 7 August 2019, the CWG:

- developed a preliminary list of criteria for use in evaluating the options for the Project;
- confirmed and agreed upon the relative importance of each criterion; and
- scored options against these criteria, thus identifying a CWG preferred option.

The criteria were formed based on the broad categories of environmental, social and economic factors and are as follows:

Table 6-6 Community Working Group criteria

Category	Criterion	Description
Environmental	Water quality	Potential impacts/benefits to water quality (groundwater, estuarine and marine) with consideration of: • water chemistry – disinfection chemicals (e.g. chlorine) and by-products, nutrients (nitrogen, phosphorus), heavy metals, microplastics; and • treated wastewater plumes and zones of influence – including during rainfall events, risk of long-shore drift/circulation/flow-back to beaches or estuaries, potential algal blooms. Human health risk (via marine contact pathways, or future re-use opportunity pathways – e.g. sporting field irrigation).
	Ecology	Terrestrial and/or aquatic impacts/benefits (with respect to any threatened species, threatened habitat or endangered ecological communities, wetlands, marine life). Potential impacts/benefits to threatened aquatic species, populations, habitat and communities – e.g. wetlands, benthic habitats, rocky reefs, disturbance of the seabed, bioaccumulation risk, noise and vibration impacts on marine mammals.
	Odour	Odour impacts/benefits (e.g. from the operation of a wastewater treatment process (including any associated lagoons/pondage), a treated wastewater flow discharge, sewer vent or pump station).

Category	Criterion	Description
	Heritage	Aboriginal and European heritage impacts/benefits (during construction or operation) such as those to scarred trees, middens, rock art sites, burial sites, buildings, historical sites, sensitive landscapes, Empire Gladstone shipwreck off Haycock Point.
	Sustainability	Resilience to climate change (e.g. rainfall variance, extreme weather, sea level rise), greenhouse gas production (in construction, operation, and/or renewal work); including: • ability to adapt to suit changing conditions – rainfall variance, extreme weather/storm impacts (e.g. east coast low pressure systems), sea level rise, capacity for ecosystem migration; • greenhouse gases; • embodied CO2 for construction, operation/maintenance, and renewal; • adaptability to technology change – including ability to continue to maximise land-based re-use, minimise ocean disposal; and • ability to meet the proposed Infrastructure Sustainability Council of Australia (ISCA) target rating.
Social	Recreation	Impacts/benefits to recreational amenity including: • fishing, including impacts/benefits to artificial reef; • diving; • swimming, surfing, beach use/beach walking/beach health; • recreational boating; • visual amenity – aesthetics (of constructed Project infrastructure); and • noise/traffic generated during construction.
Economic	Local and regional economy	Impacts/benefits to tourism, tourism-related industries, business-in-general, employment (including long-term – e.g. employment, 'clean' reputation) in areas such as: • aquaculture; • oyster, abalone, commercial fishing industries; • agriculture; • tourism - during construction; seasonal impacts – e.g. during school holidays; • Pambula Merimbula Golf Club; and • restrictions on vessels in Merimbula Bay.

Two treatment options for the STP upgrade and four options for the ocean outfall discharge location were developed by the Project Team and shared with the CWG. Combinations of these options were scored against the CWG criteria through multi-criteria analysis.

Based on the available information shared to the CWG over the course of its nine meetings, the CWG recommended that BVSC select the option most protective of the Merimbula Bay environment which they judged to be:

- the higher wastewater quality treatment option of the two offered; and
- the discharge location that takes advantage of oceanographic conditions that minimise the potential for dispersed treated wastewater to impact the environment of Merimbula Bay.

The CWG also made several recommendations to BVSC in a letter. The option selection process, including how the CWG's recommendation was considered, is described in **Chapter 4 Project development and alternatives**.

6.2.4 Feedback received during Environmental Impact Statement development

Questions and issues were raised by stakeholders and community members during the preparation of the EIS. These were captured at stakeholder briefings, community information sessions and phone calls and emails to the Project team.

Table 6-7 provides details of issues and questions raised by stakeholder groups during consultation activities and where they are addressed in this EIS.

Table 6-7 Issues raised by stakeholders

Category	Issues/questions raised	Stakeholder group/s who raised issues/questions	Where addressed in this Environmental Impact Statement
Introduction	• why wasn't there an EIS written during options development?	• wider community.	An EIS is required under the *Environmental Planning and Assessment Act 1979* for State Significant Infrastructure projects, to support an application for approval. As an approval is not sought at the options development stage, an EIS would not be prepared at this stage. An EIS must be written to assess a single, defined project often referred to as the preferred option (i.e. the Project). The purpose of the EIS and the EIS process is further described in **Section 1.3** and **Section 1.4**, and the statutory context is further described in **Chapter 5 Statutory context.**

Category	Issues/questions raised	Stakeholder group/s who raised issues/questions	Where addressed in this Environmental Impact Statement
Project description	• current treated wastewater re-use levels at Pambula Merimbula Golf Club and Oaklands Barn Farm; • proposed treated wastewater re-use as part of the Project; • current wastewater treatment level; • proposed wastewater treatment level; • proposed length and depth of ocean outfall; • current beach-face outfall discharge rate; • current and future use of dunal exfiltration ponds; • proposed ocean outfall construction material; • construction timing; • construction methodology; • potential for expanding storage and re-use at the Pambula Merimbula Golf Club • potential for total re-use of treated wastewater; and • a letter received from Pambula Merimbula Golf Club generally supported the Project but requested the use of the grounds for laydown during construction should endeavour to only occupy one fairway, to allow for continued operation of the golfing facility • Merimbula STP capacity during summer holiday periods	• political stakeholders; • Government agencies; • infrastructure and service providers; • recreation/ commercial fishing groups; • environmental interest groups; • recreational users of beach and lake; • businesses/tourism stakeholders and community groups; • action group; and • wider community.	**Chapter 2 Project description** **Chapter 4 Project development and alternatives**

Category	Issues/questions raised	Stakeholder group/s who raised issues/questions	Where addressed in this Environmental Impact Statement
Strategic context and Project need	• would preventing stormwater infiltration for the wider sewer network reduce Project need?	• wider community.	Preventing stormwater infiltration in the wider sewerage network would not affect the need for the Project, and as such, is not part of the scope of this Project. The design quantum of wastewater to be treated through the STP and disposed of is based on Average Dry Weather Flow, and therefore stormwater infiltration has little overall effect on the requirement for, options available to or design of treated wastewater disposal from the Merimbula STP. Wet Weather Flowthrough the STP is accommodated by a temporary holding pond. **Chapter 3 Project need and strategic context** provides detail regarding the Project need.
Project development and alternatives	• size and shape of the study area and the determining factors that were used to delineate the Project development study area; • impact of the topography of the Bay on Project design; • desire for options for expanding re-use; • potential for environmental investigation results to reveal that Project development study area is not suitable. • potential to explore Project alternatives, including: - transporting treated wastewater by truck to nearby farms - complete re-use via irrigation - treated wastewater disposal via wetlands - treating wastewater to drinking water standard for re-	• infrastructure and service providers; • recreation/commercial fishing groups; • environmental interest groups; • recreational users of beach and lake; • action group; and • wider community.	**Chapter 4 Project development and alternatives** provides detail regarding alternative options considered and the decision making process to select the preferred Project design in addition to Project costs and funding. The inclusion beneficial re-use of treated wastewater was also considered as part of the options analysis and has subsequently been incorporated into the Project design, however it

Category	Issues/questions raised	Stakeholder group/s who raised issues/questions	Where addressed in this Environmental Impact Statement
	use in Yellow Pinch Dam - building more wastewater storage and dams • if funds for the construction of the Project are not available, what happens? • current funding availability for Project; • Project cost; and • potential for rate increases as a result of the Project.		is noted that beneficial re-use would not have the capacity to serve as a stand-alone solution. The study area for each environmental investigation has been determined on a case-by-case basis and has been determined in line with best practice principles, and in consideration of the needs of each environmental aspect. The study area for each environmental consideration is defined under the methodology in the corresponding chapter. Each of these study areas have been selected to provide an appropriately detailed assessment of the potential for the Project to result in environmental impacts and consider such things as the proposed extent of vegetation removal, ground disturbance, nearby receptors, and so on. It is considered that the potential for local council rate increases as a result of this Project is outside of the scope of this EIS and any decisions regarding this matter would be subject to separate consideration by BVSC and would typically be informed in consideration of a variety of

Category	Issues/questions raised	Stakeholder group/s who raised issues/questions	Where addressed in this Environmental Impact Statement
			complex factors outside of the Project.
Consultation and engagement	• lack of BVSC attendance at community information sessions; and • amount of money spent on media engagement.	• wider community.	Project staff working on the Project on behalf of BVSC were present at all community information sessions. Community consultation has made up a key component of Project development funding to provide adequate community consultation and notification on the Project to address the SEARs and to be consistent with BVSC and community expectations. Further information on engagement for the Project is provided throughout this chapter (**Chapter 6 Consultation**).
Surface water and flooding	• treated wastewater quality during periods of heavy rain; • STP operations during heavy periods of rain; and • correlation between treated wastewater and algae blooms.	• government agencies; • recreation /commercial fishing groups; and • wider community.	**Chapter 8 Water quality, hydrology and flooding**
Groundwater	• current groundwater impacts from dunal exfiltration.	• wider community.	**Chapter 9 Groundwater**

Category	Issues/questions raised	Stakeholder group/s who raised issues/questions	Where addressed in this Environmental Impact Statement
Marine and coastal processes	• what direction would treated wastewater flow after dispersion? • would treated wastewater return to the beach due to ocean currents? • would treated wastewater enter estuaries?	• businesses/tourism stakeholders and community groups; • recreation/ commercial fishing groups; • action group; and • wider community.	**Chapter 10 Marine and coastal processes** and **Chapter 11 Marine ecology**
Marine ecology	• impacts to the artificial reef in Merimbula Bay; • impact of pathogens around the dispersal point; • potential for chemical use in wastewater treatment to impact marine ecology; • potential for treated wastewater (and contaminants, including microplastics) to impact marine ecology; • potential for marine ecology to become contaminated and prevent human consumption? • potential for damage/loss to abalone and other commercial fishing industries; • impact of treated wastewater on beach worms and other critters; and • likelihood of sewage spills.	• recreation/ commercial fishing groups; • environmental interest groups; • recreational users of beach and lake; • action group; and • wider community.	**Chapter 11 Marine ecology** The potential for treated wastewater potentially containing microplastics to impact marine ecology is discussed in **Appendix G** (Marine Ecology Assessment).
Terrestrial ecology	No specific issues raised	N/A	N/A

Category	Issues/questions raised	Stakeholder group/s who raised issues/questions	Where addressed in this Environmental Impact Statement
Landform, geology and soils	• potential for Project to impact on sand dunes; • impacts of dredging on the seabed; • impact on reef areas near Haycock Point; and • likelihood of sewage spills.	• environmental interest groups; • businesses/tourism stakeholders and community groups; • action group; and • wider community.	**Chapter 14 Landform, geology and soils** discusses any potential for Project to impact on sand dunes As no dredging has been proposed as part of the Project this is not assessed Any potential for impacts to reef areas near Haycock Point is discussed in **Chapter 11 Marine ecology** The likelihood of sewage spills is assessed in **Chapter 16 Hazards and risk**
Hazard and risk	• potential for human health impacts from chemical use in wastewater treatment; • potential for microplastic pollution from ocean outfall treated wastewater disposal; and • how will the Project be monitored during operation?	• environmental interest groups; • action group; and • wider community.	**Chapter 16 Hazards and risk** and **Chapter 17 Human health risk** The potential for treated wastewater potentially containing microplastics to impact marine ecology is discussed in **Appendix G** (Marine Ecology Assessment).

Category	Issues/questions raised	Stakeholder group/s who raised issues/questions	Where addressed in this Environmental Impact Statement
Human health risk	• potential for marine ecology to become contaminated and prevent human consumption; • likelihood of treated wastewater impacting the health of recreational beach users; and • pathogens around dispersal point.	• recreation/ commercial fishing groups; • recreational users of beach and lake; • environmental interest group; and • wider community.	**Chapter 17 Human health risk** and **Chapter 11 Marine ecology**
Aboriginal heritage	• impacts to Aboriginal heritage artefacts and sites from dunal exfiltration; and • impacts to Aboriginal heritage artefacts and sites during construction.	• Aboriginal stakeholders.	**Chapter 14 Aboriginal heritage**
Non-Aboriginal heritage	No specific issues raised.	N/A	N/A
Traffic and transport	No specific issues raised.	N/A	N/A
Property and land use	• potential for airport runway extension to impact on Project; • impacts to National Park/other areas outside of the study area.	• environmental interest groups; • action group; and • wider community.	**Chapter 19 Property and land use** and **Chapter 27 Cumulative impacts**
Social and economic	• will the Project take into account population growth? • impacts to commercial fishing should the Project affect marine ecology.	• Government agencies; • recreation/commercial fishing groups; • environmental interest groups; and • wider community.	**Chapter 23 Social and economic** and **Chapter 11 Marine ecology**
Noise and vibration	No specific issues raised.	N/A	N/A
Air quality	No specific issues raised.	N/A	N/A
Sustainability	No specific issues raised.	N/A	N/A

Category	Issues/questions raised	Stakeholder group/s who raised issues/questions	Where addressed in this Environmental Impact Statement
Climate change risk	• consideration of climate change projections; and • ability of infrastructure to withstand sea level rises.	• Government agencies; and • environmental interest groups.	**Chapter 25 Climate change risk**
Waste	No specific issues raised	N/A	N/A

6.3 Consultation during public exhibition of the Environmental Impact Statement

The EIS would be placed on public exhibition by DPIE from 23 August to 19 September 2021. During this period, stakeholders and the community would be able to view and download electronic copies of the EIS from the DPIE Major Projects website (https://www.planningportal.nsw.gov.au/major-projects).

BVSC would continue to consult with stakeholders during this period to discuss the EIS. A description of the consultation activities to be carried out during the public exhibition period is detailed below. Note that if COVID 19 restrictions are in effect during this period, alternative consultation methods may be undertaken.

Restrictions introduced during the COVID 19 pandemic required cancelation of some engagement activities involving face-to-face interaction with large groups. Engagement activities are limited to those without face-to-face interaction, such as via internet, radio, and print media. Given the significant and prolonged economic impact of the pandemic, some stakeholders, particularly tourism stakeholders, have limited capacity to engage.

6.3.1 Ongoing communication tools

BVSC would continue use of the contact points and information tools established for the Project. These would be available for all stakeholders to directly contact the Project team and request Project information.

6.3.2 Consultation

Project collateral would be developed to inform stakeholders and the community about the EIS exhibition period, provide instruction on how to make a submission and explain the EIS approval process, EIS display locations and the planned community information session. BVSC would undertake the following activities:

- Media release – to be published at or on approach to the commencement of the EIS exhibition period;
- Social media – posts are expected to commence on the first day of exhibition. BVSC will re-post throughout the EIS exhibition period to maximise reach through this medium;
- Newspaper advert –to be published in all three shire newspapers, including Bega District News, the Eden Magnet, and Merimbula News Weekly;
- Radio advertisement – a radio ad script would be broadcast. BVSC intend for this to occur on the first day of the EIS exhibition period, and for this to continue daily for a minimum of one week;
- Website– the Project’s ‘Have Your Say’ page is intended to go live on the first day of the EIS exhibition period. The page would expire following the exhibition period;
- Telephone – a 1800 phone number would be open to receive calls from the community regarding the Project
- Hardcopy EIS – would be placed in libraries on first day of exhibition (subject to COVID-19 restrictions); and
- Email – BVSC intends to send an email to stakeholders and community members registered on the stakeholder database, notifying them of the commencement of the EIS display period.

6.3.3 Preparation of Submissions Report

Written submissions received during the EIS exhibition period would be forwarded from DPIE to BVSC for consideration and review. After reviewing the submissions, BVSC would prepare a Submissions Report documenting the submissions received and BVSC’s response. This report would be made publicly available on the DPIE major projects website.

To inform stakeholders and the community that the Submissions Report for the Project is available to view, BVSC would:

- publish a media release;
- update the Project webpage;
- through social media updates (e.g. Facebook and Instagram);

- send an email to stakeholders and community members registered on the stakeholder database.

6.4 Future consultation proposed after public exhibition of the Environmental Impact Statement

6.4.1 Consultation during construction

BVSC would continue community and stakeholder consultation throughout the construction of the Project to ensure stakeholders and the community are kept informed about the Project. This may include key milestone updates, notifications regarding upcoming works which may disrupt the community, and communication of the established complaints handling procedure (see below). This would also include publishing Project updates in the BVSC Council News newsletter.

Consultation during construction, particularly with regards to any community complaints, would be guided by a Construction Environmental Management Plan (CEMP), which would be developed in conjunction with a construction contractor should the Project be approved.

6.4.2 Complaints handling process

Complaints about any aspect of the Project can be provided in person, in writing, by email, telephone or online via the BVSC Project website.

If a complaint is received on the Project 1800 number, Project team members would receive, register and acknowledge complaints verbally. Complaints received via email or the website would be responded to in writing. Complaints received during the construction phase about construction matters would be forwarded through to relevant BVSC Project staff and the construction contractor for a response.

During the construction phase, the CEMP would include procedures for the construction contractor to resolve and respond to community and stakeholder complaints in line with BVSC policy and procedure. If the complainant remains dissatisfied with the initial response to their complaint, the matter would be escalated as per procedures to be outlined in the CEMP.

Once operational, any complaints received about the Project would typically be dealt with by front line BVSC staff. Complaints will be acknowledged by the staff member who receives them. Details of the complaint would be recorded in a stakeholder database reported to the Project Manager for response and resolution as per existing BVSC policy and procedures for the STP.

7.0 Environmental scoping assessment

This chapter describes the process undertaken to scope the environmental assessment contained within this EIS. It also describes the subsequent prioritisation of environmental issues following provision of the SEARs, and further environmental investigations and consultation undertaken for the Project.

7.1 Overview

The environmental scoping process for the Project began in the early stages of the conception of the Project, and was captured in the preliminary environmental impact assessment section of the report: *Planning Report to Support an Application for State Significant Infrastructure - Merimbula Sewage Treatment Plant Upgrade and Ocean Outfall* (Planning Law Solutions, 2016) (Planning Report). This report was submitted to the former Department of Planning and Environment in support of an application for SEARs.

The Planning Report identified potential impacts of construction and operation of the Project (as it was described at the time), and noted that the extent of the impacts and the means of mitigating them would be determined as part of the design development process and the environmental impact assessment (i.e. this EIS). The potential impacts identified in the Planning Report included the following:

- water quality;
- marine ecology;
- native vegetation/terrestrial ecology;
- Aboriginal cultural heritage; and
- social and economic and impacts.

The Planning Report recognised that when these potential impacts are balanced against the reduction in adverse impacts expected from the Project, the Project is expected to deliver a long term net environmental improvement. These impacts are accounted for in the following sections, along with additional issues subsequently identified in the SEARs.

7.2 Methodology

The purpose of this environmental scoping assessment was to:

- identify and confirm the environmental and community issues to be considered as part of this EIS;
- identify any issues not included in the SEARs to enable appropriate assessment; and
- undertake a risk assessment of the issues to identify the ‘key issues’ for the Project, which require a greater level of assessment and prioritisation in the EIS, and alternatively to identify ‘other issues’.

A risk assessment was undertaken using BVSC’s *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. The definitions of consequences are provided in **Table 7-1**, and the definitions of likelihood are provided in **Table 7-2**. The risk matrix used is provided in **Table 7-3**, which combines the consequence and likelihood to establish the risk outcome. Note that construction of the Project is expected to take approximately 24 months, and the proposed ocean outfall pipeline has a design life of 100 years, and the assessment has been prepared in this context.

The environmental risk assessment has been prepared based on the Project description provided in **Chapter 2 Project description**, which describes how the Project would be constructed and operated. While the risk assessment aimed to identify a ‘worst case’ scenario, risk levels would vary based on the environmental context and impact type. The risk assessment is intended to identify broad environmental risks associated with the Project. Activity and site-specific risks are detailed within each individual environmental assessment chapter.

Table 7-1 Consequence criteria

Consequence levels	Risk categories consequence descriptors				
	Environmental	Financial	Legal	Reputational	Health/Safety
Catastrophic	Irreversible long-term	>$1million	Cessation of activities	Censure/ Inquiry	Death, severe permanent disablement or adverse health effect
Major	Wide long-term	$500,000 to $1million	Successful prosecution	High media	Hospitalisation, serious injuries resulting in long term absences and adverse health effect
Moderate	Wide short-term	$100,000 to $500,000	Enforceable undertaking or fine	Moderate media	Medical treatment required and/or some lost time
Minor	Minor short-term	$20,000 to $100,000	Compliance breach resulting in corrective action	Minor media	Medical treatment required, no lost time
Insignificant	Incident not requiring intervention	< $20,000	Technical compliance breach with limited material impact	Incident that does not receive any coverage	First aid injury, no lost time

Source: Procedure 6.03.1 of the *Enterprise Risk Management Framework* (BVSC, 2019)

Table 7-2 Likelihood criteria

Likelihood	Description	Probability of occurrence
Almost certain	Expected to occur in most circumstances	Within 1 year
Likely	Will probably occur in most circumstances	Within 2 years
Possible	Might occur at some time	Within 3-5 years
Unlikely	Could occur at some time	Within 10-20 years
Rare	May occur in exceptional circumstances	More than 20 years

Source: Procedure 6.03.1 of the *Enterprise Risk Management Framework* (BVSC, 2019)

Table 7-3 Risk assessment matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	High	High	Very High	Very High
Likely	Medium	Medium	High	High	Very High
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

Source: Procedure 6.03.1 of the *Enterprise Risk Management Framework* (BVSC, 2019)

7.3 Scoping assessment

Using the framework described in **Section7.2**, the preliminary environmental risk assessment undertaken for the Project is presented in **Table 7-4**. The risk assessment is a high-level assessment that identifies an initial risk rating for each of the environmental issues **without ANY mitigation,** including no standard regulatory mitigation measures.

The purpose of this absolute worst case risk assessment is intended to identify the key environmental impacts to be considered. An environmental issue can be identified as a key issue based on the risk of either unmitigated construction related impacts or unmitigated operational related impacts. For this reason, the risk assessment accounts for both construction and operational risks.

An assessment of the existing environment and potential impacts associated with each environmental issue, along with mitigation and management, are provided in the respective chapter for each environmental assessment in this EIS (refer Chapters 8 to 27). The residual risk for each environmental issue (i.e. the risk remaining post-mitigation) is then discussed in **Chapter 28 Synthesis of the EIS**.

Table 7-4 Environmental risk assessment without mitigation

Environmental issue	Construction / Operation	Consequence without mitigation	Likelihood without mitigation	Risk rating without mitigation
Water quality				
Changes to water quality in receiving environment through unmitigated release of sediment or acid sulfate soil material, or an accidental spill.	Construction	Major	Likely	High
Impacts to water quality as a result of low quality treated wastewater.	Operation	Moderate	Possible	Medium
Surface water hydrology and flooding				
Inundation of Project area by flood waters or impacts from the Project to flood behaviour	Construction	Moderate	Rare	Low
Impacts on surface water quality	Construction	Moderate	Possible	Medium
Impacts on water bodies	Construction	Major	Possible	High

Environmental issue	Construction / Operation	Consequence without mitigation	Likelihood without mitigation	Risk rating without mitigation
Inundation of Project area by flood waters or impacts from the Project to flood behaviour	Operation	Moderate	Rare	Low
Groundwater				
Groundwater drawdown	Construction	Moderate	Possible	Medium
Groundwater quality	Construction	Major	Possible	High
Groundwater drawdown	Operation	Moderate	Rare	Low
Groundwater quality	Operation	Moderate	Rare	Low
Marine and coastal processes (including protected and sensitive lands, such as coastal wetlands)				
Changes to marine sediment transport	Construction	Major	Possible	High
Impacts to wetland areas	Construction	Moderate	Possible	Medium
Changes to marine sediment transport	Operation	Moderate	Possible	Medium
Impacts to wetland areas	Operation	Moderate	Unlikely	Medium
Marine ecology				
Direct physical impacts to marine flora or fauna	Construction	Major	Possible	High
Indirect impacts to marine flora or fauna from changes to water quality	Construction	Major	Possible	High
Direct physical impacts to marine flora or fauna	Operation	Major	Possible	High
Indirect impacts to marine flora or fauna from changes to water quality	Operation	Major	Possible	High
Terrestrial ecology				
Vegetation clearing	Construction	Moderate	Almost certain	High
Displacement of fauna	Construction	Moderate	Likely	High
Disruption to critical life cycle events such as breeding or nursing	Construction	Moderate	Likely	High
Impacts to significant environmental features such as wetlands	Construction	Moderate	Likely	High

Environmental issue	Construction / Operation	Consequence without mitigation	Likelihood without mitigation	Risk rating without mitigation
Hazards and risk				
Storage and handling of dangerous goods and other chemicals	Construction	Major	Possible	High
Storage and handling of dangerous goods and other chemicals	Operation	Moderate	Unlikely	Medium
Landform, geology and soils				
Contamination impacts during ground disturbance activities	Construction	Moderate	Likely	High
Exposure to contaminated material	Construction	Moderate	Likely	High
Poor erosion and sediment control	Construction	Moderate	Likely	High
Release of acid sulfate soils	Construction	Moderate	Rare	Medium
Accidental spills (including accidental release of drilling fluids)	Construction	Moderate	Likely	High
Accidental spills	Operation	Minor	Rare	Low
Human health (health and safety)				
Human health impacts from release of treated wastewater	Construction	Minor	Possible	Medium
Human health impacts from release of treated wastewater	Operation	Minor	Unlikely	Low
Aboriginal heritage				
Potential accidental site disturbance during construction	Construction	Major	Possible	High
Impacts to previously unrecorded Aboriginal archaeological sites	Construction	Major	Possible	High
Encountering human remains	Construction	Major	Possible	High
Non-Aboriginal heritage				
Direct or indirect impacts to items or areas of heritage significance	Construction	Major	Possible	High
Unexpected discovery of a relic or potential relic	Construction	Major	Possible	High

Environmental issue	Construction / Operation	Consequence without mitigation	Likelihood without mitigation	Risk rating without mitigation
Traffic and transport				
Generation of traffic causing impacts to surrounding road network	Construction	Moderate	Likely	High
Property and land use				
Use of Crown Land	Construction	Moderate	Almost certain	High
Temporary change in land use from construction access on beach	Construction	Moderate	Almost certain	High
Temporary land use change for portion of Pambula Merimbula Golf Club	Construction	Moderate	Almost certain	High
Noise and vibration (airborne and underwater)				
Airborne noise emissions causing impacts to sensitive receptors	Construction	Major	Likely	High
Underwater noise emissions causing impacts to sensitive receptors	Construction	Major	Likely	High
Airborne noise emissions causing impacts to sensitive receptors	Operation	Minor	Rare	Low
Underwater noise emissions causing impacts to sensitive receptors	Operation	Minor	Rare	Low
Sustainability				
Being unable to optimise sustainability performance of the Project	Construction	Minor	Likely	Medium
Social and economic				
Amenity impacts to surrounding community	Construction	Moderate	Possible	Medium
Economic impacts to local community	Construction	Moderate	Possible	Medium
Negative amenity impacts to surrounding community	Operation	Insignificant	Rare	Low
Negative economic impacts to local community	Operation	Insignificant	Rare	Low

Environmental issue	Construction / Operation	Consequence without mitigation	Likelihood without mitigation	Risk rating without mitigation
Air quality				
Dust emissions causing nuisance to neighbours	Construction	Minor	Likely	Medium
Climate change risk				
Increase in frequency and intensity of extreme heat events increases risk of heat stress conditions for personnel, resulting in increased work health and safety risks and potential delays	Operation	Major	Unlikely	Medium
Increase in frequency and intensity of extreme bush fire events increases risk to personnel and infrastructure, resulting in increased work health and safety risks and potential delays	Operation	Major	Unlikely	Medium
Increase in the intensity and frequency of storm events leads to unsuitable conditions and requires stop work procedures for the safety of construction personnel, resulting in potential delays	Construction	Moderate	Possible	Medium
Increase in the intensity and frequency of extreme rainfall combined with sea level rise leads to localised flooding of construction footprint	Construction	Moderate	Unlikely	Medium
Increase in the intensity and frequency of extreme rainfall combined with sea level rise leads to localised flooding of Project	Operation	Moderate	Possible	Medium
Overflow and unregulated discharge into lagoons, sludge storage areas, storm storage ponds or other plant processes during extreme rainfall event, resulting in breach of Environmental Protection Licence (EPL) conditions for discharge and potential negative community concern.	Operation	Major	Unlikely	Medium

Environmental issue	Construction / Operation	Consequence without mitigation	Likelihood without mitigation	Risk rating without mitigation
Waste				
Impacts associated with poor waste management	Construction	Minor	Likely	Medium

7.3.1 Prioritisation of issues

Based on the environmental risk analysis outlined above, key issues for the Project have been identified as those with a risk ranking of high (for either construction or operation).

The issues identified have been re-ordered in this EIS with consideration to the SEARs and following development of the Project design (including construction methodology), and further environmental investigations undertaken for this EIS. The revised issues are shown in **Table 7-5**. Key issues identified are addressed first in this EIS, followed by other issues.

Note in accordance with the SEARs, the level of assessment undertaken for each issue is considered to be proportionate to the significance, or degree of impact on, the issue, within the context of the proposal location and the surrounding environment.

Table 7-5 Identification of 'key issues' and 'other issues'

Issue	Where addressed in this EIS
Key issues	
Water quality, hydrology and flooding	**Chapter 8**
Groundwater	**Chapter 9**
Marine and coastal processes (including protected and sensitive lands, such as coastal wetlands)	**Chapter 10**
Marine ecology	**Chapter 11**
Terrestrial ecology	**Chapter 12**
Landform, geology and soils	**Chapter 13**
Aboriginal heritage	**Chapter 14**
Non-Aboriginal heritage	**Chapter 15**
Hazards and risk	**Chapter 16**
Human health (Health and safety)	**Chapter 17**
Traffic and transport	**Chapter 18**
Property and land use	**Chapter 19**
Noise and vibration (airborne)	**Chapter 20**
Noise and vibration (underwater)	**Chapter 21**
Other issues	
Air quality	**Chapter 22**
Social and economic	**Chapter 23**
Sustainability	**Chapter 24**

Issue	Where addressed in this EIS
Climate change risk	**Chapter 25**
Waste	**Chapter 26**

7.4 Format of assessment chapters

For the benefit of the reader, a standardised approach has been adopted for the structure of each of the assessment chapters. The purpose of a standardised chapter structure is to provide a clear and consistent approach to the assessment of environmental impacts within this EIS. The standard structure of sections for each assessment chapter is as follows:

- Introduction;
- Method of assessment;
- Existing environment;
- Impact assessment; and
- Mitigation and management.

A general description of the purpose and content of each of these sections is provided in **Table 7-6**.

Table 7-6 Assessment chapter structure and content description

Section	Content description
Introduction	Provides an overview of the scope of the assessment for the chapter. It sets out the SEAR/s relevant to the assessment and describes where they have been addressed. Where applicable this section also provides reference to the relevant technical report which was prepared for the assessment.
Method of assessment	Provides the methodology which has been applied to guide the assessment. This includes (but is not necessarily limited to): • the study area/area of investigation for the assessment; • applicable guidelines and standards which have been applied to the assessment; and • key assumptions and limitations applied to the assessment. For each environmental assessment there is an explanation of the approach to identifying impacts and assessing whether a potential impact is likely to be considered significant. Assessments can either be quantitative (relying on numbers, criteria, standards and/or measurable thresholds) or qualitative (using certain scientific material, but ultimately making decisions based on professional judgement).
Existing environment	A description of the existing environment. Where applicable this is with reference to the supporting technical report. This may include (but is not necessarily limited to): • key features and/or receptors which are relevant to the assessment; • background information/monitoring; and • details of previous studies which contain relevant information.

Section	Content description
Impact assessment	An assessment of the impacts of the construction and operation of the Project within the context of the existing environment, in accordance with the method of assessment described. The level of detail and focus of the impact assessment is guided by the Project SEARs. Each matter has been assessed as either: • a 'Key Issue Assessment' in accordance with Desired Performance Outcome 3 (Assessment of Key Issues) of the SEARs (refer **Appendix A** (SEARs compliance table); or • an 'Other Issue Assessment' where the impacts are reported in this EIS and which can typically be managed through routine mitigation and management measures. Where existing criteria, guidance, environmental standards or assessment methodologies exist, the significance of an impact is based on that information. Where possible and/or necessary quantitative judgements about the significance of an impact is made using this information. Where no explicit guidance or information exists, qualitative judgements of the significance of an impact are made. Where qualitative judgements are required, some or all of the following impact characteristics are considered to understand the impact: • extent: the area potentially affected by the impact • magnitude: the size or amount of the impact • duration: how long the impact is likely to last • frequency: whether the impact is continuous, brief or intermittent • timing: if the impact occurs at a particularly sensitive time • permanence: whether the impact is permanent or temporary. The judgement as to whether an impact is significant depends on the importance or sensitivity of the receptor (e.g. as defined by legislation, policy, standards or guidance) and the magnitude of the impact affecting it (as decided by quantitative or qualitative means). The impact assessment sections of each chapter deal with impacts from the Project only. Potential cumulative impacts (i.e. those in conjunction with impacts from other surrounding projects) are addressed in **Chapter 27 Cumulative impacts** of this EIS.
Mitigation and management	Provides an analysis of how the potential environmental impacts can be avoided, minimised or managed. Performance outcomes and mitigation and management measures are summarised in this section. Environmental Management Plans would be developed for the construction and operation of the Project. The Environmental Management Plans would outline performance outcomes to be achieved and include the mitigation and management measures for construction and operation of the Project. At the end of each mitigation and management section in this EIS, the likely residual impacts expected (post-mitigation) are outlined and a discussion of the acceptability of any residual impacts with reference to relevant standards or guidelines is provided.

8.0 Water quality, hydrology and flooding

This chapter provides a summary of the water quality, hydrology and flooding impacts associated with the Project. This chapter has been informed by water quality and flooding assessments provided in **Appendix E** (Water Quality Technical report prepared by Elgin, 2020) and **Appendix F** (Flood Technical report prepared by AECOM, 2020). **Table 8-1** sets out the relevant SEARs and identifies where the requirements have been addressed in this EIS.

Table 8-1 SEARs – Water quality, hydrology and flooding

Ref	Secretary's Environmental assessment requirements	Where addressed in this EIS
1	**Water quality**	
1 (a)	The Proponent must: state the ambient NSW Water Quality Objectives (NSW WQO) and environmental values for the receiving waters relevant to the project, including the indicators and associated trigger values or criteria for the identified environmental values.	**Section 8.1.4** and **Appendix E** (Water Quality Technical report)
1 (b)	identify and estimate the quality and quantity of all pollutants that may be introduced into the water cycle by source and discharge point and describe the nature and degree of impact that discharge(s) may have on the receiving environment, including consideration of all pollutants that pose a risk of non-trivial harm to human health and the environment.	**Section 8.4.1** and **Section 8.4.2** **Appendix E** (Water Quality Technical report)
1 (c)	assess the significance of any identified impacts including consideration of the relevant ambient water quality outcomes;	**Section 8.3.1** and **Section 8.4.2** **Appendix E** (Water Quality Technical report)
1 (d)	demonstrate how construction and operation of the project will, to the extent that the project can influence, ensure that: • where the NSW WQOs for receiving waters are currently being met they will continue to be protected; and • where the NSW WQOs are not currently being met, activities will work toward their achievement over time.	**Section 8.5**
1 (f)	include results of effluent plume dispersal modelling including quantification of the impact zone under a range of conditions including northerly current, southerly current, and worse-case scenario.	**Section 8.4.2**, **Appendix E** (Water Quality Technical report), and **Appendix Q** (Dispersion modelling report)
1 (g)	include results of water quality modelling and analysis including descriptions of water quality impacts under the worse-case scenario.	**Section 8.4.2**
1 (h)	justify, if required, why the WQOs cannot be maintained or achieved over time.	**Section 8.1.4** describes WQOs applicable to the Project and also provides a justification where considered to be non-applicable

Ref	Secretary's Environmental assessment requirements	Where addressed in this EIS
1 (i)	demonstrate that all practical measures to avoid or minimise water pollution and protect human health and the environment from harm are investigated and implemented.	**Section 8.3.1, Section 8.4.2** and **Section 8.5**
1 (j)	identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments.	**Section 8.2** and **Section 8.5**
1 (k)	identify proposed water quality monitoring locations, monitoring frequency and indicators of water quality, including groundwater quality.	**Section 8.5.2**. **Chapter 9 Groundwater** and **Appendix D** (Groundwater Technical report) describes groundwater monitoring proposed as part of the Project
7	**Water - Hydrology**	
7 (1)	The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project.	The hydrology of Merimbula Bay is described in **Section 8.2** and also taken into account in treated wastewater dispersion modelling for the existing situation and proposed (refer also **Appendix E** (Water Quality Technical report)). Section **8.2** also describes Merimbula Lake and wetland, and Pambula River. Groundwater hydrology is addressed in **Chapter 9 Groundwater**
7 (2)	The Proponent must prepare a detailed water balance including inflow volumes and discharge locations, volume, frequency and duration.	**Chapter 2 Project description** (sewage inflow and treated wastewater discharge volumes are provided in **Table 2-1**, and operational water use is provided in **Section 2.2.2.** As only small volumes of water are required during operation, a

Ref	Secretary's Environmental assessment requirements	Where addressed in this EIS
		detailed water balance has not been prepared).
7 (3a)	The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including: natural processes within rivers, wetlands, estuaries, marine waters and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge.	**Section 8.3.2** and **Section 8.4.3** Groundwater impacts are addressed in **Chapter 9 Groundwater**
7 (3b)	impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement.	**Chapter 9 Groundwater**
7 (3c)	direct or indirect increases in erosion, siltation and destruction of vegetation.	**Chapter 13 Landform, geology and soils** Vegetation impacts are also addressed in Terrestrial **12 Terrestrial ecology**
7 (3d)	minimising the effects of proposed stormwater and wastewater management during construction and operation on natural hydrological attributes (such as volumes, flow rates, management methods and re-use options) and on the capacity of existing systems.	**Section 8.3.2** and **Section 8.4.3**
7 (4)	The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	The Project would not affect hydrological attributes of surface waters (e.g. flow rates, volumes) to any extent that would require monitoring. Note that **Section 8.5** describes water quality monitoring proposed.

Ref	Secretary's Environmental assessment requirements	Where addressed in this EIS
12	**Flooding**	
12	The Proponent must assess and (model where required) the impacts of flood behaviour during construction and operation for a full range of flood events up to the probably maximum flood (taking into account, sea level rise due to climate change) including:	**Section 8.3.2** and **Section 8.4.3** A Flood Technical report is also provided in **Appendix F** (Flood Technical report)
1 (a)	consistency (or inconsistency) with applicable Council floodplain risk management plans.	**Section 8.3.2**
1 (b)	compatibility with the flood hazard of the land.	**Section 8.3.2**
1 (c)	compatibility with the hydraulic functions of flow conveyance in flood ways and storage areas of the land.	**Section 8.3.2** A Flood Technical report is also provided in **Appendix F** (Flood Technical report) that addresses this issue in greater detail
1 (d)	impacts the development may have upon existing community emergency management arrangements for flooding. These matters must be discussed with the State Emergency Services.	**Section 8.3.2** and **Section 8.4.3**
1 (e)	any impacts the development may have on the social and economic costs to the community as a consequence of flooding.	**Section 8.4.3**

8.1 Assessment approach

8.1.1 Statutory context, policy and guidelines

The impact assessment of the Project on water quality, hydrology and flooding has been prepared in accordance with or with reference to the following relevant legislation, guidelines and policies:

- *Protection of the Environment Operations Act 1997* (NSW) (POEO Act);
- *Water Act 1912* and *Water Management Act 2000* (NSW) (WM Act);
- *Bega Valley Local Environmental Plan 2013;*
- *Floodplain Development Manual* (DIPNR, 2005);
- *Marine Water Quality Objectives for NSW Ocean Waters – South Coast* (DEC, 2005);
- *NSW Water Quality and River Flow Objectives, Towamba and Genoa River* (DECCW, 2006);
- *Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC, 2000); and as updated online at https://www.waterquality.gov.au/anz-guidelines* (ANZG, 2018);
- *Using the ANZECC Guidelines and Water Quality Objectives in NSW* (DEC, 2006);
- *Approved Methods for the Sampling and Analysis of Water Pollutants in NSW* (DEC, 2008);
- *Environmental Guidelines – Use of effluent by irrigation* (DEC, 2003); and
- *NSW Guidance for Recycled Water Management Systems* (DPI Office of Water, 2015).

8.1.2 Study area

The study area for the assessments in this chapter includes the marine receiving waters and terrestrial environment within and surrounding the Project area.

Terrestrial environments in the study area that are influenced by the Merimbula STP include:

- Pambula-Merimbula Golf Club (PMGC) in Merimbula, which re-uses treated wastewater for irrigation;
- Oaklands agricultural area in Pambula, which re-uses treated wastewater for irrigation; and
- dunal exfiltration ponds to the east of Merimbula STP, for treated wastewater disposal.

It is proposed that the PMGC and Oaklands agricultural area would continue to beneficially re-use treated wastewater for irrigation purposes during operation of the Project, whilst disposal of treated wastewater to the dunal exfiltration ponds would cease.

Marine and estuarine environments within the study area include:

- marine coastal waters and nearshore waters of Merimbula Bay (and south of Haycock Point towards Quondolo Point); and
- estuary waters of Merimbula Lake and Pambula River.

The study area is shown on **Figure 8-1**.

FIGURE 8-1: STUDY AREA - WATER QUALITY, HYDROLOGY AND FLOODING

Legend

- Study area
- Project area
- Project area (temporary construction area)
- Beneficial reuse site
- Approximate extent of reef

N 0 1 2 km

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

8.1.3 Assessment method

Water quality

The method of assessment for water quality included:

- a desktop review and analysis of existing information to determine potential receptors, characterise the existing environment and identify potential issues;
- a field assessment including collecting samples (water and sediment) from multiple sites to confirm and supplement the findings of the desktop analysis and refine understanding of potential issues;
- assessment of potential construction and operational impacts related to hydrology, and water quality, including:
  - qualitative assessment of potential water quality impacts from construction activities associated with the Project, as well as potential impacts to the hydrology of surface waters;
  - assessment of the construction footprint of the Project in relation to flood behaviour for a range of flood events;
  - assessment of how treated wastewater discharges from operation of the Project may impact the receiving environment, including analysis of treated wastewater plume dispersion modelling undertaken as part of the Project design. The dispersion modelling undertaken is described in *Merimbula Ocean Outfall – Dispersion Modelling Report* and is attached in **Appendix Q** (Dispersion Modelling Report). The dispersion modelling was used to assess the water quality impacts of treated wastewater discharged at the existing beach-face outfall and at the proposed ocean outfall location;
  - the assessment of water quality impacts adopted a conservative approach and was based on hydrodynamic modelling of existing treated wastewater quality (ETWWQ). This approach was adopted regardless of the expectation that the Project would result in improved wastewater quality. A description of the ETWWQ values used is provided in **Section 8.2.1**;
  - assessment of potential impacts to the hydrology of surface waters in the surrounding environment, and assessment of the Project in relation to flood behaviour for a range of flood events; and
- identification of appropriate measures to mitigate and/or manage the potential impacts identified.

Flooding and hydrology

The assessment for flooding included consideration of available data with the key study relied on being *Merimbula Lake and Back Lake Flood Study* (Cardno, 2017).

As detailed modelling has been undertaken previously, a qualitative desktop assessment of flooding impacts associated with the Project was undertaken, which included:

- a desktop review and analysis of existing information to characterise the existing environment, identify surface water receptors, existing flood behaviours and identify potential issues;
- consideration of the location of the Project area in the context of surrounding catchment areas and potential sensitivity of downstream waterways;
- identification of key topographical features which may influence overland flow paths;
- assessment of potential construction and operational impacts relating to flooding; and
- identification of appropriate measures to mitigate and/or manage potential impacts on the environment.

The *Merimbula Lake and Back Lake Floodplain Risk Management Study* (Rhelm, 2020) reviewed and adopted the modelling undertaken by Cardno (2017) as a basis for floodplain risk management within the Bega Valley Shire. Several flood planning recommendations were made as part of the Floodplain Risk Management Study and endorsed by BVSC in February 2021.

A qualitative desktop assessment was undertaken in relation to other hydrology-related impacts. This included a review of the following EIS chapters:

- **Chapter 9 Groundwater**;
- **Chapter 11 Marine ecology;**
- **Chapter 12 Terrestrial ecology**; and
- **Chapter 13 Landform, geology and soils**.

8.1.4 Marine and Estuary Water Quality Objectives

Water quality objectives (WQOs) adopted for marine and estuary receiving waters are based on the *Marine Water Quality Objectives for NSW Ocean Waters – South Coast* (DEC, 2005). These objectives apply to ocean waters that adjoin the NSW coast and extend three nautical miles seaward from the shore (DEC, 2005) and include qualitative and quantitative objectives related to protecting environmental values, such as; aquatic ecosystems, visual amenity, recreation and aquatic foods.

Merimbula Lake and Pambula River are located within the Genoa and Towamba catchment, and the *NSW Water Quality and River Flow Objectives, Towamba and Genoa River* (DC, 2006) have been adopted for purpose of the assessment.

The Project and study area have adopted these objectives for the marine and estuarine receiving waters of the study area, hereby referred to as Marine Water Quality Objectives (MWQOs). MWQOs are presented in full in **Appendix E** (Water Quality Technical report).

Based on DECC (2005), the MWQOs identify environmental values to be protected, indicators that provide a measure of water quality, and guideline criteria (trigger values) for assessing the risk of impacts to water quality and identified environmental values.

The following considerations are relevant to Project MWQOs:

- the MWQOs do not apply as an end-of-pipe wastewater discharge criteria;
- the MWQOs apply as a strategic objective for ambient waters at the outer extent of a predicted (modelled) zone of influence (hereby referred to as a mixing zone) from the outlet;
- achievement of the MWQOs at the outer extent of the mixing zone is affected by multiple diffuse sources including estuary outflows and with it stormwater discharge and agricultural runoff, marine upwellings, as well as the proposed treated wastewater discharge from the ocean outfall pipeline; and
- the MWQOs are to be used as a tool only by Project decision makers rather than as fixed criteria.

8.2 Existing environment

The existing approach to treated wastewater disposal from the Merimbula STP is discussed in **Section 8.2.1**.

The waters surrounding the Project area are shown in **Figure 8-1** and include:

- marine coastal waters of Merimbula Bay, Haycock Point and south towards Quondolo Point, including nearshore waters along Merimbula Beach and Pambula Beach; and
- estuary waters of Merimbula Lake and Pambula River, both of which are highly influenced by ocean waters.

A wetland is also located to the east of the STP site, under which a portion of the underground section of the ocean outfall pipeline alignment travels (refer Figure 12-4 in **Chapter 12 Terrestrial ecology)**.

The Project area does not support any watercourses identified on the Pambula 1:25,000 topographical map and none were identified during the biodiversity assessment undertaken for the Project (refer **Appendix H** (Biodiversity Assessment Report)).

Sections 8.2.2 to **8.2.4** provide a brief description of the water bodies and a summary of the existing water quality and patterns of flooding. Further information on the existing environment of the water bodies surrounding the Project can be found in **Appendix E** (Water Quality Technical report) and **Appendix F** (Flood Technical report).

8.2.1 Existing treated wastewater disposal

Currently, the Merimbula STP discharges treated wastewater via the existing beach-face outfall onto Merimbula Beach, and at the dunal exfiltration ponds to the east of the STP site. Treated wastewater is also disposed of via a beneficial re-use scheme at the adjacent PMGC grounds and Oaklands agricultural area.

The ETWWQ was determined using the results of monitoring data at the existing Merimbula STP from April 2004 to September 2016. A summary of the treated wastewater quality statistics is presented in **Table 8-2**.

Based on the available data, ETWWQ can be broadly described as (based on median concentrations):

- 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 flow;
- containing levels of microalgae as represented by chlorophyll-a. Once discharged to the marine environment, microalgae in treated wastewater would 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;
- relatively low microbiological indicators of enterococci and faecal coliform counts with intermittent higher counts that exceed MWQOs such as during wet weather flow; and
- containing concentrations of metals that include instances of aluminium, copper, iron, selenium and zinc, reported above MWQOs.

Table 8-2 Treated wastewater water quality summary statistics (April 2004 to September 2016)

Parameter	Sample # (n)	Units	Min	Max	Median	Wet Weather Flow Median	90th Percentile
pH	645	pH units	6.16	9.44	7.80	7.4	8.31
Suspended Solids	647	mg/L	0	56	5	11	13
Electrical Conductivity	389	µs/cm	11	2140	730	641	874
Dissolved Oxygen	368	mg/L	0.7	24	9.7	7.2	12.9
Biological Oxygen Demand	648	mg/L	0	104	2	19	6
Chemical Oxygen Demand	645	mg/L	3	138	28	51	40
Total Nitrogen	648	mg/L	1.09	30	4.29	9.10	10.1
Oxides of Nitrogen NOx (as N)	646	mg/L	0.04	29	1.92	3.40	8.06
Ammonia (as N)	648	mg/L	0.01	17	0.34	4.1	2.0

Parameter	Sample # (n)	Units	Min	Max	Median	Wet Weather Flow Median	90th Percentile
Total Phosphorus (as P)	648	mg/L	2.82	18.0	9.3	9	12.0
Ortho Phosphate (as P)	374	mg/L	2.62	15	8.1	9	11
Chlorophyll "a"	158	µg/L	0.15	300	5.2	5.2	68.8
Cl-Combined	350	mg/L	0.01	1.00	0.09	0.03	0.30
Cl-Free	359	mg/L	0	1.03	0.09	0.14	0.26
Cl-Total Residual	359	mg/L	0	1.55	0.17	0.16	0.52
Faecal Coliforms (2004-2016 data)	647	cfu/100mL	<1	15000	50	242	672
Faecal Coliforms (2014-2016 data)	89	cfu/100mL	<1	1320	1	242	180
Enterococci	89	cfu/100mL	<1	4080	1	384	188
E. Coli	87	cfu/100mL	<1	1320	1	172	140
Oil and grease	647	mg/L	<1	13	1	1	1
Calcium	101	mg/L	16.6	25.6	20.3	18.9	23.4
Magnesium	101	mg/L	5.1	16.2	9.8	8.6	13.5
Potassium	101	mg/L	9.2	33.3	21.4	17.2	25.4
Sodium	101	mg/L	40.4	184	112	85.5	156
Aluminium	101	ug/L	10	177	40.0	124	74.6
Antimony	101	ug/L	<3	<3	<3	1.5	<3
Arsenic	101	ug/L	<1	4	2	2	3
Barium	101	ug/L	3.2	31.4	6.0	6.1	10.2
Beryllium	101	ug/L	<0.1	0.3	<0.1	0.1	0.1
Boron	101	ug/L	30	140	60	60	80
Cadmium	101	ug/L	<0.05	0.32	<0.05	<0.05	<0.05
Chromium	101	ug/L	<1	3	<1	<1	1
Cobalt	101	ug/L	<0.2	1	0.3	0.3	0.5
Copper	101	ug/L	4	677	21	11.5	272
Iron	101	ug/L	50	1910	150	300	706
Lead	101	ug/L	<0.2	11.8	0.2	0.3	5.6
Manganese	101	ug/L	10.2	91.4	33.8	50	54.2
Mercury	101	ug/L	<0.1	0.2	<0.1	<0.1	<0.1
Molybdenum	101	ug/L	<1	2	<1	<1	<1
Nickel	101	ug/L	<1	4	2	2	3
Selenium	101	ug/L	<1	14	3.0	2.5	7.8
Silver	101	ug/L	<1	<1	0.5	0.5	0.5

Parameter	Sample # (n)	Units	Min	Max	Median	Wet Weather Flow Median	90th Percentile
Zinc	101	ug/L	<5	248	50	30	140.4

8.2.2 Merimbula Bay (including Haycock Point and Quondolo Point)

Merimbula Bay is a coastal marine environment located approximately 460 kilometres (km) south of Sydney and around 600 metres (m) east of the Merimbula STP. Merimbula Bay is a popular tourist destination with recreational activities such as swimming, boating, fishing and snorkelling. Merimbula Bay is home to a number of reefs, including the Hunter Reef, Rocky Reef and the Merimbula Offshore Artificial Reef, which all offer habitat to intertidal reef communities.

Offshore marine water quality

Ambient marine water quality was recorded during a 24-month long monitoring program (2014-2015 and 2016-2017) that collected water quality data from sites within and outside Merimbula Bay, and included data collection following three upwelling events. The monitoring sites are shown in **Figure 8-2**.

Statistical analysis of water quality data in **Table 8-3** indicated some parameters were higher following upwelling events, including nitrate, total nitrogen, chlorophyll-a, suspended solids, oxides of nitrogen, total phosphorus, orthophosphate, faecal coliforms and *Enterococci*. Upwellings or intrusions of cold nutrient-rich water from the continental slope, though transient and episodic in nature, represents a significant source of nutrient supply to the coastal zone. Upwelling events occur under particular oceanographic and climatic conditions with seasonal trends indicating a higher prevalence for upwellings to occur during spring and summer in NSW. It has been assumed that upwelling events are infrequent and to be conservative, median concentrations have been calculated from Merimbula Bay site data that mostly excluded upwelling event data, to provide medians that were considered more representative of typical ambient water quality conditions.

Median concentrations of the Merimbula Bay monitoring sites MBWQ20, MBWQ30 and MBWQ40 were adopted and used to establish the ambient water quality (AWQ) for each indicator, while also assessing differences in AWQs following upwelling events. The criteria used for defining an upwelling event included observations of regional current and sea surface temperature charts, and elevated nitrate concentrations in conjunction with a temperature differential between surface waters and seabed waters of 4 degrees Celsius or greater. A summary of the AWQ of Merimbula Bay is included in **Table 8-3**.

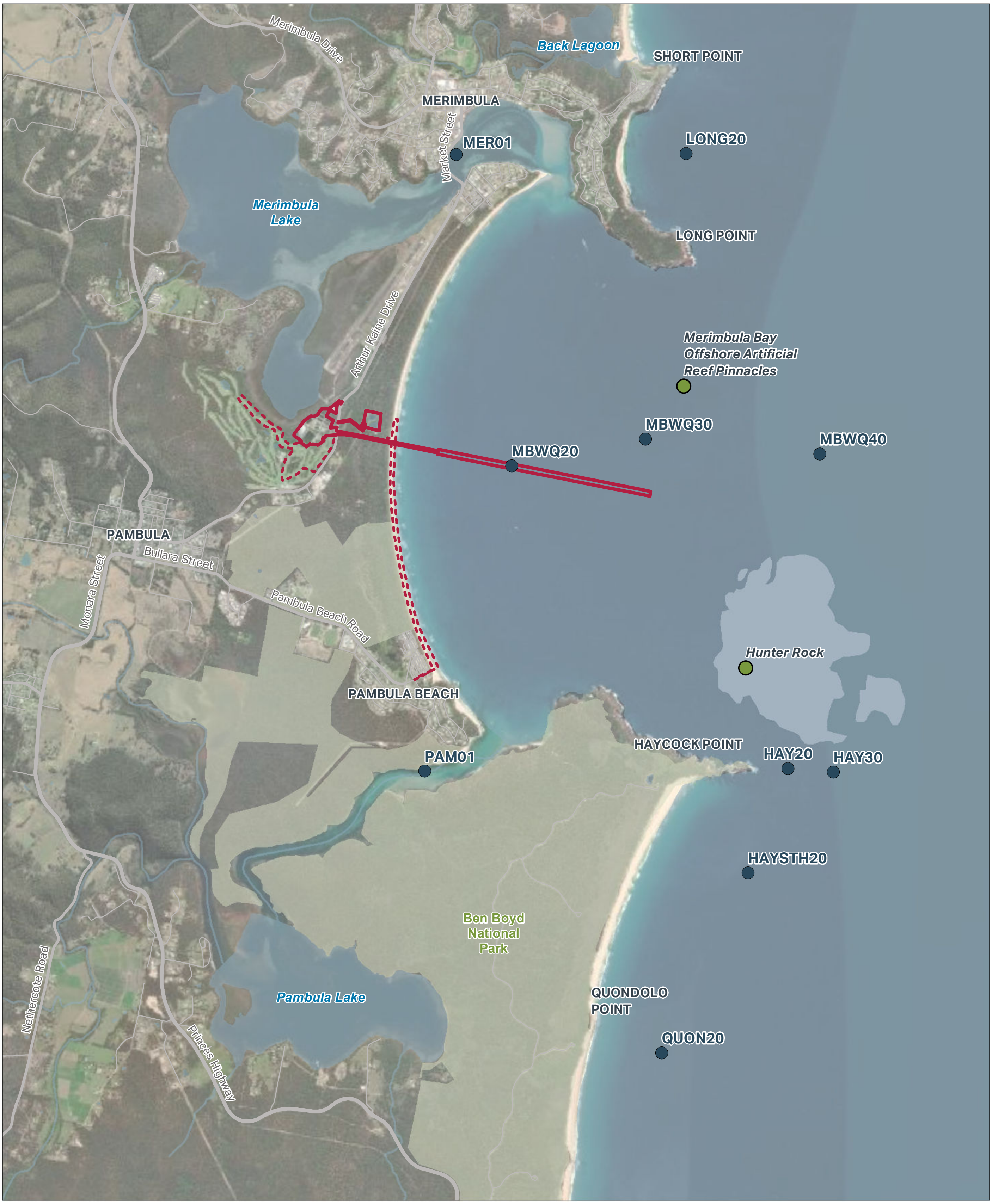

FIGURE 8-2: AMBIENT MARINE WATER QUALITY MONITORING SITES

Legend

- Project area
- Project area (temporary construction area)
- Approximate extent of reef
- Water quality monitoring site

Table 8-3 Summary of Ambient Water Quality (AWQ) and upwelling event AWQ for Merimbula Bay

Indicator	Units	Adopted AWQ	Upwelling Event AWQ	Assumption for Adopted AWQ
pH	pH units	8.17	8.13	Median of Merimbula Bay sites
Suspended Solids	mg/L	12	12	Median of Merimbula Bay sites excluding upwelling events
Turbidity	NTU	0.3	0.5	Median of Merimbula Bay sites
Electrical Conductivity	µs/cm	53408	53114	Median of Merimbula Bay sites
Dissolved Oxygen	mg/L	7.6	7.4	Median of Merimbula Bay sites
Secchi Depth	m	8.9	7.0	Median of Merimbula Bay sites
Total Nitrogen (TN)	mg/L	0.12	0.13	Median of Merimbula Bay sites excluding upwelling events
Oxides of Nitrogen (NOx)	mg/L	0.017	0.048	Median of Merimbula Bay sites excluding upwelling events
Nitrate	mg/L	0.017	0.047	Median of Merimbula Bay sites excluding upwelling events
Ammonia	mg/L	0.008	0.007	Median of Merimbula Bay sites
Ammonium	mg/L	0.008	0.007	Median of Merimbula Bay sites
Total Phosphorus (TP)	mg/L	0.007	0.010	Median of Merimbula Bay sites excluding upwelling events
Orthophosphate	mg/L	0.004	0.008	Median of Merimbula Bay sites excluding upwelling events
Chlorophyll-a	µg/L	1.2	1.7	Median of Merimbula Bay sites excluding upwelling events
Faecal Coliforms	cfu/100mL	1	47	Median of Merimbula Bay sites excluding upwelling events
Enterococci	cfu/100mL	1	11	Median of Merimbula Bay sites excluding upwelling events
Aluminium	µg/L	4.5	13.5	Median of Merimbula Bay sites
Antimony	µg/L	0.25	0.25	Median of Merimbula Bay sites
Arsenic (III)	µg/L	1.8	2.1	Median of Merimbula Bay sites
Barium	µg/L	5.9	No data	Median of Merimbula Bay sites
Boron	µg/L	4295	4005	Median of Merimbula Bay sites
Cadmium	µg/L	0.1	0.1	Median of Merimbula Bay sites
Chromium (total)	µg/L	0.25	0.25	Median of Merimbula Bay sites
Cobalt	µg/L	0.025	0.025	Median of Merimbula Bay sites
Copper	µg/L	0.2	0.1	Median of Merimbula Bay sites
Iron	µg/L	5	10	Median of Merimbula Bay sites
Lead	µg/L	0.1	0.1	Median of Merimbula Bay sites
Manganese	µg/L	0.25	0.25	Median of Merimbula Bay sites
Mercury	µg/L	0.05	0.02	Median of Merimbula Bay sites
Nickel	µg/L	0.25	0.25	Median of Merimbula Bay sites
Selenium	µg/L	1	1	Median of Merimbula Bay sites

Indicator	Units	Adopted AWQ	Upwelling Event AWQ	Assumption for Adopted AWQ
Silver	µg/L	0.35	0.13	Median of Merimbula Bay sites
Zinc	µg/L	2.5	2.5	Median of Merimbula Bay sites

Coastal processes including tidal flows, significant weather events, strong ocean currents and estuary discharge all have a direct influence on the AWQ of Merimbula Bay and can result in the exceedance of MWQOs.

Dispersion of treated wastewater from the existing beach-face outfall has been modelled (i.e. dispersion levels three days after discharge) (refer **Appendix E** (Water Quality Technical report prepared by Elgin, 2020)). Key findings of the dispersion modelling undertaken for existing conditions includes:

- treated wastewater discharged at the beach-face outfall, rapidly achieves 1,000 times dilution in the nearshore beach zone and gradually disperses to the north and south along the beach zone, and to offshore deeper waters of the central bay region where it dilutes further.
- treated wastewater although highly dilute, typically remains within Merimbula Bay and enters Merimbula Lake, the latter trend becoming more evident under stronger southward flowing current conditions.
- treated wastewater that currently may enter Merimbula Lake is between 1000 to 10,000 or 10,000 to 100,000 times dilution. Ambient water quality data for Merimbula Lake basin shows that median nutrient levels are below MWQOs. Typically, nutrient levels of Merimbula Lake only exceed MWQOs after significant rainfall that results in catchment inflows that bring sediment and nutrients to the estuary in stormwater. The pool of nutrients in ambient estuarine waters represents the sum total of all catchment inputs from various diffuse and point sources.

Nearshore marine water quality

Nearshore marine waters include the area between the shoreline and the back of the surf zone for the stretch of beach between Merimbula and Pambula. Treated wastewater discharge via the existing beach-face outfall contributes to the current water quality of the nearshore zone.

Water quality data for the nearshore zone of Merimbula Bay is currently very limited. AWQ in the nearshore zone is considered to be largely represented by the AWQ parameter levels for marine water identified in **Table 8-3**, with potential influences from Merimbula Lake and Pambula River during tidal movements as well as treated wastewater discharge from the existing beach-face outfall.

Additional data that is useful in understanding the water quality of the nearshore zone is the *Enterococci* data from the *Beachwatch Water Quality Program* (NSW Government, 2020) which is collected from five sites in the study area including Short Point, Bar Beach, Merimbula Main Beach, Pambula Beach and Pambula River Mouth. The *Enterococci* dataset is a useful addition to the water quality dataset for the Project. However, it has some limitations which include data collection when beach-face treated wastewater discharge is not occurring, and disposal is generally via the dunal ex - filtration ponds. Further, no *Enterococci* data exists for the nearshore zone in and around the existing beach-face outfall discharge location.

Dispersion modelling for the existing beach-face outfall shows that treated wastewater disperses in a longshore drift parallel to shoreline towards the *Beachwatch Water Quality Program* sites in both Merimbula and Pambula. It is possible that some of the Beachwatch *Enterococci* counts are attributable to the treated wastewater. *Enterococci* counts are also likely influenced from other sources such as stormwater runoff into Merimbula River and Pambula River and its subsequent discharge to Merimbula Bay during ebb tidal flows.

Currently there is no UV treatment of any flows discharged to ocean, dunal exfiltration or re-use occurs.

When storm events have occurred in the past and the daily flow exceeds 3.7 ML/d, the intermittently decanted extended aeration (IDEA) bioreactors divert to a storm cycle that reduces the level of treatment and lowers the treated wastewater quality. However, in a storm event the incoming wastewater is highly diluted due to the storm water inflow and infiltration.

Marine sediments

Marine sediment data was collected for the Project from sampling locations surrounding the proposed ocean outfall pipeline alignment. The data, as well as the sediment sampling locations, are discussed in the following sections.

Data sources

Available marine sediment data includes:

- sediment grab samples collected by Elgin at ambient background water quality monitoring sites on 12/12/2016. Sediment samples were collected from five sites by grab sampler and analysed for parameters that included: pH, redox potential, Total Organic Carbon (TOC), Particle Size Distribution, nutrients (TN, NO_3, NO_2, NO_x, NH_3, TP, PO_4^{3-}) and metals (Sb, As, Be, B, Cd, Cr, Co, Cu, Pb, Mn, Mo, Ni, Se, Ag, Sn, Zn, Hg). Of the five sites sampled, site 'MBWQ20' is located closest to the proposed ocean outfall pipeline alignment, approximately 200 m to the north.
- sediment grab samples collected by Elgin (2017) to assess the benthic infauna community of Merimbula Bay as part of the marine monitoring program for this EIS. Sediment samples were collected for benthic infauna taxonomic enumeration along with parameters that included: pH, redox potential, TOC, Particle Size Distribution, nutrients and metals. Of the 11 sites sampled, site S0 is located at the proposed diffuser location for the ocean outfall, with the next nearest sites S1 and S2 located 50 m south and north of the diffuser location, respectively.
- sediment grab samples collected by Marine and Earth Sciences (MES) as part of geophysical investigations in Merimbula Bay for the Project (MES, 2018). A total of 15 grab samples were collected by MES (refer Figure 2 in MES, 2018) with grab samples from sites GS10, GS11, GS14 and GS15 located nearest to the proposed ocean outfall pipeline alignment. Samples were photographed with qualitative descriptions provided for sediment type, dominant grain shape, shell content, minor components and colour. There is no particle size distribution data for these samples.
- underwater video transects collected along the seabed of the proposed ocean outfall pipeline alignment by Elgin in June 2020 used to describe sediment along the alignment.

Relevant sediment data and information has been compiled into Annexure E of **Appendix E** (Water Quality Technical report). The location of marine sediment sampling sites that are on or in the vicinity of the proposed ocean outfall pipeline are shown on **Figure 8-3.**

Ocean current conditions

Modelling investigated treated wastewater plume behaviour and trajectory for a range of ambient current strengths expected at the proposed ocean outfall location for both uniform and stratified conditions. The 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.

Southward flowing current conditions

Southward flowing current conditions occurred 88% of the time (AECOM, 2019c), and 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 East Australian Current boundary current and its eddy field is strongest.

Worse-case ‘extreme’ current conditions

Stratified conditions, defined as a temperature differential of about 6 degrees Celsius 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.

Existing flood behaviour

Merimbula Bay is a marine environment and not a flood prone area. The coastline is subject to coastal inundation (tidal/wave action), which is addressed in **Chapter 10 Marine and coastal processes**.

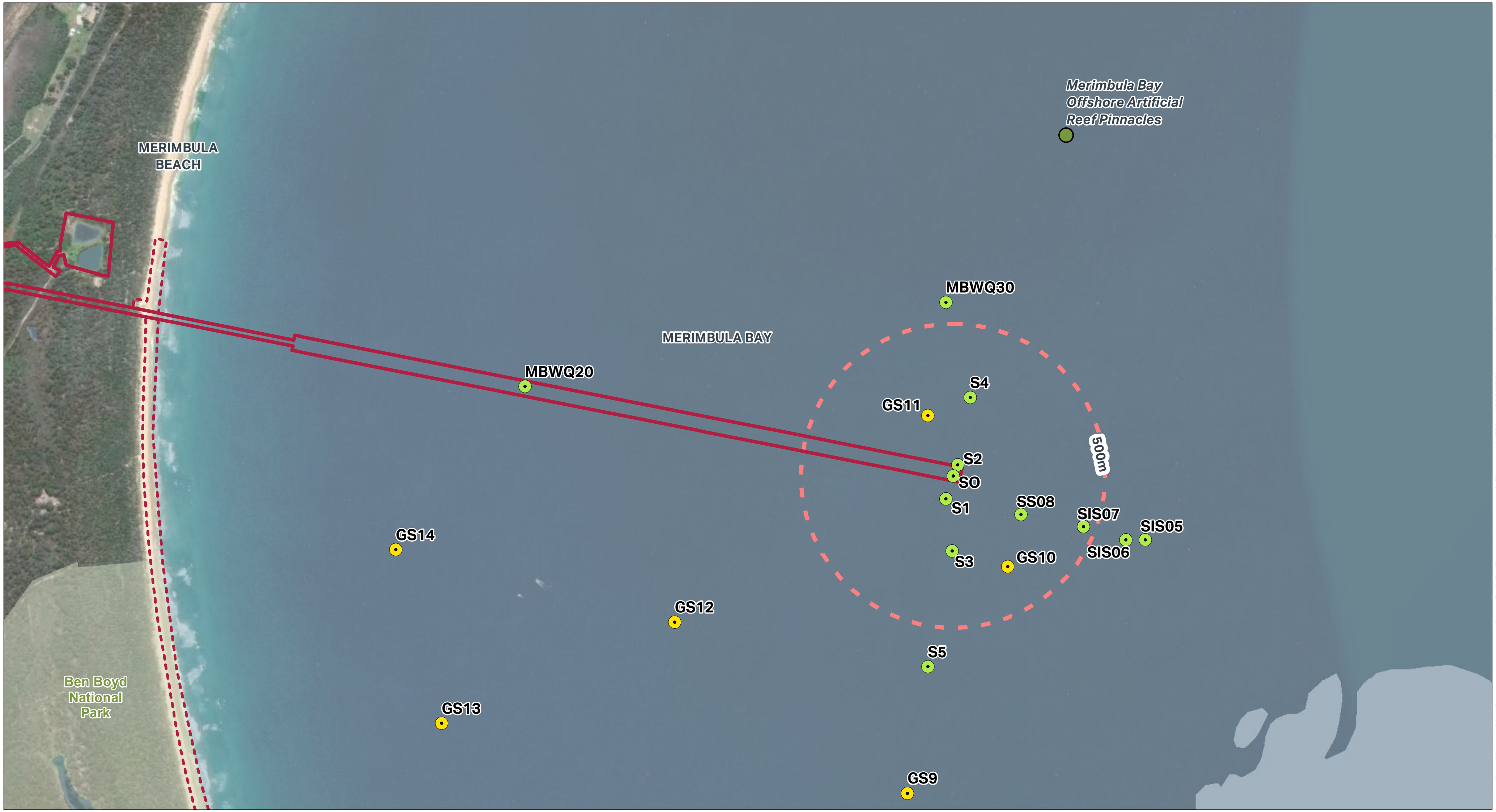

FIGURE 8-3: MARINE SEDIMENT SAMPLING LOCATIONS

Legend

- Project area
- Project area (temporary construction area)
- 500m from proposed pipeline diffuser
- Approximate extent of reef
- Elgin sample 2017 - 2020
- MES sample 2017

N

0 200 400 m

AECOM

Source: Nearmap, 2019; Cardno, 2017

Sediment Sampling Results

Sediment descriptions and Particle Size Distribution results for sampling sites on or near the proposed ocean outfall pipeline alignment are summarised below. Complete Particle Size Distribution analysis results for MBWQ20, S0, S1 and S2 sites and excerpts from MES (2018) are included in Annexure E of **Appendix E** (Water Quality Technical report).

Sediment Particle Size Distribution and chemistry results for MBWQ20, S0, S1 and S2 sites indicate:

- variability in sediment types at the four sites. At the proposed ocean outfall diffuser location (S0) and north of the diffuser (S2), sediments comprise medium to coarse brown sands with only trace fines, which differ to the sediments sampled to the south at S1 that had a higher proportion of fine sediments. Sediments with a higher proportion of fine-grained particles were also evident at site MBWQ20, located in 20 m depth of water inshore of S0 and approximately 200 m north of the ocean outfall pipeline alignment.

  Note that sediment particle size (and risk of sediment plume from the Project) is addressed in **Chapter 10 Marine and coastal processes**.
- metals detected above the laboratory limits of reporting in one or more of the four sites included; aluminium, arsenic, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, mercury, vanadium and zinc. However, all metals were reported below the applicable Low and High trigger values from the relevant Interim Sediment Quality Guidelines (ANZECC/ARMCANZ, 2000, CSIRO, 2005) (refer **Appendix E** (Water Quality Technical report) for further information).
- nutrients in sediment samples reported as both totals (total nitrogen (TN) and total phosphorus (TP)) and individual nutrient species including ammonia, nitrite, nitrate, ammonia and reactive phosphorus. Nitrate and ammonia were reported in S0, S1 and S2 but not in MBWQ20, and comprised only a minor component of TN with total kjeldahl nitrogen results indicating the majority of nitrogen species in organic form. Reactive phosphorus was reported in all four samples and represented a minor proportion of TP.
- Total Organic Carbon (TOC) ranging between 0.08% (S0) and 0.2% (S2) across the four samples.

8.2.3 Merimbula Lake and wetland

Merimbula Lake is a wave dominated barrier estuary with an open entrance in the Southern Rivers district of NSW that has a catchment area of approximately 37.9 square kilometres. Merimbula Lake is listed as a wetland of national importance based on its significant ecological and cultural values. It supports a range of habitats including seagrass meadows, mangroves, saltmarsh and intertidal sand/mud flats.

Merimbula Lake contains a significant area of coastal wetland identified under *State Environmental Planning Policy (Coastal Management) 2018* and is home to a range of threatened wader and shorebirds. The foreshores and tributary streams of Merimbula Lake are characterised by fringing mangroves and saltmarsh, estuarine and freshwater wetland areas. Mangrove stands in the lake consist of grey mangrove (*Avicennia marina*) and river mangrove (*Aegiceras corniculatum*). Merimbula Lake also supports a number of freshwater wetland habitats, which tend to consist of rushes, tea tree swamps and paperbark forests. Merimbula Lake wetland has been mapped as coastal floodplain and has the potential to contain a number of Endangered Ecological Communities (EEC), including coastal saltmarsh, swamp sclerophyll forests, swamp oak and river-flat eucalypt forest.

No fish species listed as threatened under the *Fisheries Management Act 1994* (FM Act) or the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) are known to occur in the lake. However, at least six species belonging to the Syngnathiformes (a unique group of bony fish including seahorses, seadragons, pipefish, pipehorses, ghostpipefish and seamoths) that are protected under the FM Act are known to occur. Merimbula Lake also supports a valuable oyster aquaculture industry that primarily cultivates the Sydney rock oyster (*Saccostrea glomerata*) and the southern mud oyster (*Ostrea angasi*).

The natural amenity and significant ecological values of Merimbula Lake is an important asset to the townships of Merimbula and Pambula, with the estuarine environment representing a key attraction for local residents and tourists that visit the coastal towns annually. It is among the most popular estuaries within the Bega Valley for recreational use with swimming, boating, fishing, kayaking, paddle-boarding and snorkelling being popular activities.

Note that a wetland also occurs in the hind dunes of Merimbula Beach and extends from the Project area south to Pambula. This wetland is also mapped as a Coastal Wetland under the *State Environmental Planning Policy (Coastal Management) 2018*. The Project has been designed such that the ocean outfall pipeline would traverse under a section of this mapped wetland but not impact on the wetland. This is addressed further in **Chapter 9 Groundwater** and **Chapter 12 Terrestrial ecology**.

Water quality

Merimbula Lake is characterised by good water quality and a high level of tidal flushing. Merimbula Lake water quality is based on data collected as part of the NSW estuary health Monitoring Evaluation Reporting (MER) program (OEH, 2016) and post-event data collected as part of the Merimbula ocean outfall AWQ monitoring program.

Merimbula Lake is characterised by high water quality under normal tidal and baseflow conditions. Water quality conditions decline following significant rainfall events with elevated levels of suspended sediment, nutrients and microbiological parameters exceeding MWQOs. The AWQ of Merimbula Lake is summarised in **Table 8-4**.

Under normal conditions the lake has a high level of water quality with marine tidal flows playing a key role in maintaining water quality conditions. Depth profiling studies show that the estuary basin is well-mixed through tidal flushing processes, resulting in:

- high water clarity with turbidity levels less than 1 Nephelometric Turbidity Unit (NTU) which is significantly lower than the MWQOs standard of 6 NTU;
- low microalgal abundance as indicated by the low concentration of chlorophyll a; and
- median nutrient levels including total nitrogen (TN), inorganic nitrogen (NOx), ammonium, total phosphorous (TP) and ortho-phosphate all below the MWQOs.

Following significant weather and rainfall events, the water quality of Merimbula Lake is poor, resulting in:

- poor water clarity and a maximum turbidity of 34 NTU. However, given the fast rates of tidal flushing, water clarity improves quickly;
- an increase in the levels of nutrients present in the lake, including TN and NOx; and
- a significant increase in the presence of faecal coliforms and *Enterococci*, exceeding the MWQOs and indicative of possible surcharging in the gravity sewer network infrastructure during high rainfall events. Gravity systems are usually designed to cater for a certain multiple of dry weather flows. Illegal stormwater connections, infiltration and flooding of manholes would lead to the system surcharging in high rainfall events

Treated wastewater discharged at the existing beach-face outfall typically remains within Merimbula Bay, only entering Merimbula Lake following significant weather events or under stronger southward flowing current conditions.

Dispersion modelling of the existing beach-face outfall shows that treated wastewater that currently may enter Merimbula Lake is between 10,000 to 100,000 times diluted such that wastewater indicators would be at concentration levels unlikely to be detected by laboratory analysis.

Overall, water quality of the estuary is considered high with low nutrient levels and high water clarity largely due to the lake's high flushing capacity which allows waters to be well mixed over most areas of the lake.

Table 8-4 Summary of Merimbula Lake Ambient Water Quality (2012 to 2016)

Parameter	Units	Adopted MWQO Trigger Value	Normal Conditions Basin					Post Event Lower Estuary			
			Sample (n)	Min	Max[1]	Median	Mean	Sample (n)	Min	Max[1]	Mean[1]
Physical-chemical properties											
Dissolved Oxygen (DO)	% saturation	80-100	0	0	0	0	0	4	80	108	89.8
Dissolved Oxygen (DO)	mg/L	>5[2]	10	5.8	8.3	6.5	6.7	4	6.8	7.9	7.2
Turbidity	NTU	6 [3]	34	0.1	2.6	0.3	0.5	6	0.1	**34.0**	**10.7**
Salinity	Parts per thousand (ppt)	-	33	26.3	37.8	35.4	34.8	6	18.3	33.8	25.9
Conductivity (EC)	uS/cm	-	34	41034	55612	53490	52574	6	29548	51469	40338
Temperature	°C	-	34	12.1	24.6	18.8	19.3	6	16.0	25.6	19.3
pH	pH	7.0-8.5	34	8.0	**9.1**	8.1	8.2	6	7.4	8.0	7.8
Suspended Solids (SS)	Mg/L	10	0	-	-	-	-	6	4	**36**	**17**
Nutrients											
Ammonia	mg/L	0.01	15	0	0.090	0.005	0.015	6	0.011	**0.040**	**0.024**
Ammonium (NH4+)	mg/L	0.015	10	0.003	0.010	0.007	0.006	6	0.011	**0.039**	**0.024**
Nitrate	mg/L	0.7	-	-	-	-	-	6	0.009	0.207	0.067
Oxides of Nitrogen (NOx)	mg/L	0.015	16	0.000	**0.056**	0.003	0.009	6	0.009	**0.207**	**0.024**
Total Kjeldahl Nitrogen	mg/L	-	16	0.100	0.240	0.200	0.183	-	-	-	-
Total Nitrogen (TN)	mg/L	0.3	22	0.070	**0.360**	0.196	0.202	6	0.220	**0.680**	**0.422**

Parameter	Units	Adopted MWQO Trigger Value	Normal Conditions Basin					Post Event Lower Estuary			
			Sample (n)	Min	Max[1]	Median	Mean	Sample (n)	Min	Max[1]	Mean[1]
Total Phosphorous (TP)	mg/L	0.03	22	0.004	0.022	0.012	0.011	6	0.022	**0.050**	0.023
Orthophosphate	mg/L	0.005	12	0.000	0.003	0.002	0.002	4	0.003	**0.016**	**0.008**
Biological											
Chlorophyll a (Lab)	ug/L	5	20	0.6	**10.6**	2.0	2.9	1	1.6	1.6	1.6
Chlorophyll a (probe)	ug/L	5	34	0.1	**7.5**	0.9	1.6	2	0.6	1.1	0.8
Faecal Coliforms	cfu/100 mL	150	-	-	-	-	-	6	8	**3900**	**974**
Enterococci	cfu/100 mL	35	-	-	-	-	-	6	**62**	**24600**	**4884**

Notes:

1. Values in **bold** exceed the MWQOs.

Existing flood behaviour

The *Merimbula Lake and Back Lake Flood Study* (Cardno, 2017) presents the estimated flood behaviour in the lake for a range of local catchment and coastal flooding events. Flooding behaviour is driven more by entrance conditions and ocean behaviour rather than catchment flows at peak levels due to the catchment size in relation to the storage volume available at the lake.

Maximum water extent maps for catchment flood events from the *Merimbula Lake and Back Lake Flood Study* for the 20% Annual Exceedance Probability (AEP), 10% AEP, 5% AEP, 2% AEP and Probable Maximum Flood (PMF) are presented in Figure 4-2 to Figure 4-7 (respectively) of **Appendix F** (Flood Technical report). The extent of the flood planning level (FPL) within the vicinity of the STP site is shown to be approximately 2.5 m AHD. The PMF is the largest flood event that could conceivably be expected to occur at a particular location, usually estimated from probable maximum precipitation. The PMF defines the maximum extent of flood prone land, that is, the floodplain.

The STP is located outside of both the 1% AEP and the PMF flood extents and above the FPL, and is therefore not affected by flooding. In the PMF event, the STP would not be accessible from the north via Arthur Kaine Drive however access from the south would remain flood-free.

8.2.4 Pambula River

Pambula River is a wave dominated barrier estuary with an open entrance in the Southern Rivers district of NSW. Pambula River has a catchment area of around 296.5 square kilometres and an average depth of 2.2 m (NSW Environment and Heritage, 2012). Pambula River is listed as a wetland of national importance based on its significant ecological and cultural values. It supports a range of habitats including seagrass meadows, mangroves, saltmarsh and intertidal sand/mud flats.

A significant area of coastal wetland identified under the *State Environmental Planning Policy (Coastal Management) 2018* is situated within Pambula River and offers habitat to a range of wildlife including threatened shorebirds. Six species of Syngnathiformes including seahorses and pipefishes protected under the FM Act are known to occur within the estuary. No threatened fish species listed under the FM Act or the EPBC Act are known to occur in the Pambula River estuary. Pambula River also supports a valuable oyster aquaculture industry that primarily cultivates the Southern mud oyster *(Ostrea angasi)* and the Sydney rock oyster *(Saccostrea glomerata).*

The natural amenity and significant ecological values of Pambula River is an important asset to the coastal townships of Merimbula and Pambula, with the estuarine environment representing a key attraction for local residents and tourists that visit the coastal towns annually.

Water quality

Pambula River has good water quality and a high level of tidal flushing. Pambula River water quality is based on data collected as part of the NSW estuary health MER program and post-event data collected as part of the Merimbula ocean outfall AWQ monitoring program.

Under normal conditions the lake has a high level of water quality with parameters generally meeting MWQOs. The AWQ of Pambula River is summarised in **Table 8-5**.

Depth profiling indicates that tidal flushing and wind advection (wind strength and direction) are effective in maintaining water quality conditions. Differences in water temperature and salinity between surface and bottom waters were also observed, with depth profile data showing that levels of dissolved oxygen in deeper waters do not reach levels that would be harmful to aquatic organisms living near or in the benthic sediments. The river has high water clarity, with a mean turbidity of 1 NTU. Levels of TN and TP are typically below MWQOs, while levels of ammonia, ammonium, inorganic nitrogen (NOx) and orthophosphate slightly exceed the MWQOs. Microalgal abundance is low as indicated by the low concentration of chlorophyll a.

Following significant weather and rainfall events, the water quality in Pambula River is poor, with an increase in stormwater runoff resulting in brown coloured waters, poor clarity, high suspended load and reduced salinity. Surface water quality is also poor, with elevated turbidity levels and nutrients and biological parameters all exceeding MWQOs.

Under the existing conditions, the treated wastewater discharged at the beach-face outfall typically remains within Merimbula Bay, only potentially entering Pambula River following significant weather events or under stronger northward flowing current conditions.

Dispersion modelling of the existing beach-face outfall shows that treated wastewater at 10,000 – 100,000 times dilution may enter Pambula estuary under certain current conditions. Given the dilution, treated wastewater indicators would be at concentration levels unlikely to be detected by laboratory analysis.

Table 8-5 Summary of Pambula River Ambient Water Quality (2010 to 2018)

Parameter	Units	Adopted MWQO Trigger Value	Normal Conditions Basin					Post Event Lower Estuary			
			Sample (n)	Min	Max[1]	Median[1]	Mean[1]	Sample (n)	Min[1]	Max[1]	Mean[1]
Physical-chemical properties											
Dissolved Oxygen (DO)	% sat	80-100	51	78.8	106.0	98.0	97.1	10	67.0	100.8	86.3
Dissolved Oxygen (DO)	mg/L	>5[2]	12	5.9	7.7	6.9	6.9	6	7.3	9.0	8.0
Turbidity	NTU	2.8	66	0	5	1.3	1.4	14	**4**	**72**	**32**
Salinity	ppt	-	54	30.9	37.5	35.3	35.1	14	0.1	27.5	8.4
Conductivity (EC)	uS/cm	-	66	45330	55273	53059	52749	14	140	42719	13750
Temperature	°C	-	66	11.9	25.9	20.5	19.4	14	14.7	21.5	17.5
pH	pH	7.0-8.5	51	7.8	8.2	8.1	8.0	14	**6.4**	8.2	7.4
Suspended Solids (SS)	Mg/L	10	-	-	-	-	-	10	8	**70**	**39**
Nutrients											
Ammonia	mg/L	0.01	16	0.003	**0.090**	0.007	**0.017**	12	**0.016**	**0.047**	**0.028**
Ammonium (NH4+)	mg/L	0.015	14	0.003	**0.087**	0.007	**0.018**	12	0.015	**0.046**	**0.028**
Nitrate	mg/L							5	0.003	0.006	0.005
Nitrate	mg/L	0.7	-	-	-	-	-	10	0.064	0.539	0.209
Oxides of Nitrogen (NOx)	mg/L	0.015	20	0.000	**0.110**	**0.021**	**0.025**	12	**0.064**	**0.544**	**0.197**
Total Kjeldahl Nitrogen	mg/L	-	22	0.080	0.200	0.160	0.153	2	0.300	0.400	0.350
Total Nitrogen (TN)	mg/L	0.3	24	0.060	**0.560**	0.175	0.181	12	0.270	**1.190**	**0.724**
Total Phosphorous (TP)	mg/L	0.03	24	0.004	0.027	0.011	0.013	12	0.013	**0.078**	**0.044**
Orthophosphate	mg/L	0.005	20	0.003	**0.015**	**0.006**	**0.007**	12	**0.005**	**0.012**	**0.008**

Parameter	Units	Adopted MWQO Trigger Value	Normal Conditions Basin					Post Event Lower Estuary			
			Sample (n)	Min	Max[1]	Median[1]	Mean[1]	Sample (n)	Min[1]	Max[1]	Mean[1]
Biological											
Chlorophyll a (Laboratory tested)	ug/L	2.3	38	0.7	**3.8**	1.6	1.8	2	0.8	1.7	1.2
Chlorophyll a (in-field probe)	ug/L	2.3	51	0.5	**4.6**	1.6	1.7	6	0.8	2.0	1.1
Faecal coliforms	cfu/100 mL	150	-	-	-	-	-	10	**340**	**6000**	**1897**
Enterococci	cfu/100 mL	35	-	-	-	-	-	10	**527**	**9700**	**4697**

Note:

1. values in **bold** exceed the MWQOs

Existing flood behaviour

Flood behaviour at Pambula River is driven by ocean behaviour of Merimbula Bay and Pambula River entrance conditions. Following periods of significant rainfall and or ocean current movements, the volume of water entering the mouth of Pambula River from Merimbula Bay may exceed the maximum catchment volume of the river therefore resulting in the flooding of adjacent vegetated environments. As previously mentioned, the Project is located outside of the PMF extent.

Summary of sensitivity of receiving environments

A summary and assessment of the sensitivity of the receiving environments to hydrological and water quality impacts associated with the Project is provided in **Table 8-6**.

Table 8-6 Sensitivity of receiving environments

Surface water feature	Description of surface water feature in study area	Condition	Conservation value	Sensitivity
Merimbula Bay	Marine coastal water, largely unmodified with high water quality and recreational value. Nearshore zone influenced by presence of the Merimbula STP beach-face outfall (when in use).	Nearshore condition is moderately disturbed as a result of the Merimbula STP beach-face ocean outfall (when in use). Offshore water quality generally meets the MWQOs.	Moderate conservation value	Low
Merimbula Lake	Estuarine, largely unmodified, good water quality, high ecological value, high recreational value.	Good condition under normal tidal and baseflow conditions. Disturbed following significant weather events.	High conservation value	Moderate
Pambula River	Estuarine, largely unmodified, good water quality, high ecological value, high recreational value.	Moderate condition under normal tidal and baseflow conditions. Disturbed following significant weather events.	High conservation value	Moderate

8.3 Potential impacts - construction

8.3.1 Water quality in the receiving environment

A qualitative assessment was undertaken to determine the potential impacts of construction on water quality of the receiving environment. The potential impacts are summarised in **Table 8-7.**

During construction of the Project, pollutants may be mobilised and released through rainfall (runoff), wind, or dewatering of excavations (which may be required after rainfall).

The quality and quantity of the potential pollutants generated within the construction areas would be variable and subject to the soil profile (e.g. erosion potential), phase of construction works/activities being undertaken, extent of disturbance and weather/climatic influences (e.g. rainfall). The key potential water quality pollutants of concern from construction areas would be sediment (e.g. resulting in turbidity, suspended solids), fuel/oil, grease and other chemicals used in construction (including directional drilling fluid/muds and acid sulphate soils. Other potential pollutants (such as nutrients) may also be bound to the sediment or present in dissolved form.

Mitigation and management measures to address the risk of pollutants being released during construction and impacting surrounding water quality are described in **Section 8.5**. With appropriate measures in place, release of potential pollutants during construction of the Project is expected to be either avoided, or otherwise short term and limited in extent, and managed to result in negligible or minor impacts. Any impacts are also expected to be negligible relative to the mobilisation and discharge of pollutants throughout the wider catchment area following a significant weather event, in combination with tidal flushing in the surrounding marine and estuarine environments. The potential construction impacts anticipated on receiving water quality is considered to be negligible to minor overall.

Impacts to water quality are interrelated with impacts to other environmental values, such as soils, marine ecology and human health risk. Please refer to the following assessments for assessment of the environmental values specified:

- **Chapter 13 Landform, geology and soils**: assessment of impacts and management of erosion and sedimentation, potentially contaminated sediments, acid sulphate soils and salinity;
- **Chapter 11 Marine ecology**: assessment of impacts to marine ecology; and
- **Chapter 17 Human health risk**: assessment of impacts that may result in potential risks to human health.

An assessment of waste generated by the Project (including potential pollutants that may impact water quality if accidentally released) is provided in **Chapter 26 Waste**.

Table 8-7 Potential construction impacts on water quality

Project element and potentially affected waterways	Construction activities/source of pollutants	Potential impacts
Project element: STP upgrade **<u>Waterways:</u>** Merimbula Bay Merimbula Lake Nearby wetland area	Construction and installation of additional pump stations and infrastructure within the existing STP site.	Accidental release of construction-related pollutants from the Project area into (or that could be transported into) receiving waterways, which could potentially impact the AWQ of these waterways and their associated biodiversity assemblages. Potential impacts to water quality in the receiving environment from dewatering (if required in the event that excavations capture rainfall), if dewatering is not adequately managed.
	Dust, litter and other pollutants associated with the upgrade of the STP and use of temporary construction laydown areas.	Erosion and mobilisation of exposed soils from the Project area from stormwater runoff and wind, leading to sedimentation in receiving waterways and impacts on water quality (e.g. increased turbidity and suspended solids, lower dissolved oxygen levels and increased nutrients (which could lead to algal blooms and aquatic weed growth), increases in toxicant concentration and reduced visual amenity). Accidental release of litter or other pollutants from construction of the STP upgrade to the surrounding surface water and marine environments could negatively impact AWQ.
	Leakage or spills of petroleum, oils and greases from construction machinery and equipment.	Accidental release of pollutants to the surrounding environment could result in impacts to AWQ (including changes to pH and other water quality parameters).
Project element: Construction of the ocean outfall pipeline **Waterways:** Merimbula Bay Merimbula Lake Pambula River	Underground directional drilling and extraction of drilling fluid for the construction of 'Section one' of the ocean outfall pipeline.	Underground directional drilling has the potential to impact AWQ in aquatic environments in the vicinity of the drilling alignment (e.g. the wetland area and Merimbula Bay (primarily the transition point between the underground section of pipeline and aboveground section of pipeline (Section one and Section two respectively), where directional drilling would impact the surface of the seabed). Any unexpected leakages or spillages of drilling fluid along the pipeline alignment, or release of drilling fluid into the marine environment, would increase the potential for pollutants in the fluid impacting the AWQ of receiving aquatic environments.

Project element and potentially affected waterways	**Construction activities/source of pollutants**	**Potential impacts**
Nearby wetland area	Construction of 'Section two' of the ocean outfall pipeline, including pipeline laying on the seabed and covering with rock or concrete mattresses.	Installation of the ocean outfall pipeline on the seabed would result in localised sediment disturbance and could result in a sediment plume, which would impact AWQ. The risk of sediment plume during construction is assessed in **Chapter 10 Marine and coastal processes**, which found that any sediment plume would be short term and localised in extent. The overall disturbance as a result of the construction of the pipeline on the seabed is also not anticipated to result in turbidity that would be more significant than would occur under a large swell event. An intermediate drilling site for pipeline construction may be required which would necessitate the need for the temporary compound and laydown area on Merimbula Beach, and access for construction machinery and personnel (these areas have been included in the Project area as part of the Project). This would result in an increased risk of pollution during construction which could adversely impact the water quality of Merimbula Bay. Impacts from these areas would be avoided or otherwise minimised as far as practicable through implementation of mitigation and management measures.
	Decommissioning the existing beach-face outfall.	Decommissioning the existing beach-face outfall could result in an accidental spill of pollutants such as petroleum products (including diesel, oil, grease, etc.) or other chemicals/fluids from construction machinery. This could potentially impact the AWQ of receiving environments.

8.3.2 Flooding and hydrology

Appendix F (Flood Technical report) shows that the majority of the land-based Project area is located outside of the 1% AEP and PMF flood extents, with both flood extents affecting only a small portion of the temporary construction laydown area within the PMGC grounds. It is not expected that the Project would impact on flow conveyance in floodways and/or flood storage areas during construction. In the PMF flood event, the STP is not accessible from the north via Arthur Kaine Drive but access remains flood-free to the south, towards Pambula. Flood hazard for the PMF is shown on Figure 4-9 of **Appendix F** (Flood Technical report) and shows areas of low and high hazard outside the Project area boundary.

To address the risk of the temporary laydown area within the PMGC grounds being affected by flooding, it is recommended that materials and equipment (e.g. pipeline lengths) within the laydown area are located outside of the 1% AEP flood extent indicated on Figure 4-8 of **Appendix F** (Flood Technical report) and above approximately 2.5 m AHD.

No flooding impacts to adjacent property and land are anticipated if adequate mitigation is put in place for the small portion of construction laydown area affected by relevant flood levels. The Project is not expected to impact upon existing community emergency management arrangements for flooding, and therefore the NSW State Emergency Services (SES) has not been consulted regarding the Project. Note however that as described in **Chapter 18 Traffic and transport** (and **Appendix K** (Traffic and Transport Assessment)) emergency services would be advised of all planned changes to traffic arrangements prior to applying the changes.

Potential impacts from inundation of the Merimbula Beach area from significant storm events and/or high tides is addressed in **Chapter 10 Marine and coastal processes**.

Construction of the Project is not expected to generate stormwater runoff or wastewater that would have any more than a negligible effect on natural hydrological attributes of receiving surface waters (such as volumes, flow rates, management methods and re-use options) and on the capacity of existing systems. Runoff would be re-directed around construction sites where appropriate, and there would be limited hardstand introduced for construction. Stormwater runoff during construction would be managed in accordance with water, sediment and erosion controls to minimise off-site impacts, which are included in **Chapter 13 Landform, geology and soils**.

There are no planned releases of wastewater to the receiving environment during construction of the Project, however dewatering may be required in the event that excavations capture rainfall. Any dewatering of excavations required (e.g. at the STP) after rainfall, is expected to be minor (in line with the extent of excavation proposed) and would not measurably affect hydrological attributes of the receiving environment (e.g. in terms of volumes, flow rates, management or use of water resources). Dewatering may also be required if an excavation is required at the construction laydown area on Merimbula Beach for an intermediate directional drilling site (to connect two sections of installed pipeline); however this would be seawater / marine (saline) groundwater, and therefore impacts to terrestrial (fresh or saline) groundwater are unlikely (as water pumping would occur from the seaward side of the salt-water wedge). Any dewatering required during construction would be tested prior to release (and treated if necessary) in accordance with licence/approval limits.

Decommissioning of the STP effluent storage pond would involve removing the water/sludge from the Site and transporting it to a licensed facility. Drilling fluid/mud from directional drilling would be captured and either recycled in the drilling process or otherwise removed from site.

Impacts to the hydrology of surface waters during construction is expected to be negligible. In addition, hydrological-related impacts to natural processes of surrounding surface waters and the health of the fluvial, riparian, estuarine or marine systems and landscape health (such as modified discharge volumes, durations and velocities) are expected to be negligible. The Project would also have an insignificant effect on aquatic connectivity and access to habitat for spawning and refuge.

Note that other impacts to marine ecology and terrestrial ecology are assessed in **Chapter 11 Marine ecology** and **Chapter 12 Terrestrial ecology** respectively.

8.4 Potential impacts – operation

This section assesses the potential impacts from operation of the Project to the water quality and hydrology of surface waters and addresses flooding-related impacts.

8.4.1 STP influent quality

The influent quality (entering the STP) sourced from data collected from 2014 to 2017 is presented in **Table 8-8**, along with the proposed influent design values for the year 2042 (that the Project has been designed for).

Table 8-8 Merimbula STP influent quality

Parameter	Current Median Influent Value (n=158)	Proposed 2042 Median Influent Design Value of the Project
Suspended Solids (TSS)	270 mg/L	300 mg/L
Biological Oxygen Demand (BOD)	293 mg/L	300 mg/L
Chemical Oxygen Demand	577 mg/L	580 mg/L
Total Nitrogen	60 mg/L	65 mg/L
Ammonia	46 mg/L	46 mg/L
Total Phosphorus	11 mg/L	11 mg/L
Alkalinity	276 mg/L	-
Electrical Conductivity	1130 µs/cm	-

8.4.2 Water quality

The proposed upgrades to the Merimbula STP were considered in the context of risks to waters in the receiving environment and irrigation areas subject to beneficial re-use and was based on ETWWQ data. This represents a conservative assessment as the proposed improvements to the STP were not factored into the modelling of impacts on water quality. Upgrades proposed are described in further detail in **Chapter 2 Project description**.

The proposed upgrades are expected to result in the following treated wastewater quality improvements:

- enhanced phosphorus removal, with an anticipated 90th percentile concentration reduction from current 12 mg/L to less than 1 mg/L;
- improved removal of aluminium, TSS and BOD from tertiary filtration if required;
- improved removal of virus, bacteria and pathogens from UV disinfection and chlorine dosing; and
- decommissioning of the 17 ML STP effluent storage pond would prevent potential re-contamination of the treated wastewater by waterfowl guano and prevent high chlorophyll a levels in the wastewater and microalgal growth.

Separate to the Project, BVSC also has a long-term strategy to upgrade the potable water treatment which would reduce the levels of copper and zinc in the influent.

The current Environment Protection Licence (EPL 1741) for the Merimbula STP permits a maximum daily disposal volume of 4 ML, and a total maximum annual discharge of 1,000 ML per year) to the current beach-face outfall or dunal exfiltration ponds. The total volume of wastewater discharged to the beach-face outfall typically ranges between 230 ML/year and 400 ML/year.

The volume of wastewater disposed via the new ocean outfall pipeline in any one year would be dependent on total annual flows minus the volume of wastewater beneficially re-used. The STP current average dry weather flow is 2 ML/day. This is projected to be the same post-construction, as is the treated wastewater discharge volume. The existing and proposed strategy for managing treated wastewater is provided in **Chapter 2 Project Description**. Risks to water quality associated with the proposed STP upgrades include:

- continued beneficial re-use of treated wastewater water for irrigation. Chlorination would only be used to provide further disinfection for treated wastewater that would be used for irrigation.

Risks related to water quality associated with the operation of the ocean outfall pipeline include:

- discharge of treated wastewater: risk to aquatic ecosystem health, primary and secondary contact recreational users, and aquatic foods, from water quality changes as a result of discharge of nutrients, toxicants, faecal coliforms and, *Enterococci* in treated wastewater to the mixing zone. The mixing zone is the area where discharged treated wastewater would mix until adequately diluted. Under typical conditions of median ETWWQ and a range of current conditions, a mixing zone of 25 m radius (from discharge point) is required to achieve necessary dilution to meet MWQOs at the outer boundary of the mixing zone;
- discharge above MWQOs: screening and modelling undertaken indicated that some treated wastewater parameters would discharge above MWQOs into the mixing zone (prior to dilution in the mixing zone) including oxides of nitrogen (NO_x), ammonia, total phosphorus, orthophosphate, faecal coliforms, *Enterococci* , aluminium, arsenic, copper, iron, lead, selenium and zinc. Further assessment has however indicated that with dispersion, this impact would be reduced. Dilution factors required to achieve MWQOs along with findings of the dispersion modelling for the Project are discussed in more detail below;
- discharge with low salinity: risk to aquatic ecosystem health from reduced salinity in the mixing zone; and
- settling of wastewater contaminants on seabed: risk to aquatic ecosystem health and aquatic foods from suspended sediment load, organic particulate material, nutrients and toxicants settling to the seabed zone around the diffuser and within the mixing zone.

Treated wastewater dispersion modelling for the Project was used to assess the water quality impacts of treated wastewater discharged at the existing beach-face outfall and also at the proposed ocean outfall location. This included assessing how the discharge of treated wastewater at the proposed diffuser location (approximately 2.7 km offshore in 30 m depth), is predicted to disperse and dilute (due to ocean currents and vertical mixing processes) compared to the existing discharge from the beach-face outfall at the beach zone.

Prior to dispersion modelling being undertaken, preliminary screening of ETWWQ against AWQ and MWQOs was conducted as part of the preliminary water quality assessment in Annexure A of **Appendix E** (Water Quality Assessment). The screening process identified indicators in wastewater that may present a potential risk to environmental values and therefore required quantitative assessment through dispersion modelling. Evaluation of the required dilution factors (to meet MWQOs) was also undertaken to inform the dispersion modelling. The subset of indicators for which dilution factors were calculated were selected following screening of indicators that reported ETWWQ at the highest factors above MWQO or AWQ and hence would require the highest levels of dilution and included:

- oxides of nitrogen (NO_x), ammonia, total phosphorus, orthophosphate, faecal coliforms, *Enterococci*, aluminium, arsenic, copper, iron, lead, selenium and zinc.

The preliminary screening process determined that the following dilution factors would be required:

- ETWWQ at median concentrations: a dilution factor of 237 (based on oxides of nitrogen) is required to meet all MWQOs. This scenario represents typical discharge conditions for the majority of the time; and
- for 90th percentile ETWWQ, representing a worse-case wastewater quality that may be discharged a minor proportion of time (e.g. 1% of the 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 ammonia EPL discharge limit (5 mg/L) which is higher than the ETWWQ 90th percentile (1.9 mg/L) and wet weather flow (4.1 mg/L) ammonia concentrations.

Modelling was based on typical and worse case analyte dilution scenarios by adopting the existing median and 90th percentile ETWWQ respectively and their dilution factors required to meet the

MWQOs. The calculation of dilution factors and worse-case analyte target dilutions for ETWWQ are provided in Section 6 of **Appendix E** (Water Quality Technical report).

Summary of key findings of dispersion modelling

Dispersion modelling (for near-field and far-field extents) indicated the potential behaviour of plume dispersion of treated wastewater, including the following:

- treated wastewater discharged from the proposed ocean outfall location would offer a substantial improvement in dispersion over discharge from 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 with three ports, each with two risers and treated wastewater discharged at 80 Litres per seconds (L/s)). This dispersion scenario would be expected to occur the majority of the time (~99% of the time);
- under the worse-case scenario assessed of treated wastewater discharge at the current EPL limits for the Merimbula STP / or 90th percentile concentrations of ETWWQ (based on actual, historic data), and low current speeds with or without stratification, the mixing zone extends 200 m from the ocean outfall discharge location. This would be expected to occur a minor proportion of the time which is estimated to be 1% of the time (based on 90th percentile ETWWQ combined with unusual, 10th percentile low current conditions (northward or southward)); and
- potential impacts associated with treated wastewater discharge are therefore most likely to be detected within the typical mixing zone of 25 m only, which is estimated to occur 99% of the time. Detection of impacts beyond this zone becomes less likely due to the high levels of dilution achieved over a short distance (estimated to be 1% of the time when worse case conditions may occur within a larger mixing zone of 200 m).

Far-field modelling for the Project indicates that treated wastewater discharged at the proposed outfall may enter Merimbula or Pambula lake at 10,000 to 100,000 times dilution, three days post discharge. At these dilution factors, wastewater indicators would be below laboratory detection limits and would meet relevant estuary MWQOs. It is also noted that while modelling was undertaken to assess a period longer than three days, the final reporting output does not extend beyond three days, as this data continues to demonstrate a dilution factor below laboratory detection limits.

Modelling outputs for different ocean conditions including northerly current, southerly current, and worse-case scenario are provided in Section 6 of **Appendix E** (Water Quality Technical report).

Risk to water quality is assessed in more detail in the section below. The following assumptions have been adopted using the EWWTQ in assessing the risks to water quality:

- under most conditions and the majority of time, a mixing zone of 25 m is required to achieve necessary dilution to meet MWQOs (refer to **Figure 8-4)**. Ecological receptors within this mixing zone area are limited to sandy seabed habitat and its epifauna and infauna communities. Fish and cetaceans would transit through this mixing zone.
  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 would become less likely due to the high levels of dilution achieved over the relatively short distance.
- there may be instances where treated wastewater discharged at EPL discharge limits coincides with weak ocean current conditions. Under the modelled worse-case scenario (estimated to occur 1% of the time), the mixing zone required to achieve all MWQOs is predicted to be within 200 m from the diffuser location. The indicative extent of this mixing zone is shown on **Figure 8-4** and inferred from the dispersion modelling outputs of treated wastewater at 2,500 times dilution. Ecological receptors in this larger mixing zone are also limited to sandy seabed habitat and its epifauna and infauna communities.
- other receptors of subtidal and intertidal reef communities, including Merimbula Offshore Artificial Reef, Pambula Lake and Merimbula Lake and recreational beaches are located outside of the mixing zones predicted to be required to meet the MWQOs, both for discharge under normal

conditions the majority of time (~25 m) and at a modelled worse-case scenario for a minority of time (200 m). Potential receptors and their distance from the proposed discharge location include:

- Hunter Reef located around 1400 m to the south-east;
- rocky reef shorelines from Pambula River entrance to Haycock Point located around 2000 m to the south south-west;
- rocky reef shorelines from Merimbula Lake entrance to Long Point located around 2300 m to the north;
- Merimbula Offshore Artificial Reef located around 1000 m to the north-east; and
- entrances to Merimbula Lake, Pambula River and recreational beaches including Merimbula Beach and Pambula Beach located around 2700 m to 3000 m to the south-west, west and north-west.

• the replacement of the beach-face outfall with an ocean outfall around 2.7 km offshore in Merimbula Bay would alter the distance between the discharge point and the above receptors. Distance between the proposed discharge location and potential receptors such as Merimbula Lake, Pambula Lake and Merimbula and Pambula recreational beaches would be greater than the existing beach-face outfall. Ecological receptors such as Merimbula Offshore Artificial Reef, Hunter Reef, Long Reef and Haycock Point would be closer to the proposed discharge location, however are still well outside the mixing zone.

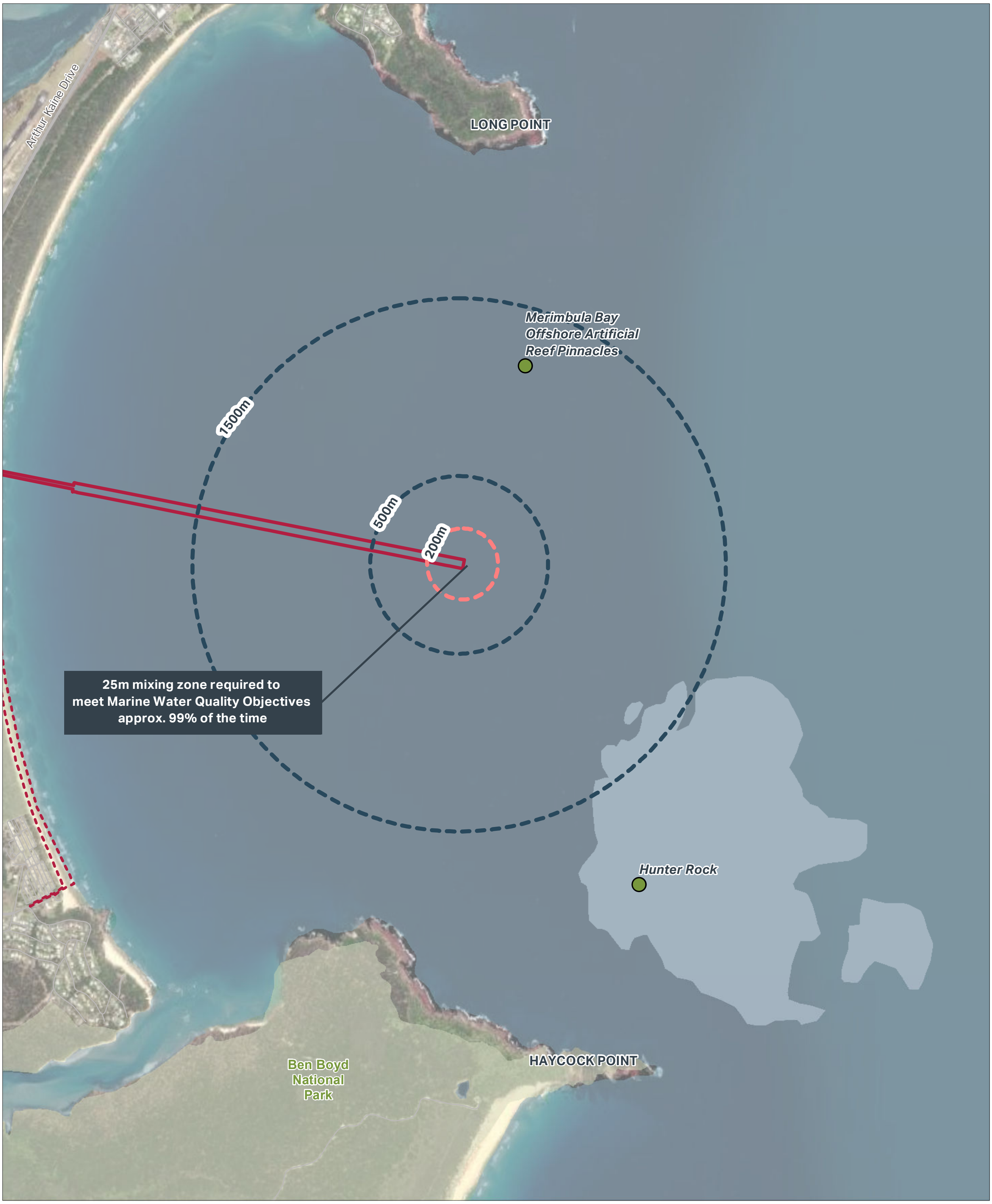

FIGURE 8-4: TREATED WASTEWATER MIXING ZONE

Legend

- Project area
- Project area (temporary construction area)
- Approximate extent of reef
- 200m radius - indicative mixing zone required to achieve Marine Water Quality Objectives under worse-case scenario
- Distance

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Risk assessment

A risk assessment was carried out for the impacts identified above. The assessment and risk ranking are set out in the following sections.

Beneficial re-use of treated wastewater at offsite locations for irrigation

Risk screening of ETWWQ against adopted water quality objectives for the beneficial re-use of treated wastewater was undertaken to identify potential risks for the proposed STP upgrade and continued beneficial re-use of treated wastewater at PMGC and Oaklands agricultural area. As part of this discussion, a qualitative overview of the likely improvements to parameter concentrations as a result of the Project has also been considered.

In considering potential receptors at PMGC and Oaklands agricultural area, trigger values for primary and secondary contact, recreation and visual amenity were also included in the screening.

For the proposed upgrade of the STP, it is expected that future limits applicable for the beneficial re-use of treated wastewater would include:

- 4-log reduction in virus, bacteria and pathogens.

ETWWQ median and 90th percentile concentrations were screened against beneficial re-use trigger values where available and are summarised in **Table 8-9**.

Table 8-9 ETWWQ screening against treated wastewater beneficial re-use trigger values

Parameter	Units	Trigger Value	ETWWQ Median[1]	ETWWQ 90th Percentile[1]
pH	pH units	5.0-9.0	7.80	8.31
Electrical Conductivity	µs/cm	-	730	874
Oxides of Nitrogen NOx (as N)	mg/L	10	1.92	8.06
Ammonia (as N)	mg/L	0.01, 0.5	**0.34**	**2.0**
Total Phosphorus (as P)	mg/L	1.0	**9.3**	**12.0**
Faecal Coliforms (2004-2016)	cfu/100mL	150	50	**672**
Enterococci	cfu/100mL	35	1	**188**
Aluminium	ug/L	200	40.0	74.6
Arsenic	ug/L	100	2	3
Barium	ug/L	1000	6.0	10.2
Beryllium	ug/L	60	<0.1	0.1
Boron	ug/L	1000	60	80
Cadmium	ug/L	5	<0.05	<0.05
Chromium	ug/L	50	<1	1
Copper	ug/L	1000	21	272
Lead	ug/L	50	0.2	5.6
Manganese	ug/L	100	33.8	54.2
Mercury	ug/L	1	<0.1	<0.1
Nickel	ug/L	100	2	3
Selenium	ug/L	10	3.0	7.8
Silver	ug/L	50	0.5	0.5
Zinc	ug/L	5000	50	140.4

Note: 1 - values in bold text and shaded exceed the re-use trigger value

The screening process indicated that ammonia (as N) in treated wastewater was above the adopted trigger value for both median (0.34 mg/L) and 90th percentile concentrations (2.0 mg/L). Further assessment of the results indicated that the ammonia (as N) levels were below the aesthetic guideline which is expected to represent the majority of treated wastewater re-use conditions. The 90th percentile concentration was above the aesthetic guideline, which is expected to occur infrequently or during wet weather flow. Irrigation/treated wastewater re-use demand is unlikely during wet weather events.

Microbiological indicators including faecal coliforms and *Enterococci* were reported in the treated wastewater, with 90th percentile counts above the treated wastewater re-use trigger value. 90th percentile conditions are expected to occur infrequently, during times of wet weather events, which is also when demand for irrigation (beneficial re-use) would be low.

The STP upgrade would also result in the inclusion of further disinfection by UV radiation and chlorination of treated wastewater, and would therefore result in a greater reduction in microbiological indicator levels than what is currently achieved. The design is based on the UV being able to treat up to 3.7ML/day flow, which is the current treatment capacity of the existing bioreactors. Flows greater than 3.7ML/d would be diverted to the wet weather storage pond. All waste water would be UV treated before it is discharged. This would reduce the microbiological levels in the wet weather storage pond during wet weather events. The UV would also provide an additional 4 log inactivation of cryptosporiduim and 4.3 log coliform inactivation of coliforms in addition to the removal provided by the IDEA tanks.

Treated wastewater that is to be re-used would undergo further disinfection using chlorine.

Potential runoff of treated wastewater to Merimbula Lake or Pambula River from the irrigation areas in the beneficial re-use scheme is managed by only irrigating during dry weather periods. Review of the ambient water quality dataset for Merimbula and Pambula estuaries shows that water quality is typically very high and potential runoff from the PMGC grounds or Oaklands irrigation area have not been identified as a cause of concern.

The treated wastewater used for beneficial re-use, would as a result of proposed treatment improvements expected from STP upgrades, provide a positive benefit to irrigation schemes at PMGC or Oaklands agricultural area.

Discharge of nutrients to mixing zone

ETWWQ includes levels of nutrients that exceed MWQOs including NO_x, ammonia, total phosphorus and orthophosphate. For most indicators, nutrient concentrations would dilute rapidly and meet the MWQOs within a 25 m mixing zone, with oxides of nitrogen requiring the highest dilution. In worst case scenarios, such as during extreme wet weather events where treated wastewater may discharge at higher rates (as beneficial re-use for irrigation is not likely to be possible due to saturated ground conditions), data shows that ammonia requires the highest degree of dilution within a mixing zone of 200 m radius in order to achieve MWQOs.

The Project includes a number of measures that mitigate the potential risk associated with nutrient discharge to marine receiving waters, including PAC dosing to decrease the level of phosphorous in treated wastewater and continuation of the beneficial re-use of treated wastewater (for irrigation at PMGC and Oaklands agricultural area). An ocean outfall would result in improved dispersion and reduces risk of entrapment in the surf zone, and there is also less potential for nutrients to enter Merimbula or Pambula estuaries. Monitoring of water quality would be required as part of STP operations and would include nutrient parameters. Overall, the risk of impacts to water quality in the mixing zone from nutrient discharge is assessed as low.

Discharge of toxicants, enterococci and faecal coliforms to mixing zone

Screening of toxicants shows that treated wastewater contains levels of the metals: aluminium, arsenic, copper, iron, lead, selenium and zinc above MWQOs. The required dilution for these metals to meet MWQOs is relatively low when compared to nutrients. Modelling indicates metal MWQOs would be achieved within 25 m from the diffuser over sandy seabed habitat and at a significant distance from rocky reef communities of Hunter Reef, Long Point, Haycock Point or the Merimbula Offshore Artificial Reef.

The potential for toxicants to impact on water quality for primary and secondary contact recreation is reduced with the proposed change from beach-face outfall to ocean outfall pipeline, as the distance to beach users is greatly increased and the risk of treated wastewater entrapment in the surf zone is eliminated. The STP upgrade would also result in a reduction of potential impacts on Merimbula and Pambula estuaries due to the distance from the diffuser as well as the proposed upgrades resulting in further metal removal from the treated wastewater stream. Receptors with potential to be exposed to toxicants at the ocean outfall location include transient demersal fish species foraging over sandy seabed habitat within the mixing zone, and potential future sessile colonisers of the diffuser structure. Potential risk for individuals engaged in recreational and commercial fishing is considered low.

As some toxicants are bio-accumulative metals, a baseline dataset for metals in target species was collected for biota from Merimbula Bay and nearby reference sites. A baseline assessment of bioaccumulation in fish species was also conducted as part of the marine ecology study (**Appendix G** (Marine Ecology Technical report)).

Monitoring of water quality as part of operations is to include metal parameters. A summary of proposed water quality monitoring during operation is provided in Section 8.5.2, including details regarding timing and frequency. Overall, the risk from toxicant discharge to the mixing zone and impact to water quality is considered low.

In terms of microbiological parameters, *Enterococci* and faecal coliforms, treated wastewater typically contains low levels and meets MWQOs. Only during peak wet weather events would treated wastewater discharge potentially exceed MWQOs for microbiological parameters, and this scenario represents a minor proportion of time. Ceasing the use of the beach-face outfall would eliminate the discharge of treated wastewater to the nearshore zone regularly used by beach-goers, whilst the ocean outfall diffuser is a significant distance from recreational beaches and the estuary entrances.

The STP upgrade would include UV disinfection which is expected to result in lower counts of *Enterococci*, faecal coliforms and the required log reductions in virus, pathogens and protozoa. All waste water would be UV treated before it is discharged through the new ocean outfall or redirected to beneficial re-use . The UV would also provide an additional 4 log inactivation of cryptosporiduim and 4.3-log coliform inactivation of coliforms in addition to the removal provided by the IDEA tanks.

Moving the discharge point from the beach-face to the ocean outfall pipeline diffuser increases dispersion and reduces risk of confinement in the surf zone and potential exposure to beach users and receptors of Merimbula or Pambula estuaries. Monitoring of water quality as part of operations is to include microbiological indicators. Overall, the risk from discharge of microbiological parameters to the mixing zone and impact to water quality and receptors is low.

Discharge of treated wastewater with reduced salinity

Based on the physical properties of the treated wastewater (i.e. lower in salinity and less dense than seawater), the treated wastewater would be buoyant upon discharge and rise upwards through the water column under normal conditions. Hydrodynamic processes would act to dilute and disperse the treated wastewater such that it is expected that salinity of the treated wastewater plume is near seawater at the edge of the 25 m mixing zone. Impact to benthic communities and stenohaline species (i.e. marine species with low tolerance to variable salinity change) is possible within the immediate vicinity of the diffuser structure but impacts to the broader Merimbula Bay marine environment is unlikely due to rapid mixing effects. Episodic floodwater discharge to Merimbula Bay from estuaries would exert more influence over marine waters compared to discharge of treated wastewater at the outfall. The risk from discharge of treated wastewater with reduced salinity to the mixing zone and impact to water quality and receptors is low.

Settling of treated wastewater contaminants on seabed

It is possible that changes to sediment chemistry may occur within the mixing zone due to deposition of suspended solids, organic particulate material and toxicants discharged in treated wastewater. This has potential to impact benthic infaunal assemblages surrounding the diffuser and within the mixing zone, causing changes in community composition including species abundance and diversity. Any potential impact is only anticipated to occur within the 25 m mixing zone, which occurs under typical conditions (99% of the time). This potential impact would be monitored with benthic infauna monitoring proposed as a key element of the marine ecological monitoring program to determine background natural variation (refer to **Chapter 11 Marine ecology**).

STP upgrades including PAC dosing would result in further removal of fine and colloidal particles, metals and nutrients from treated wastewater, reducing potential for settlement of sediment and particles on the seabed. The one exception may be during peak wet weather flows when STP processes may be compromised. The risk of settling of treated wastewater contaminants on the seabed in the mixing zone and impact to water quality and receptors is low.

Discharge of treated wastewater to the exfiltration ponds

As part of the Project, the existing dunal exfiltration ponds would cease to be used and treated wastewater would be diverted for disposal to the new ocean outfall pipeline (or otherwise beneficially re-used). As such, disposal to land at this location would cease, as would any associated impacts (e.g. nearby groundwater and soil quality impacts), resulting in a positive impact from the Project.

8.4.3 Flooding and hydrology

The STP upgrade works are located outside of the 1% AEP and PMF flood extents. As the land-based Project area is located outside of the PMF extent, there would be no impact to flow conveyance in floodways and/or flood storage areas. Operation of the Project is not expected to impact upon existing community emergency management arrangements for flooding, and therefore the NSW SES has not been consulted regarding the Project. Flood impacts to surrounding properties would be negligible.

The *Merimbula Lake and Back Lake Flood Study* considered climate change scenarios for the 1% AEP flood event by considering increased rainfall intensity combined with a tidal boundary increase of 0.4 m and 0.9 m sea level rise, representing year 2050 and year 2100 time horizons respectively (Cardno, 2017). The study showed changes due to climate change are unlikely to impact the land-based Project area due to its existing elevation and vegetative buffers providing protection from tidal inundation. Erosional and depositional changes are more likely to be located at the Merimbula Lake entrance as a result of regular tidal flow and along the western side of Merimbula Lake where the topography is lower and has greater exposure to higher tides. Council has allowed for the uncertainty of climate change impacts within its adopted freeboard placed upon the current FPL, and the flood extent shown in **Appendix F** (Flood Technical report) includes this freeboard allowance.

The Project is not expected to have any impacts on social and economic costs to the community as a consequence of flooding.

Operation of the Project is only expected to generate a small volume of additional stormwater runoff. Drainage at the STP site would continue to operate similar to the current site, although there would be small changes and additions to hardstand and drainage infrastructure to account for new infrastructure. This is only expected to have a minor impact on stormwater volume captured and discharged from the site via the existing stormwater drainage system.

Operation of the Project is also not expected to generate additional wastewater compared to the current situation. Treated wastewater would be released to a new offshore discharge point via the ocean outfall. As shown in the effluent modelling, this is expected to disperse and have a mixing zone of 25 m under most conditions. Release from the outfall would have very localised effects on hydrology (from the flow of treated wastewater being discharged), however this would not affect the hydrology of the ocean in Merimbula Bay.

Beneficial re-use of the treated wastewater would be undertaken in accordance with existing protocols in place at PMGC and Oaklands agricultural area, which avoid over-saturation or excess or channelised runoff being created by the irrigation. BVSC supplies treated wastewater to PMGC and Oaklands agricultural area under Recycled Water Supply and Use Agreements. These Agreements document the responsibilities of both parties and refer to BVSC’s Recycled Water Management System. The treated wastewater is supplied at the quality required by BVSC’s EPL specifications. The respective users (PMGC and Oaklands agricultural area) are responsible for managing the application of the treated wastewater in accordance with the Recycled Water Supply and Use Agreements and the Recycled Water Management System, in consultation with BVSC.

Operation of the Project is therefore not expected to create any additional impact on natural hydrological attributes of receiving surface waters (such as volumes, flow rates, management methods and re-use options) or on the capacity of existing systems, except for a minor volume of additional stormwater discharged from the STP site and very localised impacts at the point of discharge from the ocean outfall pipeline. This change is not expected to cause subsequent hydrological-related impacts to natural processes of surrounding surface waters and the health of the fluvial, riparian, estuarine or marine system.

8.5 Management of impacts

The approach to managing potential impacts related to water quality hydrology and flooding is described below.

8.5.1 Performance outcomes

The water quality, hydrology and flooding performance outcomes for the Project are as follows:

- potential water quality pollutants used or generated during construction would be controlled to minimise impacts to the receiving environment;
- construction of the Project is outside the 1% AEP flood extent and therefore not affected by flood waters in this event;
- treated wastewater to be beneficially re-used during operation (for irrigation) is within authorised release limits;
- treated wastewater released from the ocean outfall is within authorised discharge limits;
- marine water quality outside of the ocean outfall mixing zones (25 m 99% of the time and 200 m 1% of the time) would comply with applicable MWQO values; and
- no impacts to hydrology of surface water during construction or operation.

The Project would be designed, constructed and operated to achieve these performance outcomes.

8.5.2 Operational water quality monitoring

A water quality monitoring program for the operational phase of the Project would be undertaken, which would include monitoring of the following:

- marine coastal waters of Merimbula Bay and north and south of Merimbula Bay;
- estuarine waters of Merimbula Lake and Pambula River; and
- groundwater in and around the dunal exfiltration ponds.

Refer to **Appendix E** (Water Quality Technical report) for specific timing of operational monitoring proposed, as well as applicable indicator groups and parameters which should be considered for the operational monitoring program.

Marine coastal waters and estuarine waters

Water quality monitoring of marine and estuarine waters would have the following objective:

- to assess water quality of the receiving environment against MWQO trigger values, to protect sensitive receptors and environmental values.

A total of nine (9) monitoring sites are proposed, including six (6) marine coastal waters, two (2) estuarine waters and one (1) treated wastewater site as summarised in **Table 8-10** and **Figure 8-5**.

Table 8-10 Operational phase water quality monitoring locations

Site ID	Rationale
Diffuser	One (1) site adjacent to the outfall diffuser location situated just outside the boundary of the inferred 25 m mixing zone (based on near-field dispersion modelling results that indicates a 25 m mixing zone is required for the majority of time for MWQOs to be met).

Site ID	Rationale
MBWQ30	MBWQ30 is located approximately 500 m to the north of the diffuser location and outside the outer extent of the inferred 200 m mixing zone that may occur a minor proportion of the time (i.e. 90th percentile ETWWQ, 10th percentile weak currents). This location is also situated between the diffuser location and the Merimbula Offshore Artificial Reef and could be used to represent water quality conditions for this recreational fishing asset. The baseline dataset for MBWQ30 can also be used for comparison purposes.
MBWQ20 and MBWQ40	Monitor water quality of Merimbula Bay at two (2) sites located inshore (MBWQ20) and offshore (MBWQ40) of the outfall diffuser location. These sites would be used to assess changes in ambient water quality more broadly in Merimbula Bay and to safeguard bay receptors and environmental values. Existing baseline monitoring sites MBWQ20 and MBWQ40 would be used as they represent data continuity at receptors that include: • rocky reef habitats, such as at Hunter Reef (MBWQ40); • sandy habitats inshore and offshore in Merimbula Bay (MBWQ20 and MBWQ40); • nearshore waters and recreational beach zones of Merimbula and Pambula (MBWQ20); and • marine water column for passage of fish and other mobile species.
LONG20	Monitor water quality to the north of Merimbula Bay, at a northern reference site that is sufficiently distant from the zone of treated wastewater influence. New monitoring site.
HAYSTH20	Monitor water quality to the south of Merimbula Bay, at a southern reference site that is sufficiently distant from the zone of treated wastewater influence. Corresponds with baseline monitoring site.
MER01	Monitor water quality of the lower Merimbula Lake, to assess impact on environmental values in order to appropriately protect these values. Sample during flood tide when bay waters are entering estuary.
PAM01	Monitor water quality of the lower Pambula River estuary, to assess impact on environmental values in order to appropriately protect these values. Sample during flood tide when bay waters are entering estuary.
STP	Monitor treated wastewater quality at the STP prior to discharge to the ocean outfall pipeline.

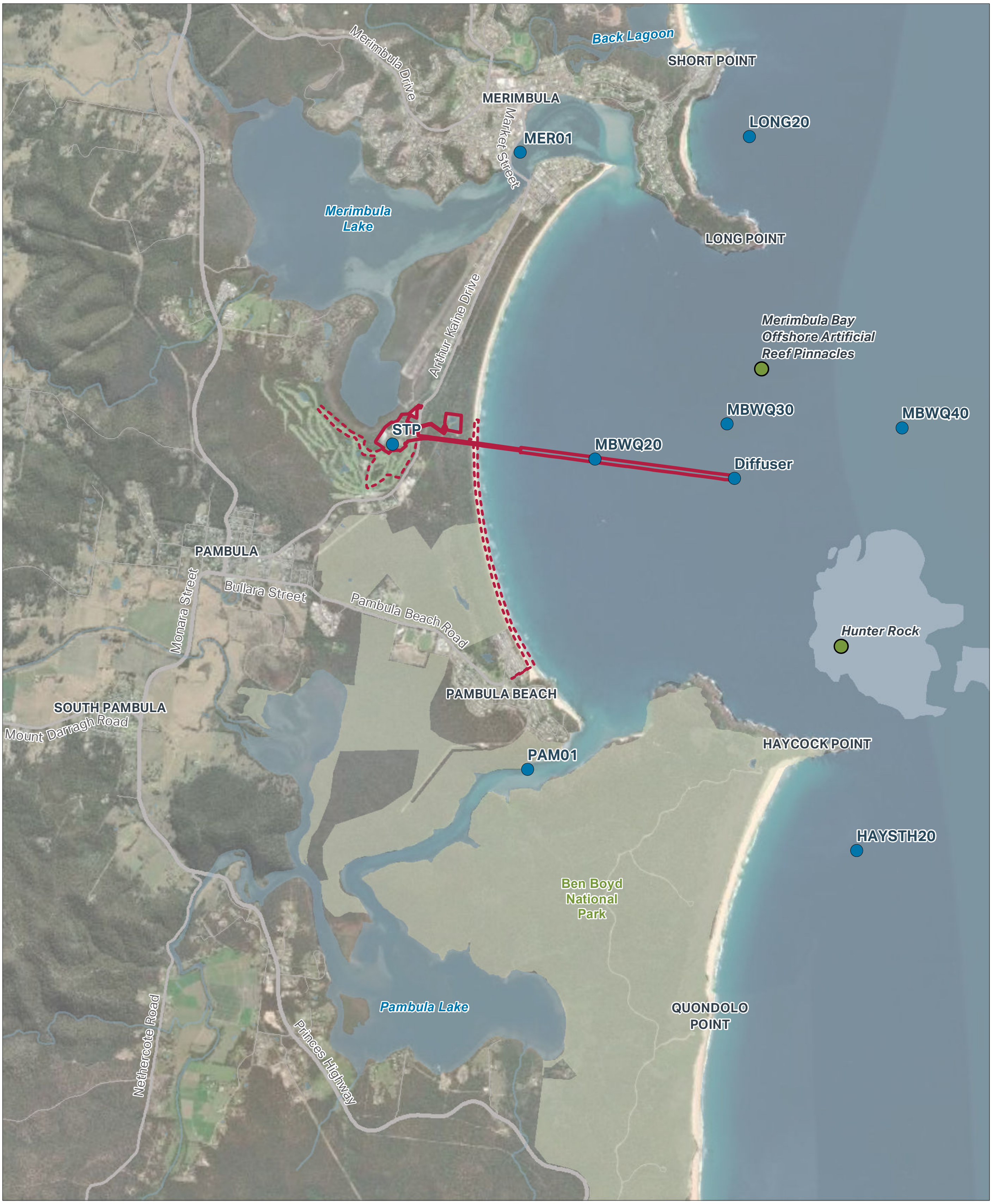

FIGURE 8-5: PROPOSED WATER QUALITY MONITORING LOCATION DURING OPERATION OF THE PROJECT

N 0 1 2 km

AECOM

Legend

- Project area
- Project area (temporary construction area)
- Approximate extent of reef
- Proposed water quality monitoring locations

Sampling and monitoring frequency

For coastal monitoring sites, samples would be collected from surface and bottom waters to consider potential stratification and/or elevated nutrient concentrations that can occur where monitoring events coincide with upwelling events. Depth profiling using a multi-parameter instrument would be used to record physio-chemical parameters.

For lower estuary monitoring sites, samples would be collected from surface waters only, as the relatively shallow entrances to each lake result in well-mixed marine waters entering each estuary during flood tide.

Monitoring frequency would initially be monthly for a minimum 24-month period in order to build up a dataset sufficient for statistical analysis and for detecting potential changes in water quality when compared to the baseline dataset of the years 2014-17. Monitoring events would be timed to coincide with discharge of treated wastewater from the ocean outfall.

Monitoring indicators

Monitoring indicators would be consistent with those used for this assessment and include parameters from physio-chemical, nutrients, metals and biological indicator groups. Nitrogen stable isotopes would also be included in the monitoring program owing to its ability to differentiate between wastewater derived nitrogen and other ambient sources. The treated wastewater data would be critical for this purpose as it would provide the nitrogen isotope signature for the treated wastewater which can then be assessed for its presence at receiving water monitoring sites. A summary of the monitoring indicators and parameters is included in **Table 8-11**.

Table 8-11 Summary of marine water quality monitoring indicator groups and parameters

Indicator group	Parameters	Sample	Frequency	Marine sites	Estuarine sites
Physio-chemical	Dissolved oxygen (DO), electrical conductivity (EC), pH/redox, turbidity, temperature	Field in-situ	Monthly	Surface and bottom waters	Surface waters
	Total Suspended solids (TSS)	Lab	Monthly	Surface and bottom waters	Surface waters
Nutrients	Total nitrogen (TN), ammonia, oxides of nitrogen (NO_x), nitrate (NO_2), nitrate (NO_3), total phosphorous (TP), orthophosphate (FRP),	Lab	Monthly	Surface and bottom waters	Surface waters
Total metals	Al, Ag, Fe, Cd, Co, Cr, Cu, Hg, Mn, Ni, Pb, Sb, Se, Sn, Zn	Lab	Monthly	Surface and bottom waters	Surface waters
Biological	Chlorophyll a, faecal coliforms, *Enterococci*	Lab	Monthly	Surface and bottom waters	Surface waters
Stable isotope	^{15}N:^{14}N stable isotopes	Lab	Monthly	Surface waters only	Surface waters

8.5.3 Mitigation and management measures

Mitigation and management measures would be implemented to avoid, minimise or mitigate impacts on water quality and flooding within the Project area. These mitigation and management measures are outlined in **Table 8-12**.

Several of the mitigation and management measures contained in **Chapter 13 Landform, geology and soils** would also contribute to management of water quality impacts.

Table 8-12 Mitigation and management measures – water quality, hydrology and flooding

Ref #	Potential impacts	Mitigation and management measures	Timing
SWF1	Impacts on water quality in the receiving environment	Monthly water quality monitoring will be undertaken within Merimbula Bay for at least 12 months prior to the commencement of construction. The data would be used as a baseline to monitor impacts on water quality during construction and operation. Monitoring would also be undertaken to coincide with discharge of treated wastewater from the ocean outfall.	Prior to construction
SWF2	Impacts on water quality in the receiving environment	The Project CEMP will include procedures to minimise potential impacts to surface water and hydrology, these will include procedures for: • dewatering excavations during construction (if required, e.g. post-rainfall), so that water is tested and if necessary treated, prior to release in accordance with approval conditions • storage and use of fuel, oil and hydraulic fluids that have the potential of release into the receiving environment.	Prior to construction
SWF3	Flood-related impacts	Temporary construction compounds, stockpiles and storage areas are to be located outside the 1% AEP flood extent. Any construction access requirements to and from the STP site during potential flood conditions should be confirmed to be from the south along Arthur Kaine, in order to avoid potential flood waters across the road north of the STP site.	Construction
SWF4	Impacts on water quality in the receiving environment	Operational water quality monitoring of Merimbula Bay, Merimbula Lake and Pambula River program will be conducted as a key performance indicator of environmental compliance. The monitoring program would have the objective of assessing marine water quality at sites inside and outside the treated wastewater mixing zone against MWQO trigger values to ensure sensitive receptors and environmental values are protected. Monitoring would comprise monthly monitoring over a minimum 24-month period, from the commencement of operation, to build up a data set that can be compared to the data set from 2014 to 2017. Monitoring following the 24-month period will occur with consideration to the frequency of discharge of the treated wastewater from the ocean outfall pipeline (i.e. will be aimed to coincide with discharge).	Operation

8.5.4 Residual risk analysis

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented. A residual risk analysis was undertaken for water quality and flooding and is provided in **Table 8-13.**

The residual risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact.

Table 8-13 Environmental risk analysis with mitigation– Water quality, hydrology and flooding

Summary of Impact	Construction /operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Impacts on water quality in the receiving environment	Construction and operation	SWF1, SWF2, SWF4	Minor	Possible	Medium
Impacts on water bodies in the receiving environment	Construction	SWF2, SWF3	Minor	Possible	Medium
Flood-related impacts	Construction	SWF3	Minor	Rare	Low

9.0 Groundwater

This chapter provides a summary of the groundwater impacts associated with the Project. A detailed Groundwater Technical report has been prepared for the Project and is included in **Appendix D**.

Table 9-1 sets out the requirements as provided in the Secretary's Environmental Assessment Requirements (SEARs) relevant to groundwater and where the requirements have been addressed in this EIS.

Table 9-1 SEARs – Groundwater

Ref	Assessment requirements	Where addressed in this EIS
7.1	The Proponent must describe (and map) the existing hydrological regime for any surface and groundwater resource (including reliance by users and for ecological purposes) likely to be impacted by the project.	**Section 9.2** describes the existing groundwater resources in the area and **Figure 9-2** shows the existing hydrological regime for groundwater. **Section 9.2.6** describes the groundwater users in the study area and **Figure 9-5** shows the locations of registered groundwater boreholes. **Section 9.2.7** describes groundwater dependent ecosystems in the area.
7(3)	The Proponent must assess (and model if appropriate) the impact of the construction and operation of the project and any ancillary facilities (both built elements and discharges) on surface and groundwater hydrology in accordance with the current guidelines, including: a. natural processes within rivers, wetlands, estuaries, marine waters, and floodplains that affect the health of the fluvial, riparian, estuarine or marine system and landscape health (such as modified discharge volumes, durations and velocities), aquatic connectivity and access to habitat for spawning and refuge;	**Section 9.3.4** and **Section 9.4.4** address potential impacts to groundwater hydrology to groundwater dependant ecosystems/wetlands. Potential impacts to surface water hydrology are addressed in **Chapter 8 Water quality, hydrology and flooding** Potential impacts to non-marine aquatic ecology is discussed in **Chapter 12 Terrestrial ecology** and to marine ecology in **Chapter 11 Marine ecology**.
7 (3)	b. impacts from any permanent and temporary interruption of groundwater flow, including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, groundwater users and the potential for settlement.	**Section 9.3** and **Section 9.4** address impacts from any interruption of groundwater flow during construction and operation (respectively); including the extent of drawdown, barriers to flows, implications for groundwater dependent surface flows, ecosystems and species, and groundwater users. Groundwater dependent ecosystems are also addressed in **Chapter 12 Terrestrial ecology**. Potential for settlement (subsidence) is addressed in **Chapter 13 Landform, geology and soils**

Ref	Assessment requirements	Where addressed in this EIS
7 (4)	The Proponent must identify any requirements for baseline monitoring of hydrological attributes.	An overview of the requirement for baseline groundwater monitoring proposed for the Project is provided in **Section 9.5**. Details of the baseline groundwater monitoring proposed is provide in **Appendix D** (Ground water Technical report).

9.1 Assessment approach

This chapter provides a summary of the Groundwater Technical report that has been prepared for the Project (refer **Appendix D**). The Groundwater Technical report describes the existing groundwater conditions within the groundwater study area (defined in **Section 9.1.2**) and assesses the potential impacts of the construction and operation of the Project on groundwater flows, groundwater levels and water quality. The Groundwater Technical report also provides groundwater management and monitoring measures that would be required to manage any potential impacts on the groundwater regime and any groundwater dependent ecosystems.

The assessment has been undertaken with consideration of relevant legislation, policies, guidelines described below.

9.1.1 Legislative and policy context

The Groundwater Technical report and this chapter have been prepared in consideration of the following legislation:

- *Water Management Act 2000;*
- *Water Management (General) Regulation 2018;*
- *Water Sharing Plan for Towamba River Unregulated and Alluvial Water Sources 2010;* and
- *Water Sharing Plan for the South Coast Groundwater Sources 2016.*

Policies and guidelines

The Groundwater Technical report and this chapter have also been prepared with consideration of the following policies and guidelines:

- *NSW Groundwater Policy Framework Document* (NSW Department of Land and Water Conservation (DLWC), 1998);
- Australian and New Zealand Environment and Conservation Council (ANZECC) and Agriculture and Resource Management Council of Australia and New Zealand (ARMCANZ) *National Water Quality Management Strategy Australian Guidelines for Fresh and Marine Water Quality* (ANZECC and ARMCANZ, 2000);
- *Using the ANZECC Guidelines and Water Quality Objectives in NSW (NSW* Department of Environment and Conservation (NSW Department of Environment and Conservation (DEC, 2006));
- *Approved Methods for Sampling and Analysis of Water Pollutants in NSW* (DEC, 2004);
- *NSW Water Extraction Monitoring Policy* (NSW Department of Water and Energy (DWE, 2007);
- *NSW Aquifer Interference Policy* (Department of Planning and Infrastructure (DPI 2012));
- *NSW Water Quality and River Flow Objectives, Towamba and Genoa River* (DECC, 2006); and
- *Managing Urban Stormwater; Soils and Construction* (Landcom, 2004), also referred to as “the Blue Book”.

A groundwater dependent ecosystem (GDE) assessment was undertaken for the Project (ELA, 2020) and is provided as part of **Appendix H** (Biodiversity Assessment Report) of this EIS. This assessment was prepared with reference to the *Risk Assessment Guidelines for Groundwater Dependent Ecosystems* (Office of Water, 2012). This GDE assessment has been used to inform this chapter, as well as **Chapter 12 Terrestrial ecology**.

9.1.2 Study area

The groundwater study area was selected based on the results of previous groundwater investigations and the groundwater flow regime defined in these previous studies. The study area also recognises the types and locations of potential groundwater receptors and encompasses pathways by which they may be impacted by the Project.

The study area extends to:

- the interface between terrestrial and aquatic environments along Merimbula Beach and the eastern shoreline of Merimbula Lake;
- the terrestrial groundwater environment:
  - upgradient to the south; and
  - downgradient to the east, north and west of the Project; and
- the groundwater flow system in a superficial aquifer comprising coastal dunes and alluvium.

The study area for this groundwater impact assessment effectively includes the Project footprint and the nearby area shown on **Figure 9-1**.

9.1.3 Methodology overview

The Groundwater Technical report was developed using desktop and field based information sources, and comprised the following methodology:

- review of available groundwater quality data to define the existing environment;
- assessment of potential impact of construction and operational activities and potential cumulative impacts on groundwater with reference to the Australia and New Zealand water quality guidelines for protection of the relevant environmental values (ANZG, 2018);
- provision of mitigation and management measures to manage potential cumulative impacts resulting from the Project, as required; and
- development of a consolidated list of mitigation and management measures that should be implemented during construction and operation to mitigate potential impacts to groundwater.

This assessment approach is discussed in more detail in the following sections.

9.1.4 Desktop assessment

A desktop assessment was completed for the Groundwater Technical report to define the existing environment, to determine potential impacts to the groundwater environment in the groundwater study area and to develop appropriate mitigation and management measures where required. This desktop assessment included a review of the following publicly available datasets, maps, and registers:

- BVSC groundwater monitoring database containing data from 2004 to 2019, with a specific focus on seven wells providing monitoring data from 1991-92 (A series" - A1, A2, A4, A5, A6, A7., shown on **Figure 9-1**);
- NSW Water Register, which provides regional groundwater bore information including water licences, approvals, and environmental water;
- 1:25,000, 1:100,000 and 1:250,000 scaled maps published by the NSW Geological Survey;
- climate information obtained from the Bureau of Meteorology (BoM) and Long Paddock patched point dataset; and
- BoM National Atlas of Groundwater Dependent Ecosystems.

In addition to the above, site-specific hydrogeological information was gathered from previous studies that have taken place within the groundwater study area, for review. **Table 9-2** provides a list of these previous studies, and a summary of key information contained in each that is relevant to the Project.

The locations of geotechnical holes and groundwater bores from previous investigations (described in **Table 9-2**) that were used to assess groundwater impacts for the Project, are shown on **Figure 9-1**. These holes are generally numbered with a prefix denoting the year they were installed followed by a number or abbreviation of the originator. Details of all bores, including recorded groundwater level and quality data near the Project is provided in the Groundwater Technical report in **Appendix D** (Groundwater Technical report).

Table 9-2 Description of key data sources used to inform the Groundwater Technical report

Information source	Data available
Appraisal of Sand Seepage Capacity and Conceptual Design of Infiltration Systems, Merimbula STW (Mackie-Martin, 1987)	Twenty-two geotechnical boreholes and groundwater sampling results have been used to determine groundwater properties relevant to the Project
Public Works Department,1988. Merimbula Wastewater Augmentation. Water Treatment Plan Stage 2 Geotechnical Investigation, (PWD, 1988)	Twelve shallow geotechnical boreholes, between five to 10 metres (m) in depth. Geotechnical information regarding underlying soils has been used to inform assessment of existing hydraulic conductivity hydraulic gradient for the Project
Assessment of Groundwater Conditions and Dune Disposal Options for Merimbula STP. EGIS/IDSM Joint Venture (PPK, 2002)	Four monitoring wells including hydrochemistry and groundwater levels. Report provides groundwater information regarding the following at the Merimbula STP: groundwater level contours; hydro chemical properties; response to tidal influence and rainfall; production of groundwater hydrographs; and analysis of pump test and infiltration test data
Investigation of the Deep Disposal Option for Reclaimed Water from Merimbula STP (draft report) (Parsons Brinckerhoff, 2004)	A pilot hole (62 m depth), environmental logging and a resistivity survey, including groundwater quality testing from the deep aquifer
AECOM, 2020. Geotechnical Interpretive Report. BVSC	Seven geotechnical holes and a geophysical survey for this Project
Merimbula STP Upgrade and Ocean Outfall Pipeline Biodiversity Assessment Report (ELA, 2020) (refer to **Appendix H**)	Vegetation and ecosystem mapping for the terrestrial components of the Project
BVSC groundwater monitoring database for the local government area (LGA), containing data from 2004 to 2019	Groundwater level monitoring data collected between December 2005 and September 2019 and groundwater quality data between 1987 and September 2019. Six of nine bores have been used for this assessment based on availability of information and proximity to the Project.

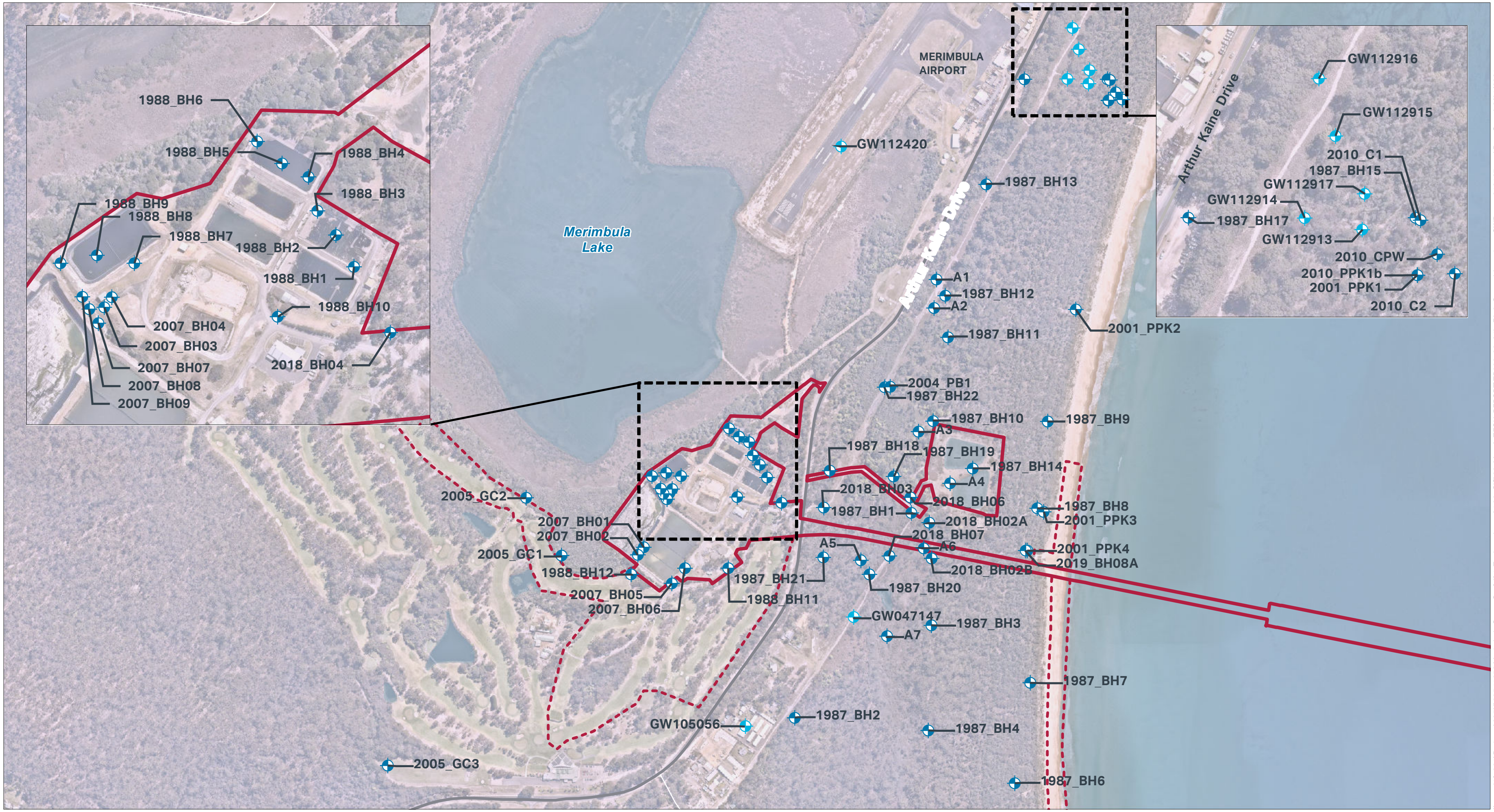

FIGURE 9-1: LOCATION OF GEOTECHNICAL HOLES AND GROUNDWATER BORES WITHIN THE STUDY AREA

Legend

- Project area
- Temporary project area for construction
- Groundwater monitoring bore
- Registered groundwater bore

0 200 400 m

AECOM

Source: Nearmap, 2019

9.1.5 Assessment criteria

The *NSW Aquifer Interference Policy* (AIP) (DPI, 2012) provides a framework for the regulation, licencing and assessment of groundwater activities to meet the requirements of the *Water Management Act 2000* (WM Act). According to the *WM Act*, the definition of aquifer interference includes the following:

- the penetration of an aquifer;
- the interference with water in an aquifer;
- the obstruction of the flow of water in an aquifer;
- the taking of water from an aquifer while carrying out mining or any other activity prescribed by the regulations; and
- the disposal of water taken from an aquifer while carrying out mining or any other activity prescribed by the regulations.

Considering the above, definitions provided by the WM Act and AIP, the Project would constitute an 'aquifer interference activity' as it would:

- extend into the aquifer below the water table (that is, it would penetrate the aquifer);
- interact/interfere with groundwater in the aquifer (to some degree); and
- potentially alter or obstruct the flow of groundwater.

The WM Act includes the concept of "no more than minimal harm" for the granting of water access licences, and the AIP identifies thresholds for key minimal impact considerations for various groundwater resources (alluvial, coastal sands, porous rock and fractured rock). These thresholds deal with water table and groundwater pressure drawdown as well as groundwater and surface water quality changes. Unless identified as exempt under the AIP, aquifer interference activities must be assessed against the relevant minimal impact thresholds.

The AIP provides the specific thresholds for minimal impact considerations for aquifers classified as highly productive and less productive groundwater sources. The superficial aquifer that is located below the Project is classified as a highly productive groundwater source as defined in the AIP as it meets the following criteria:

- has total dissolved solids of less than 1,500 milligrams per litre (mg/L); and
- underlying materials comprise coastal sands.

However, the minimal impact considerations (outlined in Table 1 and Section 3.2.1 of the AIP) state that *"if predicted impacts are less than the Level 1 minimal impact considerations, then these impacts will be considered as acceptable"*.

Under the AIP, trenches and pipelines that intersect the water table are listed as 'minimal impact activities' where a water access licence is not required. The Project meets these conditions, and as such does not require assessment under the AIP against the impact thresholds.

Protecting groundwater flow regime and groundwater quality has been assessed by considering changes the Project may impose during its construction and operational phases against the existing groundwater conditions. Protecting the groundwater resource and the human and ecological receivers that depend on it has been assessed in terms of whether there is a pathway from the Project that could lead to an impact. Therefore, the groundwater assessment has considered the locations and type of user, mechanisms that could activate an impact pathway, and the expected severity of the effect on groundwater.

The Project area is currently used to treat, and discharge wastewater. Treated wastewater is currently transported to the two exfiltration ponds and/or to an outfall on Merimbula Beach. As a result, groundwater quality near the exfiltration ponds is not regarded as the same as natural background quality.

9.2 Existing environment

9.2.1 Climate

The Project is located in a temperate climate region. The closest BoM weather station to the Project is at the Merimbula Airport (site number 061397), located about 1 kilometre north of the Merimbula STP site.

Between 1998 and 2020, the mean annual rainfall at this weather station was 727.7 millimetres (mm) per year. Monthly rainfall is typically higher in February, June and November (BoM, 2020). **Table 9-3** provides an overview of the yearly seasonal variation in average monthly rainfall. It is also noted however that data from years that experienced high rainfall such as 2010, 2012 and 2014 shows that the total annual rainfall ranged from 983.4 mm to 1131.8 mm.

Temporal variability of rainfall describes how much rainfall averages may change between seasons. An analysis of rainfall residuals between 2001 and 2012 identified the long-term variability and trends that are applicable to the groundwater study area. The annual average rainfall residuals in the region range from about -30mm to +40mm. This indicates that the natural inter-seasonal variability is between 4.1% and 5.5% of the average annual rainfall (IGGC, 2013).

Merimbula has a warm mean maximum temperature in summer (24.9°C in January) and cool mean minimum temperature in winter (4.1°C in July).

Evaporation data is not measured at this weather station, however interpolated data from the Scientific Information for Land Owners (SILO) database (Jeffrey, S.J et.al, 2001) indicates that it normally ranges between 49.4 mm/month in June to 183.1 mm/month in January. The annual average evaporation is about 1,327.3 mm/year.

Table 9-3 Mean monthly rainfall totals at Merimbula Airport

Rainfall	Jan	Feb	Mar	Apr	May	June	July	Aug	Sept	Oct	Nov	Dec	Annual Average
Mean monthly rainfall (mm)[1]	61.0	84.7	79.2	63.2	45.9	73.7	43.7	43.2	42.4	51.4	79.4	59.7	**727.7**
Mean monthly evaporation (mm)[2]	183.1	146.6	126.0	88.6	61.4	49.4	53.5	73.7	95.7	125.7	147.5	176.2	**1,327.3**

1.Rainfall averages based on records from 1998 to 2020 (current at 22/6/2020) at BoM Station 069147
2.Evaporation averages based on interpolated data from the SILO database from 1889 to 2020.

9.2.2 Geology and hydrogeology

A detailed description of the existing geological conditions in the study area is provided in **Chapter 13 Landform geology and soils**. This chapter provides a detailed description of the regional and local geological conditions associated with the Project.

The hydrogeology of the land section of the Project area, relative to identified geological units (provided in detail in **Chapter 13 Landform geology and soils**) is summarised in **Table 9-4**.

Table 9-4 Geology and hydrogeology of the groundwater study area

Geological Era/Period	Geology	Hydrogeology
Quaternary	Alluvial, colluvial and dunal deposits (Qa, Qheb, Qhbf, Qhbd and Qhbb)	Unconfined aquifer (sand deposits) Aquitard (silt and clay deposits)
Cainozoic/Tertiary	Fluvial sand, grit and lacustrine clay (Ts)	Unconfined to confined aquifer (sand deposits) Aquitard (silty and clay deposits)
Geological unconformity (time gap in the strata)	No data	No data
Late Devonian	Merimbula Group (Dm, Dmb, Dmc) sedimentary rocks: sandstone, siltstone and mudstone	Confined aquifer (fractured bedrock) Aquitard (fresh unfractured bedrock)
Middle Devonian	Boyd Volcanic Complex (Db): volcanic rocks and minor sediment	Confined aquifer (fractured bedrock) Aquitard (fresh unfractured bedrock)

Note: Geological abbreviations derived from mapping by the Geological Survey of NSW.

9.2.3 Aquifer occurrence

Groundwater can be found below the water table within sedimentary deposits that lie beneath the Project area. The following section provides an overview of the hydrogeological conditions within the study area.

Following groundwater investigative work, a preliminary description of the hydro-stratigraphy conditions within the groundwater study area has been developed (MMA 1987, PPK, 2002, and Parsons Brinkerhoff, 2004). This review has indicated that the groundwater in the study area comprises:

- an upper sand unit comprising medium to coarse sand, similar to dune sand. This upper unit can be described as a shallow unconfined aquifer with underlying clay aquitards and (presumably) confined sand aquifers;
- an underlying “middle” unit comprising clay interbedded with coarse sand starting about 5 m below the top of this unit;
- a lower unit comprising coarse sand with minor clayey interbeds; and
- inferred Pambula Palaeovalley deposits including the middle and lower units.

Hydraulic conductivity represents the ease with which water passes through a substrate, providing a measure of how fast groundwater is likely to be moving through an area. The permeability or hydraulic conductivity of various rock units varies in response to the type of substrate (pore size and pore connectivity) as well as features in the unit such as joints and fractures, along which groundwater would flow. Therefore, changes in sand and clay content, and the presence of rock fractures, as well as the orientation and interconnection of these factors can cause changes in hydrologic conductivity. Groundwater level data indicates that the groundwater study area experiences upward hydraulic gradients from deep layers of coarse sand that give rise to piezometric levels (confined aquifer groundwater levels) of about 2 m above the Australian Height Datum (AHD), which is slightly above the ground surface at some locations across the Project area.

The deep sand strata in the groundwater study area has an average hydraulic conductivity of about four metres per day (m/d) (Parsons Brinkerhoff, 2004), compared to values of 12 m/d to 47 m/d for superficial sand formations (MMA, 1987).

At a local scale the stratigraphy beneath the Project area comprises a thick succession of sand with discontinuous layers of clay and clayey sand. The succession of sand and clay under the STP has been described as being part of the Tertiary sediments, while the overlying sand formations to the east are Quaternary coastal dune and beach deposits (IGGC, 2013). A summary of aquifer test results by IGGC (2013) suggests the hydraulic conductivity of the superficial coastal sand deposits was 30 to 50m/d.

9.2.4 Groundwater recharge, levels and flow

Groundwater levels are typically controlled by the rate of recharge (typically by rainfall that infiltrates the water table), extent of tidal exchange, and the hydraulic conductivity of the superficial strata surrounding the water table.

The average rate of recharge in any location depends on the prevailing land use and intensity and frequency of rainfall events. Groundwater recharge in the groundwater study area is estimated to range from 30% to 100%. Values higher than 40% are probably the result of concentrated runoff from paved roads and other hardstand surfaces and aquifer throughflow from upgradient areas (MMA,1987, Parsons Brinkerhoff, 2004 and IGGC, 2006).

Groundwater level contours based on ‘typical’ conditions in the study area are shown on **Figure 9-2**. These groundwater level contours demonstrate the following:

- recharge accumulating at the water table has formed a north-south groundwater divide along the sand spit beneath Arthur Kaine Drive and Merimbula Airport
- groundwater flows outward from a natural mound south of the Project
- groundwater discharges to Merimbula Beach (east) and Merimbula Lake (west).

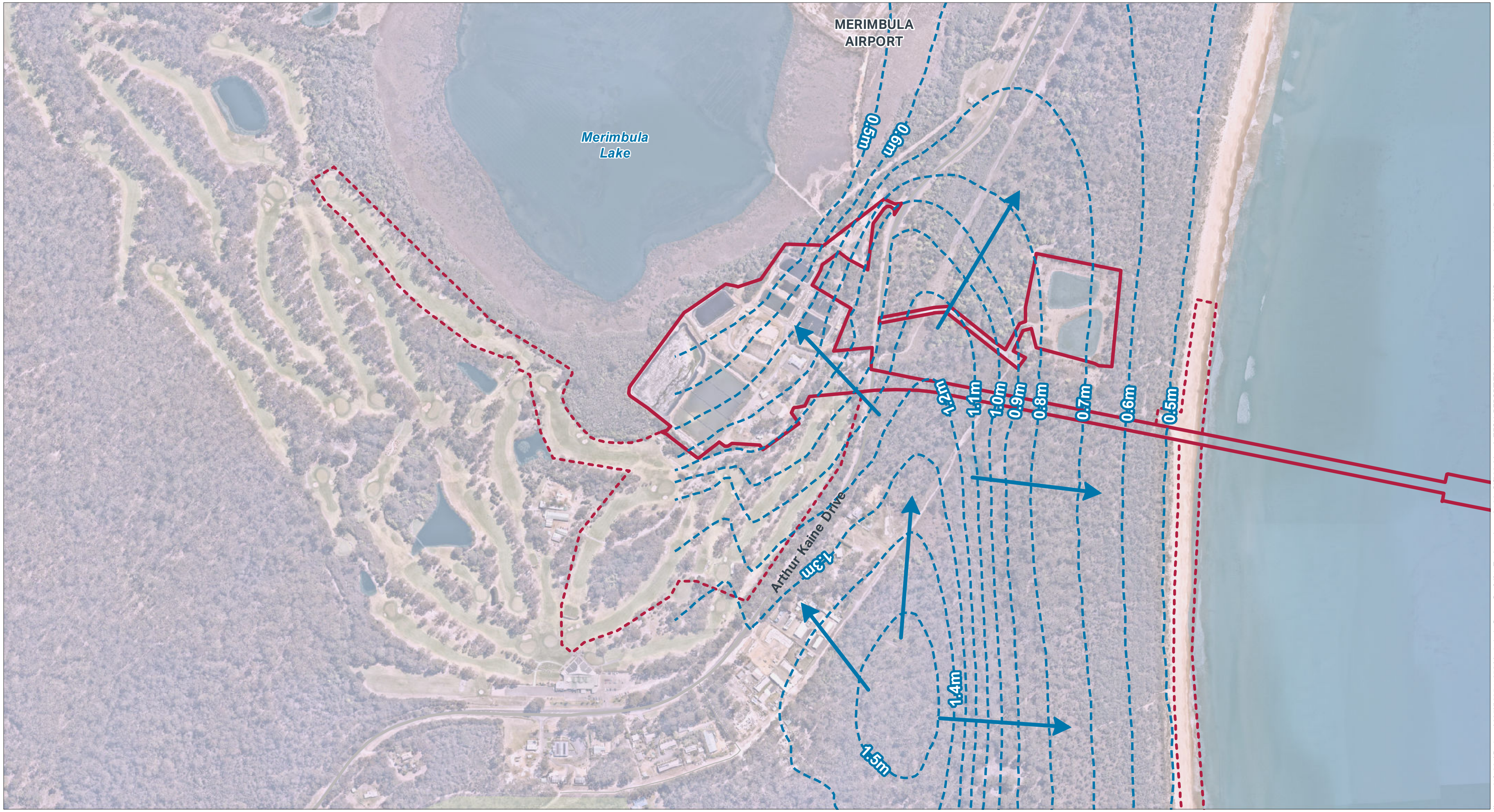

FIGURE 9-3: GROUNDWATER LEVEL CONTOURS AND INFERRED FLOW DIRECTIONS

Legend

- Project area
- Temporary project area for construction
- Groundwater level contours under normal conditions (After IGGC, 2013)
- Inferred groundwater flow

0 200 400 m

Source: Nearmap, 2019

The water table within the groundwater study area fluctuates in response to seasonal rainfall, and where it occurs in close proximity to the coast, it also varies in response to tidal fluctuations and wave action (IGGC, 2013). Hydrographs of four long-term monitoring bores (commencing in 2005) near the proposed pipeline (A5, A6, PPK3 and PPK4, refer to **Figure 9-1**) are shown on **Figure 9-3** and in **Table 9-5**.

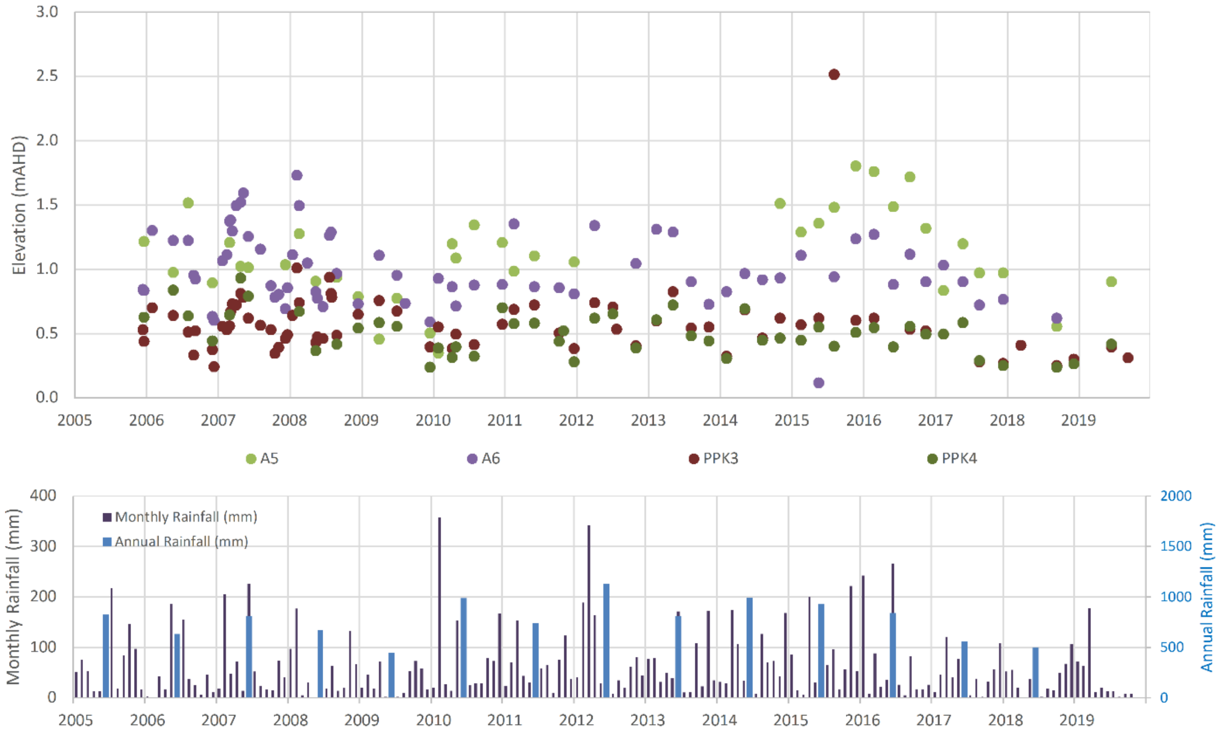

Figure 9-3 Hydrographs showing water levels of selected groundwater monitoring bores, with corresponding rainfall recorded

Groundwater levels near the proposed outfall pipeline increase when moving inland away from the beach. Close to Merimbula Beach groundwater can be found between 0.5 m AHD and 0.6 m AHD (bores PPK3 and PPK4). Further inland at bores A5 and A6 groundwater can be found between 1.0 m AHD and 1.1 m AHD. The water table generally fluctuates by about 0.5 m inland and 0.3 m close to the beach (bores PPK3 and PPK4), as shown in **Table 9-5**.

Table 9-5 Groundwater levels and fluctuation ranges

Groundwater Levels	A5	A6	PPK3	PPK4
80th Percentile (m AHD)	1.38	1.28	0.70	0.63
Mean (m AHD)	**1.10**	**1.00**	**0.58**	**0.50**
20th Percentile (m AHD)	0.88	0.78	0.39	0.37
Typical fluctuation range (m)	0.50	0.50	0.31	0.26

The water table in the groundwater study area, near Merimbula Beach, is influenced by the levels in the two exfiltration ponds, rainfall and tidal levels (IGGC 2013). Short-term fluctuations at bore PPK3 of about 0.1 m are attributed to tidal influences.

9.2.5 Groundwater quality

Groundwater quality has been monitored by BVSC since November 2001, as part of an ongoing environmental monitoring programme. During this period, BVSC has collected information on the following groundwater quality properties:

- physicochemical properties (pH, electrical conductivity (EC), temperature, dissolved oxygen (DO), redox potential, hardness, and alkalinity);
- major anions and cations (sodium, potassium, calcium, magnesium, chloride (free and total), sulfate, carbonate/bicarbonate, hydroxide;
- nutrients (ammonia, nitrogen and phosphate); and
- microbiological parameters (faecal coliform, *E. coli*, faecal streptococci and enterococci).

The water quality properties of groundwater within and near the Project area are provided in **Table 9-6** (where available). The figures presented in this table have been derived by averaging the historical results from the BVSC groundwater quality database. These results as well as the results of other studies undertaken (IGGC, 2013 and AECOM, 2020) are discussed below.

Table 9-6 Groundwater quality values from within and near the Project area (averaged)

	Location				
Property	**1987_BH10**	**A4**	**A6**	**PPK3**	**PPK4**
pH	6.71	6.76	4.96	7.93	7.81
EC (µS/cm)	735.5	979.2	206.1	906.7	829.3
Dissolved Oxygen (mg/L)	-	0.99	1.03	-	1.19
Dissolved Oxygen (% Saturation)	2.18	3.54	3.19	2.46	1.69
Redox potential (mV)	-91.7	-98.8	76.5	26.2	-104.3
Temperature (ºC)	17.0	19.2	16.7	17.9	17.5
Bicarbonate (mg/L)	146.9	348.3	5.4	182.3	178.9
Carbonate (mg/L)	2.0	-	1.7	2.0	2.0
Hydroxide (mg/L)	2.0	-	1.7	2.0	2.0
Total alkalinity (mg/L)	146.9	317.8	5.1	182.3	179.0
Chloride (mg/L)	127	119	51	145	131
Sulfate (mg/L)	15.4	31.5	2.8	34.4	30.7
Dissolved Calcium (mg/L)	23.4	100.5	2.7	45.9	41.6
Dissolved Mg (mg/L)	12.8	11.7	4.6	10.3	9.3
Dissolved Na (mg/L)	90	92	24	107	101
Dissolved K (mg/L)	16.3	41.0	1.0	20.0	19.6
Ammonia (N) (mg/L)	0.96	0.36	0.11	0.78	0.79
NO_x (N) (mg/L)	0.04	-	0.03	0.25	0.07
Nitrate (N) (mg/L)	0.06	-	0.05	0.15	0.08
Nitrite (N) (mg/L)	0.01	0.02	0.01	0.01	0.03
Total Nitrogen (mg/L)	1.62	1.30	1.56	1.43	1.28
Phosphate (mg/L)	0.48	0.06	0.02	5.02	1.48
Total Phosphorous (mg/L)	0.56	0.71	0.17	5.35	1.52

	Location				
Property	**1987_BH10**	**A4**	**A6**	**PPK3**	**PPK4**
Reactive Phosphorous (mg/L)	-	-	-	-	0.1
Faecal coliforms (CFU/100mL)	28	-	3	22	2
E. coli (Colony forming units (CFU)/100mL)	33	-	2	23	2
Faecal streptococci (CFU/100mL)	15	-	5	112	2
Enterococci (CFU/100mL)	15	8	4	2884	2

Average groundwater pH and EC values across the study area based on the BVSC database (BVSC, 2019) are shown on **Figure 9-4**. The EC is lowest at bore A6 near the wetlands and higher downgradient near Merimbula Beach (PPK2, PPK3 and PPK4), and higher still near Merimbula Lake (bore GC2). EC has also been recorded as 220 micro-siemens per centimetre (µS/cm) to brackish at 10 m depth: 2,400 µS/cm at 2018_BH02B to saline (seawater) near the coast (AECOM, 2020). This demonstrates that groundwater in the Project area is typically fresh near the water table and becomes more saline with depth. Higher salinity at depth is the result of natural processes whereby saline groundwater is more dense than fresh groundwater. Along the coastline, saline groundwater of marine origin "wedges" underneath fresh groundwater (IGGC 2013). Higher EC groundwater readings can also result from the natural accumulation of sea salt, and due to close proximity to the beach and lake.

The pH values in **Figure 9-4** (pH 6.10 to 7.93) are mostly within the normal circum-neutral range for groundwater (pH 6.0 to 8.5) but are lower near wetlands (e.g. pH 4.96 at bore A6).

Table 9-6 shows that nutrients are generally present in the underlying groundwater at low concentrations with inorganic nitrogen, measured mostly as nitrate, recorded at between 0.01 mg/L and 0.03 mg/L.

Dissolved metal concentrations were also shown to be generally low when compared against parameters defined by ANZECC and ARMCANZ 2000 guidelines, except for arsenic and zinc, and occasionally cobalt, copper and nickel, which can be elevated by local natural processes (IGGC, 2013).

The IGGC (2013) study considered the quality of wastewater subject to disposal by dunal exfiltration at Merimbula Beach. The quality of the wastewater based on data from between 2004 and 2012 was characterised as being generally good and broadly similar to local fresh groundwater, except for elevated phosphorous and the presence of faecal coliforms. Microbiological activity associated with pathogenic bacteria was found to be generally low but elevated at bore PPK3, which is downgradient of the exfiltration ponds (IGGC, 2013).

Overall, groundwater quality in the study area is reflective of the existing natural environmental conditions, including proximity to the ocean and Merimbula Lake. Groundwater in the area also has the potential to be influenced by the existing exfiltration ponds, and potential for acid sulfate soils to exist in the area. Higher recordings of pathogenic bacteria are associated with the ongoing operation of the exfiltration ponds.

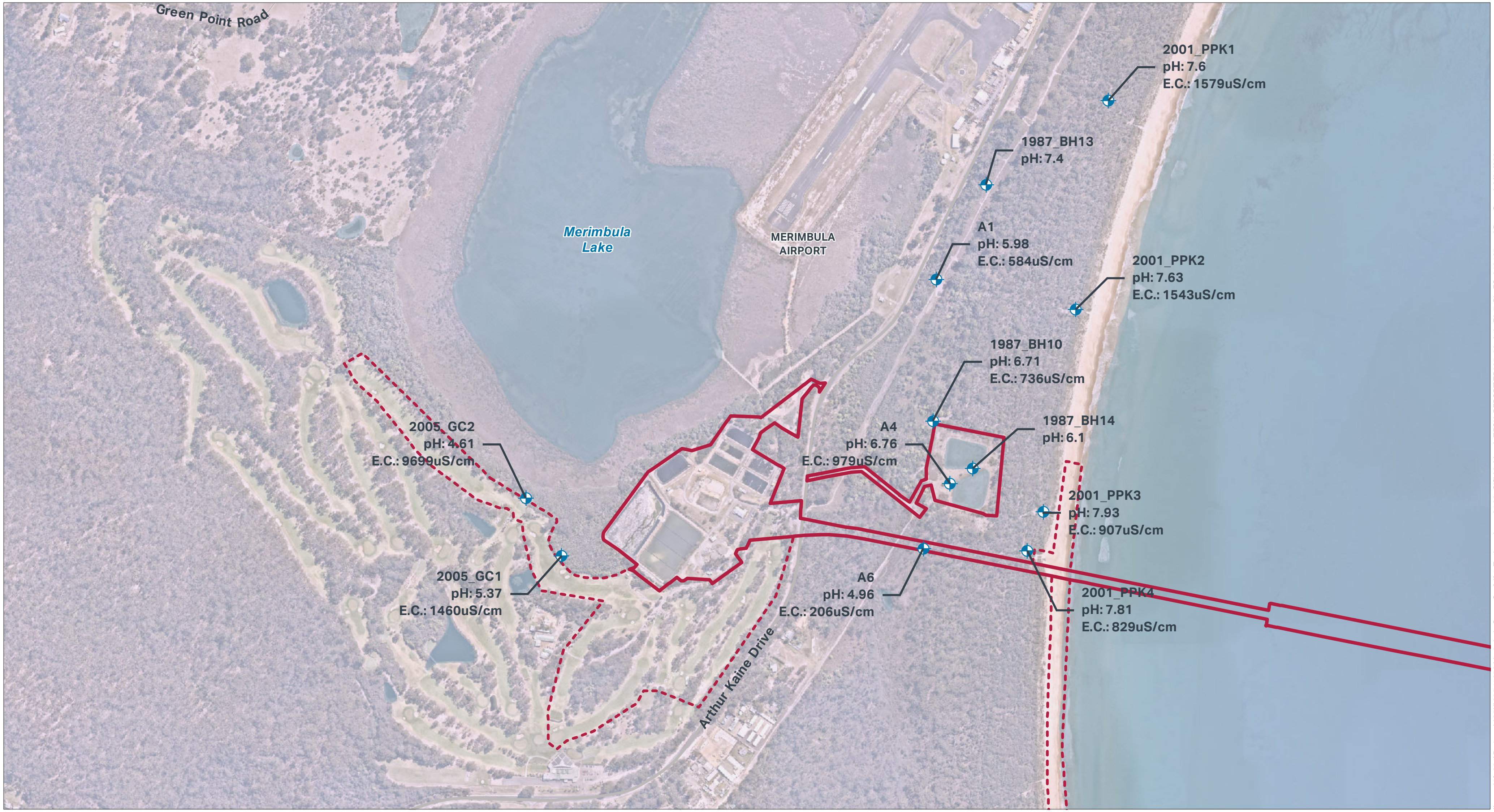

FIGURE 9-4: AVERAGE GROUNDWATER ELECTRICAL CONDUCTIVITY AND pH WITHIN THE STUDY AREA

Legend

- Project area
- Temporary project area for construction
- Groundwater monitoring bore
- **E.C.** Electrical conductivity

N

0 200 400 m

AECOM

Source: Nearmap, 2019

9.2.6 Groundwater users

The Project area is relatively remote from other groundwater users. A search of registered groundwater bores from the NSW Office of Water (DPI 2020) database indicates there are nine sites within proximity of the Project as summarised in **Table 9-7** and shown on **Figure 9-5**. The nearest bore (GW047147, about 350 m from the Project), is an unlicensed private water supply bore, used for recreational purposes. The condition of the unlicensed bores in **Table 9-7** is unknown. There are several monitoring bores near the Merimbula Airport of which two (GW112420 and GW112913) are licensed for monitoring purposes. It is noted that borehole GW040592 is located about 1.3 km from the Project area, and falls outside of the extent of **Figure 9-5**.

Table 9-7 Registered groundwater users near the Project area

Bore number	Licensed	Depth (mbgs)	Construction type	Use	Approx. distance (m) from Project area	Owner type
GW040592	No	3.0	Excavation	Unknown	1,300	Unknown
GW047147	No	14.0	Supply Bore	Recreational	350	Private
GW105056	No	79.2	Bore	Test bore for industrial purposes	480	Unknown
GW112420	Yes (10BL604910)	3.5	Bore	Monitoring	860	Private
GW112913	Yes (10BL604155)	16.0	Bore	Monitoring	1,240	Local Government
GW112914	No	16.1	Bore	Monitoring	1,220	Local Government
GW112915	No	20.5	Bore	Monitoring	1,280	Local Government
GW112916	No	11.5	Bore	Monitoring	1,300	Local Government
GW112917	No	5.0	Bore	Monitoring	1,260	Local Government

FIGURE 9-5: REGISTERED GROUNDWATER BORES NEAR THE STUDY AREA

N 0 200 400 m

AECOM

Legend
Project area
Temporary project area for construction
Registered groundwater bore

Source: Nearmap, 2019

\\ausyd1fp001\Projects\605X\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR006_03_A4L_F3-9_RegisteredGWBores_210108.mxd Date Saved: 8/01/2021

9.2.7 Groundwater dependent ecosystems

GDEs are ecosystems whose current species composition, structure and function are reliant on a supply of groundwater as opposed to surface water. GDE's are typically found in low-lying areas where the depth to the water table is consistently minimal (e.g. wetlands). These areas may include diverse communities of plants, animals and other organisms whose extent and life processes depend on groundwater.

The GDE assessment for the Project (refer **Appendix H** (Biodiversity Assessment Report) found that wetlands that may have some dependency on groundwater have been observed and mapped near the Project area as shown on **Figure 9-6** (ELA, 2020). There are two vegetation communities with a high potential for groundwater dependence, and two aquatic ecosystems likely to be fed by groundwater in the Project area. These include the following and are shown on **Figure 9-6** and **Figure 9-7** as follows:

- Coastal Sand Forest (**Figure 9-7**);
- Coastal Scrub and Beach Strand; (**Figure 9-7**)
- freshwater wetland east of the STP (**Figure 9-6**); and
- Merimbula Lake (named coastal lagoon) and coastal wetland vegetation (**Figure 9-7**).

In addition to Merimbula Lake, Coastal Wetlands mapping under the *State Environmental Planning Policy (Coastal Management) 2018* shows another wetland in the back-dunes of Merimbula Beach and extending south from the Project area. This wetland is not mapped as being groundwater dependent on the GDE Atlas but has potential to be given the shallow groundwater table in the area. The water table beneath this wetland is close to the surface because it is topographically low and close to the clay deposits with low hydraulic conductivity, and sand deposits with high hydraulic conductivity (AECOM 2020). Groundwater levels fluctuate by about 0.5 m in response to seasonal rainfall recharge (**Table 9-5**).

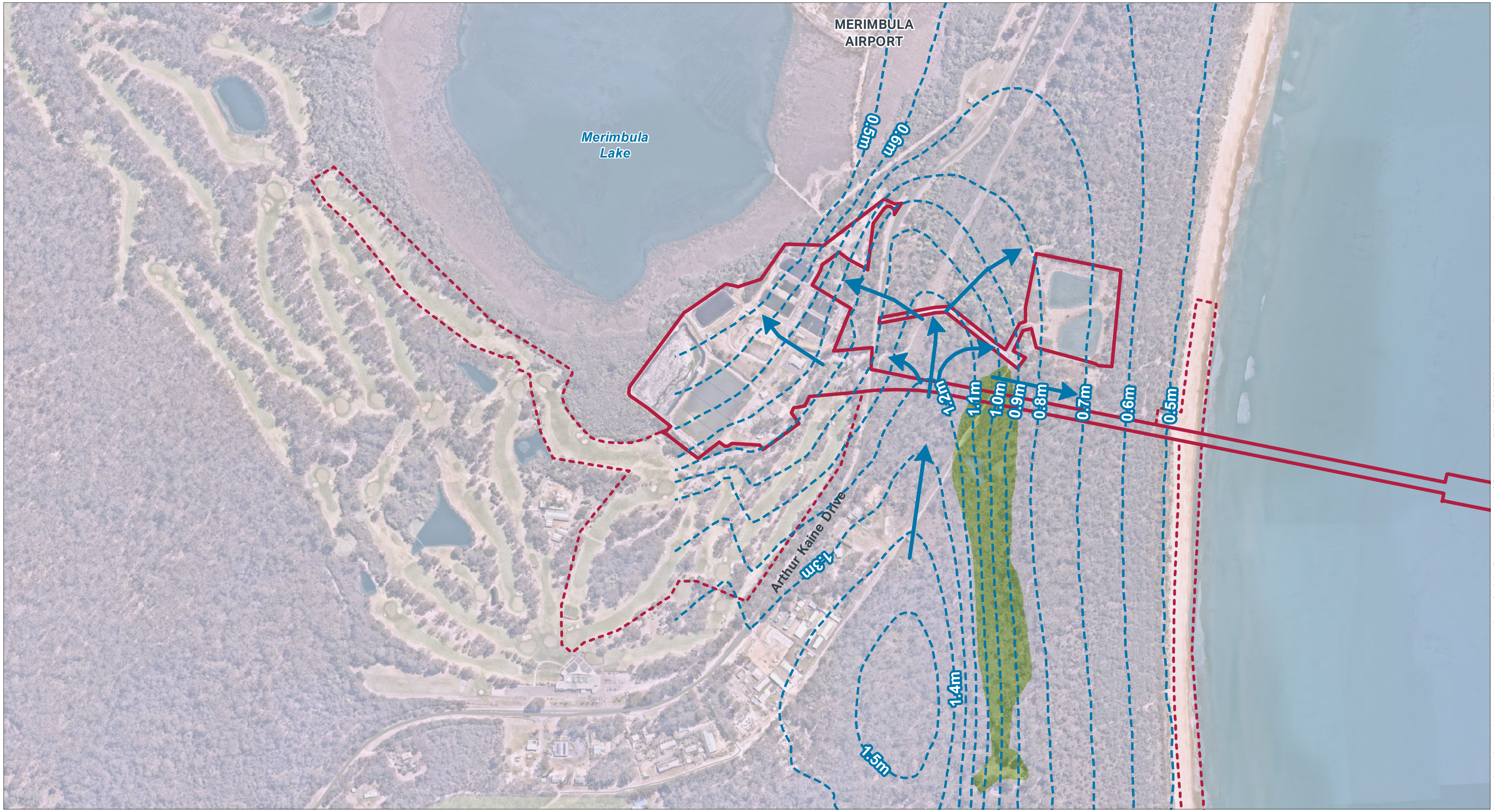

FIGURE 9-6: MAPPED GROUNDWATER DEPENDENT WETLANDS

Legend

- Project area
- Temporary project area for construction
- Wetlands
- Groundwater level contours normal conditions (after IGGC, 2013)
- Inferred groundwater flow

N

0 200 400 m

AECOM

Source: Nearmap, 2019, Bureau of Meteorology GDE Atlas

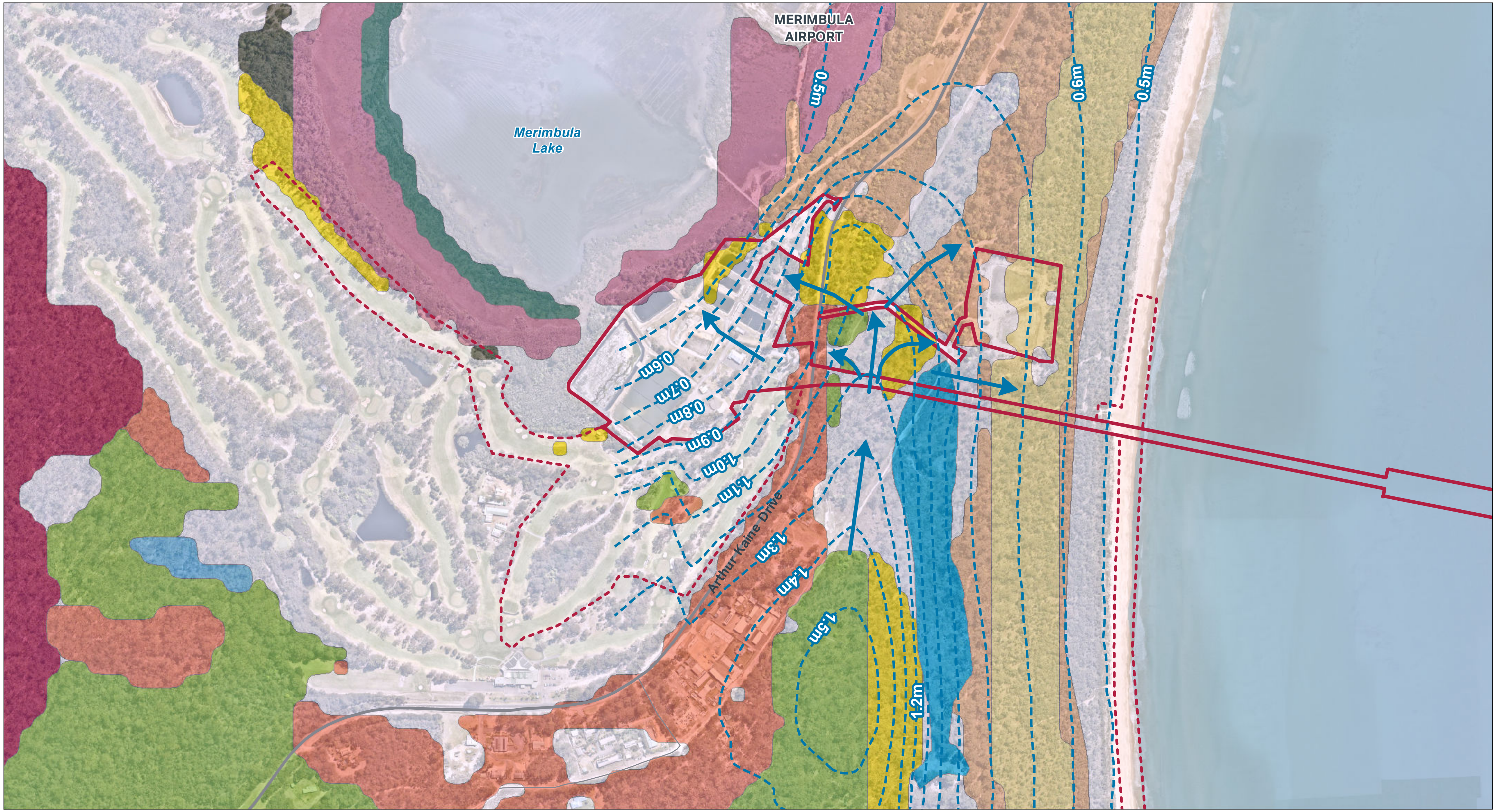

FIGURE 9-7: MAPPED GROUNDWATER DEPENDENT ECOSYSTEMS

Legend

- Project area
- Temporary Project area for construction
- Groundwater level contours normal conditions (after IGGC, 2013)
- Inferred groundwater flow
- Mapped wetlands
- Coastal Scrub & Beach Strand
- Estuarine Saltmarsh
- Far South Coast Grassy Woodland
- Coastal Sand Forest
- Eden Dry Shrub Forest
- Estuarine Mangrove Forest
- Floodplain Swamp Forest
- Lowland Gully Shrub Forest
- South Coast River Flat Forest
- Southeast Lowland Dry Shrub Forest

N

0 200 400 m

AECOM

Source: Nearmap, 2019, Bureau of Meteorology GDE Atlas

9.2.8 Conceptual hydrogeological model

A conceptual hydrogeological model of the Project area was developed as part of the **Appendix D** (Groundwater Technical report) for the Project, and is shown on **Figure 9-8**. It is based on several key elements, including:

- proposed ocean outfall pipeline route;
- lithologies based on local drillhole logs;
- water table based on the intersection of groundwater level data; and
- groundwater flow directions inferred from local groundwater level data.

The model is a qualitative representation of the hydrogeology and the way groundwater enters, flows through and discharges from the subsurface flow system. The conceptual model was used to identify source, pathway and receptor linkages that were assessed using analytical calculations to assess the severity of any potential groundwater impacts. The main hydrogeological attributes of the groundwater study area that have been established by the conceptual hydrogeological model, are shown on **Figure 9-8**, and include:

- an unconfined aquifer that is hosted by deposits of quartz sand to the east and sand with discontinuous layers of clay and sandy clay;
- the sand and clay deposits in the west are Tertiary sediments that are generally of low hydraulic conductivity while the sand deposits in the east are Quaternary coastal formations that overlap the Tertiary deposits and have high hydraulic conductivity;
- organic material that is present in the Tertiary deposits and under the wetland that may affect the groundwater quality (acidic properties);
- the groundwater divide is close to the wetland between bores 2018_BH07 and A6 (refer **Figure 9-1)** because it is low lying and adjacent to the clayey Tertiary deposits;
- the divide migrates to the east following a high rainfall event due to the higher rates of recharge through the Quaternary sand deposits;
- fresh groundwater accumulating beneath the dunes flows toward Merimbula Beach (east) and Merimbula Lake (west);
- the groundwater profile is stratified and becomes brackish, then saline at depth as observed at geotechnical hole 2018_BH02B (refer **Figure 9-1**);
- saltwater wedges are typically present in coastal settings where there is a density-driven interface between fresh (terrestrial) and saline (marine) groundwater. Groundwater discharges at the beach after riding up the saltwater wedge at higher rates after seasonal wet periods and lower rates otherwise after the water table has flattened; and
- moderately acidic groundwater beneath the wetland disperses into the flow system and is neutralised by the natural groundwater alkalinity yielding near neutral to slightly alkaline conditions where it discharges to the marine environment.

Figure 9-8 does not show the upward hydraulic gradient between sand aquifers deep within the Pambula Paleo-valley and the superficial aquifer. Evidence from deep drilling in the area (Parsons Brinkerhoff, 2004 in IGGC, 2013) indicates the upward gradient may be strong, but due to the presence of thick clayey layers, restricts the overall rate that groundwater discharges to the unconfined aquifer beneath the Project. While the rate of upward flow has not been determined, any fresh water from the deep aquifer would either discharge at the beach (as described previously in **Section 9.2.4**), or offshore where the sand aquifers may outcrop on the sea floor.

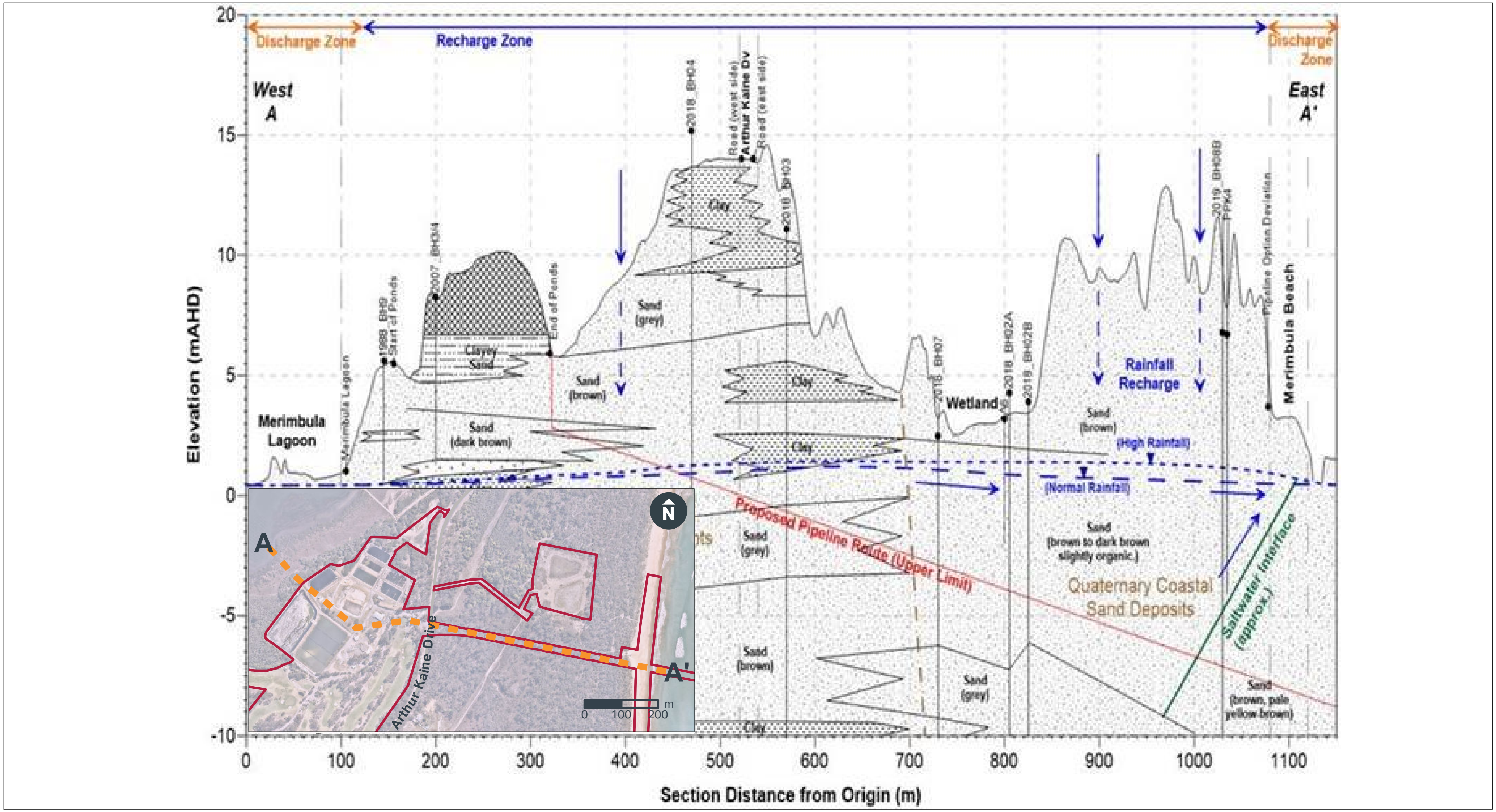

FIGURE 9-8: CONCEPTUAL HYDROGEOLOGICAL MODEL

AECOM

Legend

Project area

Alignment of conceptual model

Source: Nearmap, 2019

9.3 Potential impacts – construction

9.3.1 Background

The underground, terrestrial section of the pipeline (between the STP to Merimbula Beach) would be constructed using a trenchless directional drilling technique (e.g. horizontal directional drilling or direct drive tunnelling). As shown on **Figure 9-8**, the proposed outfall pipeline would intersect the water table about 120 m from its eastern end, it would then pass through grey and brown quartz sand. Some organic material is present in the sand beneath the wetland and it is possible this may also be intersected by the pipeline. Although the exact alignment would be determined during detailed design, the pipeline would also pass through the saltwater interface beneath the coastal dunes, possibly about 100 m west of the beach.

Section one of the pipeline would extend between the STP and an offshore location past the surf zone. The direction of drilling is still to be finalised once detailed investigations have been completed, however it is likely to commence from the STP in the west, drilling towards the beach in the east. To help keep the hole open, the hole would be directed to pass through denser sand deposits where possible. Drilling would start from a launching pit that would remain above the water table, as such dewatering would not be required for the construction of the pipeline. The initial length of the hole could have a collar installed (e.g. of about 50 m to 60 m in length) to stabilise the hole and minimise risks associated with break-out of the drilling fluids. The ultimate drill-path and methodology would be determined during detailed design. The cuttings generated by the drilling process would be flushed from the hole using drilling fluid. This fluid would contain bentonite clay (or similar) mixed to a thick slurry that would also form a layer on the walls of the hole. This clay layer combined with the pressure of the drilling fluid would stabilise the hole and would minimise the potential for exchange of drilling fluid and groundwater. Drilling fluids such as these are commonly used in the water well drilling industry using inert materials. Alternatively, if direct drive tunnelling is used, the pipeline would be inserted as the hole is drilled and is assembled on the surface as the hole progresses. Once in place, a smaller pipe would be inserted in one continuous run. At the temporary laydown area at the beach, a small (approximately 3 m x 5 m) recovery pit would be excavated to connect the pipeline to section two that passes beneath the surf zone.

A water supply would be required to undertake the drilling activities, and for dust suppression during construction. This supply would be obtained from non-groundwater sources (such as reticulated system water or recycled water) that do not pose a risk to groundwater quality. After the pipeline has been installed, the only water that would remain behind would be associated with the drilling mud cake.

Cuttings and drilling fluid removed from the pipeline borehole during drilling would be separated at the drilling rig. The cuttings and fluid would be captured in above ground tanks, and are likely to be recycled by the driller for use in the drilling process. At the end of the process, the fluid and cuttings captured in the tanks would be removed from site and disposed of in accordance with current NSW guidelines (refer **Chapter 26 Waste**). After the pipeline has been installed, the only water that would remain behind would be associated with the drilling mud. Unplanned seepage to the water table would be detected by dedicated groundwater monitoring bores, which is described in **Section 9.5**.

The construction of the Project would also include shallow excavations within the STP site for new pipes, pits and wells, with the deepest excavation proposed being about 3 m in depth. It is also noted that it is possible the excavation of a pipeline recovery pit may be required to connect the land-based portion of the pipeline to section two that passes beneath the surf zone.

9.3.2 Groundwater levels and flow

Groundwater would be intersected during the construction of the outfall pipeline. This proposed activity is considered to be “disturbance” as defined by the WM Act and the NSW AIP for the following reasons:

- it would penetrate the aquifer;
- it would interact with groundwater in the aquifer (to some degree); and
- it may obstruct the flow of water in the aquifer.

Shallow excavations within the STP site for new pipes, pits and wells (up to about 3 m in depth), and at the beach for the possible pipeline recovery pit are not expected to intercept groundwater (refer **Figure 9-8**). It is not anticipated that groundwater would be extracted to supply water or to dewater excavations for any subsurface works associated with the Project.

As shown on **Figure 9-8**, the outfall pipeline is expected to pass below the water table by at least 5 m to 10 m (8 m to 20 mbgs) (depending on the final design). Drilling into the aquifer would have the potential to alter its hydraulic characteristics. As described in **Section 9-9**, groundwater flows through the superficial aquifer in response to the rate of recharge and hydraulic conductivity. The Project would not alter the rate that rainfall would recharge the aquifer since the pipeline does not require disturbance at the surface where it passes under the high recharge zone across the sand dunes, nor would it introduce any substantial area of paved surface that would prohibit or significantly redirect recharge waters.

As described in **Section 9.3.1**, the directional drilling is likely to use a collar during the initial hole drilling, and drilling fluids to stabilise the hole to minimise interaction with groundwater in the aquifer. If drilling fluid does not contain enough of the components required to form a wall cake or should the physical characteristics of the drilling fluid (density, viscosity) or chemical characteristics (pH, salinity etc.) not be maintained, it is possible the drilling fluid could disperse into the aquifer. Where drilling fluid escapes, it can clog and reduce the hydraulic conductivity of the aquifer or alter the quality of groundwater (pH and possibly the salinity) nearby. The distance fluid can disperse within an aquifer depends on its permeability and the time taken to introduce loss-circulation materials (cellulose/polymers) to the drilling fluid.

The potential for this impact to result would be minimised by engaging a drilling fluid engineer who would be responsible for maintaining the physical and chemical attributes of the drilling fluid while the hole is being drilled. The drilling fluid engineer would undertake this work in accordance with a drilling fluid management plan, which would be developed for the Project by the drilling contractors.

As the fluid is recirculated from the drill bit to the surface (carrying cuttings with it) the drilling fluid engineer would closely monitor the properties of the slurry and add one or more products to maintain the volume (as more mud is required to replace the cuttings removed) and physical and chemical characteristics if the formation or groundwater cause it to be altered.

The drilling fluid/wall cake remains would remain in place after the pipeline is installed. The small gap between the natural formation and pipeline, including the residual wall cake, would close around the pipeline adding an additional protective, low-permeability shroud around the pipeline. The total disturbance to the aquifer from the drilling fluid is expected to be the pipeline diameter plus a few tens of centimetres around it.

As a result of the proposed construction technique for the installation of the outfall pipeline, the risk to the aquifer, the groundwater it contains, its characteristics that define levels and flow, and existing users during the construction of the Project would be low. To further limit the potential for drilling fluids to affect the quality of groundwater, a groundwater level and quality monitoring program would be implemented during the construction of the Project. This management measure is provided in **Section 9.5**.

9.3.3 Groundwater quality

The products selected for mixing the drilling fluid slurry would be inert (such as bentonite clay) or biodegradable (such as biopolymers or xanthan gum), many of which are certified for use in aquifers containing potable quality groundwater.

Risks to the quality of groundwater are anticipated to be linked to the selection of drilling fluid additives and the successful implementation of the drilling program. Impacts to the quality of groundwater that would be intersected by the construction of the pipeline would be minimised by maintaining the physical and chemical properties of the drilling fluid throughout the construction phase of the pipeline. As discussed above a drilling fluid engineer would be present for duration of these works, in accordance with the drilling fluid management plan.

It would also be important to minimise interaction between groundwater and the drilling fluid and cuttings stored at the rig site near the launching pit. The excess fluid would be stored in a tank to avoid seepage to the water table and disposed offsite (refer **Chapter 19 Waste**).

The construction of the Project would employ the following standard design features and mitigation and management measures:

- incorporating features into the final design that avoid disturbance of the aquifer and groundwater wherever practicable, as described in **Section 9.3.1**;
- avoiding the use of potentially harmful substances where practicable, including the use of ecologically harmless drilling fluid compositions;
- placing barriers between the source(s) of contamination and the water table;
- handling potentially contaminating substances such as fuels, hydraulic oils and caustic (drilling mud additive) in accordance with relevant regulations; and
- developing and implementing an adequate spill response plan that complies with relevant regulations.

With the implementation of the design features and mitigation and management measures described above, the risk of groundwater contamination due to accidental spills and leaks during the construction would be low. Changes in the groundwater quality that would lower the beneficial uses of the groundwater underlying the Project (including for groundwater dependent ecosystems, as discussed below) are not anticipated.

9.3.4 Groundwater dependent ecosystems

Groundwater dependent ecosystems occur in proximity to the Project. The proposed trenchless method of constructing the ocean outfall pipeline would allow the Project to avoid physical disturbance of groundwater dependent ecosystems as the pipeline would be at least 5 m below the surface at this location.

Interaction between the construction activities and overlying wetlands is unlikely if the drilling fluid is maintained in accordance with the drilling fluid management plan. As described in **Section 9.3.3**, the drilling fluid would create a low-permeability barrier between the fluid in the hole and the aquifer. Positive pressures in the hole maintain the stability of the hole walls and mud-cake, which is only required until the continuous carrier pipe is inserted in the hole and the aquifer is sealed off. While there may be a slight change in the hydraulic pressures (and small exchange of water until the mud cake is formed) near the open section of the hole, these would dissipate quickly in the sand aquifer, which is very transmissive (IGGC, 2013).

The risk of seepage and water table mounding are likely to be minimal, if the drilling technique used allows for the active drilling face (open hole ahead of the conveyor pipe) to be only several metres long. Using the horizontal directional drilling method, this would be smaller again as a result of the wall-cake lining the open hole wall. Following this, the hole would be held open by the drilling mud. Conservatively, any changes to the water table from the fluid-drilling process are expected to be in the order of centimetres. Once it is sealed-off, the water table would return to background levels quickly (days to weeks) because of the permeable nature of the coastal sand aquifer. Groundwater mapping along the pipeline (**Figure 9-8**) indicates the depth to water during a high rainfall period (reasonable worst-case conditions) is about 1.1 m below ground surface and fluctuates by about 0.5 m seasonally (**Table 9-5**). Short-term changes in the order of centimetres from drilling is insignificant in this context.

The risks of significant changes to the water table elevation and quality of groundwater that supports the wetlands and groundwater dependent ecosystems due to drilling are considered to be low. Further details regarding groundwater dependant ecosystems relative to the Project are provided in **Chapter 12 Terrestrial ecology** and **Appendix H** (Groundwater Dependent Ecosystem Assessment)

9.4 Potential impacts – operation

9.4.1 Background

As indicated on **Figure 9-8**, the proposed outfall pipeline would intersect the water table. Section one (the landward section) of the outfall pipeline would pass through clayey Tertiary sediments for approximately the first 380 m and then Quaternary coastal sand deposits for the remaining 400 m.

Wastewater treatment upgrades at the STP would not interfere with groundwater during operation.

9.4.2 Groundwater levels and flow

As described in **Section 9.2.4**, groundwater levels at the Project area are reflective of the hydraulic gradient conditions in the groundwater study area, which are dependent on the transmissivity of the aquifer and the recharge rate. The rate of groundwater recharge is not anticipated to change as a result of the operation of the Project given the operational outfall pipeline would not result in or require disturbance at the surface where it passes under the high recharge zone across the sand dunes, and as the Project would not introduce any substantial new area of paved surface that would prohibit or significantly redirect recharge waters. For this reason, the operation of the Project would only result in changes to groundwater levels if the transmissivity of the aquifer were to be significantly altered by the presence of the outfall pipeline.

The proposed outfall pipeline would cross the groundwater divide, which runs roughly perpendicular to the pipeline along the peninsula (as shown on **Figure 9-8)**. The cross-sectional area of the pipeline is small (approximately 1 m^2). Where the pipeline would be positioned in the direction of groundwater flow (either side of the divide), the presence of the pipeline would not measurably change the aquifer hydraulics or direction of groundwater flow. The change in transmissivity (aquifer thickness x hydraulic conductivity) for a 1 m^2 area, would be calculated as close to zero and, therefore insignificant. This demonstrates that where the pipeline would be positioned in the direction of groundwater flow, groundwater would simply flow alongside the pipeline.

Where the pipeline passes across the divide, groundwater would flow across the pipeline route. In this orientation, the pipeline would present a partial barrier to groundwater flow for about 50 m of its length. The impact of this on groundwater flow has been assessed by the change in transmissivity to the aquifer in relation to the hydraulic gradient in that area, considering the following:

- this analysis is based on the arrangement shown conceptually on **Figure 9-9**;
- given the pipeline would be impermeable, then changes in transmissivity can be considered in terms of the proportion of the pipeline diameter relative to the aquifer thickness;
- geotechnical logs indicate the base of the sand formation where the pipeline passes across the divide ranges between -9.3 m and -19.5 m AHD (AECOM, 2020). This gives rise to an average aquifer transmissivity ranging from 416 m^2/d to 693 m^2/d (IGGC, 2013);
- based on data from the recent geotechnical drilling programme, the saturated thickness of the aquifer the pipeline is passing through (in the divide area) is between 10.5 m and 20.6 m (**Table 9-8**), or between 9.5% and 4.8% of the aquifer (AECOM, 2020); and
- using a worst-case scenario approach, the smaller aquifer thickness of 10.5 m has been adopted for this analysis.

Table 9-8 Superficial sand aquifer properties

Hole*	Water table elevation (m AHD)**	Base of sand (m AHD)	Submerged thickness (m)	Estimated transmissivity (m^2/d)***	
				K = 30	K = 50
2018_BH02A	0.9	-11.7	12.6	378	630
2018_BH02B	0.8	-13.6	14.4	432	720
2018_BH03	**1.2**	**-9.3**	**10.5**	**315**	525
2018_BH07	1.1	-19.5	20.6	618	1030
2019_BH08B	0.5	-10.7	11.2	336	560
Averages	0.9	-13.0	13.9	416	693

Notes:
* Geotechnical holes are illustrated on Figure 9-1
** Water table interpolated from regional contours
*** Transmissivity calculated from submerged thickness x hydraulic conductivity (K = 30 m/d to 50 m/d - **Section 9.2.3**).

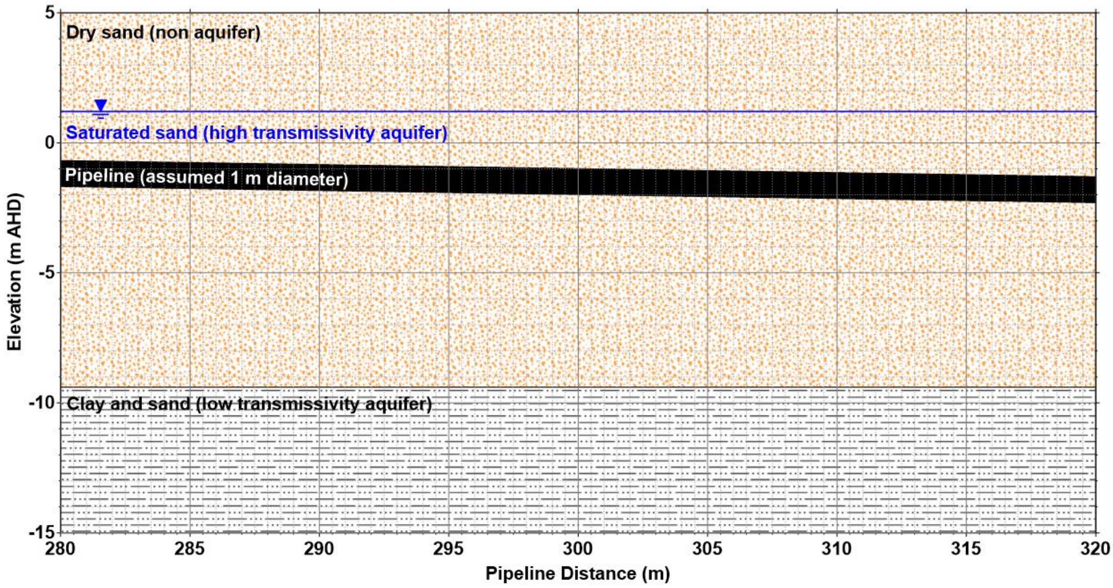

Figure 9-9 Conceptual model for pipeline flow-impedance analysis

Based on the groundwater contours (**Figure 9-2**) the gradient across the proposed outfall pipeline route is 0.00067 (unitless). Under existing conditions, the rate of groundwater flow (Q) can be estimated using Darcy's Law (a formula commonly used to describe the movement of water through an aquifer), as follows:

Q = KiA

where: K = hydraulic conductivity

i = hydraulic gradient, and

A = cross-sectional area.

Since transmissivity **(T) = *K x aquifer thickness***, we can assume (for a one metre section width) that for each cross-sectional metre (width):

Q = T x i.

Using the smallest transmissivity from 2018_BH03 and 2018_BH07 of 315 m^2/d (from **Table 9-8**), the rate of groundwater flow under existing conditions is conservatively estimated to be about 0.21 m^3/d per cross-sectional metre width, or 10.5 m^3/d across the 50 m of pipeline.

As indicated on **Figure 9-10**, a reduction of the transmissivity of up to 9.5% has been estimated, and under worst case conditions it may reduce the throughflow by 0.9 m^3/d to about 9.6 m^3/d.

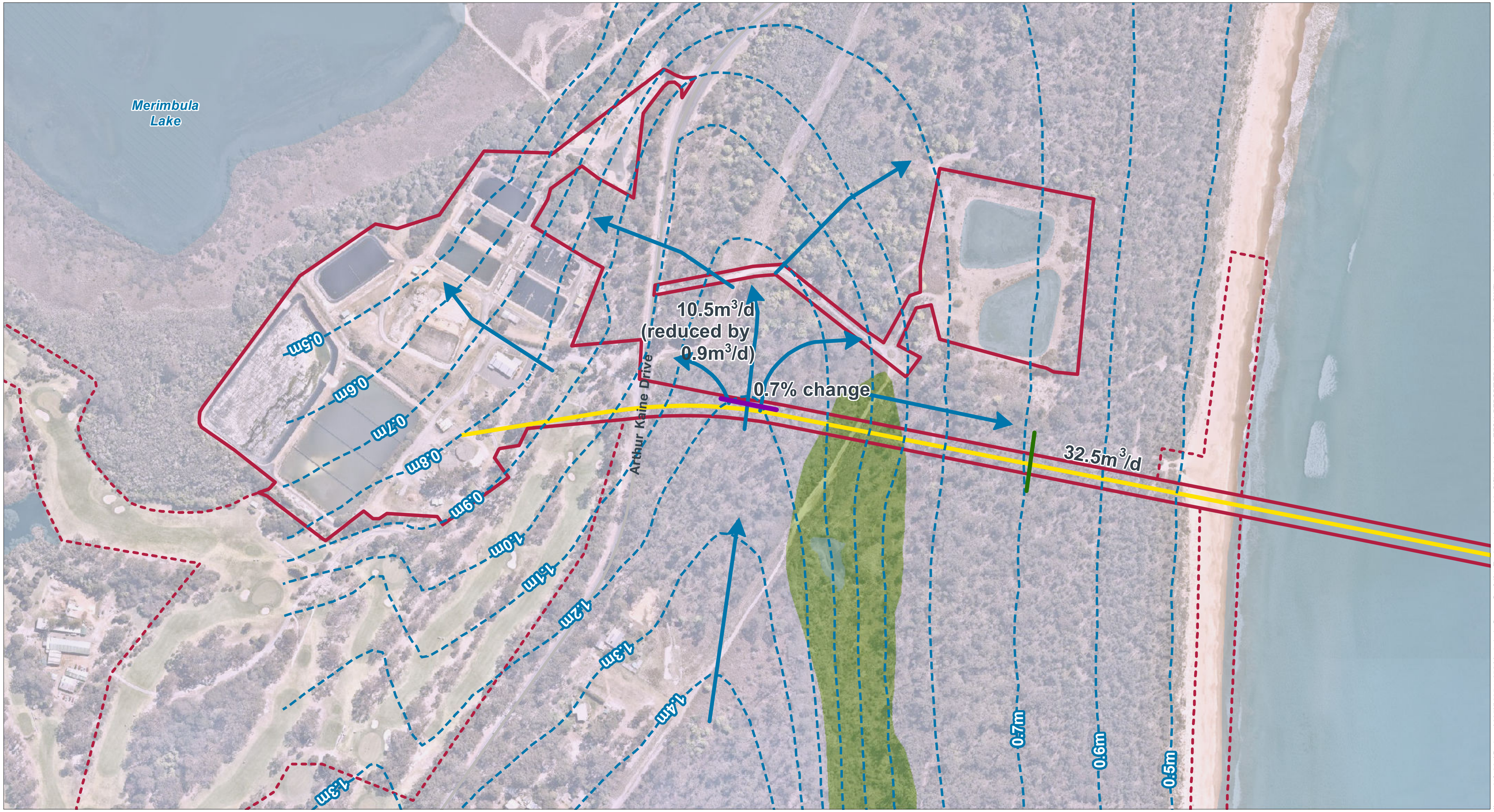

FIGURE 9-10: PREDICTED CHANGES TO GROUNDWATER FLOW DUE TO OCEAN OUTFALL PIPELINE

Legend

- Project area
- Temporary project area for construction
- Wetlands
- Pipeline
- Groundwater level contours normal conditions (After IGGC, 2013)
- Inferred change to groundwater flow

N

0 100 200 m

AECOM

Source: Nearmap, 2019

For context, the contours suggest the natural rate of flow along the pipeline and across the wetland towards Merimbula Beach would be three times higher at 32.5 m^3/d over a corresponding 50 m width (green line on **Figure 9-10**). In this context, the reduction in throughflow (0.9 m^3/d) represents a change of about 2.8% assuming all the water from the divide flowed east. According to the contours and inferred change to groundwater flow in the area shown on **Figure 9-10**, only about 25% of the groundwater that would pass across this section of pipeline flows under the wetland, meaning the net change to the wetland north of the pipeline is estimated to be about 0.7% (purple line on **Figure 9-10**).

In conclusion, the Groundwater Technical report for the Project found that under reasonable worst-case conditions, in this location, the proposed outfall pipeline is estimated to reduce the flow that passes under the wetland by a small amount only(0.7%), which would be within the range of natural climatic variability (**Section 9.2.1**). This would therefore not be significant, and within the context of seasonal variations of 0.5 m, this change is expected to be largely undetectable.

Given the small magnitude of the predicted change in groundwater flow rates and levels, risks from impacts to off-site receptors during operation, such as the wetland and existing groundwater bore to the south and coastal groundwater discharges are low.

9.4.3 Groundwater quality

The proposed ocean outfall pipeline would be designed and constructed using materials to minimise the risk of leaks of treated wastewater. Any leaks are therefore highly unlikely. In the unlikely instance an unforeseen leak should occur, the wastewater would disperse into the groundwater and migrate east to Merimbula Bay or west to Merimbula Lake depending on where the leak is located (based on groundwater flow conditions, shown on **Figure 9-2**).

Any seepage from an unforeseen leak that is migrating east to Merimbula Bay, would discharge along the beach close to where the pipeline passes under it. Any seepage migrating to the west would be slower in its migration due to the higher clay content in this location. However, based on inferred flow directions, it would pass under the existing facility and eventually discharge to the lake shoreline.

Any impact from seepage on groundwater quality would depend on the severity of the leak. However, it is highly unlikely that a leak of any proportion would alter the quality as much as the existing exfiltration ponds have done, as demonstrated in the groundwater measured at bore 2001_PPK3. It is also unlikely that any leak would impact groundwater quality to a greater extent than the existing outfall (in terms of superficial groundwater quality). Ceasing the use of the exfiltration ponds would likely have a net benefit to the receiving environment over time as treated wastewater would cease to be released from this location into the environment (and subsequently into groundwater) (for example, the source of microbiological activity associated with pathogenic bacteria as measured at bore PPK3 would cease).

Under normal operating conditions, groundwater quality is not expected to be altered by the pipeline or the treated wastewater it would contain. Under a reasonable worst-case scenario involving a significant leak, groundwater is predicted to be locally altered and discharge at the low tide mark across a narrow zone where it would disperse at the beach.

Depending on the method of construction, if a carrier pipe was inserted into the pipeline casing installed during drilling, it is possible that the space between casing and pipe may be affected by seawater if it was not sealed off at the beachside riser. This would only be a potential problem if the casing pipeline degraded and allowed seawater to pass into the coastal sand aquifer. The natural density balance between fresh and saline groundwater would largely keep the seawater in place, meaning significant intrusion of seawater is not expected to occur. The casing would be removed once the carrier pipe has been installed.

Ceasing the use of the exfiltration ponds would likely have a net benefit to the receiving environment over time as treated wastewater would cease to be released to land (and subsequently into groundwater) from this location. There would be a reduction in the nutrient and microbiological loadings to groundwater and discharging to the coastline, and this would also reduce the amount of temporary mounding at times as a result of their operation in the past.

Based on the above, risks to groundwater quality and off-site receptors from the operation of the Project are considered to be low and impacts to beneficial uses (including groundwater dependent ecosystems, as discussed below) are considered unlikely.

9.4.4 Groundwater dependent ecosystems

As discussed in **Section 9.4.2**, the wetland that would overlie the outfall pipeline receives groundwater from local recharge as well as throughflow from the groundwater divide. The importance of local recharge via the coastal sand dunes is reflected by the shift in the location of the divide following above-average seasonal rainfall (**Figure 9-8**).

The Project when operational would not change the rate of aquifer recharge. The rate of throughflow to the wetland from the small area where the pipeline would cross the groundwater flow direction is predicted to change the rate north of the pipeline by only about 0.7%. This reduction would however flow to the wetland south of the pipeline. Both are considered insignificant in terms of the natural seasonal variation and variability in rainfall between years. As such, the pipeline is not anticipated to significantly change the water balance to the wetland.

9.5 Management of impacts

The mitigation and management measures identified to avoid and minimise the identified groundwater impacts are outlined in **Table 9-9,** and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

9.5.1 Performance outcomes

The groundwater performance outcome for the Project are as follows:

- potential impacts to groundwater are minimised and managed during drilling;
- risk of groundwater contamination due to accidental spills and leaks during the construction are managed; and
- groundwater monitoring results during operation are within applicable criteria developed.

The Project would be designed, constructed and operated to achieve these performance outcomes.

9.5.2 Consideration of the interaction between measures

Mitigation and management measures in other chapters that are relevant to the management of potential groundwater impacts include:

- **Chapter 8 Surface water, hydrology and flooding**, specifically mitigation measure SWF1 in regard to a program to monitor potential water quality impacts; and
- **Chapter 12 Terrestrial ecology**, specifically the risk assessment undertaken for impacts to GDEs during construction of the Project.

9.5.3 Mitigation and management measures

Mitigation and management measures to minimise impacts to groundwater from the construction and operation of the pipeline are detailed in **Table 9-9**.

Table 9-9 Mitigation and management measures – Groundwater

No.	Impact	Mitigation and management measures	Timing
GW1	Excessive loss of circulating fluids during drilling affecting water quality.	Potentially adverse impacts to groundwater levels would be minimised by the detailed design of the drill-path and implementation of a drilling fluid management plan which would consider the appropriate design, management and control of the physical and chemical characteristics of the drilling fluid, this plan would be incorporated in the groundwater management plan (discussed in more detail below). The make-up of the drilling fluid would be determined by an appropriately qualified drilling fluid engineer, based on local groundwater and soil	Construction

No.	Impact	Mitigation and management measures	Timing
		geochemistry so that it forms a suitable wall cake thus minimising fluid loss and exchange with local groundwater. Inert or non-contaminating but effective additives for drilling fluids would be used. Any drilling fluid additives used e.g. bentonite clay, xanthan gum and/or biopolymer compounds would be certified for use in potable aquifers (certified to *American National standards Institute (ANSI)/NSF International (NSF) STD 60 Certified well Drilling Aids and well Sealants*). The drilling fluid additives would be closely monitored by the drilling fluid engineer and driller so that it remains chemically stable and volumetrically balanced with the progression of the hole and, if necessary, modified to maintain stability and minimise interaction with the groundwater. The appropriately experienced and qualified drilling fluid engineer would supervise the drilling operations and control the types, rates and volumes of additives should the fluid chemistry be unexpectedly altered by the formation. Drilling would be undertaken by a directional borehole driller who is appropriately trained and experienced with the selected drilling and casing installation technique.	
GW2	Construction impacts to groundwater.	A groundwater monitoring program will be developed and implemented for construction. The groundwater monitoring programme would include appropriate investigations and baseline monitoring during the detailed design phase so that the drilling programme can incorporate contingency measures to minimise impacts to groundwater levels and flow conditions. It will include but not be limited to infill test drilling to determine the physical characteristics (grain size analysis, permeability, organic content) of the materials and quality of groundwater in the aquifer through which the pipeline would pass. Ground water monitoring during construction would consider methods for checking: • that the water table is not significantly mounded indicating drilling fluids are being released to the aquifer; and • that the drilling fluids are not affecting the quality of groundwater in a manner that could lead to a deterioration in the ecological value. To achieve this, groundwater monitoring should be undertaken at existing and new monitoring bores as specified in **Appendix D** (Groundwater Technical report) (refer to Table 4-1 and Figure 14).	Pre-Construction and Construction

No.	Impact	Mitigation and management measures	Timing
GW3	Impacts to groundwater quality	The groundwater monitoring program would include groundwater quality trigger levels which if exceeded would initiate response actions as follows: confirmation, investigation, risk assessment and, if required, a construction method review and/or remediation. The trigger levels should be defined based on the results of baseline monitoring and be selected to identify potentially abnormal changes to groundwater levels and quality.	Construction
GW4	Impacts to groundwater quality, groundwater levels or groundwater flows during operation	The groundwater monitoring program would monitor groundwater levels and groundwater quality in the superficial sand and clayey sand formations at the commencement of the operations phase. The monitoring should be a continuation of the construction groundwater monitoring program. The monitoring program should be developed in consultation with the NSW Environment Protection Authority, NSW Department of Planning Industry and Environment-Water and BVSC. The program should identify groundwater monitoring locations, performance criteria in relation to groundwater levels and groundwater quality and potential remedial actions that would manage or mitigate any non-compliances with performance criteria. The monitoring program should include manual and automatic (using dataloggers) groundwater level monitoring and groundwater quality monitoring from selected monitoring wells intersecting groundwater in the superficial aquifer. The monitoring frequency should be six-monthly for three years or as stated in the conditions of Project approval (refer to **Appendix D** (Groundwater Technical report).	Operation
GW5	Adverse impacts on the local hydrogeological regime due to pipeline leakage	Any operational constraints and compliance criteria should be developed in accordance with ANZG 2018 and with consideration to the relevant NSW Water Quality Objectives. The operational water quality objectives are likely to be set by the local land services of the receiving waters in consultation with the NSW EPA.	Operation

9.5.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for groundwater and is provided in **Table 9-10**.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Table 9-10 Environmental risk analysis with mitigation– Groundwater

Summary of Impact	Construction/operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Excessive loss of circulating fluids during drilling, and groundwater quality adversely affected by drilling operations	Construction	GW1	Minor	Rare	Low
Construction impacts to groundwater, particularly during the construction of the ocean outfall pipeline (drilling operations)	Construction	GW2	Moderate	Unlikely	Medium
Poor water management leading to adverse impacts on the environment	Construction	GW3	Moderate	Rare	Low
Impacts to groundwater quality, groundwater levels or groundwater flows	Operation	GW4	Moderate	Rare	Low
Adverse impacts on the local hydrogeological regime due to pipeline leakage	Operation	GW5	Moderate	Rare	Low

10.0 Marine and coastal processes

This chapter provides a summary of impacts to and from the Project on marine and coastal processes. **Table 10-1** sets out relevant requirements in the Secretary's Environmental Assessment Requirements (SEARs) and where the requirements have been addressed in this Environmental Impact Statement (EIS).

Table 10-1 SEARs

Ref	Assessment requirements	Where addressed in this EIS
1.1	The Proponent must: (e) include results of sampling of sediments (particularly particle size analysis) along the preferred pipeline route to quantify the risk of a sediment plume being created during the construction phase;	Sediment sampling results are described in **Section 10.2** and **Appendix E** (Water Quality Technical report). Potential impacts are described in **Section 10.3** and Section **10.4**.
6.1	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: (a) land identified as a "coastal wetland" under the *State Environmental Planning Policy (SEPP) (Coastal Protection) 2018*; (b) land identified as "proximity area for coastal wetlands" under the SEPP (Coastal Protection) 2018; (c) land within the coastal environment area under the *State Environmental Planning Policy (Coastal Protection) 2018*; (d) land within the coastal use area under the SEPP (Coastal Protection) 2018;	**Section 10.5** and **Table 10-6**. Statutory requirements are also addressed in **Chapter 5 Statutory context**. Ecological values are identified, and potential impacts assessed in **Chapter 12 Terrestrial ecology**.
6.1	(e) land otherwise within the coastal zone;	**Section 10.5** and **Table 10-6**.
6.1	(f) coastal hazards identified in studies completed by local councils or state agencies (including risk mitigation strategies that reduce coastal hazards exposure);	**Section 10.3.2**.
6.1	(g) coastal processes (including dune stability, sediment movement etc.) associated with adopted risk mitigation actions;	**Section 10.3.2**.
6.1	(i) coastal environmental values and natural coastal processes;	**Section 10.3**, **10.5** and **Table 10-6**. Potential marine ecology impacts are addressed in **Chapter 11 Marine ecology**, and terrestrial ecology impacts are described in **Chapter 12 Terrestrial ecology**.
6.1	(n) use of the surf zone.	**Section 10.3, 10.4** and **10.5** (**Table 10-6**).

10.1 Assessment approach

10.1.1 Overview

The assessment in this chapter addresses coastal process and coastal hazard impacts within the *coastal zone* as defined under *State Environmental Planning Policy (Coastal Protection) 2018* (Coastal Management SEPP), including to coastal environmental values and environmentally sensitive land within the coastal zone.

This chapter also provides a summary of the offshore sediment transport impacts associated with the ocean outfall pipeline that is proposed to be laid on the seafloor and covered with a rock or concrete mattress. The pipeline would travel from the STP in an east-south-easterly direction to a location approximately 2.7 km offshore in Merimbula Bay, and would be laid from about -10 m Australian Height Datum (AHD) to the diffuser (its discharge point) at about -30 m AHD. Given that the section of the outfall pipeline that would be laid on the sea floor would begin beyond the active surf zone (after the underground section of the pipeline), where cross-shore morphology occurs in response to waves, the existing submarine morphology is described to understand the expected interactions of the outfall pipeline with morphology, and the expected outcomes.

10.1.2 Legislative context

Section 5 of the *Coastal Management Act 2016* defines the *coastal zone* to mean the area of land comprised of the following coastal management areas:

a. the coastal wetlands and littoral rainforests area;

b. the coastal vulnerability area;

c. the coastal environment area; and

d. the coastal use area.

Parts of the Project would be located within the *coastal zone* (refer **Section 10.1.3**).

State Environmental Planning Policy (Coastal Protection) 2018 (Coastal Management SEPP) adopts these management areas and identifies the specific development controls applying to development requiring consent within each management area (Division 1 to 4), as well as general development controls applying to the coastal zone as a whole (Division 5).

Division 1 of the Coastal Management SEPP (the coastal wetlands and littoral rainforests area), identifies development controls applying to land within ‘coastal wetlands’ and ‘littoral rainforests’ (Division 1, Clause 10), and for land ‘in proximity to coastal wetlands or littoral rainforest’ (Division 1, Clause 11).

Clause 8 of the Coastal Management SEPP refers to the NSW Planning Portal (e-spatial viewer) for the identification of land classified as coastal management areas under the SEPP. Based on mapping provided in the NSW e-spatial viewer (accessed October 2020), parts of the Project are identified to be located on land defined under the SEPP as:

- land in proximity to coastal wetlands (coastal wetland proximity area under the SEPP)- note the Project is not located on any land mapped as ‘coastal wetland’, however a portion of the underground section of the pipeline would travel under an area mapped as coastal wetland, (refer Figure 10-1);
- coastal environment area, and
- coastal use area.

It is noted that the Project area is not located on land mapped as ‘littoral rainforests’. No areas mapped as ‘littoral rainforests’ or land ‘in proximity to littoral rainforest’ occur in the vicinity of the Project area based on a 2 km search area applied.

The e-spatial viewer does not include a mapping layer for the coastal vulnerability area. However, matters identified under the Coastal Management SEPP for this management area (Division 3) have been considered in relation to the Project, where applicable, for completeness (refer **Section 10.3** and **Section 9-24** in **Chapter 9 Groundwater**).

As explained in **Chapter 5 Statutory context**, the Project is designated State Significant Infrastructure (SSI) and does not require development consent under the Coastal Management SEPP. However, consistent with the requirements of the Project SEARs, impacts within the coastal zone have been assessed with consideration to the matters outlined in Division 1 to 5 of the Coastal Management SEPP (refer **Section 10.3**).

10.1.3 Study area

The Project area, Merimbula Beach and Merimbula Bay have been considered as the study area for this assessment (refer **Figure 10-1**).

FIGURE 10-1: MARINE AND COASTAL PROCESSES STUDY AREA

Legend

Project area

Project area (temporary construction area)

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

10.1.4 Assessment approach

A desktop assessment was undertaken which relied on several studies and reports prepared for the Project.

Existing conditions and offshore coastal processes operating within Merimbula Bay were investigated in the following reports:

- *Sea Bed Validation Survey for the Preferred Pipeline Alignment and Diffuser Location North-Short* (Elgin, 2020) – this study was undertaken for the Project to determine sea bed sediment characteristics along the length of the proposed outfall pipeline through sediment sampling;
- *Merimbula Offshore Artificial Reef Coastal Processes Investigation* (Manly Hydraulics Laboratory (MHL) Report MHL2586) (Young, 2017) – a report prepared for the NSW Government to provide reference information on bed forms and sediment characteristics;
- Hydrodynamic modelling using Delft3D for the Merimbula Bay proposed ocean outfall – modelling undertaken by AECOM to define the coastal hydrodynamics, with a particular focus on current speed and direction along the proposed pipeline alignment;
- *Merimbula Bay bathymetry survey* (AECOM, 2018) – a survey undertaken for the Project to reveal scale and orientation of larger bed forms including sand waves, larger scale bed features and reef extent; and
- *The Merimbula Lake and Back Lake Flood Study* (Cardno, 2017) – undertaken to define the current and future flood behaviour of these catchments and establish the basis for subsequent floodplain management activities.

Coastal hazards likely to affect the coastline of the Bega Valley Local Government Area (LGA), including under climate change scenarios, was assessed on behalf of BVSC in 2015 and described in the report: *Bega Valley Shire Coastal Processes and Hazards Definition Study* (BMT WBM, 2015). Key coastal processes and hazards identified in this report have informed the assessment of coastal hazards with respect to the Project.

In addition, other assessments, including specialist technical assessments, have informed this desktop assessment of impacts to environmental values and environmentally sensitive areas within the study area. These include the following:

- **Chapter 8 Surface water and flooding;**
- **Chapter 9 Groundwater;**
- **Chapter 11 Marine ecology** and **Chapter 12 terrestrial ecology;**
- **Chapter 13 Landform, geology and soils;**
- **Chapter 14 Aboriginal heritage** and **Chapter 15 Non-Aboriginal heritage**; and
- **Chapter 25 Climate change risk assessment.**

10.2 Existing environment

10.2.1 Marine sediment characteristics

Based on the Seabed Validation Survey (Elgin, 2020) undertaken for the Project, the seabed along the length of the proposed pipeline alignment is characterised by unconsolidated sandy sediments. Sediment samples were taken within Merimbula Bay at a depth of approximately 30 m (from an area surrounding the proposed outfall pipeline alignment), which had a range of average grain sizes from 140 micrometres (µm) to 820 µm. Transect photos from both the *Merimbula Offshore Artificial Reef Coastal Processes Investigation* (Young, 2017) and the studies undertaken for this Project reveal that the sea bed material is sorted in the sand ripples and waves, with shell grit typically found in troughs (refer **Figure 10-2**). Therefore, the average grain size of sediment samples vary significantly depending on where a sample was taken. Given the variance, an average grain size of 260 µm (which is the mean sediment size of four samples taken within close proximity to the proposed pipeline alignment) was selected as being representative of sediment grain size in this location. This sediment size corresponds to ‘medium sand’ (Wentworth, 1922).

Figure 10-2 Image of the sea bed at a depth of 22 m – note the sediment size sorting with larger shell grit found in the trough

Sediment descriptions and Particle Size Distribution (PSD) results for sampling sites on or near the proposed ocean outfall pipeline route are also provided in Section 3.2.5 and Annexure D of **Appendix E** (Water Quality Technical report).

Video footage screenshots taken in approximately 28 m depth inside a 500 m radius of the proposed diffuser location illustrate a transition from relatively flat sand ripple areas characterised by fine, medium grain sands to large sand waves characterised by coarser grain sands and shell material (Elgin, 2020). The latter are indicative of a more active hydrodynamic environment along some sections of the ocean outfall pipeline alignment.

For a fluid to begin transporting sediment from rest, the bed shear stress exerted by the fluid must exceed the critical shear stress for initiation of motion. Larger grain sizes resist the shear stress and require higher velocities to initiate motion. The critical near bed orbital velocity required to initiate sediment transport under waves for grain sizes found in the vicinity of the proposed pipeline alignment is presented in **Figure 10-3**. For the adopted grain size of 260 μm, the critical orbital velocity is approximately 0.3 metres per second (m/s).

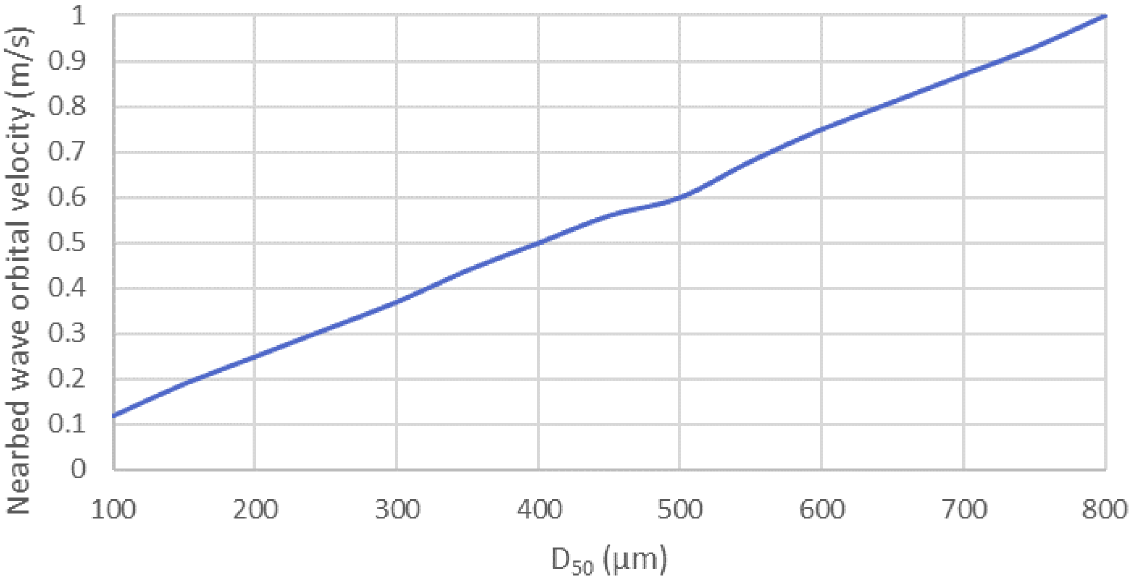

Figure 10-3 Critical near bed velocity required to mobilise sediments for various grain sizes in wave-dominated flow

10.2.2 Hydrodynamics and morphology

From 800 m to 2,700 m offshore the seabed is active, as shown in the images of the seabed (**Figure 10-4** to **Figure 10-7**) where ripples and sand waves indicate active transport under currents or waves. As such when the pipeline is laid on the seabed there is potential for the pipeline to either become buried or undermined by scour. Both of these processes are dependent on how the pipeline would interact with sediment transport. The criteria for sediment transport (mobility) depends on the current- and wave-generated shear stress forces on the seabed exceeding the resisting forces of the sediment. Sediment transport within Merimbula Bay may be initiated by either current-generated forces, wave-generated forces or a combination of both. The following sections investigate the conditions in which sediment becomes mobile for each of these forces.

Figure 10-4 Sand ripples at 20 m water depth (Young, 2017)

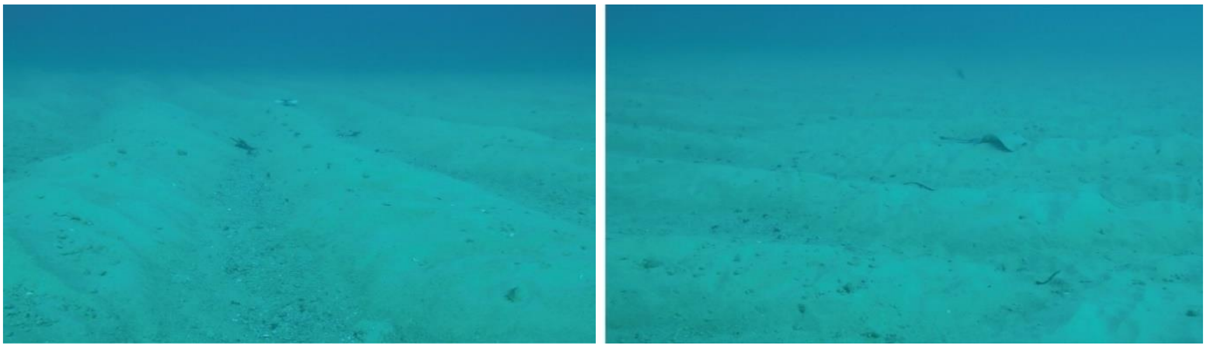

Figure 10-5 Sand waves at Haycock south (south of Project area) with 20 cm secchi disk (left) and stingray (right) at 22 m water depth (Young, 2017)

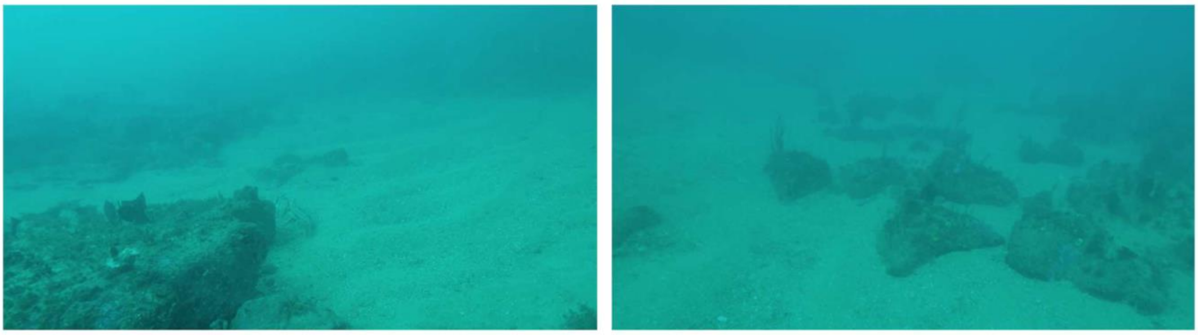

Figure 10-6 Low-profile reef with bedforms in Merimbula Bay, 1,400 m south east of the proposed pipeline alignment, at 34 m water depth (Young, 2017)

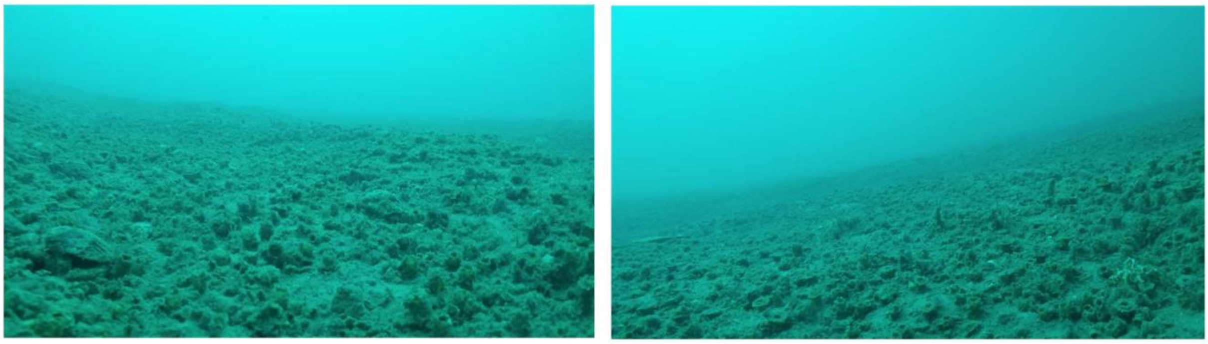

Figure 10-7 Algae covering the seafloor, approximately 1,000 m offshore of the proposed pipeline diffuser location, at 40 m water depth (Young, 2017)

Currents

Large scale ocean currents flow north to south and vice versa off the coast and generate currents inside the bay and over the proposed pipeline alignment. The depth of water in the bay has an impact on the relationship between the near bed velocities and the depth averaged currents. In deeper water the overall current required to mobilise the bed is greater than in shallow water. The relationship between water depth and depth-averaged current to mobilise the 260 µm sand particles is presented in **Figure 10-8**.

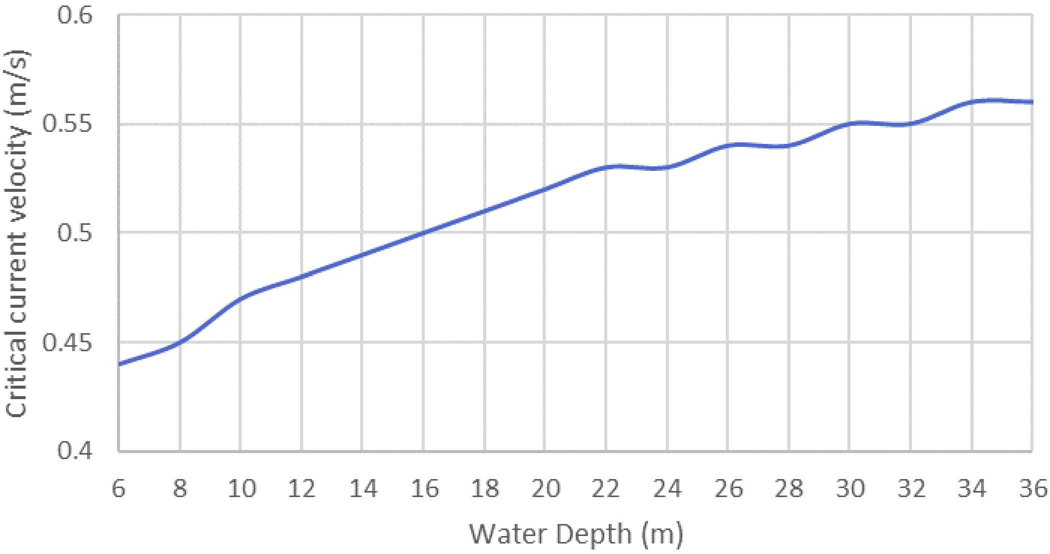

Figure 10-8 Relationship between depth and depth-averaged current to initiate sediment transport for 260 µm sediment size

For the proposed outfall pipeline this translates to critical depth-averaged current speeds to initiate sediment transport of 0.49 m/s at -14 m AHD to 0.55 m/s at -30 m AHD. However, depth average currents measured by a 'mini-Waverider' buoy deployed off Quondolo Beach (south of Haycock Point) during the Merimbula field data collection exercise (Young, 2017) revealed that measured currents nearer to shore were less than 0.3 m/s, despite currents offshore being much stronger.

Hydrodynamic modelling for the proposed outfall pipeline was undertaken by AECOM in 2019, using a range of data sources for calibration and validation to assess impacts. The model extent included the entirety of the study area as seen in **Figure 10-1**. The modelling found regional currents, offshore from Merimbula (Haycock Point), comprise sustained southerly currents approximately 80% of the time, while weaker northerly currents also occur.

Currents within the Merimbula embayment were also observed to be quite different in both speed and direction to those observed offshore. During dominant southerly currents an eddy (a circular current, separate to the predominant current) is formed in the bay with currents near the proposed pipeline alignment directed towards the shore, as seen in **Figure 10-9**.

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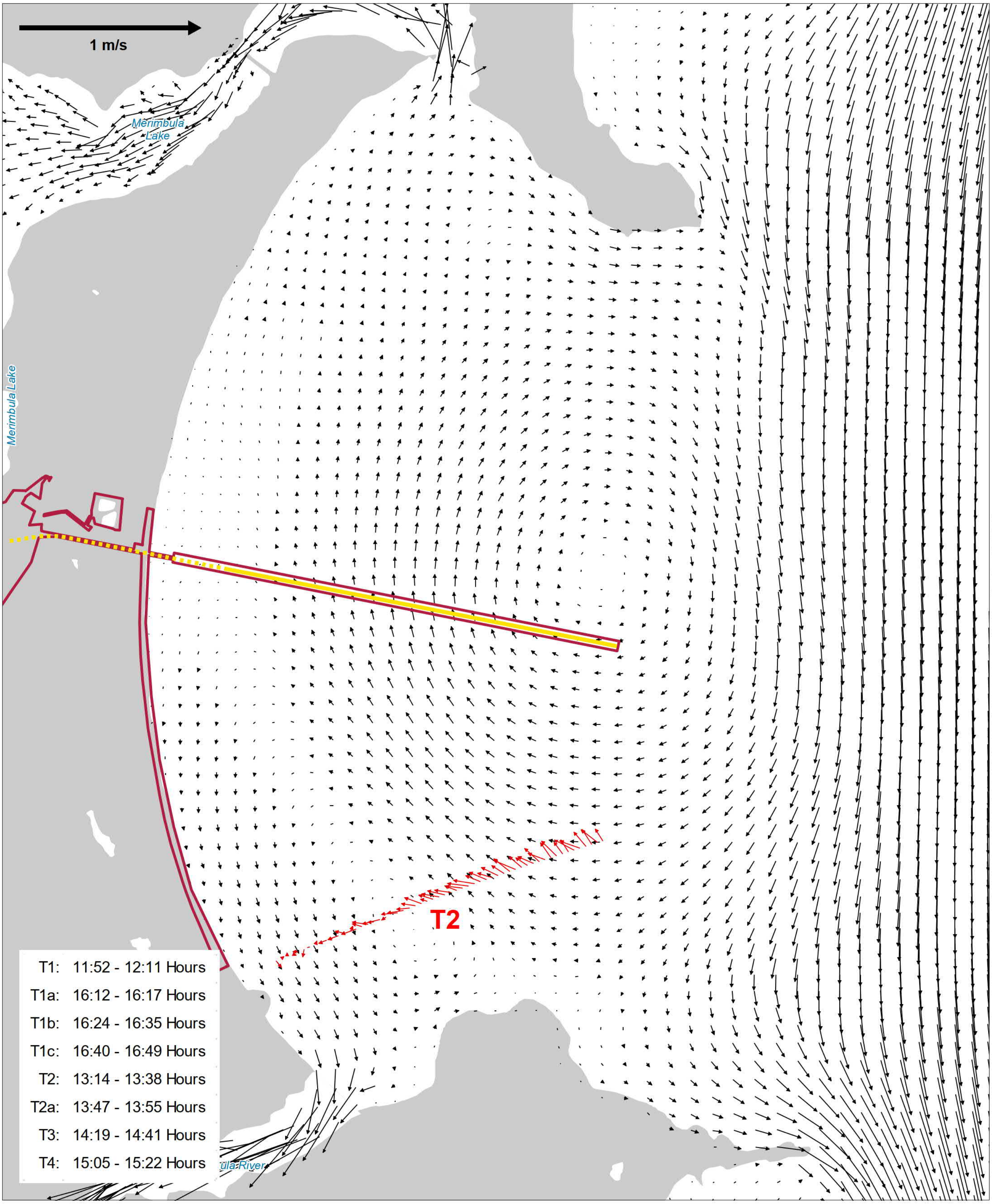

FIGURE 10-9: MERIMBULA HYDRODYNAMIC MODELLING

EVENT 6: 11 JUNE 2015 TIME: 13:30

AECOM

N 0 0.5 1 km

Legend

- Project
- Pipeline (Above Ground)
- Pipeline (Below Ground)
- Model Results
- Measured ADCP, 3 m depth (Every 2nd vector shown)

Exceedance probability analysis of the Haycock Point current data (offshore currents) reveals that for the dominant southerly currents speeds are significantly stronger than the less common northerly currents as shown in **Table 10-2**. As a result, this assessment has focused on the dominant and stronger southerlies.

Table 10-2 Offshore current exceedance (Haycock Point)

Current direction	10% exceedance (m/s)	50% exceedance (m/s)	90% exceedance (m/s)	Extreme (m/s)
Southerly	0.15	0.40	0.56	0.96
Northerly	0.05	0.15	0.34	0.53

The depth-averaged current velocities over the proposed outfall pipeline alignment were obtained from the hydrodynamic modelling. The reduced velocities in the area of interest were found to be approximately 25% of the offshore current speeds. For depth-averaged currents, the critical threshold for sediment mobility increases with depth (**Figure 10-8**). The values reported were used to determine the forecast current speed over the proposed pipeline alignment at depths of 14 m, 22 m and 30 m.

The critical depth-averaged current speed at which sediments initiate motion was also calculated as a function of the grain size and water depth. The workings and outcomes of these equations are provided in detail in **Appendix Q** (Dispersion Modelling Report) and are further summarised in **Appendix E** (Water quality Technical report).

The outcomes of these calculations revealed that the larger southerly currents within the bay generate currents that would not mobilise the bed (refer **Table 10-3**). All other modelled currents similarly had no effect on sediment transport. For ambient conditions, current-generated sediment transport is not likely to occur.

Table 10-3 Current-only sediment transport potential

Deep water current (Haycock Point)	Water depth (m)	Current over outfall pipeline (m/s)	Critical current speed (m/s)	Sediment transport
10% Southerly	14	0.04	0.47	Immobile
10% Southerly	22	0.04	0.52	Immobile
10% Southerly	30	0.04	0.55	Immobile
50% Southerly	14	0.10	0.47	Immobile
50% Southerly	22	0.10	0.52	Immobile
50% Southerly	30	0.10	0.55	Immobile
90% Southerly	14	0.14	0.47	Immobile
90% Southerly	22	0.14	0.52	Immobile
90% Southerly	30	0.14	0.55	Immobile
Extreme Southerly	14	0.24	0.47	Immobile
Extreme Southerly	22	0.24	0.52	Immobile
Extreme Southerly	30	0.24	0.55	Immobile

Although the regional offshore currents examined in the modelling do not drive sediment transport on their own, they are broadly in the same direction as the wave induced orbital velocities and would contribute to the bed morphology in this way.

Waves

Data from Eden (about 6 km to the south) and Batemans Bay (about 100 km to the north) show that the wave climate in the region is dominated by southerly and south-south-east waves (**Figure 10-10**) (Young, 2017). Wave heights offshore form Merimbula are summarised in **Table 10-4**.

Table 10-4 Offshore wave climate

Event	Significant wave height (m)	Wave period (seconds)
90% Exceedance	1.0	8 (6 to 16)
50% Exceedance	1.5	8 (6 to 16)
10% Exceedance	2.5	9 (6 to 16)
2% Exceedance	3.5	10 (8 to 14)
1% Exceedance	4.0	11 (8 to 14)
1 year ARI	5.4	11 (10 to 14)
10 year ARI	7.0	11 (10 to 14)
50 year ARI	8.1	12 (10 to 14)
100 year ARI	8.5	13 (10 to 14)

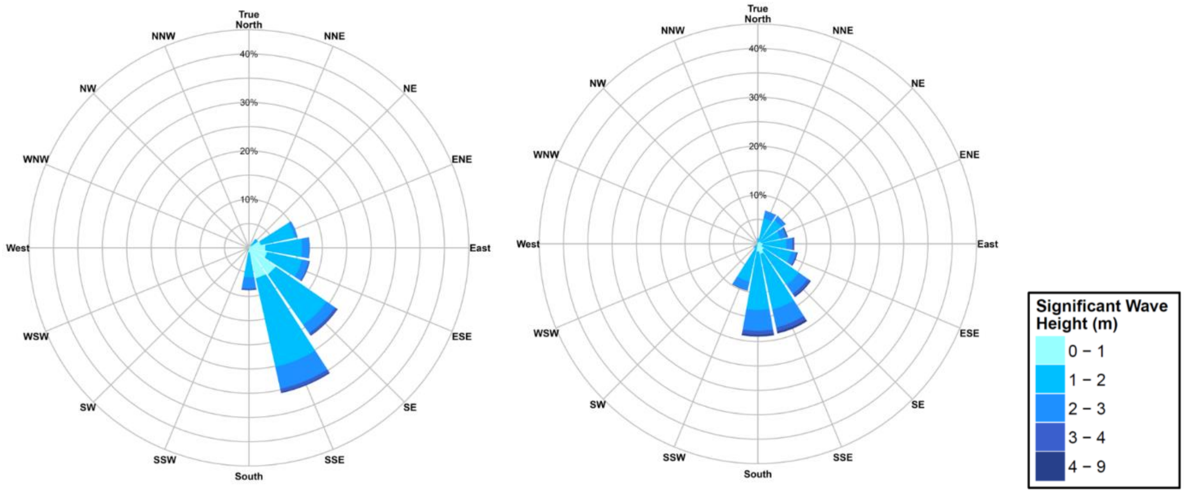

Figure 10-10 Wave roses for Batemans Bay (left) and Eden (right), showing wave height and direction(Young 2017)

Waves approaching from the south diffract around Haycock Point and refract into Merimbula Bay. As the waves move into the bay, they achieve a more shore normal orientated direction, (i.e. orientated in an east to south-easterly direction).

Refracting and diffracting waves dissipate energy, resulting in reduced wave heights. The assessment of waves within Merimbula Bay was based on the analysis of wave heights undertaken for the Merimbula Reef assessment (Young, 2017). Using measured wave heights, the analysis of waves near Haycock Point (in 20 m water depths) revealed that waves were attenuated by approximately one third from offshore to near shore. This results in a reduction coefficient in wave heights from offshore to near shore of 0.67.

Considering the wave attenuation, the wave heights were estimated at the discharge point of the proposed outfall pipeline (i.e. at the diffuser) (refer **Table 10-5**). These values are likely to be conservative as wave attenuation is based on data collected near Haycock Point. Three locations along the proposed pipeline alignment have been used to calculate the peak wave orbital velocity at depths of 14 m, 22 m and 30 m. Results show that sediment is likely to become mobile for the largest wave events at shallower depths. However, for everyday (non-storm) wave conditions, wave-generated sediment transport is not likely to occur. Refer to **Appendix Q** (Dispersion Modelling report) for further detail on methodology used to calculate peak orbital velocity. This information is also summarised in Section 6.1.3 in **Appendix E** (Water Quality Technical report).

Table 10-5 Wave-only sediment transport

Wave event / exceedance	Wave height at outfall (m)	Water depth (m)	Peak orbital velocity, (m/s)	Critical orbital velocity, (m/s)	Sediment transport
90% exceedance	0.67	14	0.11	0.19	Immobile
90% exceedance	0.67	22	0.07	0.19	Immobile
90% exceedance	0.67	30	0.06	0.19	Immobile
50% exceedance	1.01	14	0.16	0.19	Immobile
50% exceedance	1.01	22	0.11	0.19	Immobile
50% exceedance	1.01	30	0.08	0.19	Immobile
10% exceedance	1.68	14	0.28	0.20	**Mobile**
10% exceedance	1.68	22	0.20	0.20	**Mobile**
10% exceedance	1.68	30	0.15	0.20	Immobile
2% exceedance	2.35	14	0.41	0.21	**Mobile**
2% exceedance	2.35	22	0.30	0.21	**Mobile**
2% exceedance	2.35	30	0.23	0.21	**Mobile**
1% exceedance	2.68	14	0.48	0.21	**Mobile**
1% exceedance	2.68	22	0.34	0.21	**Mobile**
1% exceedance	2.68	30	0.27	0.21	**Mobile**
1 year ARI[1]	3.62	14	0.56	0.22	**Mobile**
1 year ARI	3.62	22	0.39	0.22	**Mobile**
1 year ARI	3.62	30	0.32	0.22	**Mobile**

1. ARI- average recurrence interval

Table 10-5 shows that bed sediments are mobilised by waves alone approximately 10% of the time. Due to greater bed shear stresses in shallow water, the frequency of waves mobilising the bed is higher near shore and lower in the deeper water at the proposed diffuser location. The larger, less common, wave events would mobilise the bed significantly along the full length of the pipeline alignment.

Combined current and waves

The wave and current inputs described above were used to calculate the combined bed shear stress of currents and waves on a rippled seabed. The maximum bed shear stress and the mean bed shear stress were calculated for a range of conditions. These applied shear stresses were then compared with the calculated shear stress threshold for mobility (taking into account both currents and waves on a rippled bed) to determine under which conditions sediment mobility occurs.

Exceedance of the threshold by the maximum shear stress indicates that sediments are moving but are only mobilised for short bursts. Exceedance by the mean shear stress would indicate sustained mobility and transport of sediments. **Appendix E** (Water Quality Technical report) provides the methodology used to calculate sheer stresses.

The results for the combined bed shear stresses reveal that the maximum bed shear stress exceeds the threshold for mobility, for events that occur roughly 50% of the time at the shoreward end of where the exposed pipeline would be located (-14 m), decreasing to less than 10% of the time at the diffuser/outfall end of the proposed pipeline (-30 m). However, the mean bed shear stress is significantly below the threshold for motion for all events.

This means that sediments are likely to be mobile for large wave events, increasingly so nearer to shore. This mobility would be linked to passing individual waves that would drag sand up and over the crests of ripples and sand waves. As a result of this sediment movement these bed features would, themselves, slowly move across the seafloor.

Wave induced currents move towards shore under the wave crest and seaward under the trough of the wave. As the waves move into shallower water, they increasingly feel the bottom and shoal. As waves shoal, the crests become progressively peaky while the troughs become longer and flatter, culminating in waves breaking when the depth of water is not enough to sustain the waves passage. This shoaling results in more intense short-lived currents towards the shore and weaker longer lasting currents away from the shore with each passing wave. As the threshold of motion prevents movement under weaker currents, this effect results in a net shoreward migration of sediments under waves. Considering the directionality of the currents and the waves, there would be net sediment transport towards the shore, roughly parallel to the proposed pipeline alignment. The rate of transport would also be greater closer to shore.

Visual observations

Sand ripples and waves

The *Sea Bed Validation Survey(Elgin 2020)* found sand ripples from a depth of 6 m continuing to a depth of 21 m water depth (see **Figure 10-5**). Between the depths of 22 m and 30 m, the bedforms transition between sand ripples and sand waves.

Sand ripples and waves are bedforms generated by agitation of the seabed driven by the unidirectional current flows or oscillating flows under waves:

- Ripples are formed by oscillatory wave currents that drag sediment towards the crest where particles fall over the crest, resulting in steeper slopes (angle of repose) just over the crest on both sides of the ripples. For the study area ripples are formed where the level of sediment transport is higher such as shallower water depths and smaller particle sizes (Soulsby, 1997).
- Sand waves are typically formed by oscillatory flows where sediment is mobilised and moved towards the crest of the bedform, where it is opposed by gravity forces and drag, therefore increasing the deposition at the crest creating symmetrical bedforms with smooth crests. Sand waves occur where the applied bed shear stress is not significantly greater than the critical shear stress, meaning the particles are only just being moved. In the study area this occurs in deeper waters with larger grain sizes (Soulsby, 1997).

The seabed nearer to shore is dominated by ripple formations with bed shear stresses sufficiently large to drive their formation. Sand ripples (**Figure 10-4**) in Merimbula Bay are of the order 1 cm to 5 cm high with equally short wavelengths. From the *Merimbula Offshore Artificial Reef Coastal Processes Investigation* (Young, 2017), it was observed that the sand ripples were less than 10 cm in height.

Further offshore the reduced bed shear stress allows sand wave formations to dominate, especially where sand grain sizes are larger. Sand waves (**Figure 10-5**) are in the order of 20 cm to 30 cm in height with wavelengths of approximate 1 m. The presence of sand waves indicate that sediment is mobilising by orbital velocities (i.e. waves). Previous studies, including *Merimbula Offshore Artificial Reef Coastal Process Investigation* (Young, 2017), have similarly concluded that the sand waves are “indicative of no net sediment transport either onshore or offshore”. The orientation of sand waves is perpendicular to the water motion which aligns with the observed wave and current direction at this location.

Raised Hard Features

The bedforms in **Figure 10-6** reveal intermittent low-profile reef rocks with sand waves in sediments between the rocks. The nature of the sandy bed does not appear to be consistently in a sediment flux (net sediment transport). There is no evidence of sediment depositing around the edges of the reef or on top of the reef, indicating that there is low sediment mobility at this depth (34 m).

Deeper water (limit of sediment transport)

Further offshore the wave induced bed shear drops away to the point that sediment transport becomes so infrequent that algae can colonise the surface. In **Figure 10-7** turfing algae is apparent across the seafloor, leaving a flat bathymetry. In these deeper waters there is effectively no sediment transport occurring, with the coverage of algae inhibiting movement even when waves are sufficiently large to initiate transport on exposed sand.

Large scale features

The *Merimbula Bay bathymetry survey* (AECOM, 2018) (**Figure 10-11**) reveals large scale bedforms inconsistent with sand waves or ripples along the proposed pipeline alignment. In section view (**Figure 10-11**) these features are seen in the bed as relatively steep steps 0.5 m to 1.0 m high with lengths between them of hundreds of metres. No definitive data is available to determine the mechanisms which may have initiated formation of these features. However, based on observation of their shape and locations, a plausible explanation is that they are caused by flow concentration, possibly related to hard bathymetric features (reefs and headlands). This results in subtle changes in the bed shear and subsequently morphology, leading to these features developing over time.

A closer examination of one of the features in the vicinity of the proposed diffuser location reveals a step approximately 0.5m high near the end of the ocean outfall pipeline alignment and a series of smaller sand waves approximately 10 m to 20 m long. These features are generally too subtle to be identified in the limited images of the seafloor.

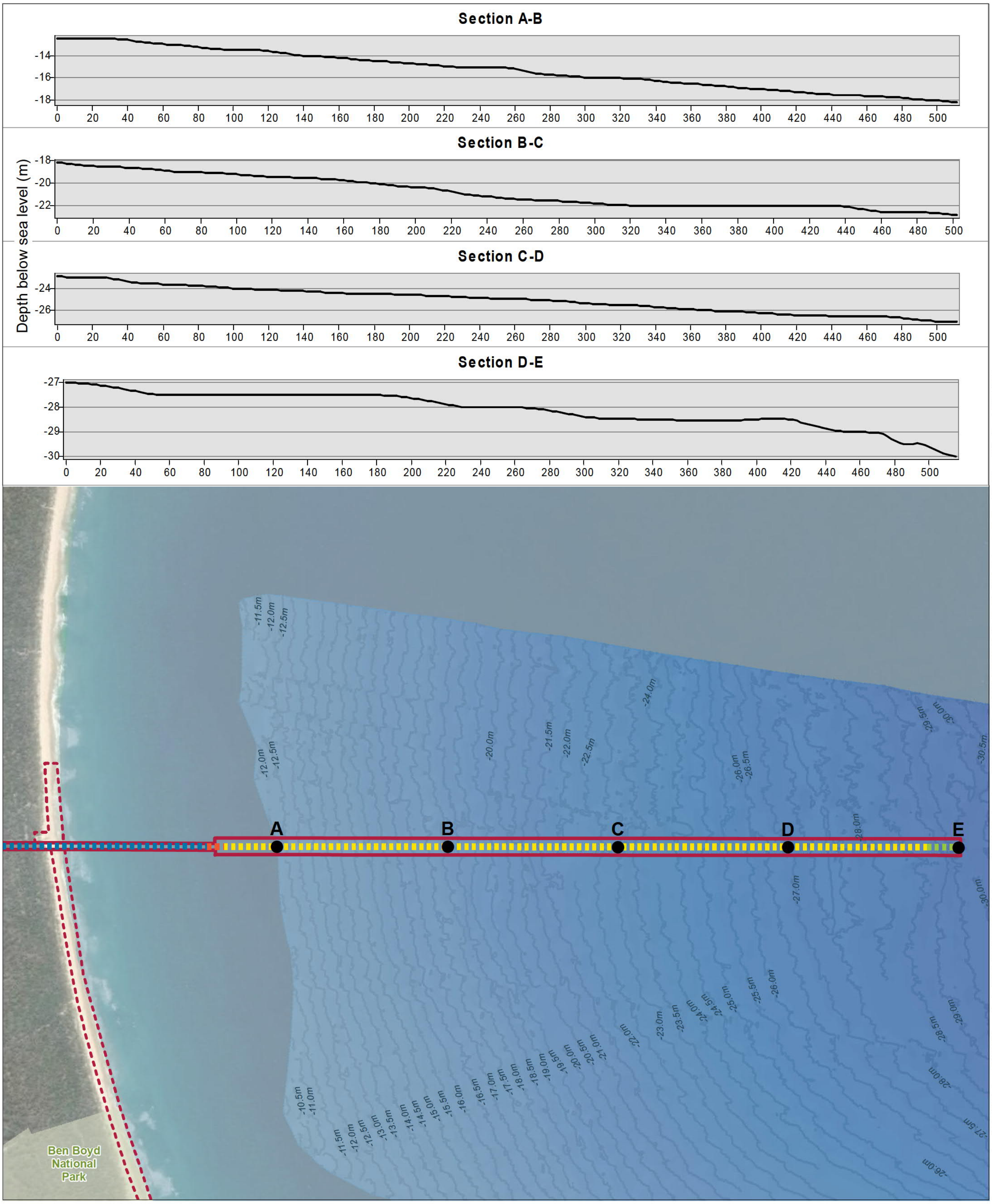

FIGURE 10-11: SEAFLOOR PROFILE ALONG PIPELINE

N

0 250 500 m

AECOM

Legend

- Project area
- Temporary project area for construction
- Outfall pipeline – Section 1 (below ground)
- Transition Zone
- Outfall pipeline – Section 2 (above seafloor)
- Diffuser (above seafloor)

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

10.2.3 Coastal hazards and processes

The *Bega Valley Shire Coastal Processes and Hazards Definition Study* (BMT WBM, 2015) provides that coastal hazards arise where coastal processes interact with use and development of coastal land and assets, or where human development has impeded natural coastal processes. The major coastal hazards identified in the report comprise:

Coastal erosion hazard

- beach erosion: resulting from storms and associated dune slope instability;
- shoreline variability: relating to short to medium term variations in wave climate or sediment distribution beach rotation; and
- long term recession: relating to persistent sediment deficits and potential sea level rise in the future.

Coastal inundation hazard

- coastal inundation: associated with high tides, storms, wave run-up and sea level rise that may overtop coastal barriers and inundate low lying land adjacent to estuaries or coastal lagoons.

Entrance instability

- coastal entrance instability: and effects on immediately adjacent shorelines; and
- sand drift.

Based on an analysis of prevailing coastal processes, the report identified the key coastal hazards to the Merimbula Coast (including North Tura Beach, Tura Beach, Short Point Beach, Middle Beach, Merimbula Beach, Pambula Beach and Jiguma Beach). These are as follows:

Coastal erosion hazard

Merimbula Bay is subject to coastal erosion, with the principal mechanisms for coastal erosion within the Merimbula Coast district including:

- short term ‘storm bite’ erosion (during storms, increased wave heights and elevated water levels cause sand to be eroded from the upper beach/dune system (above 0 m AHD), which is often termed ‘storm bite’). Storm bite of 80 m^3/m (almost certain) up to 100 m^3/m (unlikely) were identified for Merimbula Beach;
- short to medium term fluctuations due to entrance dynamics following flood events (which have small impacts on the central section of Merimbula Beach); and
- long term shoreline recession due to underlying erosion trends and sea level rise. The *Bega Valley Shire Coastal Processes and Hazards Definition Study* (BMT WBM, 2015) found that the beaches of Merimbula Bay are exhibiting a moderate ongoing loss of beach sand and therefore a future long term retreat of this section of coast is likely. It predicted:
    - long term recession due to underlying erosion trends of between 0.1 m per year and 0.2 m per year (5 m to 10 m by 2070) for Merimbula Beach and
    - long term recession due to sea level rise of 9 m to 13 m by 2050, and 28 m to 33 m by 2100, assuming an applicable sea level rise of 0.84 m.

Coastal inundation hazard

Coastal inundation hazards identified for Merimbula Bay, included:

- wave run-up and overtopping: along Pambula Beach and Merimbula Beach, design run-up levels were calculated to be approximately 5.3 m AHD during a 100 year ARI storm event, with somewhat lower levels at the northern end of Merimbula Beach, at Long Point. Dune elevations along the southern part of Pambula Beach are typically at or below 5.5 m AHD, indicating that those areas may experience overtopping during infrequent storm events at present. It is likely that those areas would experience enhanced wave run-up and overtopping in the future as sea level rises. Along the other parts of Merimbula Coast beaches, the dune system is generally sufficiently high to accommodate wave run-up without direct inundation from the sea, with the exception of areas at and adjacent to the entrance of Back Lake; and

- estuary storm tide inundation (at Merimbula Lake at the north of Merimbula Bay and Pambula River at the south of Merimbula Bay). For Merimbula Lake Estuary, coastal inundation levels of 1.73 m AHD ('almost certain' case) to 2.14 m AHD ("unlikely" case) were predicted under the present-day scenario rising up to 2.01 m AHD to 2.98 m AHD in the future scenario (2100 with sea level rise).

Entrance instability

Entrance instability was identified as a hazard, with morphology of the entrance influencing both the tidal exchange and sand budgets on the adjacent beaches. The entrance of Merimbula Lake and Pambula River are governed by bedrock associated with the adjacent headlands, which results in tidal flow velocities through the entrances that, combined with fluvial discharges are large enough to prevent its closure. However, the *Bega Valley Shire Coastal Processes and Hazards Definition Study* (BMT WBM, 2015) indicated that with higher mean sea levels, the relative influence of these geomorphic controls may reduce, which may increase the susceptibility to closure of the entrance at Merimbula Lake and Pambula River.

10.3 Potential impacts - Construction

10.3.1 Marine sediment and morphology

Construction of the offshore section of the ocean outfall pipeline is the only construction activity that would impact on marine sediment and morphology. Construction of the outfall pipeline would involve two methodologies:

- directional drilling through the active beach and surf zone (i.e. from behind the dunes eastward to -14 m AHD) where the pipeline would be buried with sufficient depth to avoid coastal hazards; and
- laying on the seafloor offshore (from -10 m AHD to the outfall at -30 m AHD), with rock or concrete mattresses/anchors laid on the pipeline periodically.

This construction methodology for the pipeline is a low impact option when considering marine and coastal processes. The near-shore works would not have impacts until the pipeline emerges from underground at the offshore edge of the surf zone. At this point it is expected that there would be minor disturbance associated with directional drilling and the pipeline connection at that location (including installation of a pipeline riser which may be required).

Offshore the pipeline would be laid from a barge, with the pipeline and rock or concrete mattresses/anchors laid directly on the seafloor. There would be some minor disturbance when the pipeline is being laid and inspections/testing that follows, as well as installation of the diffuser. This disturbance may result in an increase in sediments being suspended in the water column resulting in a turbid plume. Any construction activity that results in mobilising marine sediments would be short-term and localised in extent. However, to reduce the likelihood of turbid plumes, mitigation measures would be put in place (such as sediment curtains, where required in areas of soft sediments) and included in the Construction Environmental Management Plan (CEMP) (refer **Chapter 11 Marine ecology**).

10.3.2 Coastal hazards and processes

Project construction activities may be at risk from short term coastal hazard events identified in the *Bega Valley Shire Coastal Processes and Hazards Definition Study* (BMT WBM, 2015), including:

- 'storm bite' erosion: storm activity may affect and / or delay construction activities associated with pipeline construction along Merimbula Beach, including the construction laydown and intermediate drilling site (if required) on Merimbula Beach and associated construction access, as well as offshore construction activities.
- coastal inundation:
  - coastal inundation associated with high tides combined with significant storm events may impact construction activities along Merimbula Beach. The construction laydown on Merimbula Beach (and intermediate drilling site if required) and associated construction access would be susceptible to coastal inundation in significant storm events and/or when combined with king tides.

- construction activities may be affected in an extreme flood event. The flood assessment prepared as part of the EIS, identified that the existing STP is located above the Flood Planning Level (FPL), and therefore the STP is not currently affected by flooding. In the case of a Probable Maximum Flood (PMF) event, Arthur Kaine Drive to the north of the STP site would be affected and so the STP site would be inaccessible from the north, however access from the south would remain flood-free. A small portion of the construction compound area on the Pambula Merimbula Golf Club would also be partially affected under the PMF event (refer to **Chapter 8 Surface water and flooding** for further consideration of flooding).

Construction of the Project would not affect entrance stability to Merimbula Lake or Pambula River mouth.

The risk of construction activities being affected by coastal hazards would also carry a risk of impacts to the beach and marine environment, if construction materials were to be mobilised from site/washed away by tide and wave action. This could result in impacts to water quality, beach/dune stability (e.g. limited and localised erosion/sand movement), dune flora and fauna, and visual amenity. If these events coincided with a storm event there may be increased impacts to water quality, beach/dune stability and visual amenity as a result of flood water coming out of the Pambula and Merimbula estuaries.

The risk of coastal hazards, particularly from storms, swell events and high and king tides would be considered in construction planning for the use of Merimbula Beach including mitigation and management measures described in **Section 10.6.**

Given the use of floating plant/barges to install the offshore pipeline section, construction and contingency planning for the Project would also need to take into account potential construction disruption and impact from significant weather events and associated coastal hazards.

Regular coastal processes (including dune stability and sediment movement are not expected to be impacted, or impact on, the Project to more than a minor or negligible degree with the implementation of mitigation measures described in **Section 10.6**. The Project would avoid the dune system (and associated vegetation) of Merimbula Beach and use the beach front only. The temporary access along Merimbula Beach would result in some movement and compaction of sand as vehicles travel along the access, however is not expected to impact coastal processes such as dune formation or beach stability. Further, the use of the beach would be temporary (in line with construction timeframes), of a limited intensity (in line with the low number of construction vehicles expected), and although the access would run from Pambula Beach up to the proposed laydown area, would be limited in width (e.g. several metres wide only).

10.3.3 Coastal zone

Construction within the 'coastal zone' (as defined under the Coastal Management SEPP) is addressed in **Table 10-7**.

10.4 Potential impacts - Operation

10.4.1 Marine sediment and morphology

The placement of a pipeline on the seabed would alter water flow which could result in changes to sediment transport around the pipeline. This can result in erosion (scour) around the pipeline with increased flow velocities or accretion (sedimentation/burial) with sediment transport trapped by the pipeline. The extent of erosion or accretion is dependent on the near-bed flow conditions, sediment properties and pipeline geometry. While current and wave generated sediment transport is unlikely during everyday wave conditions, the pipeline could potentially impact bed morphology.

Effect of the ocean outfall pipeline on seabed morphology

The ocean outfall pipeline is to be placed on top of the seabed at a small angle to wave propagation. Research on the effects of pipelines on seabed morphology is typically based on pipelines laid perpendicular to the dominating direction of flow (refer Fredsøe, 2016 for a comprehensive review). No information could be found or the effect of a shore-normal pipeline on largely cross-shore processes.

Analysis of the seabed morphology has shown that sediment is only mobilised during larger wave events. During these conditions, the pipeline would interfere with currents near the bed but it is unlikely to lead to significant morphological impacts. It is possible that some sediment may be trapped adjacent to the pipeline, however, the wave-induced sediment transport is at a small angle to the pipeline, meaning the pipeline is less likely to act as a groyne and block sediment transport or become buried.

Effect of the seabed morphology on the pipeline

Natural bed forms that are sufficiently large enough to result in bridging of the pipeline include sand waves and wider seabed features captured in survey. These features have heights typically less than 0.5 m, though some are up to 1 m high with others hundreds of metres long. The sand waves would be mobile, albeit slow moving, while the longer features could be mobile, though they are likely to be fairly stable if they are the result of flow concentrations linked to reef and head land features. Potential impacts to the pipeline include:

- bridging (scour): When flows are across the line of the pipeline, pre-existing gaps under a pipeline (such as those created by sand waves or pipeline stirrups) are known to initiate pipeline scour (Chiew 1990, Sumer et al. 2001). This can expand via tunnel erosion (Sumer and Fredsøe 2002, Leeuwenstein 1985). The scour hole typically begins to extend along the pipeline at a rate which is dependent on the near-bed velocity, pipeline geometry and pipeline initial embedment (Hansen et al. 1991, Wu and Chiew 2013). It is noted, the dominant cross-shore sediment transport regime is anticipated to limit the amount of scour along the pipeline, The installation of the rock or concrete mattress would also help to mitigate the risk of scour under the pipeline.
- burial: Burial can occur with sand built up against the pipeline, by self-burial as a result of scour under the pipeline, or via the natural bed forms moving over the pipeline. It is considered unlikely that significant sediment build-up against the pipeline would occur. Similarly, burial of the pipeline is unlikely with potential for scour limited by the orientation of the pipeline to the bed shear. The movement of bed forms may result in localised burial or partial burial of the pipeline. The scale of the bed forms, particularly near the diffuser are sufficient to cover the pipeline. As a consequence, in this area, the pipeline would be designed considering the possibility of pipeline burial Progressive covering, protection and stabilisation works for the pipeline using concrete or rock mattresses) would assist in preventing pipeline burial.

10.4.2 Coastal hazards and processes

The Project design has, and would continue to take into account, long term trends of inundation from sea level rise, increased/more intense storm activity and storm surge flooding by locating built infrastructure above the FPL and the PMF, and placing infrastructure outside forecast erosion impact zones.

The *Merimbula Lake and Back Lake Flood Study* (Cardno, 2017) considered climate change scenarios for the 1% AEP flood event by incorporating tidal boundary conditions with a 0.4 m and 0.9 m sea level rise, representing year 2050 and 2100 time horizons respectively. The study showed that changes due to climate change are unlikely to impact the STP site due to its existing elevation and vegetative buffers providing protection from tidal inundation. Erosional and depositional changes are more likely to be located at the Merimbula Lake entrance as a result of regular tidal flow and along the western side of Merimbula Lake where the topography is lower and has greater exposure to higher tides.

Through the active beach zone the adopted solution for the Project is an underground section of pipeline installed via directional drilling. The pipeline would be installed deep enough to be sufficient to protect the infrastructure from long term trends of beach and dune erosion, and inundation effects from storm surges and seal level rise (refer Figure 9-8 of **Chapter 9 Groundwater** for indicative pipeline depth). Given the depths at which the pipeline would be installed under the Merimbula Beach dune system, the Project is not expected to affect dune stability at this location.

As identified in **Section 10.3.1** the majority of the offshore section of the pipeline would be laid on the sea bed (beyond the surf zone), and would be designed to consider scour and burial impacts resulting from typical marine processes.

The pipeline is not predicted to materially affect or change natural coastal processes in the area and accordingly is not expected to significantly exacerbate or change long-term coastal hazard trends predicted in the *Bega Valley Shire Coastal Processes and Hazards Definition Study* (BMT WBM, 2015) for the Merimbula Coast. Regular coastal processes (including dune stability and sediment movement are also not expected to be impacted, or impact on, the Project to more than a minor or negligible degree with the adoption of risk mitigation measures described in **Section 10.6**.

Climate change-related risk (including inundation and increased erosion from predicted future sea level rise) is addressed in **Chapter 25 Climate change risk**. Future flood events accounting for climate change projections (from increased rainfall and increased sea level rise) have also been addressed in **Chapter 8 Water quality, hydrology and flooding**.

10.5 State Environmental Planning Policy (Coastal Protection) 2018

Impacts to the coastal zone (as defined in the Coastal Management SEPP) are summarised in **Table 10-6** below, informed by the following assessments:

- Marine and coastal processes (**Section 10.2** and **Section 10.3.1**)
- Coastal hazards (**Section 10.4.2**);
- Hydrology and flooding (refer **Chapter 8**);
- Groundwater (refer **Chapter 9**);
- Marine and terrestrial ecology (refer **Chapters 11 and 12** respectively);
- Landform, geology and soils (refer **Chapter 13**);
- Aboriginal and non-Aboriginal heritage (refer **Chapters 14 and 15** respectively); and
- Climate Change risk (refer **Chapter 25**).

The Coastal Management SEPP mapping layers are shown in **Figure 10-12**.

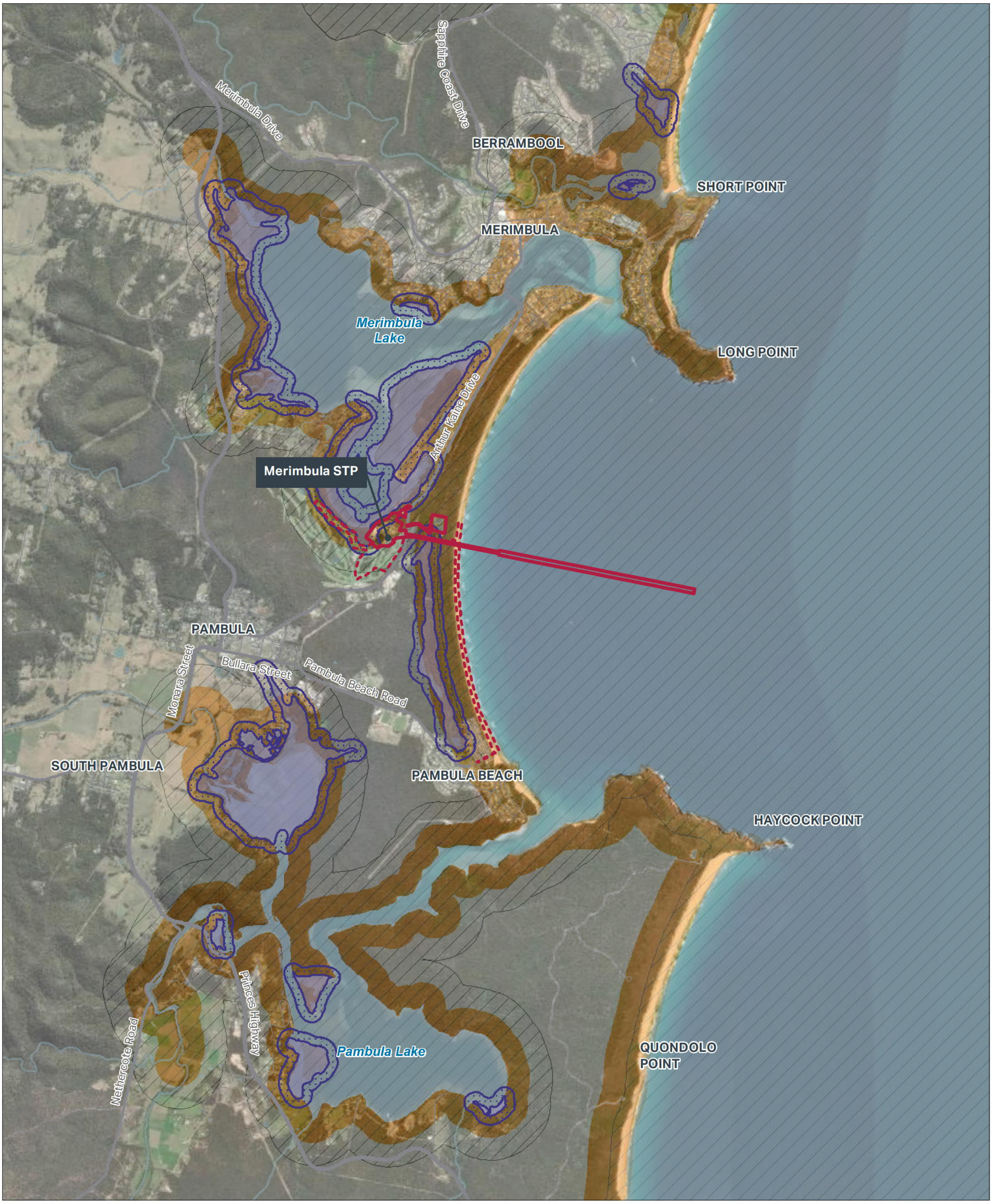

FIGURE 10-12: COASTAL MANAGEMENT AREAS UNDER THE STATE ENVIRONMENTAL PLANNING POLICY (COASTAL MANAGEMENT) 2018

AECOM

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

- Project area
- Project area (temporary construction area)
- Coastal use area
- Coastal environmental area
- Coastal wetland
- Coastal wetland proximity area

Note: There are no areas mapped as 'littoral rainforest' or 'land in proximity to littoral rainforest' within the study area. There are currently no areas mapped as 'coastal vulnerability area' under the NSW Planning Portal e-spatial viewer

Table 10-6 Coastal Management SEPP requirements

Coastal Management Area	Affected by Project?	Project consideration
Division 1, Clause 10 - Coastal wetlands and littoral rainforests area	The underground section of the pipeline would travel under a mapped coastal wetland	A wetland within Merimbula Lake and along Pambula Beach as well as other wetlands within the vicinity of the Project are classified as 'coastal wetlands' under the Coastal Management SEPP. The Project is not located on any land mapped as 'coastal wetland', however a portion of the underground section of the pipeline would travel under an area mapped as coastal wetland, along the dunal area to the east of the STP site (refer **Figure 10-1**)). As this section of the pipeline would be directionally drilled there would be no direct surface impacts to the mapped wetland. The groundwater assessment (**Chapter 9**) found that the pipeline would travel under the wetland area (indicatively by several metres) and therefore also avoid direct impacts. The risk of impacting groundwater and groundwater dependent ecosystems was therefore considered low and not significant (for construction or operation). Notwithstanding, mitigation measures have been proposed in **Chapter 9 Groundwater** to address the low risk of potential groundwater impacts. Mitigation measures would also need to be applied to minimise the potential for indirect impacts (such as sediment runoff) during construction activities. Mitigation measures have been proposed in **Chapter 13 Landform, geology and soils** for erosion and water management and in **Chapter 9 Groundwater** for managing groundwater-related impacts to groundwater dependent ecosystems/wetland areas. The Project area does not include any areas mapped as 'littoral rainforest' under the Coastal Management SEPP.
Division 1, Clause 11 - Land in proximity to coastal wetlands and littoral rainforests area	Yes	Parts of the Project area are located on land mapped as being 'in proximity to coastal wetlands' under the Coastal Management SEPP. However, the Project area does not include any areas mapped as land 'in proximity to littoral rainforest'. In relation to development proposed within this management area, the SEPP requires demonstration that the proposal would not significantly impact on: • <u>the biophysical, hydrological or ecological integrity of the adjacent coastal wetland [or littoral rainforest]</u> – as mentioned above the Project would not directly impact the wetland at the surface, and underground directional drilling is also not expected to directly impact the wetland or groundwater dependent ecosystems. The Project pipeline construction would not involve groundwater extraction, and directional drilling fluids would be used to stabilise the drill hole and minimise interaction between the circulating fluid and groundwater in the aquifer. In addition, the pipeline is not expected to pose a significant barrier to groundwater flow during operations, thereby posing minimal risks to groundwater dependent ecosystems, including the wetland. Similarly, the location of the pipeline as proposed is not expected to affect marine processes or coastal hazards such as to impact on wetland systems. • <u>the quantity and quality of surface and ground water flows to and from the adjacent coastal wetland or littoral rainforest</u> – construction and operational groundwater and surface water impacts have been assessed to be of low

Coastal Management Area	Affected by Project?	Project consideration
		risk and not significant (refer **Chapter 8 Water quality, hydrology and flooding** and **Chapter 9 Groundwater**), however as mentioned above mitigation measures have been proposed to mitigate potential impacts. As the Project is not expected to result in any direct disturbance to surrounding wetlands, impacts are limited to potential indirect impacts from construction and operation works that could affect the quantity, quality or flow of surface and/ or groundwater resources relied upon by the wetlands. As mentioned above these impacts are expected to be of low risk, and relevant mitigation measures have been proposed. During overland construction, erosion and sediment control measures would be put in place to manage surface runoff and erosion from disturbed areas (refer **Chapter 13 Landform, geology and soils**). Based on the above, the terrestrial ecology, marine ecology and groundwater assessments prepared for the Project have not predicted any significant adverse impacts to surrounding wetlands, consistent with the aims of the Coastal Management SEPP.
Division 2 - Coastal vulnerability area	No	There are currently no areas mapped as coastal vulnerability area in the e-spatial viewer. Notwithstanding relevant matters for consideration have been assessed for completeness. In relation to development proposed within this management area, the Coastal Management SEPP requires demonstration that: • if it comprises the erection of a building or works—the building or works are engineered to withstand current and projected coastal hazards for the design life of the building or works. The Project has been and would continue to be, designed with consideration to coastal hazards as discussed in **Section 10.4.2**; • it is not likely to alter coastal processes to the detriment of the natural environment or other land. The installation of the pipeline as proposed is not predicted to materially affect or change natural coastal processes such as to pose risks of detrimental effects to the natural environment; • it is not likely to reduce the public amenity, access to and use of any beach, foreshore, rock platform or headland adjacent to the proposed development during construction. The Project would temporarily limit access to parts of the Merimbula Beach (for the presence of a construction access and laydown area / intermediate drilling site (if required). This would also temporarily reduce the amenity in the immediate area. However once operational, the Project would substantially increase the public amenity and usability of the beach by replacing the beach-face outfall with an ocean outfall which would have the effect of improving near-shore water quality and amenity for beach users. As the ocean outfall would be installed underground to out beyond the surf zone, the pipeline would not be visible or affect public amenity or access to the beach, foreshore, rock platform or headland areas. • it incorporates appropriate measures to manage risk to life and public safety from coastal hazards. The Project would incorporate appropriate construction and operational mitigation and management measures to address hazard risks (coastal erosion, flooding and inundation risks) to minimise safety risks to construction workers and the

Coastal Management Area	Affected by Project?	Project consideration
		public (as required). This may include planned flood safety routes, safety protocols and emergency measures to deal with extreme weather events (including for re-accessing construction or operation sites that may be eroded or flood damaged). • measures are in place to ensure that there are appropriate responses to, and management of, anticipated coastal processes and current and future coastal hazards. As above (refer **Section 10.6**).
Division 3 - Coastal environment area	Yes	Parts of the Project are located on land mapped as 'coastal environment area' under the SEPP. In relation to development proposed within this management area, the SEPP requires consideration of whether it is likely to cause an adverse impact on the following: • the integrity and resilience of the biophysical, hydrological (surface and groundwater) and ecological environment. As discussed above, the Project would improve water quality outcomes in the near-shore marine estuarine environment and the underground installation of the pipeline is not expected to materially impact on groundwater flow, quantity or quality subject to appropriate directional drilling methodology being employed. The existing STP site is located beyond the 1% AEP and the PMF flood extents and as the pipeline would be underground, no change to overland flood movements are expected from the Project. Terrestrial ecology impacts have been minimised through Project design and undergrounding of the pipeline, resulting in up to a maximum of only 0.28 ha of highly modified vegetation requiring clearance. Offshore water quality changes from the discharge of treated effluent and temporary disturbance during construction (from increased suspended sediment) have the potential to impact on marine ecology, however these impacts are likely to be localised due to the mixing and dilution effects of the offshore environment. Significant impacts to marine ecology are not predicted. • coastal environmental values and natural coastal processes. Coastal values of the area would materially benefit through water quality improvements from the replacement of the beach-face outfall with an ocean outfall, which would improve the amenity, recreation and environmental values of the beach, nearshore environment and surf zone. The installation of the pipeline as proposed is not predicted to materially affect or change natural coastal processes in the area. • the water quality of the marine estate (within the meaning of the *Marine Estate Management Act 2014*), in particular, the cumulative impacts of the proposed development on any of the sensitive coastal lakes identified in Schedule 1 of the SEPP. As discussed above the Project would result in materially improved nearshore marine and estuarine water quality outcomes compared to the existing situation, and also reduce cumulative contributions to water quality effects in the area. Water quality is further addressed in **Chapter 8 Water quality, hydrology and flooding**, which found that the risk to marine water quality outside of the mixing zone at the discharge point would be low. Merimbula Lake is not listed as a sensitive coastal lake in Schedule 1 if the Coastal Management SEPP. • marine vegetation, native vegetation and fauna and their habitats, undeveloped headlands and rock platforms. As discussed above, the specialist terrestrial and marine ecology assessments do not predict significant environmental

Coastal Management Area	Affected by Project?	Project consideration
		impacts subject to the implementation of appropriate construction methodology and mitigation and management measures. • existing public open space and safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability. Following construction, the Project would not change existing access to and along the foreshore, beach, headland or rock platform for members of the public. The pipeline would be installed underground via directional drilling beyond the active beach/surf zone and would not pose an access hazard to users of the beach or nearshore environments. • Aboriginal cultural heritage, practices and places. A specialist Aboriginal cultural heritage assessment report (ACHAR) was prepared for the Project in consultation with Aboriginal stakeholders, and included an archaeological survey and test excavation works (refer **Appendix I** (Aboriginal Cultural Heritage Assessment Report)). The assessment identified that dune ridges and areas of back-barrier sand flat within the eastern portion of the Project area are of high Aboriginal archaeological sensitivity. However, the pipeline installation which is proposed to traverse this area was assessed as carrying a negligible Aboriginal heritage impact risk, given the proposed depth of drilling which would greatly exceed the probable depth of subsurface archaeological deposits in the landscape. • the use of the surf zone. The *surf zone* is defined in the *Coastal Management Act 2016* as the area from the line of the outer most breaking waves to the limit of wave run up on the beach. Water quality benefits of the Project would improve the amenity, recreation and environmental values of the surf zone. The installation of the pipeline underground beyond the surf zone, would mean that the infrastructure does not pose a hazard to beach users, swimmers and surfers within the surf zone. The installation of the pipeline as proposed is not predicted to materially affect or change natural coastal processes in the area such as to affect the use or natural functioning of the surf zone.
Division 4 - Coastal use area	Yes	Parts of the Project are located on land mapped as 'coastal use area' under the SEPP. In relation to development proposed within this management area, the SEPP requires consideration whether it is likely to cause an adverse impact on the following: • existing, safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability. As discussed above, no changes to public access would result from operation of the Project. • overshadowing, wind funneling and the loss of views from public places to foreshores. The installation of infrastructure associated with the Project would not result in these impacts, noting that the pipeline would be underground and the STP upgrade would be limited to the existing STP site and comprise the installation of ancillary facilities which are in keeping with the existing character of the site. • the visual amenity and scenic qualities of the coast, including coastal headlands. The Project would not affect the scenic qualities of the local area, and would result in a positive impact to amenity and scenic qualities of the beach.

Coastal Management Area	Affected by Project?	Project consideration
		• Aboriginal cultural heritage, practices and places. No adverse impacts to Aboriginal cultural heritage values are predicted. • cultural and built environment heritage. A non-Aboriginal heritage assessment was prepared for the Project which indicated that the terrestrial works associated with the Project would not impact on any identified historic heritage items (namely six survey reference trees) within the Project area. The marine assessment identified a single site along the proposed pipeline alignment which may indicate a shipwreck site or shipwreck material. Further investigation (marine diver/ underwater camera) was undertaken and it was determined that the site contained no material of historic value.
Division 5 - Coastal zone overall	Yes	The Project is located on land defined as the coastal zone under the Coastal Management SEPP, as parts of the Project are located on land mapped as coastal management areas under the SEPP. In relation to development proposed within this management area, the SEPP requires demonstration that it: • is not likely to cause increased risk of coastal hazards on that land or other land. As shown in **Section 10.3.1**, the pipeline is not predicted to materially affect or change natural coastal processes in the area and accordingly is not expected to significantly exacerbate or change long-term coastal hazard trends as predicted in the *Bega Valley Shire Coastal Processes and Hazards Definition Study* for the Merimbula Coast. • has taken into consideration the relevant provisions of any certified coastal management program that applies to the land. BVSC is currently developing a range of new Coastal Management Programs. An LGA wide Management Program is being developed to address coastal hazards, alongside separate management programs for a range of estuaries including Wallaga Lake, Bermagui River, Back Lake, Merimbula Lake and Lake Curalo. When complete, the suite of new management programs would guide BVSC’s future work to improve the coastal environment, reduce risks to natural and built assets, and maintain the value of this stretch of the NSW coast. Depending on the timing of the release of the final management programs, the Project construction environmental management plan and operational environmental management plans would be reviewed and updated to reflect relevant measures outlined in the final program (where appropriate and relevant to coastal hazard management as it relates to the Project).

10.6 Management of impacts

The mitigation measures identified to help avoid and minimise the identified marine and coastal processes impacts are outlined in **Table 10-7,** and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

10.6.1 Performance outcomes

The marine and coastal processes performance outcome for the Project is as follows:

- marine sediment and morphology impacts are minimised and managed during construction;
- no impacts to Merimbula Lake or Pambula River mouth entrance stability from the Project;
- operational marine sediment and morphology impacts are minimised through design; and
- no direct surface impacts to the mapped wetland in State Environmental Planning Policy (Coastal Protection) 2018 (Coastal Management SEPP).

The Project would be designed, constructed and operated to achieve these performance outcomes.

10.6.2 Consideration of interaction between measures

Mitigation and management measures in other chapters that are relevant to the management of potential Marine and coastal processes impacts include:

Chapter 8 Water quality, hydrology and flooding specifically measure SWF1, SWF2 and SWF4 to address the potential for construction activities to result in adverse impacts on water quality; and

Chapter 12 Terrestrial ecology, specifically measure B6 to address the potential for ground disturbing activities to result in adverse impacts on water quality.

10.6.3 Mitigation measures

Management and mitigation measures to address the potential impacts identified are described in **Table 10-7** below.

Table 10-7 Mitigation measures – Marine and coastal processes

No.	Impact	Mitigation and management measure	Timing
MC1	Interruption of sand transport by pipeline	Although not expected to be a significant issue, subsequent design stages of the ocean outfall pipeline would review the findings presented in **Appendix E** (Water Quality Technical report) regarding interruption of marine sediment/sand transport by the ocean outfall pipeline.	Design
MC2	Scour leading to excessive bridging in the above-ground section of the ocean outfall pipeline	Scour with flow below the ocean outfall pipeline can cause bridging of the pipeline. The pipeline design would consider the possibility of sag with up to 1 m height in differential settlement in supports (Fredsøe et al. 1988).	Design
MC3	Damaged pipeline (anchor drag of pipeline movement) resulting in leak and impact outside of the mixing zone	The pipeline design would take into account possible anchor or net drag as well as large wave forces (which could result in a leak and impact outside of the mixing zone). If deemed an issue, coverage by armour rock/mattress could be considered.	Design

No.	Impact	Mitigation and management measure	Timing
MC4	Interaction of coastal hazards with construction of the Project	The CEMP would include specific provisions and a work plan for use of Merimbula Beach (laydown and intermediate drilling site, if required as part of the Project). This would include (but not be limited to): • planning works around tide times, and avoiding high tides and king tides (including mobilisation to site, site access, and other activities); • frequent review of weather forecasts, and planning to avoid adverse weather, including storms, high wind or swell events; • planning the laydown area so that plant and materials are stored at the back (western extent) of the beach, but avoiding the sand dunes; • establishing and using the beach access in accordance with requirements of the NSW National Parks and Wildlife Service; • minimising the number of plant, equipment and materials on the beach at any one time; • no storage of fuel, chemicals or oil at the beach laydown; • implementing speed limits and only using the established beach access, as well as daily visual observations of the condition of the access; • minimising construction timeframes as far as practicable; • having evacuation plans in place to rapidly demobilise from site if required (e.g. if a weather forecast changes).	Detailed design and construction
MC5	Interaction of coastal hazards with construction of the Project	Offshore construction works would be planned to avoid adverse weather events, including storms, strong wind and swell events. Frequent review of weather forecasts and contingency planning for the construction timeframes and works required would be undertaken.	Detailed design and construction

10.6.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for marine and coastal processes and is provided in **Table 10-8**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the environmental impact after the proposed mitigation measures have been implemented.

Table 10-8 Environmental risk analysis with mitigation - Marine and coastal processes

Summary of Impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Interruption of sand transport by pipeline	Design (for operation)	MC1	Insignificant	Possible	Low
Scour leading to excessive bridging in the above-ground section of the ocean outfall pipeline	Design (for operation)	MC2	Insignificant	Possible	Low
Damaged pipeline (anchor drag of pipeline movement) resulting in leak and impact outside of the mixing zone	Design (for operation)	MC3	Moderate	Rare	Low
Interaction of coastal hazards with construction of the Project	Construction	MC4	Minor	Unlikely	Low
Interaction of coastal hazards with construction of the Project	Construction	MC5	Minor	Unlikely	Low

11.0 Marine Ecology

This chapter provides a summary of the marine ecology impacts associated with the Project.

A detailed marine ecology assessment has been prepared for the Project and is included in **Appendix G** (Marine Ecology Technical report).

Table 11-1 sets out the requirements as provided in the SEARs relevant to marine ecology and where the requirements have been addressed in this EIS.

Table 11-1 SEARs – marine ecology

Ref	Assessment requirements	Where addressed in this EIS
1.1	The Proponent must: j. identify sensitive receiving environments (which may include estuarine and marine waters downstream) and develop a strategy to avoid or minimise impacts on these environments	**Chapter 11** Marine Ecology and **Appendix G** (Marine Ecology Technical report)
4.0	**Biodiversity**	
4.4	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 *Threatened Species Conservation Act 1997* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environment Protection and Biodiversity Conservation Act 2000* (EPBC Act)	**Section 11.6**
4.5	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 Department of Primary Industries (DPI) Threatened Species Assessment Guidelines. Relevant threatened fish species included (but not limited to) Grey Nurse Shark, southern Bluefin Tuna, White Shark, Black Rock Cod.	**Section 11.6** and **Appendix G** (Marine Ecology Technical report)
4.6	The Proponent must include a description of benthic habitats along and adjacent to the full length of the proposed outfall pipe and for at least 500 metre (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.	**Section 11.3.5** and **Appendix G** (Marine Ecology Technical report)
6.0	**Protected and Sensitive Lands**	
6.1	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; j. water quality of the marine estate (within the meaning of the *Marine Estate Management Act 2014*); k. marine vegetation, rocky reefs and benthic habitats, native vegetation and fauna and their	**Section 11.3, Section 11.4, Section 11.5, Section 11.6** and **Appendix E** (Water Quality Technical report)

Ref	Assessment requirements	Where addressed in this EIS
	habitats, undeveloped headlands and rock platforms; o. protected areas (including land and water) managed by Office of Environment and Heritage (OEH) now Department of Planning Industry and Environment (DPIE) and/or DPI Fisheries under the *National Parks and Wildlife Act 1974* and the *Marine Estate Management Act 2014*; p. Key Fish Habitat as mapped and defined in accordance with the FM Act; r. land or waters identified as Critical Habitat under the TSC Act, FM Act or EPBC Act	

In addition to the Project SEARs, Department of Primary Industries – Fisheries (DPI) and community and stakeholder consultation, identified a number of additional items that required assessment and inclusion in the marine ecology assessment. **Table 11-2** provides details of these additional requirements.

Table 11-2 Department of Primary Industries – Fisheries and Community and Stakeholder Requirements

Additional DPI Requirements	Where addressed in this EIS
A detailed description of construction methods, timing, duration and associated risks.	**Chapter 2 (Project description)** and **Chapter 8** to **Chapter 27** of this EIS
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).	**Appendix G** (Marine Ecology Technical report)
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.	**Section 11.2** and **Section 11.3**
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.	**Section 11.3** and **Section 11.4**
An outline of environmental protection measures that would be employed during the construction phase.	**Section 11.7**

Additional DPI Requirements	Where addressed in this EIS
Issues arising from community and stakeholder consultation	**Where addressed in this EIS**
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 treated 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).	**Section 11.3**
Risk to local abalone population stocks that are the basis of an important commercial fishery for a number of fishermen.	**Section 11.3** and **Section 11.4** and **Appendix G** (Marine Ecology Technical report)

11.1 Assessment approach

The marine ecology assessment involved two stages of marine ecological investigations (Stage 1 and Stage 2) with the purpose of describing marine ecological environments and baseline conditions for the impact assessment. The objective of each stage is outlined below:

- **Stage 1** (completed between 2017-2018): to provide a preliminary description of marine and estuarine ecological values (i.e. habitats and communities) and identify potential ecological constraints to inform potential pipeline alignment options, including:
  - intertidal rocky shore;
  - sub-tidal rocky reef;
  - sandy seabed;
  - water column;
  - seagrass, saltmarsh and mangrove; and
  - threatened species.
- **Stage 2** (2019 – ongoing):
  - 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
  - to provide an assessment of potential impact to marine ecology addressing the Project SEARs.

Further detail on the surveys completed within Stage 1 and 2 is provided in **Section 11.2.2**. The methodology for this marine ecology assessment is provided below and in full in **Appendix G** (Marine Ecology Technical report).

11.1.1 Legislative and policy context

The marine ecology assessment was undertaken in accordance with the following NSW and Commonwealth legislation:

- *Fisheries Management Act 1994* (FM Act)*;*
- *Biodiversity Conservation Act 2016* (BC Act)*;* and
- *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act).
- *Protection of the Environment Operations Act 1997* (POEO Act)

11.1.2 Approach

In accordance with the *Policy of Guidelines for Fish Habitat Conservation and Management* (NSW DPI, 2013) and *Aquatic Ecology in Environmental Impact Assessment – EIA Guideline* (Lincoln Smith, 2003), the marine ecology impact assessment comprised:

1. **Establishing the context.** Context included information about the marine environment of Merimbula Bay and proposed Project activities.
    - **Identify marine ecological receptors and values** – provide detail regarding the extent and quality of marine ecological receptors (i.e. habitats and communities) within the study area and an understanding of the sensitivity of each receptor or value in order to assess 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 activities can cause direct and indirect impacts via physical, chemical or biological effects.
2. **Evaluation 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 study area and pathway(s) of potential impact by the Project is provided in **Table 11-3** below.

    Potential impacts were considered in further detail in Stage 2 based on information provided in the *30% Concept Design Report* (AECOM, 20219 that describes the preferred pipeline alignment, diffuser design and anticipated construction methods. The dispersion modelling report Annexure B of **Appendix E** (Water Quality Technical report) predicts the behaviour and dilution of the treated wastewater plume in the near-field and far field and the anticipated water quality impacts (Elgin, 2020).
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. 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.
4. **Environmental management measures** – identifying appropriate control measures to mitigate the risk of Project hazards and threats where applicable.

Table 11-3 Summary of marine ecological values and pathway(s) of potential impact

Marine Ecological Value	Project Phase	Pathway/s of Potential Impact
Soft sediment infauna and epifauna	Construction	Direct disturbance to soft sediment habitat during construction phase – establishment of the ocean outfall 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

Marine Ecological Value	Project Phase	Pathway/s of Potential Impact
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
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
Shellfish (e.g. 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
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
Shallow sub-tidal macroalgal assemblages at Hunter Reef	Operational	Altered water quality - reduced salinity and increased nutrient levels
Shallow sub-tidal macroalgal assemblages at Haycock Point	Operational	Altered water quality - reduced salinity and increased nutrient levels
Low shore intertidal macroalgal assemblage and herbivore community at Haycock Point	Operational	Altered water quality - reduced salinity and increased nutrient levels
Threatened species - Whales	Construction	Disturbance from construction noise and potential for vessel strike
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

11.1.3 Study area

The marine ecology assessment considered the marine habitats, communities and environmental values present within the following areas:

- Department of Planning, Industry and the Environment (DPIE) Project area of investigation (the Project area);
- 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 DPIE Project area of investigation and Haycock Point, with the extent of field investigations expanded in Stage 2 to establish reference locations as part of the MMP. Reference locations include Tura Beach and Tura Head in the north to Quondolo and Lennards Island in the south (refer to **Figure 11-1**).

FIGURE 11-1: MARINE ECOLOGY STUDY AREA

N 0 1 2 km

AECOM

Legend

- Project area
- Project area (temporary construction area)
- DPIE project area of investigation
- Marine ecology study area

Assessing potential impacts of the Project construction and operational phases to marine ecological receptors and values was undertaken in a qualitative risk analysis, which considered the Project design information and data gathered during the preparation of this report. Information was based on the following key elements:

The Project

- upgrade of STP processes to improve treated wastewater quality;
- construction and operation of ocean outfall pipeline for disposal of treated wastewater;
- decommissioning the beach-face outfall;
- decommissioning dunal ex-filtration ponds; and
- ongoing beneficial re-use of treated wastewater.

Potential sensitive receptors

- 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 include:
  - soft sediment habitat (Type 3 fish habitat);
  - benthic infauna and epifauna communities;
  - sub-tidal rocky reef communities (Type 2 fish habitat);
  - fish assemblage;
  - intertidal reef communities; and
  - phytoplankton and drift algae.
- estuarine habitats and communities in Merimbula Lake and Pambula River estuary.

Environmental Values to be protected

- estuarine and marine waters aquaculture;
- recreational and commercial fishing; and
- abalone fishery.

The risk analysis was undertaken using a matrix of likelihood and consequence definitions developed for assessing risks associated with identified hazards / threats to marine ecological receptors and environmental values. The likelihood and consequence definitions and risk ratings tables are included as **Table 11-4**, **Table 11-5,** and **Table 11-6** below**.**

Table 11-4 Marine ecology likelihood of impact definitions

Likelihood Level	Rare 1	Unlikely 2	Possible 3	Likely 4	Almost Certain 5
Likelihood of impacts	Never reported for this situation, but still plausible within the timeframe (< 5%)	Uncommon, but has been known to occur elsewhere. Expected to occur here only in specific circumstances within the timeframe (5-30%)	Some clear evidence exists to suggest this is possible in this situation within the timeframe (30-50%)	Expected to occur in this situation within the timeframe (50-90%)	A very large certainty that this will occur in this situation within the timeframe (>90%)

Table 11-5 Qualitative measures of consequence applicable to the spatial scale of the Project area for marine ecology values

Consequence	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Environmental Value	No measurable negative impacts on habitats and/or biotic assemblages are or will be evident against natural variations	Barely measurable negative impacts on habitats and/or biotic assemblages are or will be evident compared to total habitat area or abundance of biota against natural variations.	Measurable and on-going negative impacts on habitats and/or biotic assemblages are or will be evident in one or more locations. Nevertheless, both the level and the percentage of habitats and/or biotic assemblages affected have not or will not influence their overall recovery capacity, and a change in the overall trophic/community structure isn't and will not be evident.	Substantial measurable and on-going negative impacts on habitats and/or biotic assemblages are or will be evident in in one or more locations, and the proportion of habitats and/or biotic assemblages affected will influence the recovery capacity of the habitats and/or biotic assemblages, with some clear shifts in the overall trophic/community structure and function	The level of habitat and/or biotic assemblages negatively affected endangers their long-term survival and will result in extreme changes to the region's trophic/community structure as well as the function of the remaining habitat and/or biotic assemblages.

Consequence	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Abalone	No measurable negative effect on abalone or abalone habitats will be evident against natural variations	Barely measurable negative effect on abalone or abalone habitats will be evident against natural variations	Measurable negative effect to abalone (i.e. reduced abundance) and abalone habitats localised to some Merimbula Bay reefs. Level of effect may be short-term and does not influence overall capacity of species recovery.	Measurable and on-going negative effect to abalone (i.e. reduced abundance) and abalone habitats on reefs within Merimbula Bay. Level of effect will influence overall capacity of species recovery. Commercial fishery of Merimbula Bay reefs impaired.	Abalone and abalone habitats negatively affected (i.e. reduced abundance) within Merimbula Bay, with limited prospect of species recovery. Commercial fishery of Merimbula Bay reefs no longer viable.
Sub-tidal Rocky Reef	No measurable effect on subtidal assemblage will be evident against natural variations	Barely measurable negative effect on subtidal assemblages against natural variations	Measurable negative effect (i.e. reduced species diversity and abundance) on subtidal assemblage localised to reefs closest to mixing zone	Measurable and on-going negative effect (i.e. reduced species diversity and abundance) to subtidal assemblages of reefs closest to mixing zone, with potential effect extending further to one or more other rocky reef locations	Subtidal reef assemblages of Merimbula Bay negatively affected and changes to the broader trophic/community structure of those areas likely.
Intertidal Shore	No measurable effect on intertidal assemblage will be evident against natural variations	Barely measurable negative effect on intertidal assemblages against natural variations	Measurable negative effect (i.e. reduced species diversity and abundance) on intertidal assemblage localised to Merimbula Bay	Measurable and on-going negative effect (i.e. reduced species diversity and abundance) to intertidal assemblages within Merimbula Bay with potential effect extending to one or more locations beyond Merimbula Bay	Intertidal assemblages of Merimbula Bay negatively affected and changes to the broader trophic/community structure of those areas likely.

Consequence	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Benthic Infauna	No measurable effect on infauna assemblage will be evident against natural variations	Barely measurable negative effect on infauna assemblage (i.e. reduced species diversity and abundance) within the mixing zone would be evident compared to broader Merimbula Bay against natural variations	Measurable negative effect (i.e. reduced species diversity and abundance) on infauna assemblage localised to the mixing zone, and evidence that effect potentially extends outside the mixing zone. A change in the overall trophic/community structure within or outside the mixing zone would not be evident	Measurable and on-going negative effect (i.e. reduced species diversity and abundance) to infauna assemblage outside the mixing zone, including negative effect(s) extending to one or more locations in broader Merimbula Bay. Change in local infauna assemblage causing broader change in trophic/community structure at those locations possible.	Infauna assemblage negatively affected beyond the mixing zone, and changes to the trophic/community structure of those areas likely.
Phytoplankton	No measurable negative or positive effect on phytoplankton assemblage will be evident against natural variations	Barely measurable negative or positive effect on phytoplankton assemblage within the mixing zone would be evident compared to broader Merimbula Bay against natural variations	Measurable negative or positive effect (i.e. reduced or increased species diversity and abundance) on phytoplankton assemblage localised to the mixing zone, and evidence that effect potentially extends outside the mixing zone. A change in the overall trophic/community structure within or outside the mixing zone would not be evident	Measurable and on-going negative or positive effect (i.e. reduced or increased species diversity and abundance) outside the mixing zone, including negative or positive effect(s) extending to one or more locations in broader Merimbula Bay. Change in local phytoplankton assemblage causing broader change in trophic/community structure at those locations possible	Phytoplankton assemblage negatively or positively affected beyond the mixing zone, and changes to the trophic/community structure of those areas likely

Consequence	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Fish Assemblage	No measurable negative effect on fish assemblage will be evident against natural variations	Barely measurable negative effect on fish assemblage (i.e. reduced species diversity and abundance) within the mixing zone would be evident compared to broader sand habitat of Merimbula Bay against natural variations	Measurable negative effect (i.e. reduced species diversity and abundance) on fish assemblage localised to the mixing zone, and evidence that effect potentially extends outside the mixing zone to broader sand habitat areas of Merimbula Bay. A change in the overall trophic/community structure within or outside the mixing zone would not be evident	Measurable and on-going negative effect (i.e. reduced species diversity and abundance) outside the mixing zone, including negative effect(s) extending to one or more locations. Change in fish assemblage causing broader change in trophic/community structure at those locations possible	Fish assemblage negatively affected beyond the mixing zone, such that some species no longer locally present, and changes to the trophic/community structure of those areas likely

Consequence	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Threatened and protected marine species (*FM Act, BC Act, EPBC Act*)	No measurable negative impacts on threatened or protected species are or will be evident against natural variations	Barely measurable negative impacts on threatened or protected species are or will be evident against natural variation. Nevertheless, there are either no substantial negative impacts or only extremely few mortalities within 5-10 years, and there is not and will not be a measurable effect on local population status of protected species or recovery of threatened species	Many individuals of a threatened or protected species are or will be measurably negatively affected. Nevertheless, no on-going impact on local dynamics or overall number of individuals is or will be evident, and the impact has not or will not significantly affect population status of protected species or recovery of already threatened species	Substantial measurable and on-going negative impacts that are or will affect the number of individuals of protected species and recovery of already threatened species	The ongoing level of mortality has or will generate significant additional declines to already threatened or protected species leading to potential local extinction in NSW

Table 11-6 Risk ratings matrix

		Consequence				
		Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Likelihood	Almost Certain 5	Low 5	Medium 10	High 15	High 20	High 25
	Likely 4	Minimal 4	Low 8	Medium 12	High 16	High 20
	Possible 3	Minimal 3	Low 6	Low 9	Medium 12	High 15
	Unlikely 2	Minimal 2	Minimal 4	Low 6	Low 8	Medium 10
	Rare 1	Minimal 1	Minimal 2	Minimal 3	Minimal 4	Low 5

LEGEND:

High Risk	Unacceptable level of risk. Measures to reduce risk to a lower level required.
Medium Risk	Tolerable level of risk, routine measures to reduce and/or manage risk required.
Low Risk	May be considered acceptable, routine and cost-effective measures to reduce and/or manage risk.
Minimal Risk	Acceptable level of risk with no further mitigation measures required.

11.2 Methodology

An overview of the methods used in preparation of the marine ecology assessment is outlined below and described in further detail in the following sections:

- assessment of threatened marine species and critical habitats listed under NSW and Commonwealth legislation;
- 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 bioaccumulative contaminants in treated wastewater and potential risk to fish and shellfish;
- 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 (refer below) 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; and

- preparation of the marine ecology assessment report to convey the findings of field investigations and provide an assessment of potential Project impacts from construction and operational phase activities.

11.2.1 Threatened and Protected Marine Species

The threatened and protected marine species assessment was conducted via desktop assessment with incidental observations recorded during field surveys to help inform the likelihood of occurrence assessment. The assessment comprised the following:

- preliminary identification of threatened species, populations, ecological communities and critical habitat that have been reported or modelled to occur within a 5km radius of the study area, was achieved through searches of the following databases:
  - DPIE (previously Office of Environment and Heritage (OEH)) BioNet threatened species database
  - DPI Fisheries records of threatened and protected species and Key Threatening Processes (KTPs) listed under Schedules 4 to 6 of the FM Act were reviewed to satisfy the requirements of the Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management (NSW DPI 2013) and the NSW *Environmental Planning and Assessment Act 1979*.
  - EPBC protected matters search tool.
  - likelihood of occurrence assessment was completed to determine which of the threatened species, populations and ecological communities preliminarily identified are likely to occur in the Project area. This comprised:
  - search of ALA (2017) Atlas of Living Australia, URL: https://www.ala.org.au/
  - search of RLS (2017). Reef Life Survey Data Portal, URL: http://reeflifesurvey.imas.utas.edu.au/portal/search
  - Dorsal (2018). Shark Reporting URL: https://www.dorsalwatch.com/report/

Based on information concerning habitat requirements of each species and observations gathered during marine ecology field surveys, each species was assigned a score based on two criteria: (1) the likelihood of occurrence, and (2) when the species was last reported in the BVSC region. Scores were then multiplied together to generate a likelihood of occurrence score - high, moderate, low or unlikely to occur (**Table 11-7**). Results of the likelihood of occurrence assessment can be found in **Table 2-2** of **Appendix G** (Marine Ecology Technical report).

Table 11-7 Qualitative assessment criteria for species likelihood of occurrence

Qualitative Assessment Criteria	
Likelihood of Occurrence Score	
5	Confirmed present - species identified within the Project area during field surveys
4	Species known from the Project area, and suitable habitat (such as foraging habitat) exists within the Project area
3	Species known from the broader BVSC region though not recorded from the Project area, and potential suitable habitat (such as foraging habitat) exists within the Project area
2	Species not known from the broader BVSC region, though potential suitable habitat (such as foraging habitat) exists within the project area
1	No suitable habitat exists for the species within the Project area
Last Reported in BVSC Region Score	
5	Last reported in the BVSC region less than 5 years ago
3	Last reported in the BVSC region between 5 to 10 years ago
1	Last reported in the BVSC region more than 10 years ago

Qualitative Assessment Criteria	
0	Not reported in the BVSC region
Likelihood Score	
20 25	High likelihood of occurring within the Project area
11 - 19	Moderate likelihood of occurring within the Project area
6 - 10	Low likelihood of occurring within the Project area
0 - 5	Unlikely to occur within the Project area

11.2.2 Desktop Review and Field Surveys

The marine ecology assessment was completed based on a desktop review, agency and stakeholder consultation and field surveys.

Field surveys provided data to enable the definition of marine habitats; the sub-tidal reef community; the abalone population; fish assemblage; risk of bioaccumulative contaminants to shellfish; the benthic infauna and epifauna community; the intertidal rocky-shore community; phytoplankton assemblage and drift algae. A comprehensive desktop review supplemented the survey results and provided additional information on estuarine habitats and communities and aquaculture operations that could potentially be impacted by the Project.

A summary of the method and data collected is provided in **Section 11.2.3** to **Section 11.2.14** below.

A total of 50 fieldwork days were undertaken in the Stage 1 and Stage 2 marine ecological surveys for the Project as shown in **Table 11-8**.

At the time of compilation of this EIS, pre-construction baseline surveys for abalone, benthic infauna and sub-tidal rocky reef communities were still ongoing.

Table 11-8 Summary of fieldwork completed for the marine ecology assessment

Marine receptor or value	Field work		Desktop studies and stakeholder consultation
	Number of Days	Date	
Threatened species	-	-	• database searches for species listed under FM Act, BC Act, EPBC Act • DPIE wildlife atlas • DPI Fisheries records • Atlas of Living Australia
Marine habitats	10	2017 – 2020	• previous seabed mapping by Department of Environment Climate Change and Water (DECCW) (now DPIE) • bathymetry mapping by Marine and Earth Sciences (MES) (2018) • Total Hydrographic (2018) for work undertaken in Stage 2 • DPI Fisheries
Sub-tidal reef community	8	2017 – 2021	*Monitoring is ongoing*
Abalone population	3	2018	• DPI Fisheries • Abalone stakeholders *Pre-construction baseline monitoring is ongoing.*

Marine receptor or value	Field work		Desktop studies and stakeholder consultation
	Number of Days	Date	
Fish assemblage	6	2017 to 2019	• DPI Fisheries • Reef life survey • Atlas of Living Australia
Bioaccumulation risk to fish and shellfish	3	2019 – 2020	Previous studies and datasets
Benthic infauna	9	2017 – 2021	*Monitoring is ongoing*
Intertidal rocky shore community	2	2017 and 2018	-
Phytoplankton	4	2017 – 2020	• DPIE algal bloom register • NSW Food Authority Shellfish Quality Assurance and Quality Control (QAQC) Program
Drift algae	2	2018 and 2019	Previous studies and datasets
Estuaries	-	-	Previous studies and datasets
Aquaculture	-	-	-
Reconnaissance inspections for Stage 2 reference sites	3	2019	-

11.2.3 Marine Habitats

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

- Stage 1 - 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 - 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.

Stage 1 survey

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. A total of nine tow video transects (approximately 7.3 km) were completed in Stage 1. 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).

Stage 2 survey

Seabed validation surveys commenced over three days commencing on 2 October 2019 once the northern alignment had been identified as the preferred option for the pipeline. However, the preferred outfall option, 'North-Short' at 30 m water depth or 'North-Long' at 40 m water depth had not yet been confirmed, therefore, following selection of the preferred outfall option (North-Short at 30 m water depth), surveys resumed on 6 May 2020 and concluded on 11 June 2020.

A total of six tow video transects (approximately 8 km) were recorded in Stage 2 to validate seabed characteristics along the preferred pipeline alignment and a 500 m radius around the diffuser ports.

Seabed validation

In addition to the field surveys the following tasks were completed to better understand the marine habitats present in the survey area.

- *Review of existing seabed habitat mapping*

  Publicly available habitat mapping layers from within the survey area were collated using GIS software from platforms such as; Geoscience Australia, NSW DPI and OZCoasts. This assisted in identifying 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 was limited to less than 20 m water depths and up to 1 km offshore.

- *Review of Merimbula bathymetric survey data*

  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 as part of the Merimbula Offshore Artificial Reef (Merimbula OAR) project. The southern portion of Merimbula Bay was surveyed by Marine and Earth Sciences in 2018 as part of this Project. This survey data was used to inform the habitat mapping.

- *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 (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.

The results of the marine habitat surveys are presented in **Section 11.3.3** and **Appendix G** (Marine Ecology Technical Report).

11.2.4 Sub-tidal Reef Community

The nearest sub-tidal reef is the northwest edge of Hunter Reef, approximately 1400 m from the selected treated wastewater diffuser location. Field surveys were conducted for shallow sub-tidal reefs (0 to 20 m depth) using a remote sampling method, that utilised a drop camera quadrat frame, to sample and characterise the community composition along transects of sub-tidal habitats at Haycock Point. The drop camera quadrat frame was deployed from a work vessel into targeted habitat/substrate by lowering it to the seafloor using a winch/pot hauler.

A total of 616 images from 11 transects were checked visually to ensure that the drop camera quadrat frame was grounded on the seafloor and that the photo was in focus. A subset of 382 images was selected for analysis of macroalgal community and abundance of herbivorous invertebrates, refer to **Section 11.3.4** and **Appendix G** (Marine Ecology Technical Report).

Intermediate sub-tidal reefs (25 to 35 m depth) that also support sessile filter feeding assemblages are being targeted during the Stage 2 pre-construction baseline surveys which are still ongoing. Methods described above are being used in Stage 2 surveys.

11.2.5 Abalone

During client and stakeholder consultation in August 2017, DPI Fisheries recommended that an initial baseline assessment of abalone populations at Haycock Point be undertaken as part of Stage 1 investigations. The assessment was based on available information provided by DPI Fisheries and a field survey of the abalone population at Haycock Point.

Surveys of abalone abundance at Haycock Point were based on the stratified transect methodology recommended by Gorfine *et al*. (1996) and Hart *et al*. (1997) and undertaken by divers on SCUBA over three days between 7 to 9 January 2018. Abalone were counted along four belt transects (50 m long by 1 m wide) at six sites around Haycock Point, with sites selected based on a range of factors such as; habitat preference, depth, topography and aspect.

The habitats encountered along each transect were recorded using a GoPro underwater camera. This provided archival video footage of each transect.

Collected data were separately processed for each site to determine:

- total count of abalone by size class per site (small (0 mm to 60 mm), medium (60 mm to 117 mm) and large (greater than 117 mm));

- mean count of undersize[6] (small and medium) versus legal sized (large) abalone per transect; and
- mean density of undersize versus legal sized abalone per 10 m2 interval (representing the smallest sampling unit along each transect).

The results of the Stage 1 abalone surveys are presented in **Section 11.3.5** and **Appendix G** (Marine Ecology Technical Report). Additional pre-construction baseline abalone surveys are also being conducted.

11.2.6 Fish assemblage

A review of existing data was undertaken comprising:

- records of fish observations reported for survey locations between Batemans Bay (NSW) and Mallacoota (Victoria) by Reef Life Survey (RLS, 2017)
- correspondence with DPI Fisheries regarding observations of threatened species, commercial catch data and recreational fishing statistics.

DPI Fisheries was consulted regarding anecdotal reports and records of threatened and protected fish species (i.e. Black cod, Grey nurse shark, Great white shark) in considering the selection of sampling sites. While no specific sampling sites were recommended by DPI, with regards to threatened species, location coordinates were provided for an area of subtidal reef in 40 m water depth known to be productive for fishing and considered worthy of investigation.

Baited Remote Underwater Video (BRUV) was used to investigate the local fish assemblage associated with demersal habitats within the study area. Demersal habitat types included sandy seabed and subtidal rocky reef, with reef further categorised as barrens habitat, or macroalgae dominated reef. Stage 1 surveys sampled all habitat types between 3 and 9 November 2017, with Stage 2 surveys undertaken on 10 October 2019 to focus specifically on the fish assemblage associated with sand habitats around the preferred alignment option.

A total of 30 BRUV drops were deployed across the study area over Stage 1 and Stage 2 surveys. BRUV deployments were distributed across three major habitat types including reef, macroalgae covered reef and sandy substrate. Five BRUV drops were deployed within a 500 m radius of the diffuser location, including at the diffuser location.

The results of this survey are presented in **Section 11.3.6** and **Appendix G** (Marine Ecology Technical Report).

11.2.7 Bioaccumulation risk and shellfish

A preliminary assessment of the risk from bioaccumulative contaminants was undertaken during Stage 1 with a desktop review of:

- STP licence conditions and policies, existing beach face outfall discharge and the proposed upgrades to the STP and location of proposed outfall ‘North-Short’ option;
- treated wastewater quality data and other information in identifying potential bioaccumulative contaminants;
- ambient water quality in marine receiving waters of Merimbula Bay and dispersion modelling results of the ocean outfall pipeline; and
- published literature on biota metal concentrations in fish and shellfish in NSW coastal waters, including food standards for metals in fish and shellfish.

Field sampling of target shellfish and fish species included:

- collection of blue mussel (*Mytilus galloprovincalis*), black-lip abalone (*Haliotis rubra*) and flathead (*Platycephalus spp*.) from locations within Merimbula Bay and the area of investigation, along with other locations to the north and south of the Bay; and

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[6] Undersize abalone are not subject to commercial harvest and therefore assessing the population structure of this size class is considered a more reliable indicator for identifying potential population change.

- analysis of blue mussel, black-lip abalone and flathead biota samples for metals by NATA accredited Australian Laboratory Services (ALS). The metal suite included cadmium, chromium, copper, lead, mercury, nickel, selenium, silver and zinc.

Sample collection was conducted under the Scientific Collection Permit issued to Elgin (P17/0047-1.1) by DPI for the Project. Following collection, mussel, abalone and fish samples collected at each site were measured, weighed and photographed, with field sampling sheets and photographs in **Appendix G** (Marine Ecology Technical report (refer **Appendix D**)).

Mussel and abalone were shucked whilst flathead was dissected to sample fillet flesh and livers, with samples despatched in chilled eskies under chain of custody to ALS for the following analysis.

- Mussels – analysis of soft flesh from four selected individual samples from each of the five sampling sites, a total of 20 samples;
- Abalone – analysis of foot flesh from four legal minimum length (LML) individuals from each of the four sampling sites, a total of 16 samples; and
- Flathead – analysis of the edible fish fillet on four selected individual fish from each of the four fish sampling sites, with a total of 16 fillet samples. The liver was also dissected from the four selected fish collected at each site. Due to the anticipated small mass of the liver for analytical requirements, fish livers were composited into a single sample from each site, with a total of four (4) liver composite samples.

The results of this survey are presented in **Section 11.3.7**.

11.2.8 Benthic Infauna and Epifauna Community

An initial pilot study was undertaken in Stage 1 to collect some preliminary baseline information to describe the benthic infauna community and sediment conditions at two locations that, at the time, were being considered as potential options for the pipeline and outfall diffuser. The locations included 30 m depth at Haycock Point and 30 m depth in central Merimbula Bay.

Findings from the pilot study were then used to design an appropriate sampling program to be implemented during Stage 2 following selection of the preferred pipeline and diffuser option.

Sediment samples were collected from a total of four sites at each location spaced at 0 m, 50 m, 200 m and 400 m intervals along a uniform depth contour with similar sediment characteristics. Sediment samples were collected using a van veen grab sampler for analysis of benthic infauna community characterisation and sediment chemistry.

Further field surveys for benthic infauna were initiated in Stage 2 following selection of the diffuser location in 30 m depth in central Merimbula Bay. A total of 15 monitoring sites were established including four sites within the near-field mixing zone (diffuser to 25 m), five sites in the far-field mixing zone (25 m to 200 m), and six sites outside the far-field mixing zone at increasing distances from the diffuser.

Sediment samples were submitted to ALS under chain of custody (COC) for analysis of:

- Total Organic Carbon (TOC) – important for understanding current status of organic enrichment of sediments;
- Sediment Particle Size Distribution (PSD) sorted to 63 µm by laser diffraction – to characterise/demonstrate differences (if any) in sediment types between sites;
- Total Metals aluminium, arsenic, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, mercury, vanadium, zinc, antimony, beryllium, boron, cadmium and molybdenum and
- Nitrogen and Phosphorus nutrients.

Samples were sorted under dissection stereoscope, separating major taxonomic groups *(*i.e. polychaete worms, crustaceans, gastropods) with taxa identified to lowest practical taxonomic resolution and abundances of each taxon recorded. Taxon groups were stored in separate vials of 70% ethanol and archived as Project vouchers. Taxonomic identification QAQC included sending voucher specimens to the Australian Museum for identification checks. All voucher reference samples have been lodged with the Australian Museum marine invertebrate collection.

A qualitative assessment of sessile and mobile epifauna inhabiting the sandy seabed was based on observations recorded opportunistically from video surveys of the seabed.

The results of this survey are presented in **Section 11.3.8** and **Appendix G** (Marine Ecology Technical report).

11.2.9 Intertidal Rocky-Shore Community

The southern side of Haycock Point was sampled on 7 December 2017 with the northern side sampled on 2 January 2018 to examine the natural variation of the intertidal communities associated with different exposure aspects. Quantitative sampling focused on the low shore zone while the mid and high shore zones were qualitatively assessed.

Two replicate 25 m long transects were sampled within the low shore zone on the south side and two on the north side, with 12 photo-quadrats sampled per transect at random intervals.

The low shore zone available for survey was limited to sloping reef characterised by algae and cunjevoi. Vertical rock faces were present in the low shore zone, but these were excluded due to difficult access for assessment. Consequently, replicate transects targeting sloping reef areas were separated over a scale of 50 m to 100 m.

The results of this survey are presented in **Section 11.3.9** and **Appendix G** (Marine Ecology Technical report).

11.2.10 Phytoplankton assemblage

Review of available datasets from the following sources was undertaken:

- phytoplankton monitoring data collected by the oyster growers of Pambula and Merimbula Lakes as part of the NSW Shellfish Quality Assurance Program (NSWSQAP) and available from NSW Food Authority; and
- incidences of past regional (i.e. Twofold Shelf Bioregion) and localised phytoplankton bloom events (data held by OEH Coastal Sciences Section).

A field survey comprising four monitoring rounds was completed to provide a baseline description of the phytoplankton assemblage for the Merimbula Bay coastal region.

Five sites were sampled including three within Merimbula Bay, one northern site off Tura Beach and one southern site off Quondolo Beach.

The following tasks were conducted for each site:

- water samples for analysis of total phytoplankton species composition were collected using a plankton tow net (20 µm mesh, 245 mm diameter, 1.2 m length) with an attached 120 ml plastic jar drawn vertically through the water column from the maximum depth at each of the five sites. Samples were immediately preserved with Lugols solution and returned to the laboratory for taxonomic analysis of community composition;
- additionally, a 1 L surface water sample was collected from a depth of 0.5 m for phytoplankton counts from each site. Once back in the laboratory, water samples were gently concentrated using vacuum filtration on to a 5 µm millipore filter. Filters were then washed with filtered seawater to a final volume of 10 ml; and
- water quality depth profiles were recorded at each site using a YSI 6600-V2_4 sonde calibrated prior to sampling. In-situ measurement of water quality included parameters pH, temperature, dissolved oxygen, salinity, turbidity and chlorophyll a. A discrete water sampler was used to collect a sample from mid-water depth at each site for laboratory analysis of nutrients (NH_3, NO_2, NO_3, TN, TP, FRP, Chl a).

Phytoplankton taxa were identified and enumerated to the lowest possible taxonomic level (refer to **Section 11.3.10** and **Appendix G** (Marine Ecology Technical Report) for the results).

11.2.11 Drift algal biomass

Drift algae refers specifically to macroalgae or seaweed that is no longer attached to substrate and drifting freely over the seabed or as rafts on the sea surface.

Visual surveillance monitoring for accumulations of drift algal biomass was conducted opportunistically during marine ecology field investigations between 2017 and 2020. Visual inspections were carried out from a slow-moving vessel zig-zagging within the nearshore zone between Pambula and Merimbula (refer to **Section 11.3.11** and **Appendix G** (Marine Ecology Technical report) for the results).

11.2.12 Estuarine Communities

Estuarine habitats and communities with potential to be impacted by the Project were identified and examined through a desktop assessment of available literature from recent studies including:

- Pambula River estuary processes study (Cardno, 2012);
- Merimbula Lake flood study (Cardno, 2016);
- potential ecological impacts of dunal ex-filtration of treated wastewater (AECOM and Elgin, 2013);
- water quality and estuary health monitoring (Elgin, 2014); and
- estuarine macrophyte mapping (Creese et al., 2009; Cardno, 2012).

An analysis of the potential risks or benefits of the Project to recreational fishing in Merimbula and Pambula Lakes was also carried out which reviewed the current setting of the beach-face outfall and its relative location to the estuary entrances of both Merimbula and Pambula Lakes (refer to **Section 11.3.12** and **Appendix G** (Marine Ecology Technical report)).

11.2.13 Aquaculture

A desktop review of existing aquaculture operations within the study area was undertaken to assess and evaluate the potential impacts as a result of the Project, including the opportunity for future marine waters aquaculture in Merimbula Bay under the *Marine Water Sustainable Aquaculture Strategy* (MWSAS – DPI, 2018). A desktop evaluation of the risk of potential impact and constraints from construction and operational phases of the Project was also completed.

11.2.14 Introduced Marine Pest Species (IMPs)

A desktop review of available literature was undertaken to determine the IMPs recorded in or in proximity to the study area.

The *Introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales* is listed as a KTP under the FM Act and is considered with regards to its potential impact to the marine habitats and communities at the study area and broader Merimbula Bay.

11.3 Existing environment

11.3.1 Threatened and protected marine species

The desktop review undertaken for the marine ecological assessment identified 33 species to have a moderate to high likelihood of occurrence within the study area, including:

- five EPBC Act listed threatened cetaceans: Humpback whale, Southern right whale, Killer whale, Common dolphin, and Bottlenose dolphin;
- two EPBC Act and BC Act listed seals: New Zealand fur seal and Australian fur seal;
- four FM Act and or EPBC Act fish species: Black cod, Southern Bluefin tuna, Grey nurse shark and White shark (also referred to as a Great white shark);
- two syngnathids listed as protected under the FM Act: Big- belly seahorse and Weedy seadragon; and
- 20 marine birds that includes eight EPBC Act listed species and 14 BC Act listed species, with two birds listed under both Acts.

Significance assessments were conducted for each of these species as outlined in **Section 11.6** and detailed in **Appendix G** (Marine Ecology Technical report). A description of the species is provided below.

Humpback whale (Megaptera novaengliae)

Humpback whales are listed as Vulnerable on both the NSW BC Act and EPBC Act. The life cycle of Humpback whales in the Southern Hemisphere involves feeding and advancement to maturity in the Southern Ocean during summer months, followed by northward migration during winter to reproduce and give birth in subtropical and tropical waters (Jefferson *et al.*, 1993). Merimbula Bay is part of the biologically important area identified for the species and they are commonly observed within the embayment during their southern (September to November) migration. Locally, the western edge of the species southerly migratory pathway appears to follow the approximate 30 m depth contour of Merimbula Bay commencing offshore from Long Point south to Hunter Reef then south-east to Haycock Point. Individuals or mothers and calves may use Merimbula Bay for resting and foraging prior to moving southward.

Southern right whale (*Eubalaena australis*)

Southern right whales are listed as Endangered under both the NSW BC Act and EPBC Act. The species life cycle is based around summer feeding grounds in the Southern Ocean, before migrating to warmer waters along the coastal region of southern Australia between winter and spring to calve and breed. Southern right whales were subject to severe depletion across their range due to whaling in the late 18th and early 19th centuries and the current global population is estimated at 16,000 or between 16 to 27% of estimated pre-exploitation levels (IWC, 2010). The Australian population of Southern right whales is comprised of two genetically distinct sub-populations, a south-west and south-east population. Whales visiting NSW waters belong to the south-east population that is considered very small. Documented sighting records suggest there are a growing series of biologically important areas (BIAs) for the south-east population, these include Disaster Bay and Twofold Bay. Although it is generally thought that mainly non-calving individuals are frequenting these areas.

Smith (2001) has estimated the total number of Southern right whales now visiting NSW in any one year to be less than ten. There are several records of the species occurring within Merimbula Bay with the most recent sighting in 2016. For the most part, sighting a southern right whale in Merimbula Bay could be considered a rare occurrence.

Killer whale (*Orcinus orca*)

The Killer whale, often referred to as Orca, is listed as Protected under the BC Act and as *migratory* and *a whale or other cetacean* under the EPBC Act. Killer whales are rarely seen in nearshore coastal waters, foraging activity occurs primarily along the edge of the continental shelf/east-Australian boundary current, however they are also known to follow or occur close to prey aggregations, such as Humpback whale migration routes and seal colonies. The last sighting of a Killer whale in the region was in Twofold Bay in 2015, therefore this species is not expected to be a regular visitor to the Project area.

Common dolphin (*Delphinus delphis*) and Indo-Pacific bottlenose dolphin (*Tursiops truncates s. str.*)

The Common dolphin and Indo-Pacific bottlenose dolphin are listed as Protected under the BC Act and *as a whale or other cetacean* under the EPBC Act. Both species have a wide global distribution including the Temperate East and South East Marine regions. The Common dolphin mainly occurs in offshore waters, while the Indo-Pacific bottlenose dolphin prefers inshore coastal waters. Both species are regularly observed foraging across Merimbula Bay and the wider coastal waters of the BVSC region and both were sighted during marine ecology investigations for the Project. Merimbula Bay is not reported to be a breeding ground for either species.

New Zealand fur seal (*Arctocephalus forsteri*) & Australian fur seal (*Arctocephalus pusillus*)

New Zealand and Australian fur seals are listed as Vulnerable under the BC Act and as marine species on the EPBC Act. Colonies of non-breeding New Zealand and Australian fur-seal exist at Montague Island approximately 80 km to the north of the Project area, and a colony of non-breeding Australian fur seal are known at Green Cape. Both seal species are known to forage in waters offshore of Merimbula and Pambula and solitary Australian fur seals were observed within the Project area on multiple occasions during marine ecology investigations undertaken for this Project.

Black cod (Epinephelus daemelii)

The Black cod (*Epinephelus daemelii*) is a large reef-dwelling species belonging to the grouper family (Serrandiae). It occurs in the warm temperate and subtropical waters of the south western Pacific including south-eastern Australia, Lord Howe Island, Norfolk Island, the Kermadec Islands and northern New Zealand. The species Australian range includes from southern Queensland to eastern Victoria, with the NSW coastline forming the species main range.

According to sighting records held by ALA (2017) and RLS (2017), there have been four recorded observations of the Black cod in the BVSC region since 1972, none from Merimbula. These include Twofold Bay in 1972, Bitangabee Bay and Green Cape in 1989, and Bermagui in 2005. More regular sightings of black cod are reported from locations in the Eurobodalla shire region such as the Narooma breakwater and Montague Island (RLS, 2017). With only four confirmed sightings since 1972, the occurrence of a local viable population of black cod in the BVSC region can be considered rare, however suitable habitat is present within the Project area.

Southern bluefin tuna (*Thunnus maccoyii*)

Southern bluefin tuna (*Thunnus maccoyii*) is listed as endangered under the FM Act. It is a highly migratory pelagic fish, found in oceanic waters normally on the seaward side of the continental shelf. In Australian waters southern bluefin tuna range from north-western Australia around southern Australia to northern NSW. The western boundary of the species migratory path lies within NSW State waters.

The Southern bluefin tuna is targeted by recreational fishers in BVSC coastal waters each year, typically during July to January period as the species migrates northwards. The species is usually observed in deep offshore waters along the continental shelf and rarely sighted within Merimbula Bay. However, in January 2018, a solitary Southern bluefin tuna was observed in the Pambula broadwater likely having followed baitfish up the river (Merimbula News Weekly, 16 January 2018).

Grey nurse shark (*Carcharius taurus*)

Grey nurse shark is listed as Critically Endangered on both the NSW *FM Act* and *EPBC Act*. It is a large shark native to subtropical to cool temperate waters (DPI, 2007). In NSW, Grey nurse sharks are typically found in coastal inshore waters, around rocky reefs and boulders or sand filled gutters in water depths of 15 to 40 m but also spend some time in deeper waters (DPI, 2007). They tend to be found in groups at specific locations known as aggregation sites. It is these aggregation sites that are considered habitat critical to the survival of the species. The nearest known aggregation site of the Grey nurse shark considered critical to the species survival is Montague Island approximately 80 km north of the study area (DoE, 2014).

The Grey nurse shark has been reported from at least seven locations in the BVSC region (Refer Appendix 1 in DoE, 2014) including at Tura Head and Twofold Bay, to the north and south of Merimbula Bay respectively. In addition, Grey nurse shark sightings have been reported near to the Merimbula wharf on five occasions (2/12/2016, 8/4/2017, 12/10/2017, 21/1/2018, 11/12/2018 as listed by ALCW, 2020). No Grey nurse sharks were observed during marine ecology field surveys undertaken for this Project.

White shark (Carcharodon carcharias)

The White shark (*Carcharodon carcharias*), also referred to as a Great white shark, is a migratory species listed as Vulnerable under the FM Act. White sharks are found around south-eastern Australia from close inshore around rocky reefs, surf beaches and shallow coastal bays to outer continental shelf and slope areas. Adult White sharks are more frequently observed in regions with high prey density, such as fur seal colonies, and are long-lived, living for 30 years or more (DSEWPaC, 2013). Juveniles appear to aggregate seasonally in certain areas and in NSW, those areas include the coastal region between Newcastle and Forster.

White shark individuals are sighted along the BVSC coast each year, typically in the spring to summer period with the pattern of sighting records coinciding with the southerly migration of Humpback whales. No White sharks were observed during marine ecology field surveys undertaken for this Project.

Syngnathiformes

Syngnathiformes are a unique group of bony fish including seahorses, seadragons, pipefish, pipehorses, ghost pipefish and seamoths. They are protected under the NSW FM Act and EPBC Act and there are currently up to 31 syngnathids (seahorse, pipefish, pipehorse and seadragon), four solenostomids (ghost pipefish) and two species of pegasids (seamoths) that are known to exist in NSW waters.

The majority of these species are typically found in seagrass and algal habitats of estuaries and protected embayments, with six species recorded during estuarine surveys including: Alligator pipefish (*Syngnathoides biaculeatus*); Australian long-nosed pipefish (*Vanacampus poecilolaemus*); Hairy pipefish (*Urocampus carinirostris*); Port Phillip Pipefish (*Vanacampus phillipi*); Wide-bodied pipefish (*Stigmatophora nigra*); and Spotted pipefish (*Stigmatophora argus*).

Two species that may occur on the rocky reef habitats of Merimbula Bay include the Big-belly seahorse (*Hippocampus abdominalis)* and Weedy seadragon (*Phyllopteryx taeniolatus)*. The nearest reported population of the Weedy seadragon is from *Posidonia* seagrass and algal habitats in East Boyd Bay (Wilson *et al.,* 2016), approximately 30 km south of the study area. Syngnathiformes were not observed in marine ecology field surveys undertaken for this Project.

Migratory and marine birds

Twenty migratory and marine birds listed under the BC Act and or EPBC Act are considered to have moderate to high likelihood of occurrence within the study area. The Project area offers suitable foraging habitat for these marine birds, though none are reliant on the area for roosting or nesting. Nine of the species were observed foraging or transiting over Merimbula Bay waters within the study area during marine ecology surveys including:

- Wedge-tailed shearwater (*Ardenna pacificus*);
- Short-tailed shearwater (*Ardenna tenuirostris*);
- Silver gull (Chroicocephalus novaehollandiae);
- Little penguin (*Eudyptula minor*);
- Australasian gannet (*Morus serrator*);
- Black–faced cormorant (*Phalacrocorax fuscescens*);
- Pied cormorant (Phalacrocorax varius);
- Little tern (*Sternula albifrons*); and
- Crested tern (Thalasseus bergii).

Merimbula Bay represents a small proportion of the total area used for foraging by these species. A limited area of the beach zone that falls within the Project area may be used by some species for resting such as Silver gull, Little tern and Crested tern.

11.3.2 Water and sediment quality

Water and sediment quality are key aspects of the marine environment, with background conditions contributing to the distribution and condition of the biological communities present in the Project area prior to Project construction and operation. Changes to marine water and sediment quality may result in impacts to biological marine receptors, where the reduced water or sediment quality falls outside of the tolerance limits of a biological receptor.

A detailed description of the existing marine water and sediment quality in the Project area is provided in **Section 8.2** of this EIS, with a high-level overview provided below.

Offshore marine water quality

Ambient marine water quality data was collected following a 24-month long monitoring program (2014 to 2015 and 2016 to 2017) from sites within and outside Merimbula Bay and included data collection following three upwelling events.

Some indicators were higher following upwelling events, including nitrate, total nitrogen, chlorophyll-a, suspended solids, oxides of nitrogen, total phosphorus, orthophosphate, faecal coliforms and enterococci.

Coastal processes including tidal flows, significant weather events, strong ocean currents and estuary discharge all have a direct influence on the ambient water quality of Merimbula Bay and can result in the exceedance of Marine Water Quality Objectives (MWQOs).

The existing impact of treated wastewater disposal via the existing beach-face outfall has been modelled in terms of dispersion levels three days after discharge, (refer to **Section 8.2** of this EIS) for further information on dispersion modelling outputs.

Nearshore marine water quality

Nearshore marine waters include the area between the shoreline and the back of the surf zone for the stretch of beach between Merimbula and Pambula. Existing treated wastewater discharge via the existing beach face outfall contributes to the current water quality of the nearshore zone.

Additional data that is useful in understanding the water quality of the nearshore zone is the Beachwatch enterococci data which is collected from five sites in the study area including Short Point, Bar Beach, Merimbula Main Beach, Pambula Beach and Pambula River Mouth.

Dispersion modelling for the existing beach face outfall (refer to **Section 8.2** of this EIS) shows that treated wastewater disperses in a longshore drift parallel to the shoreline towards Beachwatch sites in both Merimbula and Pambula. It is possible that some of the Beachwatch enterococci counts are attributable to the treated wastewater. Enterococci counts are also likely influenced from other sources such as stormwater runoff into Merimbula and Pambula Rivers and its subsequent discharge to Merimbula Bay during ebb tidal flows.

Sediment quality

Particle size distribution results and sediment descriptions indicate variability in sediment types. Metals detected above the laboratory limits of reporting in one or more of the four sites included; aluminium, arsenic, chromium, cobalt, copper, iron, lead, manganese, nickel, selenium, silver, mercury, vanadium and zinc. However, all metals were reported below the applicable Low and High trigger values from the relevant Interim Sediment Quality Guidelines (ANZECC/ARMCANZ, 2000, CSIRO, 2005) (refer **Appendix E** (Water Quality Technical report) for further information).

Nutrients in sediment samples were reported as both totals (Total Nitrogen (TN) and Total Phosphorus (TP)) and individual nutrient species including ammonia, nitrite, nitrate, ammonia and reactive phosphorus. Nitrate and ammonia were reported in samples collected in proximity to the proposed diffuser location, with results indicating the majority of nitrogen species is in an organic form. Reactive phosphorus was reported in all four samples and represented a minor proportion of TP.

Total Organic Carbon (TOC) ranged between 0.08% (S0) and 0.2 % (S2) across the four samples collected (refer to Section 8.2 for sampling locations).

11.3.3 Marine habitats

Merimbula Bay – physical setting

Merimbula Bay 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 the seabed depth gradually increases with increasing distance from the shoreline. The seabed of Merimbula Bay is predominantly sand with extensive subtidal reefs extending from the north and the south. A large isolated subtidal reef that is surrounded by sand, known as Hunter Reef, lies approximately 500 m north of Haycock Point. The outer margins of Hunter Reef lie within the 35 m to 40 m depth contours with the reef system rising to its shallowest point approximately 10 m below the surface.

Video footage screenshots taken during field surveys in approximately 28 m water depth, inside the 500 m radius of the proposed diffuser location, illustrate a transition from relatively flat sand ripple areas (characterised by fine, medium grain sands), to large sand waves (characterised by coarser grain sands and shell material). The latter are indicative of a more active hydrodynamic environment along some sections of the ocean outfall pipeline alignment. These areas are also visible in the hydrographic survey data (MES, 2018).

Marine protected areas and sensitive ecological values

Biogeographical setting – marine bioregion

Merimbula Bay is situated within the South-East Marine Region of Australia (COA, 2015). Compared to other marine regions, the South-East Marine Region is relatively low in nutrients and primary productivity. However, in some locations, 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). Upwelling events occur under particular oceanographic and climatic conditions, with seasonal trends indicating a higher prevalence for upwellings to occur during spring and summer in NSW.

The continental shelf waters offshore of Merimbula are dominated by the East Australian current (EAC) and its eddy field. 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, which support fisheries and biodiversity, including top order predators, marine mammals and seabirds.

Merimbula Bay is also located at the boundary of warm temperate and cool temperate marine bioregions, 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.

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 are both listed as a nationally important wetland (DAWE, 2020). Both estuaries support significant areas of sensitive Coastal Wetland identified under the State Environmental Planning Policy (Coastal Management) 2018.

Critical habitat

There is no critical habitat for aquatic and marine species listed under the EPBC Act or FM Act located near Merimbula Bay. As such, critical habitat under these Acts was not assessed further.

Key fish habitat

According to the NSW DPI Policy and Guidelines for Fish Habitat Conservation and Management (NSW 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 (e.g. 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, are classified as the following key fish habitat types:

Type 2 – Moderately Sensitive Key Fish 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 infauna.
- 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 and includes an isolated patch of *Zostera*

seagrass estimated to be less than 5 m^2. 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.

Type 1 highly sensitive fish habitat (seagrasses, marine park or aquatic reserve, or declared critical habitat under the FM Act) does not occur within the study area. The nearest known Type 1 habitat comprises seagrass meadows and saltmarsh within the estuaries of Pambula River and Merimbula Lake.

Results of Stage 1 survey of seabed

Unconsolidated sediments comprise approximately 84% of the study area varying from fine to coarse sands, and terrain varying from flat (less than1 cm high), to ripples (less than 10 cm high), to waves (greater than10 cm high). Areas of sand waves are indicative of high current flow and typically comprise 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 study area with most of the reef associated with the Hunter Reef. The reef system occurs primarily between the 25 m 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 under large swell events. Reef substrates are highly varied including low relief to high relief bedrock and boulder fields.

A total of six benthic communities were identified within the area of investigation including:

- benthic 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 water depth; and
- isolated and small patch of *Zostera* seagrass in 14 m water depth.

Results of Stage 2 survey of the seabed along pipeline alignment

Similar to the environment described above from the Stage 1 surveys, 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. The terrain 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.

There are several sediment gutter-like features which 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. 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 5 m^2, it is considered Type 2 fish habitat.

Type 2 rocky reef habitat has been avoided by the pipeline alignment with the nearest rocky reef habitat located at Hunter Reef approximately 1,400 m to the south-east.

11.3.4 Sub-tidal Reef Community

Shallow Sub-tidal Reef

The sub-tidal reef community of Haycock Point is comprised of at least seven habitat types that have been previously described along the NSW coast. Five habitats were sampled including *Ecklonia* (kelp) forest, barrens, turf, mixed algae-fringe and deep reef habitat and two habitat types, *Pyura* and *Phyllospora* forest habitat, occur in shallower waters but were inaccessible for sampling due to safety reasons of the survey method employed.

Barrens and *Ecklonia* habitat are the most dominant habitats at Haycock Point occurring in depths between 4 m to 19 m. *Ecklonia* habitat was the most species rich habitat recorded, comprising of at least 18 species. Barrens habitat comprised a total of 13 species.

Five mobile invertebrates were recorded from sub-tidal habitats including:

- Long-spined urchin *C. rodgersii;*
- Carnivorous gastropods *Dicathais orbita* and *Cabestana spengleri*;
- Herbivorous gastropod *Astralium tentoriiforme;* and
- Limpets.

As many as three limpet species occur however due to their small size were identified collectively as ‘limpets’. The highest mean abundance of mobile invertebrates was found in barrens habitat with low numbers found in *Ecklonia* and turf habitat and no mobile invertebrates recorded in mixed algae-fringe or deep reef.

Intermediate Reef – Preliminary Findings

Various forms of consolidated reef were observed during surveys, ranging in complexity from relatively flat ‘low relief reef’ through to ‘high relief reef with overlying boulders’, ‘slab rock’ or ‘boulder field’. Intermediate reefs were characterised by a mosaic of benthic sessile invertebrates, with community composition varying with reef substrate and depth.

Much of Hunter Reef was represented by consolidated (continuous unbroken) reef dominated by a diverse array of sponges, black corals, octocorals, gorgonians, sessile and stalked ascidians, bryozoans, solitary stony corals and hydrocorals. Some mobile grazers were also common.

Reef margins at Haycock Reef, were generally comprised of large boulders and cobbles that supported a diverse assemblage of sponges, cnidarians, and ascidians. Long Point was dominated by sponges on areas of continuous reef, with cnidarians, ascidians, and non-geniculate encrusting coralline algae recorded on outer boundaries comprised of cobbles and small boulders.

Sea-whips were observed in areas of patchy reef covered with sand, along with a mixed assemblage of erect and cup sponges, hydrocorals, black corals and octocorals.

11.3.5 Abalone

A total of 715 abalone were counted across all sites with 66% of abalone observed belonging to the small and medium size classes (below 117 mm), with 34% of abalone belonging to the large size class (over 117 mm) and available for harvest. This is not unexpected for a location that is subject to regular commercial harvest.

A higher abalone count was recorded from sites located on the northern side of Haycock Point, which may be a result of two sites on the southern side characterised as low profile reef with less optimal habitat for abalone. The northern side of Haycock Point was comprised of extensive boulder fields and crevices not impacted by sand and considered optimal for abalone.

11.3.6 Fish assemblage

A total of 73 fish species were observed in the study area. Of the 73 species, 56 were bony fishes and 17 were classified as sharks or rays.

The fish assemblage of reef habitats was significantly different to macroalgae-covered reef and sand habitats. Reef habitat was found to support an overall higher diversity of species more evenly represented within that habitat. Macroalgae-covered reef areas and sand had lower species diversity and were dominated by high abundances of fewer species. Higher levels of diversity and abundance were observed on sand habitats near to reef areas.

Only three species were observed at the diffuser site and these were recorded at very low abundances during the field surveys.

All species observed during the surveys are common to south-eastern NSW and many of the species are popular with recreational anglers and targeted by commercial fishermen.

Five fish taxa listed as threatened or protected under the FM Act and or EPBC Act are predicted to occur in habitats within Merimbula Bay (refer to **Section 11.3.1**). None of these species were observed during field surveys.

11.3.7 Bioaccumulation in fish and shellfish

The Merimbula STP has operational policies and legal controls in its licence that mitigate the potential risk of bioaccumulative contaminants entering the STP treatment system and treated wastewater stream.

Potential bioaccumulative contaminants identified during the desktop review included metals, organochlorine (OC) and organophosphate (OP) pesticides, Per- and polyfluoroalkyl substances (PFAS) and microplastics.

Under current operating conditions, some metals were reported in the Merimbula STP treated wastewater, at concentrations above default guideline values for aquatic ecosystem protection. Dispersion modelling results for metals in treated wastewater discharged from the existing beach face outfall, identified that metals are likely to rapidly dilute in the nearshore beach zone, a short distance from the discharge point, with dispersion to the north and south along the beach (towards Merimbula Lake and Pambula Lake) and out into Merimbula Bay.

The aquatic biota sampling for metals, undertaken as part of this assessment, provides a baseline bioaccumulation dataset for existing conditions at Merimbula Bay and reference sites at Tura Head and Lennards Island. Target species included flathead, blue mussel and black-lip abalone. Baseline survey results indicate that:

- Zinc, as an essential trace metal, was detected in all three target species at concentrations that were within or slightly above data reported in the literature and slightly above generally expected levels in the food standards; and
- Cadmium, as a non-essential trace metal, was reported in blue mussels at four of the five sampling sites at concentrations that were within data reported in the literature and at or below maximum levels in the food standards.

The biota metals dataset is considered to reflect existing environmental conditions in this part of the NSW coast and there were no standout results for any of the sites, including the Merimbula Bay sites. The dataset provided no evidence to suggest a potential impact from bioaccumulative metals discharged in treated wastewater from the existing STP thus further enforcing that the risk of bioaccumulative metals to fish and shellfish is considered low.

The risk of OC and OP pesticides being present in the treated wastewater is also considered low because they are no longer commercially available due to bans on the use of these pesticides.

Merimbula Airport was identified as a potential PFAS source in the STP catchment. PFAS is not a parameter in the treated wastewater monitoring program, however, can be present in treated wastewater. The PFAS National Environmental Management Plan (NEMP) notes that further work in collaboration with the treated wastewater industry is to be undertaken to establish criteria and guidance in relation to PFAS for water authorities and environmental regulators. PFAS was not evaluated in the marine ecology assessment.

There is no known data from the Merimbula STP to indicated whether microplastics are likely to pose a risk to the receiving environment.

11.3.8 Epibenthic fauna and Benthic Infauna

Haycock Point sediment characteristics were different to Merimbula Bay. Haycock Point sediments were dominated by fine to medium grain sands, compared to the medium to coarse grained sediments of Merimbula Bay sites. Locations were characterised by similar levels of organic enrichment.

A total of 66 infauna taxa were recorded, where 12% of taxa were represented by a single specimen. Annelid worms made up the greatest proportion of taxa.

Merimbula Bay sites were characterised by a more diverse infauna assemblage than Haycock Point, with greater number of species and generally higher abundances. The difference between locations was attributed to the different physical properties of the sediment with the larger sediment particle size of Merimbula Bay favouring a more diverse infauna assemblage.

Epifauna observed within the study area include hermit crabs, sea stars, and the sessile Great sea pen (*Sarcoptilus grandis*).

11.3.9 Intertidal Rocky-Shore Community

The intertidal community of Haycock Point is comprised of at least 45 taxa with higher diversity observed at lower shore heights, which is typical for most intertidal shorelines.

Species composition and abundance was different between the southern and northern sides of Haycock Point. The low shore zone on the northern side was characterised by an increased cover of coralline algae with fewer gastropod species and overall lower abundances compared to the southern side was characterised by less algal cover and an increased cover of cunjevoi (sea squirts) and bare rock that provided habitat for a more diverse and abundant gastropod assemblage.

The dominant gastropods of the low shore zone include *Scutellastra peronii, Cellana tramoserica, Patelloida latistrigata* and *Montfortula rugosa*, which are suitable indicator species for monitoring changes in community composition at the low shore zone if required.

Green algal species that are known to respond rapidly to increased availability of nutrients were rare in the low shore zone but prevalent in the mid shore zone, although patchy in distribution.

11.3.10 Phytoplankton assemblage

Long-term monitoring data for eastern Australia show that phytoplankton assemblages, abundance and species composition: vary over short-term (days to weeks); within-year (seasonal); and over years (interannual-to-decades). At least 309 taxa have been recorded from these monitoring sites, although the phytoplankton community is typically dominated by 20 taxa mostly belonging to diatoms.

The EAC is a major factor controlling phytoplankton dynamics in the south eastern Australian region (as discussed in **Section 11.3.3**). Interannual community composition is predominantly driven by temperature and season. Blooms of phytoplankton can occur when upwellings of slope water bring, cold nutrient rich (phosphate, silicate and nitrate) water into the euphotic zone (layer close to the surface with enough light for photosynthesis to occur).

One harmless bloom event was reported in 2003 which impacted Merimbula Bay and a large portion of the far south coast region. One potentially harmful bloom was reported along the NSW far south coast region in 2016. No human illnesses were reported from that event.

Merimbula Lake and Pambula River estuary have reported the occasional exceedance of phytoplankton action limits (PALs) associated with several potentially harmful taxa through positive detections of biotoxins in oyster flesh (for a minor proportion of those PAL exceedances). While potentially harmful taxa are known to occur in most estuaries in NSW they are typically in low abundance and not a cause for concern. However, maintaining and protecting water quality is important in reducing future risk of potential harmful algal bloom events.

A total of 85 phytoplankton taxa were recorded across all sites included within the study area. Diatoms were the most diverse group and typically accounted for between 80 to 90% of total abundance. During an upwelling event on 7 April 2020, the assemblage was dominated by a tropical cyanobacteria (48% of total abundance).

Phytoplankton assemblage dynamics in the marine environment are highly variable and operate at large biogeographic scales responding to broadscale nutrient inputs and environmental factors. The local phytoplankton assemblage of Merimbula Bay is likely indicative of the broader bioregional assemblage at any point in time.

11.3.11 Drift algal biomass

Drift algae is a natural occurrence in the marine environment that can comprise a wide array of species that have been dislodged from their point of attachment and can accumulate on the seabed.

Major scale aggregations of drift algal biomass, often referred to as nuisance algal blooms, have been a historical issue for the Merimbula and Pambula communities. The use of the term bloom here refers specifically to macroalgae, those algae that are conspicuous to the naked eye, none of which are harmful to humans, either through primary or secondary contact. Blooms of macroalgae are distinct from blooms of microalgae which, as discussed in **Section 11.3.10**, can result in harmful algal blooms.

The occurrence of nuisance algal biomass is common to many coastal embayment's around the world and often symptomatic of eutrophication of waterways due to human activities. However, a winter-spring or spring-summer bloom is a natural seasonal occurrence for many macroalgal species, due to a range of environmental factors that provide stimulus for prolific growth and development of significant biomass.

Drift algal biomass in Merimbula Bay regularly observe two species of brown algae *Colpomenia sinuosa* and *Hincksia sordida*.

Anecdotal accounts of major aggregation events extend back to the 1950s and prior to the commissioning of the Merimbula STP and discharge of treated wastewater to the marine environment in 1971. A study on the nuisance algal blooms in 2012 investigated the alga *Hinksia* using nitrogen stable isotope analysis. Whilst this study was unable to unequivocally conclude that *Hinksia* was isotopically enriched with nitrogen derived from treated wastewater from Merimbula STP, it did conclude that drift algae in Merimbula Bay, including *Hinksia,* would utilise treated wastewater derived nutrients where available. This was along with a range of other potential nutrient sources including catchment inputs, slope water, groundwater discharge and release from benthic sediments. Assessing the relative contribution of nutrients from these diffuse sources is difficult due to their episodic nature.

Ocean water quality monitoring in Merimbula Bay between 2014 and 2016 provides a dataset of ambient background levels of nutrients and a range of metals in ocean waters. Median levels of nitrate in Merimbula Bay often exceeded the Australia and New Zealand Environment and Conservation Council (ANZECC) guideline (25 µg/L) for the protection of aquatic marine ecosystems. However, during upwelling events and intrusions of slope water to the coastal zone, nitrate levels have been measured well above this guideline in Merimbula Bay (126 to 138 µg/L), and in the range (>70 - 250 µg/L) previously reported for slope waters in other NSW regions. Upwelling events trigger blooms of phytoplankton and provide stimulus for increased primary productivity generally.

Drift algal biomass was detected in the nearshore zone during surveys between 2017 and 2020 including a minor scale accumulation in January 2018 and a major scale accumulation in October 2019. The major scale accumulation was largely un-noticed on the beaches by recreational users and indicates that these events likely occur more frequently than is often reported.

11.3.12 Estuarine community

Merimbula Lake and Pambula River estuaries are listed as wetlands of national importance, based on their significant ecological and cultural values (refer to **Section 11.3.3**). A range of habitats are supported in the estuaries including; seagrass meadows, mangroves, saltmarsh and intertidal sand/mud flats.

Both estuaries are characterised by good water quality and a high level of tidal flushing. Water quality assessments in both estuaries have also found that they are occasionally subject to high levels of nutrients, suspended solids and microbiological parameters (i.e. Faecal coliforms, Enterococci) from diffuse sources (i.e. catchment runoff and urban stormwater) during high rainfall events. Water quality improves quickly after rainfall events due to efficient tidal flushing.

A number of threatened wader and shorebirds have been recorded from both estuaries. There are no fish species listed as threatened under the FM Act or EPBC Act known to occur in the estuaries. However, at least six species belonging to the Syngnathiformes (seahorse, pipefish, pipehorses) and protected under the FM Act are known to occur. These include:

- Alligator pipefish (*Syngnathoides biaculeatus*);
- Australian long-nosed pipefish (*Vanacampus poecilolaemus*);
- Hairy pipefish (*Urocampus carinirostris*);
- Port Phillip Pipefish (*Vanacampus phillipi*);
- Wide-bodied pipefish (*Stigmatophora nigra*); and
- Spotted pipefish (*Stigmatophora argus*).

Both estuaries support a valuable oyster aquaculture industry (refer to **Section 11.3.13** below).

The natural amenity and significant ecological values of these estuaries are important assets to the coastal townships of Merimbula and Pambula, with the estuarine environment representing a key attraction for local residents and tourists that visit the coastal towns annually. They are among the most popular estuaries within the Bega Valley for recreational use, with swimming, boating, fishing, kayaking, paddle-boarding and snorkelling being popular activities.

11.3.13 Aquaculture

Oyster aquaculture is currently the only existing aquaculture within the study area, representing an important local industry in Merimbula Lake and Pambula River estuaries. The local industry is based primarily of Sydney rock oyster (*Saccostrea glomerata*), with smaller quantities of southern mud oyster (*Ostrea angasi*) also cultivated. The primary threat to sustainable oyster aquaculture is protection and maintenance of water quality.

Under normal ambient conditions, water quality of both Merimbula and Pambula estuaries is very good. Poor water quality can lead to eutrophication and increased risk of algae blooms and in particular harmful algal blooms (refer to **Section 11.3.10**). Poor water quality typically occurs following significant rainfall events with high levels of nutrients, suspended solids and microbiological parameters (i.e. faecal coliforms, enterococci), exceeding regulatory guidelines that can result in short-term closures of oyster harvest areas.

Merimbula and Pambula estuaries are characterised by a diverse assemblage of phytoplankton (refer to **Section 11.3.10**). For the monitoring period 2005 to 2016, occasionally elevated abundance of a potentially harmful taxon, that also exceeded the NSW PALs, was reported from both estuaries. However, only a few PAL exceedances resulted in a positive biotoxin detection.

Future opportunities for marine waters aquaculture, under the NSW Marine Waters Sustainable Aquaculture Strategy 2018, include the nearshore waters of Merimbula Bay. Merimbula Bay would be considered suitable for most forms of marine waters aquaculture, excluding sea pen aquaculture due to the generally shallow depths.

11.3.14 Introduced Marine Pest Species

IMP species pose a serious threat to biodiversity and marine primary production in NSW (NSW DPI, 2008). They can foul marine infrastructure, alter marine habitats, outcompete, or prey on, native species and put at risk Australia's fisheries and aquaculture industries. They may be introduced in various ways, including in ballast waters, attached to the hulls of domestic or international ships, or imported deliberately as aquarium or aquaculture species (NSW DPI, 2008).

The Introduction of non-indigenous fish and marine vegetation to the coastal waters of NSW is listed as a KTP under the FM Act and is considered with regards to its potential impact to the marine habitats and communities within the study area as well as broader Merimbula Bay.

Three IMPs reported from the Port of Eden, 30 km to the south, not yet reported at Merimbula Bay include; the dinoflagellate *Alexandrium catenella*, European fan worm (*Sabella spallanzanii*) and the New Zealand Screwshell (*Maoricolpus roseus*) (Pollard et al., 2003).

- *Alexandrium catenella* can exist as resting cysts within soft sediments. The Project would not disturb or move sediments at the Port of Eden, therefore the likelihood that this dinoflagellate would be translocated to Merimbula Bay is low. Whilst *Alexandrium catenella* was not reported in phytoplankton monitoring undertaken as part of this marine ecology assessment, it was reported in low abundance at Merimbula Lake between 2012 and 2013;

- for the European fan worm to be introduced to Merimbula Bay, it would first need to be transported as larval phase in ballast waters, and those ballast waters released at Merimbula Bay. In the southern hemisphere, spawning of *S. spallanzanii* has been reported to occur during the autumn to winter period, and coincides with falling water temperatures (11 ºC to 14 ºC, Port Phillip Bay in Currie et al*.,* 2000). Based on this, it can be assumed that the highest risk period for translocating *S. spallanzani* larvae in ballast water from Twofold Bay would typically be the winter to early spring (July to September), when local waters are typically cooler;
- the New Zealand screwshell is known to occur in deeper waters of the continental shelf off Merimbula, but it is not present within Merimbula Bay or the study area. If conditions at Merimbula Bay were suitable for the species, then it would likely already be present. The risk of translocating this species via vessels and equipment is considered low; and
- another two IMPs reported from Twofold Bay include; the Pacific oyster and European green shore crab (*Carcinus maenus*). Both species are already known to occur within the estuarine habitats of Merimbula and Pambula Lakes.

Other IMPs not yet detected in Twofold Bay but that are considered a possible high risk to coastal waters of the Twofold Shelf Bioregion include; the Yellowfin goby, Japanese goby, Northern Pacific sea star, *Caulerpa taxifolia* and Japanese kelp (*Undaria pinnatifida*). These IMPs could also pose a threat to habitats and species at Merimbula Bay.

11.4 Potential impacts – construction

Construction phase activities include installation of the ocean outfall pipeline, which would be carried out in two sections, as described below:

- Section one: STP to a location beyond surf zone – underground trenchless drilling method; and
- Section two: Installation of riser, connecting underground pipe (at a location beyond surf zone) to the offshore pipeline that continues to the termination point (diffuser) – laying of a 450 mm diameter pipeline on the seabed and with rock armour or concrete mattresses.

Potential impacts to marine habitats and communities associated with construction of the ocean outfall pipeline include:

- introduction of an IMP via construction vessels and equipment;
- disturbance to, and loss of, Type 3 soft sediment habitat as a result of establishing the pipeline and diffuser infrastructure;
- construction noise from vessels and equipment;
- vessel or anchor cable strike, resulting in injury or mortality of protected species;
- accidental spills from construction vessels and equipment causing a reduction in water quality;
- disturbance of sediments resulting in turbid plumes; and
- reduced opportunities for future marine waters aquaculture.

A summary of the construction related impacts and the associated risk level for each marine ecological receptor and value is outlined in **Table 11-10**.

11.4.1 Translocation or introduction of Invasive Marine Pests

There is potential for the introduction or translocation of an IMP to Merimbula Bay from Twofold Bay at the Port of Eden, which could potentially impact on the Merimbula Bay subtidal rocky reef habitat. One known translocation pathway from one area to another for fragments of *Caulerpa taxifolia* is via vessels or machinery that have not been thoroughly cleaned of such fragments between deployments. Similarly, planktonic larvae of organisms could conceivably be introduced to the waters of Merimbula Bay via ballast water discharge, which may also be possible for the *Perkinsus olseni* parasite, which poses a known direct threat to abalone populations. **Appendix G** (Marine Ecology Technical report) provides further details regarding these potential threats.

Introduction or translocation of an IMP from Twofold Bay, during construction phase activities, could potentially impact on the Merimbula Bay reef habitat and fish assemblage more widely. This is considered unlikely and a low risk, as is the risk of translocating the *Perkinsus* parasite to the resident abalone population via that transmission pathway. While these risks may be considered low, primarily due to the considerable distance (more than 2,000 m) between the construction site(s) and the subtidal rocky reef habitat off Long Point and Haycock Point, the risks nonetheless must be acknowledged and managed.

Other IMPs not yet detected in Twofold Bay but that are considered possible high risk to coastal waters of the Twofold Shelf Bioregion include; the Yellowfin goby, Japanese goby, Northern Pacific seastar, *Caulerpa taxifolia* and Japanese kelp (*Undaria pinnatifida*). These IMPs could also pose a threat to habitats and species at Merimbula Bay.

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 with implementation of standard environmental management practices and controls, in accordance with the *National Marine Pest Plan 2018-2023.* This would mitigate the risk of IMPs and other such vessel-borne threats during the construction phase (refer **Section 11.7**).

11.4.2 Construction equipment and vessel noise

Noise disturbance from the Project includes vessel and equipment noise generated during construction activities. Noise would be generated from vessel movements, installation of the pipeline and diffuser infrastructure on the seabed and the anchoring of the pipeline with protective concrete mattress or rock armour. Noise from these activities is classified as non-impulsive, steady-state continuous noise, as opposed to impulsive noise such as from activities involving pile driving, explosions, and airgun shots. Impulsive noise generation results in greater impacts to marine fauna than non-impulsive noise generation.

Marine fauna most likely to be affected by construction noise are marine mammals including; whales, dolphins and seals. Exposure to anthropogenic underwater noise can interfere with key life functions of marine mammals (i.e. foraging, mating, nursing, resting, migrating), by impairing hearing sensitivity, masking acoustic signals, eliciting behavioural responses, or in extreme cases (if the receptor is close enough to the noise source for long enough) possible physiological stress and / or injury.

A number of listed threatened and protected marine mammals have a high likelihood of occurrence within the Project area and are known to be sensitive to noise. These include; Southern right whales, Humpback whales, Killer whales, Bottlenose dolphins and seals. An assessment of underwater noise (refer to **Chapter 21 Noise and vibration (underwater)**) identified zones within which marine mammals may experience noise related impacts. The zone of potential hearing injury, where there is potential risk of permanent physiological impact (referred to as PTS), to low frequency cetaceans (i.e. Humpback whale and Southern right whale) is modelled to potentially occur within a 170 m radius from the noise source. Temporary hearing injury (referred to as TTS) for low frequency cetaceans may occur within a radius of 2.3 km from the noise source. For high frequency cetaceans (i.e. Killer whales and dolphins) there is a potential risk of TTS occurring within an 85 m radius of the noise source and for seals the potential risk of TTS may occur within a 70 m radius of the noise source. The zone of potential responsiveness (i.e. where any of the above marine mammals may show a behavioural response, such as avoidance), is considered to be within a 16 km radius of the noise source (refer to **Figure 11-2**).

The risk of noise impacts to whales can be reduced by timing construction works, where practicable, to outside of whale migration periods, and introducing safety zones (see **Section 11.7.3**). Of the marine mammals that may occur within the Project area, there is high likelihood for the Humpback whale to occur during its southerly migration between late August and early November, with dolphins and seals occurring in Merimbula Bay all year round. At a local level, the approximate 30 m depth contour of Merimbula Bay appears to be the western edge of the southerly migratory pathway for Humpback whales. Individuals, mothers and calves were observed following this depth contour commencing offshore from Long Point south to Hunter Reef then south-east to Haycock Point.

The Southern right whale is rarely seen in Merimbula Bay with the most recent sighting in 2016 and is generally considered rare in NSW (Smith, 2001). Similarly, the Killer whale is rarely seen in nearshore coastal waters, preferring to forage along the edge of the continental shelf with the last regional sighting in Twofold Bay in 2015.

The risk of noise impacts can be further reduced to low by implementing control measures such as safety zones (shut-down zones and watch zones) based on hearing threshold limits for those marine fauna likely to occur in the Project area. A shut-down zone of 170 m radius from the noise source would be implemented during June and November (Humpback and Southern right whale migration periods) and would result in works being shut-down (when safe to do so), if a whale is seen within this zone. A watch zone of 2.3 km radius, from the noise source, would also be implemented during June and November and result in marine fauna observers continuously monitoring for whale activity within this zone.

Noise modelling results indicate that permanent hearing (PTS) threshold levels for dolphins and seals would not be exceeded during Project construction activities, therefore no shut down zone is required. A 500 m watch zone would be implemented for dolphin and seals during noise generating activities.

Marine fauna observers would be present during all underwater noise generating activities and would record all marine fauna observed during shifts.

Dolphins and seals are exposed to regular boating traffic in Merimbula Bay for recreational, commercial and charter fishing purposes and are therefore regularly exposed to noise levels similar to those that are anticipated to be generated by the Project. They are therefore considered a lower risk of exposure to underwater noise generated from the Project. Dolphins may also be disturbed by construction vessels resulting in altered foraging behaviour (*i.e.* preference to move away to another area). Any potential change in their foraging and migratory behaviour is expected to be short-term. Control measures would be implemented to effectively mitigate the risk of these impacts, such as a safety zone of 500 m, vessel speed limits and use of marine fauna observers.

Birds and fish are generally considered to be less likely affected by construction noise and would avoid or move away from the area as required. However, it is now understood that fish with swim bladders are sensitive to noise disturbance although the physiological effects from noise are not yet well understood (Hawkins and Popper, 2017; Popper and Hawkins, 2019). As the works would be conducted over sand habitats characterised by a fish assemblage of lower diversity and abundance compared to rocky reef habitats (refer to **Section 11.3.7**) and in an area that does not contain habitat critical to the survival of a threatened or protected fish species, the risk of noise impacts to fish is considered minimal.

Noise levels from the proposed construction methods as described in **Chapter 2 Project description** are expected to be similar to the range of ambient steady state noise that already occurs in Merimbula Bay from recreational, charter and commercial vessels. Noise effects would be short-term, localised and it is considered that marine mammals and fish within the vicinity of construction activities would avoid or move away from the area as required. However, due to the sensitivity of marine mammals listed as threatened or protected species, the potential risk of non-impulsive underwater noise is considered a key issue that can be effectively managed at low level with adoption of routine mitigation measures during construction (refer **Section 11.7**).

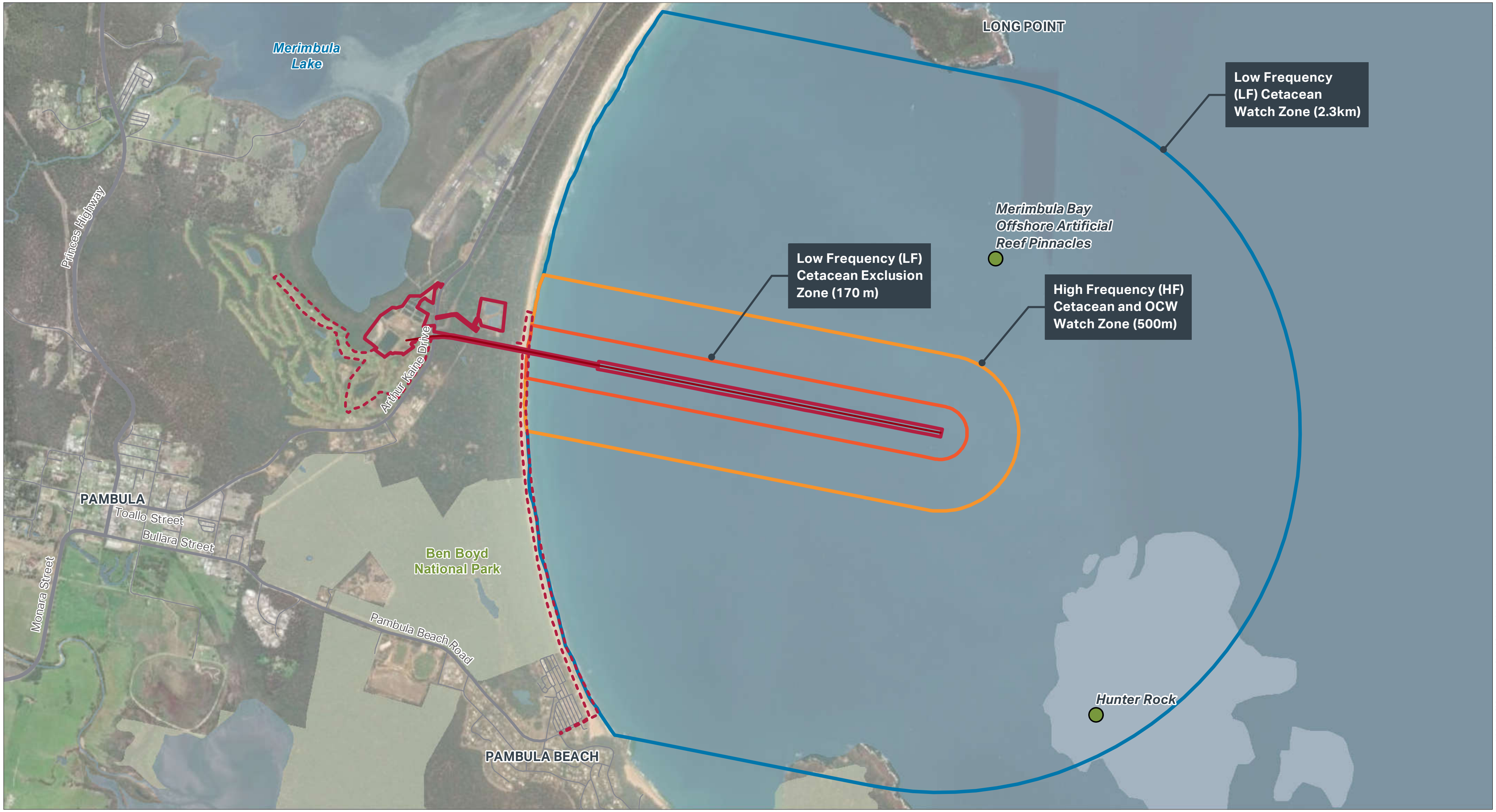

FIGURE 11-2: PROJECT SPECIFIC UNDERWATER NOISE SAFETY ZONES

0 500 1,000 m

Legend

- Project area
- Project area (temporary construction area)
- Approximate extent of reef
- Low Frequency (LF) Cetacean Exclusion Zone (170 m)
- High Frequency (HF) Cetacean and OCW Watch Zone (500m)
- Low Frequency (LF) Cetacean Watch Zone (2.3km)

Source: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

11.4.3 Vessel or anchor cable strike to marine mammals

Construction works would require vessels and materials to mobilise from Twofold Bay to Merimbula Bay. Construction activities broadly may include towing the pipeline to site, anchoring vessels, laying pipeline into position, and anchoring pipeline with protective concrete mattress or rock armour.

Vessel strike to marine fauna is a world-wide problem (Marsh et al., 2003) 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 Project area is most likely to involve slower moving marine mammals such as whales, with seals or dolphins considered at lower risk as they can easily out manoeuvre approaching vessels. Vessel strike has the potential to cause injury and or death, depending on vessel size, travel speed and species involved.

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 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 (**Section 11.7**).

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

There is the potential for hazardous substances (i.e. fuels, oils and other construction vessel related fluids) to accidently enter the water through spills or leaks from construction vessels and/or equipment. Water pollution resulting from an accidental spill would typically impact the water surface initially and depending on the scale of the spill and prevailing weather conditions, could potentially spread towards intertidal shorelines at Long Point, Haycock Point or beach zone.

Water pollution has the potential to cause harm to a wide variety of marine fauna, including; sessile and mobile invertebrates, fish, reptiles, birds and marine mammals. Marine mammals may swim and feed in or near an oil spill and some fish may be attracted to oil because it appears similar to floating food. Birds can then be attracted to schools of fish and inadvertently become covered in, or ingest, fuels or oils. Impacts from water pollution on marine fauna can potentially occur via ingestion or substances such as oils smothering their bodies, fur or feathers.

In the event of a large spill that could not be contained and managed, there may be changes in chemical composition over subsequent days, such that various product components would become mixed into the water column and or may potentially sink and impact the benthos that could include sandy seabed or rocky reef habitat.

The potential impacts of water pollution can be harmful and is considered a medium risk to marine fauna that occur or forage near surface waters, such as marine mammals and birds. Fish and subtidal communities are considered at low risk of impact. The potential risk can be reduced by implementing a range of routine control measures to protect water quality during the construction phase that would be outlined in a Construction Environmental Management Plan (CEMP) as discussed in **Section 11.7**.

11.4.5 Disturbance and loss of Type 3 soft sediment habitat

The installation of Section 2 of the offshore pipeline involves laying the proposed 450 mm diameter pipeline directly on the seafloor and anchoring with a protective 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 Type 3 soft sediment habitat, considered minimally sensitive with regard to fish habitat. Given there is in the order 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 benthic infauna or sessile epifauna 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. Sessile epifauna such as the Great sea pen may be present along the pipeline alignment and could be lost due to direct physical damage. 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.

No control measure is included in the Project to mitigate the loss of sand habitat and benthic infauna or epifauna within the construction footprint. The scale of the sand 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 sand 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 sandy 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 artificial reef that 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 result in an overall net increase in species diversity due to the intermediate disturbance that provides both early and late successional species an opportunity to establish. Therefore, the Project may result in a net positive effect on species diversity and abundance in the central region of Merimbula Bay.

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.

11.4.6 Disturbance of sediments resulting in turbid plumes

Impacts from the construction of the pipeline from activities such as pipe laying, rock armouring and / or laying concrete mattresses, installation of the riser, and installation of the diffuser, may result in an increase in sediments being suspended in the water column resulting in a turbid plume.

Any construction activity that may result in mobilising sediments would be short-term and therefore unlikely to have a negative impact on sub-tidal reef assemblages. However, to reduce the likelihood of turbid plumes, mitigation measures would be put in place (such as sediment curtains, where required in areas of soft sediments) and detailed in the CEMP..

11.4.7 Reduced opportunities for future marine waters aquaculture

Construction phase impacts to aquaculture considers the risk of construction activities to existing estuarine aquaculture and future opportunities for marine waters aquaculture in Merimbula Bay. Any potential impacts from the construction phase of the Project would only apply to Merimbula Lake given its proximity to the STP site.

The risk of construction impacts to ecological values of Merimbula Lake was assessed as minimal with works to be implemented under a CEMP that describes measures to mitigate risks. Therefore, risk of impact to oyster aquaculture from construction phase activities is also low to minimal.

The NSW Marine Waters Sustainable Aquaculture Strategy (MWSAS – DPI, 2018) has been adopted as an aquaculture industry development plan under the FM Act. As detailed in Section 11.3.13, under this strategy Merimbula Bay would be considered suitable for most forms of marine waters aquaculture, excluding sea pen aquaculture, due to the shallow depths.

Under the MWSAS there are three criteria and constraints applicable to the Project, where marine waters aquaculture operations would not be permissible. These are detailed in **Table 11-9**.

Table 11-9 Criteria and constraints relevant to marine waters aquaculture in Merimbula Bay (MWSAS - DPI, 2018).

Criteria	Constraint
3. Pipelines and cables	Must not be within 1 km of sewage outfall pipelines of protection zones for submarine cables.
6. Substrate type	Must not be located over rocky reefs
10. Marine infrastructure and monitoring equipment	Must not be within 1 km of marine infrastructure (i.e. mooring, boat ramps, marinas) and monitoring equipment (i.e. wave rider buoys, acoustic listening stations, IMOS buoys).

For Merimbula Bay, the pipeline and cables criterion is triggered by the proposed outfall, extensive areas of rocky reef are present at the northern and southern extent of the embayment, with the marine infrastructure and monitoring equipment criterion triggered by the DPI SharkSmart VR4G acoustic listening station situated off Merimbula Beach (see **Figure 11.3**).

The ocean outfall pipeline and outfall diffuser would therefore reduce the area of Merimbula Bay available for future marine aquaculture under the MWSAS (refer to **Appendix G** (Marine Ecology Technical report)).

11.4.8 Construction phase risks to marine ecological receptors and environmental values

The qualitative risk analysis addressing the likelihood and consequence of construction phase risks to marine ecological receptors and environmental values is provided in **Table 11-9**. The likelihood and consequence definitions and risk ratings tables are included in **Section 11.1.4**.

The risk ratings assume the mitigation and management measures outlined in **Section 11.7** have been applied.

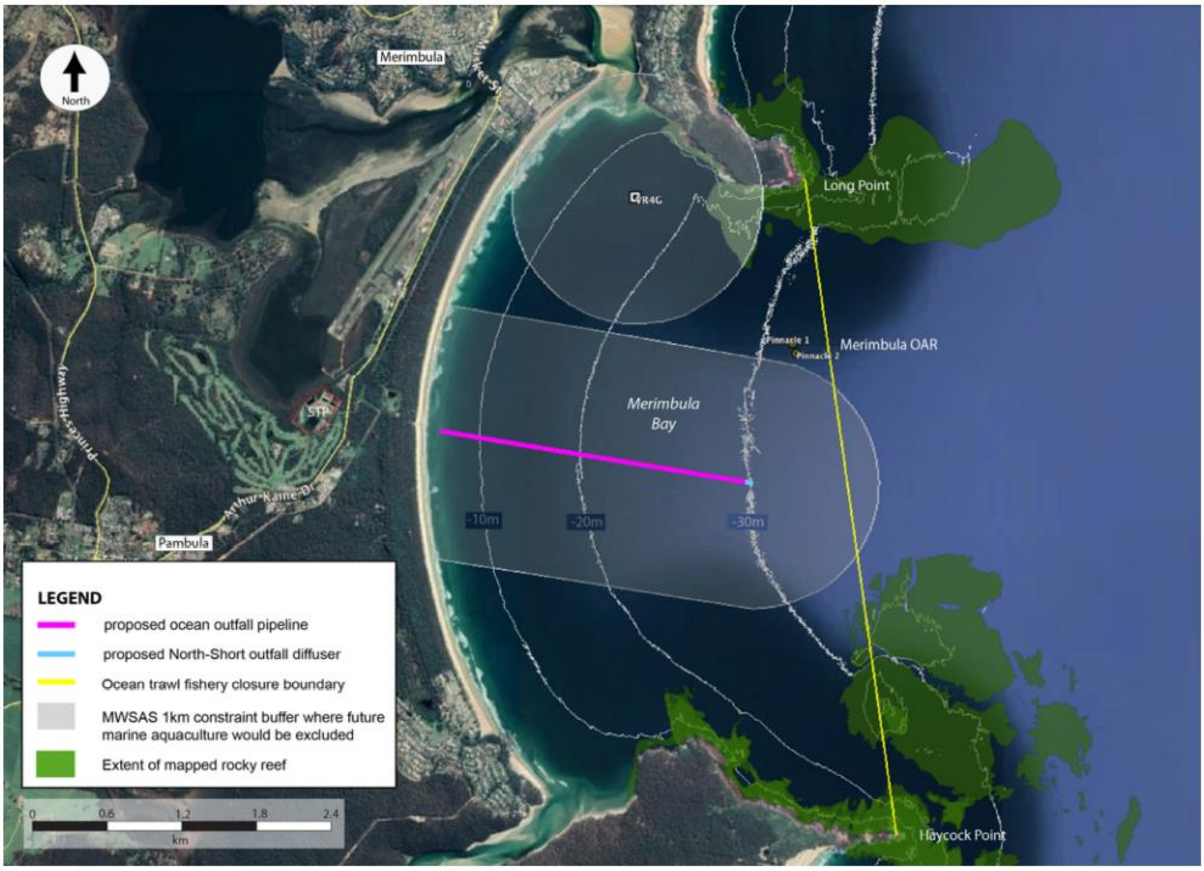

Figure 11-3 Constraint areas to potential future marine aquaculture in Merimbula Bay under MWSAS (DPI, 2018).

Table 11-10 Potential construction related impacts and risk level to marine ecological receptors and values (post mitigation)

Potential hazard / threat	Marine ecological receptors and values												
	Threatened and migratory marine mammals	Threatened and protected fish	Type 3 soft sediment marine habitat	Subtidal rocky reef communities	Abalone and abalone fishery	Fish assemblage	Benthic infauna communities	Intertidal reef communities	Phytoplankton	Drift algae	Estuaries	Aquaculture	Recreational and commercial fishing
Introduction of an invasive marine pests (IMP) via construction vessels and equipment	N/A	N/A	Low	Low	Low	Low	Low	N/A	N/A	N/A	N/A	N/A	Low
Disturbance to, and loss of, Type 3 sandy seabed habitat as a result of establishing the pipeline and diffuser infrastructure	Minimal	N/A	Medium	N/A	N/A	Low	Medium	N/A	N/A	N/A	N/A	N/A	N/A
Construction noise from vessels and equipment	Low	Low	N/A	N/A	N/A	Minimal	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Vessel or anchor cable strike, resulting in injury or mortality of protected species	Low	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Accidental spills from construction vessels and equipment causing a reduction in water quality	Low	Low	Low	Low	Low	Low	Low	N/A	N/A	N/A	N/A	N/A	N/A
Disturbance of sediments resulting in turbid plumes	N/A	N/A	N/A	Minimal	Minimal	Minimal	Minimal	N/A	N/A	N/A	N/A	N/A	N/A
Reduced opportunities for future marine waters aquaculture	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	Low	N/A

11.5 Potential impacts – operation

The potential impact to marine ecological values during the operational phase of the Project relate primarily to how the discharge of treated wastewater may impact the water and sediment quality of Merimbula Bay and the scale of that impact. Assessment of operational phase impacts was based on key findings from the water quality assessment in **Appendix E** (Water Quality Technical report) to this EIS identifying the following water quality threats:

- discharge of nutrients and toxicants above MWQOs to the mixing zone[7] that includes oxides of nitrogen (NOx), ammonia, total phosphorus, orthophosphate, faecal coliforms, enterococci, aluminium, arsenic, copper, iron, lead, selenium and zinc, including potential bioaccumulation risk of toxicants in fish and shellfish;
- discharge of treated wastewater resulting in marine waters with reduced salinity within the mixing zone that may result in mortality or reduced health of stenohaline species;
- increased suspended sediment load, organic particulate material, nutrients and toxicants settling to the seabed around the diffuser and within the mixing zone; and
- Reduction in nutrients available as a result of moving the existing beach face outfall

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 treated wastewater gradient. Exposure of marine communities to dispersing treated wastewater generally depends on their distance to the outfall.

A summary of the operational related impacts and the associated risk level assumed for each marine ecological receptor and value is outlined in **Table 11-11** and discussed below.

11.5.1 Potential impacts to water quality associated with treated wastewater discharge

The operation of the Project has a number of potential impacts associated with changes in marine water quality. A description of the background existing marine water quality, results of dispersion modelling and the potential impacts to marine water quality have been described in **Section 8.2**.

This section discusses the potential impacts reduced marine water quality may have on the marine ecology within the Project area, with a focus on a mixing zone around the discharge point.

11.5.2 Potential impacts due to changes in water quality

While not considered an end receptor in itself, potential impacts to marine water quality have the ability to result in indirect effects to other receptors that are sensitive to changes to one or more physical or chemical water quality properties.

These potential impacts are considered in the context of 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. 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 treated wastewater stream.

[7] The 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.

An ocean outfall would result in improved dispersion of treated wastewater and would reduce the risk of entrapment in the surf zone and therefore a reduction in the risk of nutrients (associated with the treated wastewater) entering Merimbula or Pambula estuaries.

Potential impacts to marine ecology, water quality and ecological receptors (based on modelling results presented in **Section 8.2)** include:

- under most conditions and majority of time (estimated at 99%), a mixing zone of 25 m is required to achieve necessary dilution to meet MWQOs. Ecological receptors within this mixing zone area is limited to sandy seabed habitat and its epifauna and infauna communities. The treated wastewater discharge would be buoyant and rise upwards in the water column, it is therefore likely that the majority of this nutrient load would be assimilated by phytoplankton within the mixing zone. Only a minor proportion of the nutrient load would be available to other marine flora in the mixing zone including benthic microalgae and may include drift algae on occasion when present within Merimbula Bay;
- fish and cetaceans would transit through this mixing zone on an intermittent basis. 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;
- 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 10th percentile and higher concentrations at upper 90th percentile, these combined conditions are predicted a minority, or 1%, of the time. Ecological receptors in this larger mixing zone is also limited to sandy seabed habitat and its epifauna and infauna communities; and
- the nearest 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 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) refer to **Figure 8-4**.

11.5.3 Bioaccumulation of toxicants in fish and shellfish

Dispersion modelling of a range of conditions indicates that the required dilution factor of 100 to achieve all metal default guideline values is predicted to occur within a 5 to 25 m diameter mixing zone around the diffuser (refer to **Section 8.4** of this EIS), which would be located in sandy seabed habitat. When enhanced metals removal is included in the STP upgrade, this mixing zone would be expected to be further reduced.

Sand foraging fish such as flathead would be expected to transit through this mixing zone on an intermittent basis with very low exposure time. The nearest rocky reef habitats for reef fish, abalone and other shellfish are located at least 1,400 m away (Hunter Reef), fish aggregation artificial habitat at 1,000 m distance (Merimbula OAR) and oyster aquaculture 2,700-3,000 m away (Merimbula and Pambula Lakes).

The relatively small mixing zone required for metal attenuation and the relatively large distances to these habitats indicates that the risk of bioaccumulative metals to fish, abalone and other shellfish is low and that the water quality objective of "bioaccumulation of contaminants – no change from natural conditions" would not be precluded by the Project.

11.5.4 Reduced salinity within the mixing zone

Based on the physical properties of the treated wastewater (i.e. lower in salinity and less dense than seawater), the treated wastewater would be buoyant upon discharge and rise upwards through the water column under normal conditions. Hydrodynamic processes would act to dilute and disperse the treated wastewater such that it is expected that salinity of the treated wastewater plume is near seawater levels at the edge of the 25 m mixing zone.

Impact to benthic communities and stenohaline species (i.e. marine species with low tolerance to variable salinity change) is possible within the immediate vicinity of the diffuser structure, but impact to broader Merimbula Bay marine environment is unlikely, due to rapid mixing effects. Episodic floodwater discharge to Merimbula Bay from estuaries would exert more influence over marine waters compared to discharge of treated wastewater at the outfall location.

11.5.5 Settlement of particulate matter associated with treated wastewater discharge

The potential impact to Type 3 soft sediment habitat is a change in sediment chemistry arising from the deposition of particulate organic material (POM) and contaminants adsorbed to particles discharged in treated wastewater. Accumulation of deposited POM can cause localised enrichment of sediments and or depletion of oxygen within those sediments. The benthic infauna community of Type 3 soft sediment habitats are known to be sensitive to such changes and the potential effects of enrichment, associated with treated wastewater discharges, has been widely studied both in Australia (Otway, 1995; Scanes and Philip, 1995) and overseas (Warwick, 1993; Gray and Elliot, 2009; Puente and Diaz, 2015). 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.

The benthic infauna community associated with the Project area is comprised typically of variable proportions of three main taxon groups; polychaete worms, crustacea, and molluscs, as well as other minor groups (nemerteans, sipunculids, cnidarians, echinoderms and fish) (refer to **Section 11.3.8**).

The scale of the potential impact is related to the hydrodynamic environment, volume and quality of treated wastewater being discharged, with higher energy environments such as deep water oceanic settings at lower risk of POM accumulation near the outfall.

Treated wastewater from the 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 a ten year period and is attributed to microalgae growth within the treated wastewater storage pond prior to discharge. The discharge of freshwater microalgae in treated 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 treated wastewater discharge, particularly during upwelling events. Overall, current treated wastewater quality is very high and in terms of POM accumulation to sediments within the mixing zone the risk would be relatively low, noting that upgrades to the STP would result in further improvements in treated 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 the marine ecology assessment (refer to **Appendix G** (Marine Ecology Technical report). It found 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 and small in scale compared to episodic nutrient inputs from upwellings and catchment flood events. In addition, 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 there be changes to sediment chemistry as a result of the Project, these would likely be limited to the near-field mixing zone of 25 m radius from the diffuser, with some level of change to the benthic infauna community possible. It is then expected that the magnitude and likelihood of potential change would decrease with increasing distance from the diffuser and the ability to detect change beyond the mixing zone, if some change has occurred, becomes less likely.

11.5.6 Changes to nutrient availability associated with change to outfall location

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 results in change of distance from treated wastewater discharge point to the above receptors. For example, the distance to receptors of Merimbula Lake and Pambula River estuary increases substantially with the ocean outfall compared to the existing beach face outfall. Conversely, ecological receptors of Hunter Reef, Haycock Point and Long Point and the OAR are closer to the proposed ocean outfall than the beach face outfall.

It is possible that communities that may have been subject to and benefited from nutrient inputs associated with the beach face outfall may be positively, or negatively, impacted as a result of the change in discharge location.

11.5.7 Operation phase risks to marine ecological receptors and environmental values

A summary of the operational related impacts assumed for each marine ecological receptor and value is outlined in **Table 11-11**. These risk ratings addressing the likelihood and consequence of operation phase risks to marine ecological receptors and environmental values based on the likelihood and consequence definitions and risk ratings tables included in **Section 11.1.4**.

The risk ratings assume the mitigation and management measures outlined in **Section 11.7** have been applied.

The cumulative impacts associated with the operation of the Project are addressed in **Section 27**.

Table 11-11 Potential operational related impacts and risk level to marine ecological receptors and values (post mitigation)

Potential hazard / threat	Marine ecological receptors and values												
	Threatened and migratory marine mammals	Threatened and protected fish	Type 3 soft sediment marine habitat	Subtidal rocky reef communities	Abalone and abalone fishery	Fish assemblage	Benthic infauna communities	Intertidal reef communities	Phytoplankton	Drift algae	Estuaries	Aquaculture	Recreational and commercial fishing
Discharge of levels of metals that exceed MWQOs within mixing zone* with potential to bioaccumulate in fish greater than natural background levels	Low	Low	Medium	Minimal	Minimal	Low	Medium	Minimal	N/A	N/A	Minimal	N/A	Low
Discharge of treated wastewater resulting in marine waters with reduced salinity within the mixing zone	Low	Minimal	Medium	Minimal	Minimal	Minimal	Medium	Minimal	N/A	N/A	Minimal	N/A	Minimal
Increased suspended sediment load, organic particulate material, nutrients and toxicants settling to the seabed around the diffuser and within the mixing zone	Low	Low	Medium	Minimal	Minimal	Low	Medium	Minimal	Minimal	Minimal	Minimal	Low	Low
Reduction in available nutrients as a result of moving the existing beach face outfall	Low	N/A	N/A	N/A	N/A	N/A	N/A	Minimal	N/A	N/A	Low	Low	Minimal

* the mixing zone is defined as a radius of 25 m from the diffuser 99% of the time and a 200 m radius 1 % of the time.

11.6 Significance assessment

11.6.1 Fisheries Management Act 1994

Part 7A of the FM Act includes in Section 220ZZ, seven factors which are to be considered when determining if a proposed development action or activity '…*is likely to significantly affect threatened species, populations or ecological communities, or their habitats'.* These seven factors must be taken into account by consent or determining authorities when considering a development proposal or development application.

Significance assessment under the FM Act were carried out for the following species:

- Black cod;
- Southern bluefin tuna;
- Great white shark;
- Grey nurse shark; and
- two members of Syngnathiformes (Big belly seahorse, and Weedy seadragon).

The significance assessments in **Appendix G** (Marine Ecology Technical report) found the Project is not likely to have an adverse effect on threatened or protected species listed under the FM Act.

The Project as a whole is not considered a KTP. However, in relation to the recognised KTP - *introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales*, a potential risk exists for this KTP to occur during Project construction activities. The Project construction phase would require vessels and materials to mobilise from Twofold Bay where a number of IMPs are known to occur. The risk of translocating an IMP via construction vessels is considered a medium risk that can be reduced by implementing environmental management controls as discussed in **Section 11.7.**

11.6.2 Biodiversity Conservation Act 2016

Section 7.3 of the BC Act includes five factors which are to be considered when determining if a proposed development or activity '…*is likely to significantly affect threatened species, populations or ecological communities, or their habitats'*. These five factors must be addressed by consent or determining authorities when considering a development proposal or development application.

Significance assessment under the BC Act were carried out for the following species:

- New Zealand fur seal;
- Australian fur seal;
- Southern right whale;
- Humpback whale;
- Killer whale;
- Common dolphin; and
- Bottlenose dolphin.

Based on the current information available for both the diffuser location, dispersion modelling, and the species of significance identified, the Project is not likely to have an adverse effect on threatened or protected species listed under the BC Act.

11.6.3 Environment Protection and Biodiversity Conservation Act

The EPBC Act Significant Impact Guidelines (DEWHA 2013) for threatened species and for endangered ecological communities was reviewed and the Project was assessed in relation to – *An action is likely to have a significant impact on a critically endangered, endangered or vulnerable species if there is a real chance or possibility that it would trigger one or more of the following nine impact criteria*. The assessment found that:

Criteria 1) The Project would not lead to a long-term decrease in the size of a population;

Criteria 2) The Project would not reduce the area of occupancy of the species;

Criteria 3) The Project would not fragment an existing population into two or more populations;

Criteria 4) The Project would not adversely affect habitat critical to the survival of a species;

Criteria 5) The Project would not disrupt the breeding cycle of a population or of an important population (for vulnerable species);

Criteria 6) The Project would not modify, destroy, remove, isolate or decrease the availability or quality of habitat to the extent that the species is likely to decline;

Criteria 7) By adopting environmental controls as recommended in **Section 11.7**, the Project is not likely to result in invasive species that are harmful to a critically endangered, endangered or vulnerable species becoming established in the species' habitat;

Criteria 8) The Project is unlikely to introduce disease that may cause the species to decline; and

Criteria 9) The Project would not interfere or interfere substantially (for vulnerable species) with the recovery of the species.

On this basis, it is determined that the Project would not have a significant impact on a matter of national environmental significance and a referral under the EPBC Act is not required.

11.6.4 Summary

Based on the findings of the significance assessments, it is concluded that the Project is not likely to have an adverse effect on the threatened or protected species listed under the FM Act, BC Act, or EPBC Act.

11.7 Management of impacts

The mitigation measures identified to help avoid and minimise the identified marine ecology impacts of the Project are listed in **Table 11-12**, and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

11.7.1 Performance outcomes

The marine ecology performance outcomes for the Project are as follows:

- the Project design considers all feasible measures to avoid and minimise impacts on marine biodiversity;
- the Project is designed, constructed and operated to avoid or minimise impacts on protected and sensitive species; and
- the Project would be designed, constructed and operated to achieve these performance outcomes.

11.7.2 Consideration of the interaction of measures

Mitigation measures in other chapters that are relevant to the management of potential marine ecology impacts include:

- **Chapter 8 Surface water, hydrology and flooding,** specifically measures SWF1, SWF2 and SWF4 which address water quality impacts in Merimbula Bay during construction and operation
- **Chapter 10 Marine and coastal processes**, specifically measures MC1 to MC5 which address impacts to marine and coastal processes during construction and operation
- **Chapter 21 Noise and vibration (underwater),** specifically measure NVU1 which requires preparation of a Construction Noise and Vibration Management Plan (CNVMP) for the Project. The Plan would include underwater noise and vibration mitigation measures, including implementing safety zones.

11.7.3 Mitigation and management measures

Mitigation measures to manage risks associated the marine ecology are provided below in **Table 11-12.**

Table 11-12 Mitigation measures – Marine ecology

Ref #	Potential impacts	Mitigation and management measures	Timing
ME1	Introduction or translocation of marine pests (It is expected that construction vessels would adopt standard environmental management practices and controls that meet the broad objectives of the *National Marine Pest Plan 2018-2023* to mitigate the risk)	All contractors must undertake a vessel risk assessment prior to mobilising the vessel to site. This would include an inspection of all vessels and equipment considered uncertain or at high risk for introduction of invasive marine pest (IMP). Any vessel or equipment mobilising to site from outside of Australia would automatically be considered high risk and an IMP inspection would be required	Construction
ME2		Construction vessel antifouling must be maintained to avoid the attachment and potential translocation of IMPs from Twofold Bay	
ME3		No sediments from Twofold Bay are to be disturbed or carried by construction vessels en-route to Merimbula Bay	
ME4		Ballast water management procedures are to be adopted by all construction vessels and barges in accordance with the *Australian Ballast Water Management Requirements* (DAWE, 2020)	
ME5	Underwater noise disturbance	A CNVMP would be prepared as part of the Construction Environmental Management Plan (CEMP), and would include measures for minimising underwater noise emissions. The CNVMP should include general feasible and reasonable work practices as identified in 'Section 6 Work practices' of the *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change (DECC), 2009). The CNVMP would include the following measures as a minimum: • undertake works during standard construction hours where practicable; • works undertaken during June to November during the whale migration period (southern right and humpback whale southern migrations) would be avoided where possible, or otherwise minimised. If work is required within this period adopt a safety shut-down zone of 170 m and a watch zone of 2.3 km where work activity would either be temporarily halted or varied in event that a LF cetacean occurs within these zones; • works undertaken outside of June to November, will implement a watch zone of 500 m where marine mammals	Construction

Ref #	Potential impacts	Mitigation and management measures	Timing
		(dolphins and seals) will be observed and recorded. No shut down zone is required; • vessels are to have a trained marine mammal observer onboard during all underwater noise generation activities, to record observations of when a cetacean or pinniped enters the 2.3 km watch zone. All marine fauna sightings are to be recorded; • prior to commencing noise disturbance activities, the watch zone is to be clear of marine mammals for a period of at least 10 minutes; • all injured marine mammals should be immediately reported to ORRCA (02 94153333) and National Parks and Wildlife Service Merimbula office (02 64955000); and implement vessel speed limits to reduce vessel noise.	
ME6	Accidental spills and mobilisation of marine sediments	Routine control measures to protect water quality during the construction phase are to be outlined in a CEMP. The CEMP would outline the following minimum control measures to mitigate the risk of accidental spill of hazardous substances from construction vessels and equipment and the mobilisation of sediment as a result of construction activities: • all contractor vessels to demonstrate a spill response plan that includes procedures, roles and responsibilities. The plan should include contact details of authorities that are to be notified in the event of a spill including NSW EPA; • spill response plan to be included as part of general site works induction; • All contractor vessels to carry spill response kits; • secure and safe storage of all fuels, oils and fluids for construction equipment; and; • where required, construction will use specialised equipment such as sediment curtains or similar to reduce the likelihood of turbid plumes.	Construction
ME7	Marine mammals, risk of vessel strike	The Project CEMP would also include provisions for mitigating risk of vessel strike to whales when mobilising to site. Control measures to be adopted to reduce risk of vessel or anchor cable strike include: • construction phase works to be undertaken where practicable outside of peak whale migration periods (June and November);	Construction

Ref #	Potential impacts	Mitigation and management measures	Timing
		• vessels to adopt safe travel speeds no greater than 10 knots when mobilising to site; • vessels maintain a 300 m exclusion zone with all whales en-route to and from construction site; • slower speeds adopted in the event a whale is observed within 100 m of the vessel; and • vessels are to have a trained marine fauna observer onboard to record observations of marine fauna when transiting in the vessels.	
ME8	Changes in water quality associated with treated wastewater discharge	• Upgrades to STP process such as PAC dosing, UV treatment and tertiary filtration if required; • Long-term strategy to upgrade reticulated water system to reduce copper and zinc concentrations in treated wastewater streams; and • Operational water quality monitoring.	Operation
ME9	Settlement of particulate matter associated with treated wastewater discharge	• upgrades to the STP will improve treated wastewater quality; and • operational monitoring to include infauna and sediment from sites within an outside of the mixing zone to assess any potential impacts from the wastewater discharge.	Operation

11.7.4 Residual risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for marine ecology and is provided in **Table 10-8**.

A level of assessment was undertaken commensurate with the potential degree of impact the project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the environmental impact after the proposed mitigation measures have been implemented.

Table 11-13 Environmental risk analysis with mitigation– Marine ecology

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Translocation or introduction of Invasive Marine Pests	Construction	ME1, ME2, ME3, ME4	Moderate	Unlikely	Low
Underwater noise disturbance	Construction	ME5	Minor	Unlikely	Low
Accidental Spills	Construction	ME6	Minor	Unlikely	Low
Marine mammals' risk of vessel strike	Construction	ME7	Minor	Unlikely	Low
Changes in water quality associated with treated wastewater discharge	Operation	ME8	Minor	Likely	Low
Settlement of particulate matter associated with treated wastewater discharge	Operation	ME9	Minor	Possible	Low

11.8 Environmental operational monitoring

As part of operational licence requirements, water quality monitoring of marine and estuarine waters would be undertaken. Details for a proposed water quality monitoring program are included in **Appendix E** (Water Quality Technical report).

The operational water quality monitoring program is likely to run in parallel with a marine ecological monitoring program. Components for the marine ecological monitoring program would be based on risk of impact as indicated by the operational water quality monitoring and may include:

- benthic infauna monitoring to validate assumptions of dispersion modelling, the extent of the mixing zone and predicted impacts on water quality;
- sampling of fish and shellfish for bioaccumulative contaminants;
- monitoring the pipeline and diffuser infrastructure to validate predictions regarding enhancement of local biodiversity through creation of Type 2 habitat; and
- a strategy for operational phase monitoring of abalone populations in the form of a two-data-source approach to be able to quickly detect potential changes to Merimbula Bay abalone populations, and accurately and reliably assess whether any changes detected could reasonably be attributable to treated wastewater discharge though the risk is assessed as minimal to low.

- source 1 would involve analysis of fishery-dependent Catch Per Unit Effort (CPUE) data; and
- source 2 would involve analysis of fishery-independent data in the form of diver field surveys of abalone abundance and population size structure.

Alternatively, a two-stage approach could be implemented, for which Source 2 data (field surveys) would only be required if triggered by Source 1.

12.0 Terrestrial ecology

This chapter provides a summary of the terrestrial ecology impacts associated with the Project.

A detailed Biodiversity Assessment Report (BAR) has been prepared for the Project and is included in **Appendix H** (Biodiversity Assessment Report).

Table 12-1 sets out the requirements as provided in the SEARs relevant to terrestrial ecology and where the requirements have been addressed in this EIS.

Table 12-1 SEARs – Biodiversity

Ref	Assessment requirements	Where addressed in this EIS
4.1	The Proponent must assess biodiversity impacts in accordance with the Framework for Biodiversity Assessment (FBA).	**Section 12.1.1**
4.2	The Proponent must assess impacts on threatened biodiversity, native vegetation and habitats resulting from any changes to hydrology.	**Section 12.2.3** **Section 12.2.4**
4.3	The Proponent must assess impacts on Endangered Ecological Communities (EECs), threatened species and/or populations, and provide the information specified in s9.2 of the FBA.	**Section 12.2.1** **Section 12.7**
4.4	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 *Threatened Species Conservation Act 1997* (TSC Act), *Fisheries Management Act 1994* (FM Act) and *Environment Protection and Biodiversity Conservation Act 2000* (EPBC Act).	**Section 12.5**
4.5	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.	**Chapter 11 Marine ecology**
4.5	The Proponent must 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.	**Chapter 11 Marine ecology**
4.7	The Proponent must identify impacts to coastal wetlands and consider: (a) the category of wetland that is being impacted; (b) whether the wetland itself and/or its buffer area is being impacted; (c) the extent of the impact; (d) the condition of the wetland or buffer area subject to the impact; (e) any indirect impacts; and (f) the measures proposed to minimise impact.	**Section 12.2.3** **Section 12.3** **Section 12.7**

Ref	Assessment requirements	Where addressed in this EIS
4.8	The Proponent must outline the considerations of site maintenance and proposed plans for the final condition of the site (ensuring its suitability for future uses) including rehabilitation of the site.	**Section 12.7**

12.1 Assessment approach

12.1.1 Legislative and policy context

The biodiversity assessment has been undertaken in accordance with the following legislation and statutory planning instruments:

- *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act);
- *Biodiversity Conservation Act 2016* (BC Act);
- *Fisheries Management Act 1994* (FM Act);
- *Water Management Act 2000* (WM Act); and
- *State Environmental Planning Policy (Coastal Management) 2018* (Coastal Management SEPP).

Policies and guidelines

The BAR has been prepared to assess the impacts of the Project on biodiversity values in accordance with the requirements of the NSW Biodiversity Offsets Policy for Major Projects and the Framework for Biodiversity Assessment (FBA).

The FBA provides the assessment methodology required to quantify and describe the biodiversity values within the study area, and the methodology to assess the biodiversity offsets required for any unavoidable impacts.

The BAR for the Project has assessed the impacts on all EPBC Act listed threatened species and ecological communities that may be on the study area using the significant impact criteria and guidelines established by the Commonwealth.

The FBA applies predominantly to terrestrial impacts. The assessment of impacts of the Project on aquatic environments is provided in **Chapter 11 Marine ecology**.

The BAR has also considered the following guidelines:

- The Biodiversity Assessment Method and Offset Rules (OEH, 2017);
- NSW Threatened Biodiversity Survey and Assessment: Guidelines for Developments and Activities – Working Draft November 2004 (NSW DEC, 2004);
- Draft Threatened Species Survey and Assessment: Guidelines (NSW Department of Environment and Conservation, 2004);
- Commonwealth Survey Guidelines for Australia's Threatened Frogs (DEWHA, 2010);
- Matters of National Environmental Significance Significant Impact Guidelines 1.1 Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth, 2013); and
- Biobanking Assessment Methodology (BBAM) and the Biobanking credit calculator (BBCC).

12.1.2 Methodology

Study area

A preliminary study area was identified at the commencement of the preliminary design for the Project. This comprised those onshore areas that were initially considered likely to have been affected by the Project and comprised the Merimbula STP and the land to the east between the STP and Merimbula Beach. At the outset of this assessment, survey and assessment was concentrated within the preliminary study area.

In response to ongoing design refinement, the study area was reviewed to also comprise:

- a small area of vegetation between Pambula Surf Life Saving Club (SLSC) and Pambula Beach that would require clearing to provide construction access to Pambula Beach;
- Pambula Beach extending north to the location where the proposed pipeline would meet the beach. This is for temporary access during construction; and
- parts of the Pambula Merimbula Golf Club (PMGC) grounds which would be used for a temporary laydown area during construction.

In summary, for the purposes of this terrestrial ecology assessment, the study area is defined as the onshore, above-ground areas that would be affected by the Project including the Merimbula STP and the land to the east between the STP and Merimbula Beach as well as the proposed temporary construction access, storage and laydown areas. The study area is inclusive of the preliminary study area. The study area is also referred to as the ‘development footprint’ in the BAR. The study area for the BAR is shown on **Figure 12-1.**

FIGURE 12-1: TERRESTRIAL ECOLOGY STUDY AREA

0 300 600 m

AECOM

Legend

- Project area
- Project area (temporary construction area)
- Preliminary study area
- Study area

Source: Department of Customer Service, 2020;

Desktop assessment

The desktop assessment included a review of the following information sources, databases and aerial photography and spatial datasets:

- Environment, Energy and Science Atlas of NSW Wildlife (10 kilometre (km) radius search) (EES, 2020);
- EPBC Act Protected Matters Search Tool (10 km radius search) (DoAWE, 2020);
- Vegetation of South East NSW: a revised classification and map for the coast and eastern tablelands (Tozer et al, 2010);
- Biometric vegetation types of the Shoalhaven, Eurobodalla and Bega Valley local government areas GIS layer (OEH, 2013);
- NSW Vegetation Information System (VIS classification database) (OEH, 2015b); and
- NSW Threatened Species Profile Database (OEH, 2015c).

Field surveys

The assessment presented in the BAR was undertaken in accordance with the survey guidelines specified by the SEARs, which is outlined in Section 2.1.1 of **Appendix H** (Biodiversity Assessment Report).

In addition, the number of vegetation plots/transects utilised in this assessment meets or exceeds the FBA minimum number of plots required (OEH 2014b).

The field survey methods employed to undertake the field assessment of the biodiversity values of the study area are outlined below. The surveys conducted considered the relevant survey guidelines for various threatened species. If information was not available on whether or not threatened species occurred within the study area, then a precautionary approach was adopted, whereby the presence of the species was assumed. This approach is consistent with the SEARs, FBA, and relevant impact assessment guidelines.

Avoidance strategies

A number of avoidance strategies were incorporated into the Project and field assessment. This includes the following:

- preliminary constraints analysis - undertaken at the outset of the Project. this identified a number of biodiversity constraints at the outset of the assessment process including EEC, coastal wetlands and known or potential threatened species;
- alternate designs and construction methods - biodiversity constraints identified during the preliminary assessment influenced the Project design, which has been designed to avoid and minimise impacts on terrestrial biodiversity. This was achieved by:
    - largely restricting the footprint of the proposed works to the footprint of the existing STP;
    - constructing the 0.8 km onshore component of the proposed ocean outfall pipeline using the underground trenchless drilling method;
- utilising existing access tracks and stockpiling locations - the Project would utilise existing access roads and tracks as far as possible to avoid the need to construct new roads and associated vegetation disturbance; and
- stockpiling location - the location of stockpiles and material storage areas would utilise existing disturbed/cleared areas or areas within the existing STP that support regrowth scrub. No relatively undisturbed native vegetation would be cleared for stockpiling.

Preliminary vegetation mapping and habitat assessment

Vegetation communities were identified from a combination of floristic surveys and transect traverses conducted on 8 and 9 August 2017. Plant community types (PCTs) were assigned according to classifications as per *Native Vegetation of South East NSW: a revised classification and map for the* *coast and eastern tablelands* (Tozer et al. 2010) and the *NSW Vegetation Information Systems* (VIS) classification database (OEH 2015b).

To assess the habitat potential of the study area, hollow bearing trees, sheltering habitats, feed trees and other foraging resources, and other potentially important habitat resources were recorded.

Biometric plots

Biometric plots were undertaken in accordance with the FBA over two days (9 August 2017 and 11 February 2020) and included:

- a 20 metre (m) by 20 m full floristic plot;
- a 20 m by 50 m plot identifying hollow bearing trees and fallen wood; and
- a 50 m transect to collect data on canopy cover, mid-storey cover, and ground cover for native and exotic species.

Flora

Targeted flora searches for threatened species potentially occurring in the study area were undertaken within the Project area and immediate surrounds on 11 February 2020.

Fauna

Fauna surveys were undertaken as opportunistic sightings. Additionally, any evidence of fauna, including diggings, evidence of foraging and scats, were recorded. Fauna habitat assessments were also undertaken on 8 and 9 August 2017 and 9 October 2020 to identify important habitat features that may provide potential habitat for threatened fauna. Any potential habitat for threatened fauna species, including features such as hollow bearing trees, water habitats and foraging substrates occurring within the Project area were recorded.

12.2 Existing environment

The study area is located in the South East Corner Interim Biogeographic Regionalisation for Australia (IBRA) Bioregion and South East Coastal Ranges IBRA subregion. Typical of this coastal bioregion, the study area is characterised by extensive areas of remnant native vegetation with patches of urban and semi-rural development. The study area is located within the Bodalla-Nadgee Coastal Sands Mitchell landscape and is mostly located on Holocene sand sheet, between Merimbula Beach and Merimbula Lake. No watercourses have been identified within the Project area.

12.2.1 Native vegetation

Five PCTs occur within the study area, three of which are listed as threatened ecological communities (TECs). Two of these PCTs would be directly impacted by the Project. PCT 777 would be impacted during vegetation clearing required at the STP site and PCT 772 during minor vegetation clearing that may be required to decommission the beach-face outfall pipeline. These are described below in **Table 12-2** and shown on **Figure 12-2** and **Figure 12-3**.

Table 12-2 Plant community types and TECs in the Project area and immediate surrounds

Plant community type	TEC	Occurs in the Project area
Coast Banksia - Coast Wattle dune scrub of the Sydney Basin Bioregion and South East Corner Bioregion (PCT 772)	No	Yes
Coast Grey Box - Mountain Grey Gum - stringybark moist shrubby open forest in coastal gullies, southern South East Corner Bioregion (PCT 777)	No	Yes

Plant community type	TEC	Occurs in the Project area
Bangalay - Old-man Banksia open forest on coastal sands, Sydney Basin Bioregion and South East Corner Bioregion (PCT 659).	Bangalay Sand Forest of the Sydney Basin and South East Corner Bioregions (BC Act)	No
Forest Red Gum - Woollybutt - Pithy Sword-sedge swamp woodland in dune swales near Pambula, southern South East Corner Bioregion (PCT 839).	Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (BC Act)	No
Swamp Paperbark - Swamp Oak tall shrubland on estuarine flats, Sydney Basin Bioregion and South East Corner Bioregion (PCT 1236).	Swamp Oak Floodplain Forest of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions (BC Act) Coastal Swamp Oak Forest of New South Wales and South East Queensland (EPBC Act).	No

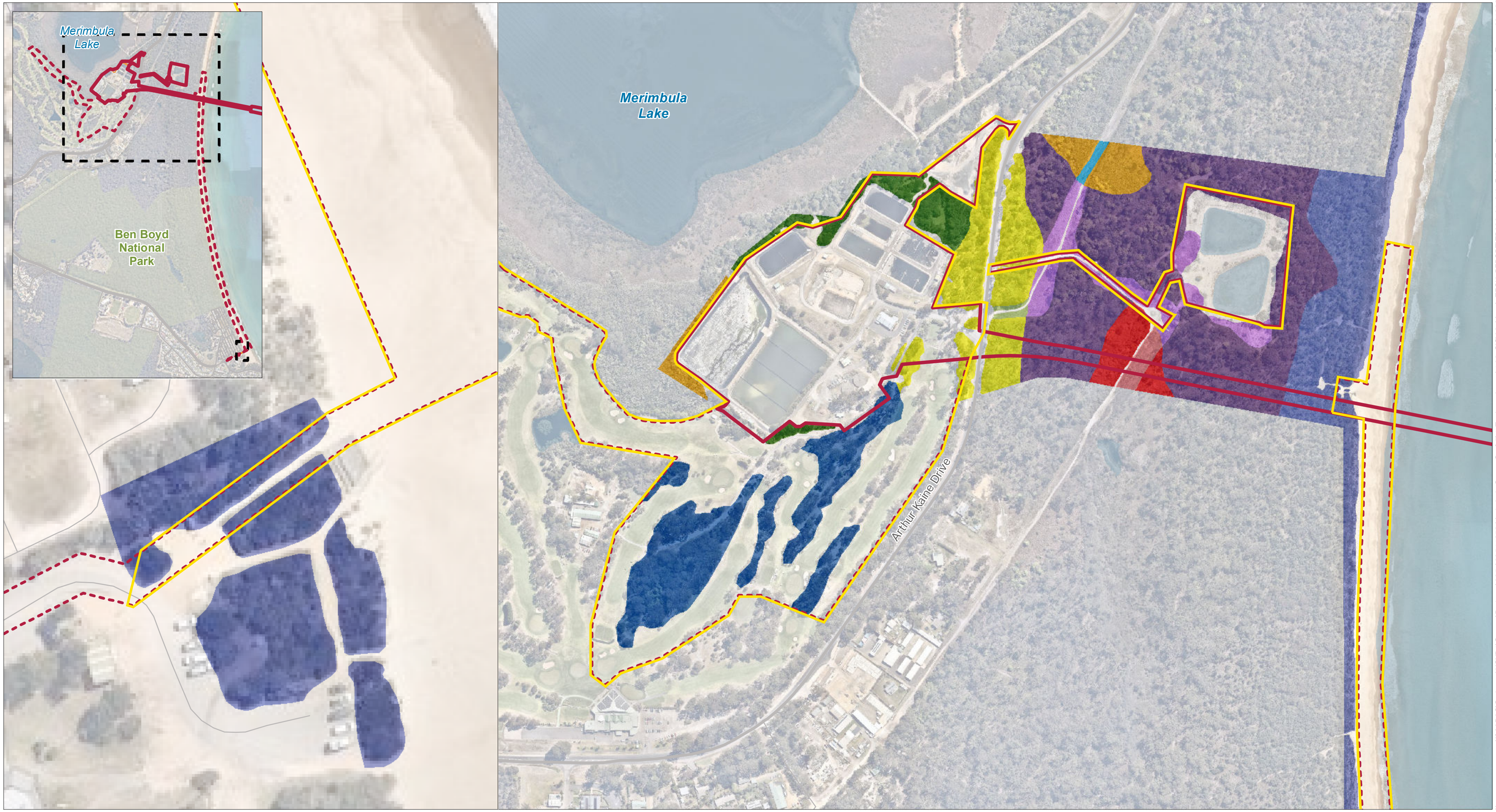

FIGURE 12-2: LOCATION OF SURVEYED PLANT COMMUNITY TYPES

Legend

- Project area
- Project area (temporary construction area)
- Study area
- Zone 1, PCT 772, Excellent condition Coastal Scrub
- Zone 2, PCT 659, Excellent condition Sand Forest
- Zone 3, PCT 659, Derived shrubland
- Zone 4, PCT 839, Excellent condition Swamp Woodland
- Zone 5, PCT 839, Derived sedgeland
- Zone 6, PCT 1236, Excellent condition Estuarine Scrub
- Zone 7, PCT 777, Good condition Open Forest
- Zone 8, PCT 777, Derived shrubland
- Zone 9, PCT 777, Post disturbance regrowth scrub
- Zone 10, PCT 1236, Derived shrubland
- Zone 11, PCT 777, Remnant Trees on golf course

N

0 100 200 m

AECOM

Source: Nearmap, 2019

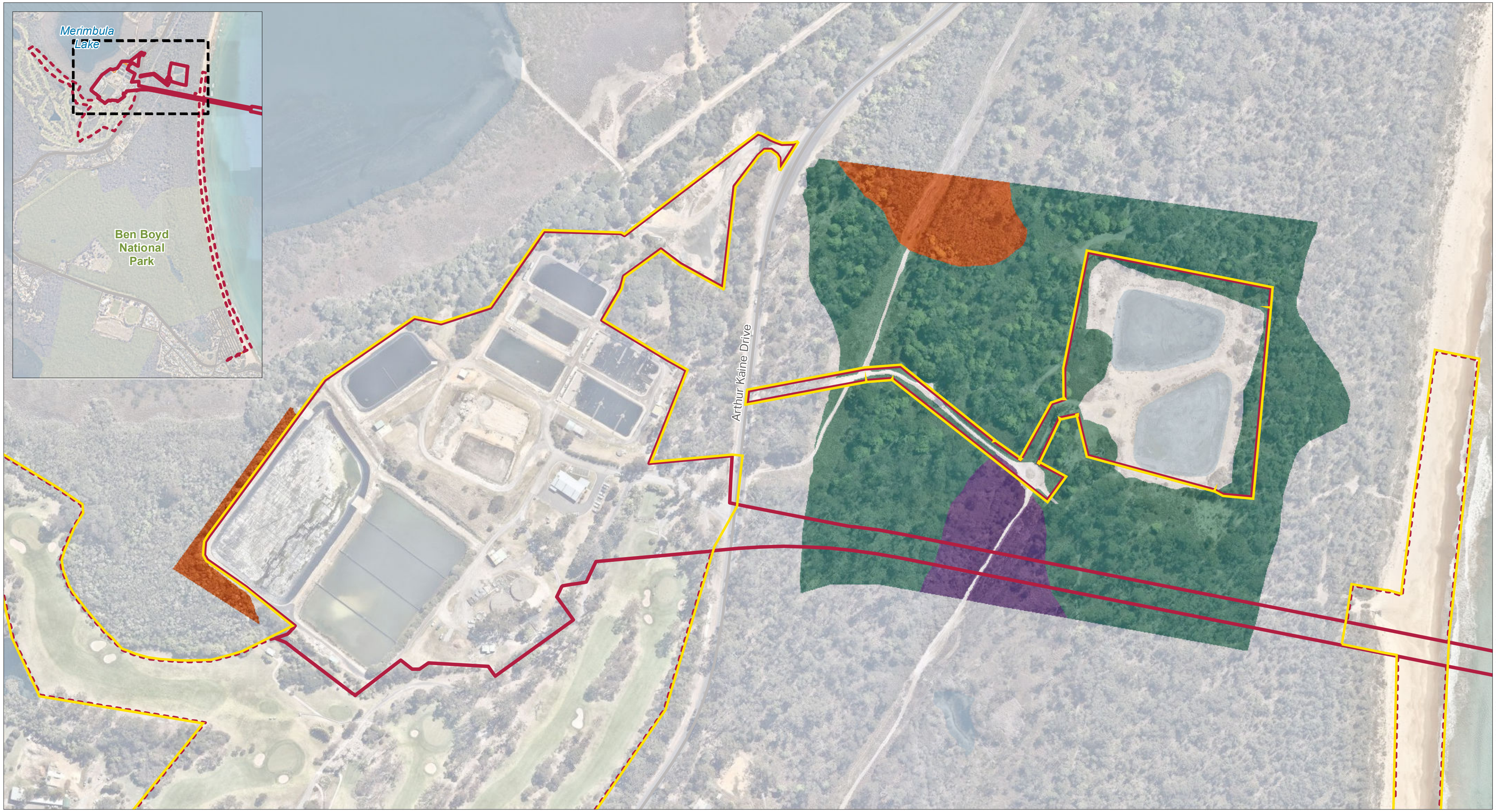

FIGURE 12-3: LOCATION OF THREATENED ECOLOGICAL COMMUNITIES IN THE STUDY AREA

Legend

- Project area
- Project area (temporary construction area)
- Study area
- Bangalay Sand Forest TEC (PCT 659)
- Swamp Oak Floodplain Forest TEC (PCT 1236)
- Swamp Sclerophyll Forest TEC (PCT 839)

0 80 160 m

AECOM

Source: Nearmap, 2019

\\na.aecomnet.com\lfs\APAC\Sydney-AUSYD1\Secure\Projects\605x\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99 GIS\02_Maps_TECH_REPORT\TR087_01_A4L_F12-3_TerrEcology_TECLocations_201208.mxd
Date Saved: 2/02/2021

12.2.2 Threatened species and habitat

Three threatened species were detected during the preliminary vegetation mapping and habitat assessment:

- *Artamus cyanopterus* (Dusky Woodswallows) – Vulnerable (BC Act);
- *Petaurus australis* (Yellow-bellied Glider) - Vulnerable (BC Act); and
- *Syzygium paniculatum* (Magenta Lilly Pilly) – Endangered (BC Act) and Vulnerable (EPBC Act).

Hollow bearing trees that were observed within the study area provide potential habitat for a range of fauna, including threatened species such as the Yellow-bellied Glider, microchiropteran bats, threatened owls such as *Tyto novaehollandiae* (Masked Owl), *Cercartetus nanus* (Eastern Pygmy-possum) and *Phascogale tapoatafa* (Brush-tailed Phascogale).

12.2.3 Wetlands

Merimbula Lake, located immediately adjacent to the study area, is, listed on the Directory of Important Wetlands in Australia as a wetland of national importance. Additionally, two areas mapped as Coastal Wetlands or as Proximity Area to Coastal Wetlands under the Coastal Management SEPP have been identified within the Project area (refer to **Figure 12-4**).

The estuarine habitats of Merimbula Lake are mapped as Coastal Wetlands. The Project area does not intersect with the mapped Coastal Management SEPP Coastal Wetlands associated with Merimbula Lake, however the western parts of the Project area, are mapped as a Proximity Area to Coastal Wetlands.

The wetland that occurs in the hind dunes of Merimbula Beach and extends from the Project area south to Pambula is also mapped as a Coastal Wetland. The Project area intersects with this Coastal Wetland and the Proximity Area.

The mapped extent of groundwater dependent wetlands is shown in **Figure 12-5**. The extent of groundwater dependent wetlands largely corresponds with that of Coastal Wetlands mapped under the Coastal Management SEPP.

Groundwater dependent wetlands are discussed in more detail in the following section.

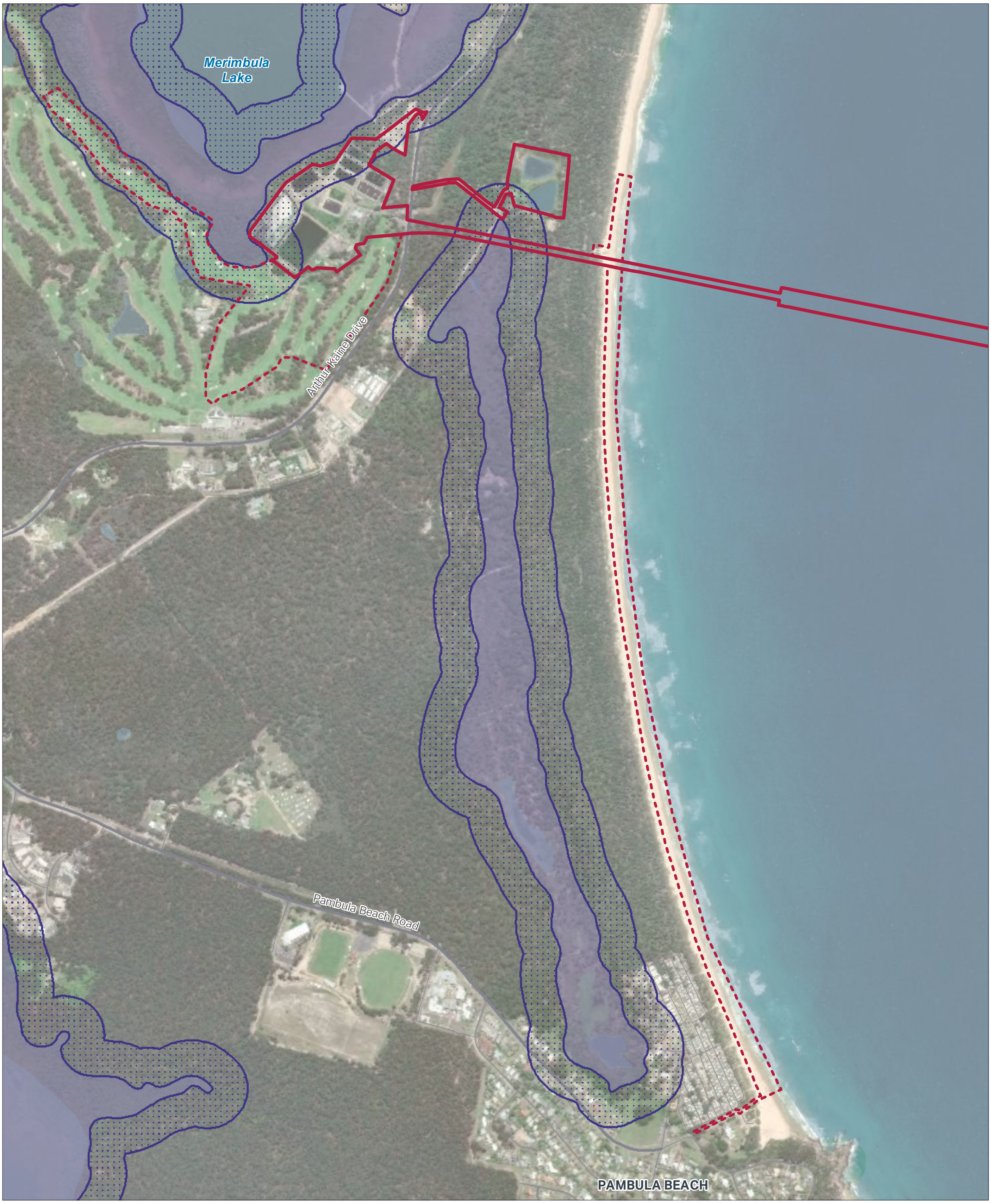

FIGURE 12-4: COASTAL WETLANDS UNDER THE STATE ENVIRONMENTAL PLANNING POLICY (COASTAL MANAGEMENT) 2018

Legend

- Project area
- Project area (temporary construction area)
- Coastal wetland
- Coastal wetland proximity area

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

12.2.4 Groundwater dependent ecosystems

Groundwater dependent ecosystems (GDEs) are ecosystems whose current species composition, structure and function are reliant on a supply of groundwater as opposed to surface water. In Australia, most ecosystems have little to no dependence on groundwater. The exception to this is wetland communities, for which it is thought that most have some level of dependence on groundwater resources.

A number of aquatic and terrestrial GDEs are located within or immediately adjacent to the Project area including:

- aquatic:
  - Merimbula Lake, an estuarine lake to the west of the STP and mapped as highly likely to depend on groundwater inflow; and
  - Coastal wetland vegetation on the shore of Merimbula Lake. This includes estuarine mangrove forest and saltmarsh communities.
- terrestrial:
  - Far South Coast Grassy Woodlands (Low Potential GDE);
  - Lowland Gully Scrub Forest (Low Potential GDE);
  - Coastal Sand Forest (High Potential GDE); and
  - Coastal Scrub and Beach Strand (High Potential GDE).

Note that the existing groundwater environment is described in **Chapter 9 Groundwater**.

12.2.5 Aquatic flora and fauna

Aquatic habitats within the Project area include the STP ponds, the exfiltration ponds, the coastal wetlands discussed above, and estuarine habitats. These provide a range of different habitats types for waterbirds and amphibians.

Most of the STP ponds are actively used in wastewater treatment and represent a highly variable environment (e.g. regularly drained and biosolids removed). As such the water levels and quality are highly variable and they typically do not support important microhabitats such as emergent vegetation. This reduces the quality of the ponds within the STP as habitats for threatened waterbirds and amphibians.

The coastal wetlands, estuarine habitats and exfiltration ponds all provide potential habitat for a range of amphibians and wetland birds, although similar habitats are extensive in contiguous vegetation. The Project would use underground trenchless drilling to construct the ocean outfall pipeline avoiding the need to trench through the coastal wetland in the east of the Project area.

Aquatic flora and fauna species within the marine extent of the Project area that may be potentially impacted by Project are discussed in more detail in **Chapter 11 Marine ecology**.

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FIGURE 12-5: MAPPED GROUNDWATER DEPENDENT ECOSYSTEMS

Legend

- Project area
- Project area (temporary construction area)
- Coastal Scrub & Beach Strand
- Estuarine Saltmarsh
- Far South Coast Grassy Woodland
- Coastal Sand Forest
- Eden Dry Shrub Forest
- Estuarine Mangrove Forest
- Floodplain Swamp Forest
- Lowland Gully Shrub Forest
- South Coast River Flat Forest
- Southeast Lowland Dry Shrub Forest
- Mapped wetlands

N

0 100 200 m

AECOM

Source: Nearmap, 2019

12.3 Potential impacts – construction

12.3.1 Direct impacts

Loss of vegetation or habitat

Loss of vegetation and fauna and flora habitat would occur as a result of the Project due to unavoidable vegetation clearance. However, the construction of the Project has been designed to avoid the important biodiversity values recorded within the study area, and the need for vegetation clearance has been reduced as far as practicable. As a result, impacts on vegetation have been limited to about 0.28 hectares (ha) of native vegetation, seen in **Figure 12-6**, most of which is already highly modified.

In addition to the above, the removal of vegetation on the roundabout at the Princes Highway/Toallo Street intersection may be required to accommodate the passage of oversized construction vehicles (such as the drill rig truck). This vegetation comprises planted garden natives and exotics, and is not considered to have significant ecological or habitat value. Any removal of the vegetation at the Princes Highway/Toallo Street intersection would be undertaken in consultation with relevant stakeholders and following the completion of construction, all disturbed areas at the roundabout would be restored to a pre-construction condition, or better.

A hollow-bearing, Yellow-bellied Glider feed tree within the STP site may need to be removed for construction access (and has been accounted for in the BAR). However, given the avoidance and mitigation and management measures proposed which have been incorporated into the design and methodology of the Project, it is unlikely that any hollow bearing, Yellow-bellied Glider feed trees or other potentially important habitats would be removed or otherwise adversely affected. Notwithstanding the capacity to avoid and minimise impacts on fauna habitats, hollow-bearing trees in close proximity to the STP are unlikely to be important habitat for threatened fauna given their location on the edge of a busy road, within a golf course or STP, and in the context of the extent of superior resources in contiguous forests.

The Project has been designed to avoid impacts on TECs and would be concentrated predominately in disturbed vegetation. No threatened flora species are likely to be affected by the Project.

The proposed construction access along Pambula Beach would affect potential habitat for a number of threatened shorebirds, including *Sterna albifrons* (Little Tern), *Thinornis rubricollis* (Hooded Plover), *Haematopus longirostris* (Pied Oystercatcher) and *Haematopus fuliginosus* (Sooty Oystercatcher). Whilst it is possible that these species may utilise the habitats on the beach from time to time, particularly the Pied Oystercatcher and Sooty Oystercatcher, it is unlikely that they would breed there or that the beach would comprise important habitat for these or any other threatened or listed migratory shorebirds.

The beach habitats within the development footprint have not been identified as an important shorebird area despite a long-term shorebird recovery and monitoring program on the south coast (the South Coast Shorebird Recovery Program) (S. Hall-Aspland pers. comm. 2020). Whilst it is possible that species such as the Hooded Plover or Little Tern could breed there, it is unlikely, and there are no records of these species on this area of beach let alone nesting there. Whilst the Pied Oystercatcher and Sooty Oystercatcher may occur on this section of beach from time to time, as they do on most beaches on the south coast, they wouldn’t breed there given the absence of suitable breeding habitat.

Notwithstanding the limited potential for adverse impacts on shorebirds, it is recommended that pre-construction targeted surveys be undertaken to ensure the affected areas are not being used by threatened shorebirds.

Frog species, including the Green and Golden Bell Frog could potentially breed in the wetlands in the study area, and within the STP ponds. The wetland habitats in the study area are not likely to be affected by the Project, and would remain available to these species. The STP ponds are not considered likely to be important to these species given the extent of similar and superior habitat locally. Notwithstanding the limited potential for adverse impacts on frogs, including the Green and Golden Bell Frog, it is recommended that pre-construction targeted surveys be undertaken by a suitably qualified ecologist within the Project area to confirm that the affected areas are not being used by threatened amphibians.

Although biodiversity impacts have been largely avoided in the design of the Project, the clearing of 0.28 ha of vegetation would impact some vegetation communities (Coast Banksia - Coast Wattle dune scrub of the Sydney Basin Bioregion and South East Corner Bioregion; and Coast Grey Box - Mountain Grey Gum - stringybark moist shrubby open forest in coastal gullies, southern South East Corner Bioregion), and fauna species (*Cercartetus nanus* (Eastern Pygmy-possum) and *Phascogale tapoatafa* (Brush-tailed Phascogale)). These impacts would have implications for biodiversity offsetting, which is addressed in **Section 12.6**. Impacts to wetlands have also been considered in **Section 12.7**.

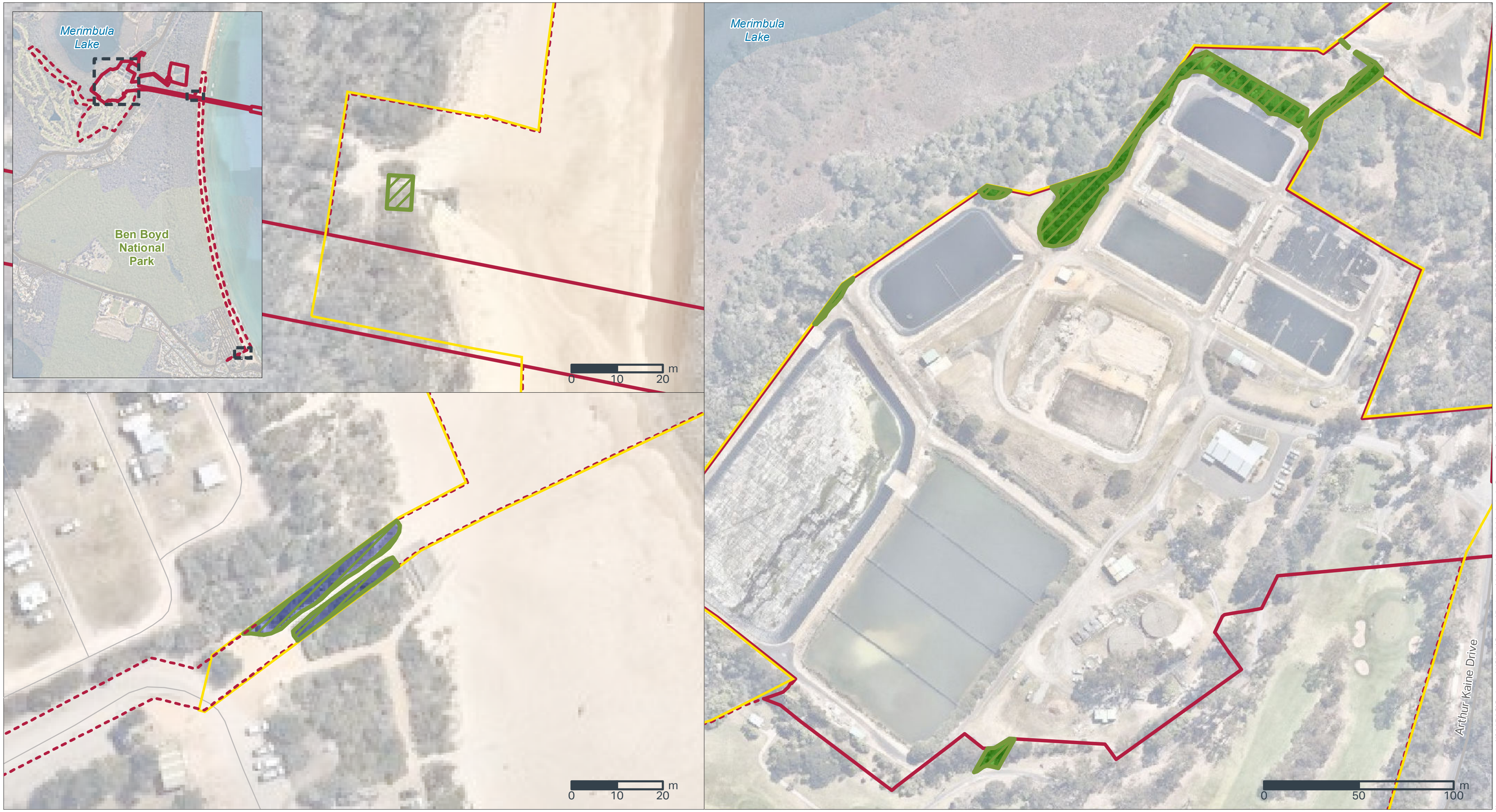

FIGURE 12-6: VEGETATION TO BE CLEARED FROM THE PROJECT AREA

Legend

- Project area
- Project area (temporary construction area)
- Study area
- Vegetation to be cleared
- Zone 1, Excellent condition Coastal Scrub
- Zone 9, Post disturbance regrowth scrub

N

AECOM

Source: Nearmap, 2019

Marine benthic habitat

Direct impacts to marine benthic habitat during construction are discussed in **Chapter 11 Marine ecology**.

12.3.2 Indirect impacts

Invasive species and pathogens

Weeds were generally restricted to the STP and other heavily modified areas. *Eragrostis curvula* (African Love Grass) is the main high threat weed species within the study area. The species is spread through seed dispersion from truck and people movement. It occurs mostly on the edge of tracks and along the powerline easements. Mitigation and management measures have been identified to control the spread of weeds and are provided in **Section 12.8**.

Invasive species and pathogens identified in the area are outlined in **Table 12-3**. The invasive species and pathogens identified are listed as Key Threatening Processes (KTP). Impacts from KTPs listed under the EPBC Act and BC Act are discussed in more detail in **Section 12.5**.

No pathogen or pest species were identified in the Project area. However, they are known to exist in the Bega Valley Local Government Area. Given that no animal pests or pathogens have been identified within the study area during the field survey, it is unlikely that animal pests and pathogens would have a significant impact on flora and fauna as part of this Project, provided that the mitigation and management measures listed in **Section 12.8** are implemented.

Table 12-3 Invasive species and pathogens in the study area and Bega Valley local government area

Species	Scientific name	Key Threatening Processes	Legislation
Invasive species			
European red fox	*Vulpes*	Predation by the European Red Fox *Vulpes* (Linnaeus, 1758)	BC Act and EPBC Act
Feral cat	*Felis catus*	Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)	BC Act and EPBC Act
European rabbit	*Oryctolagus cuniculus*	Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus (L.)*	BC Act and EPBC Act
Pathogens			
Myrtle rust	*Uredo rangelli*	Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	BC Act
Chytrid fungus	*Batrachochytrium dendrobatidis*	Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	BC Act and EPBC Act
Phytophthora	*Phytophthora cinnamomi*	Infection of native plants by *Phytophthora cinnamomi*	BC Act and EPBC Act

Fauna injury and mortality

Fauna injury or mortality could occur during construction, particularly as a result of increased vehicle and machinery movement, or vegetation clearance activities.

During vegetation clearing, some mobile species (such as birds) may be able to move away quickly. Other species may be slower to move or may not relocate at all, such as some reptiles and amphibians, potentially resulting in injury or mortality of some individuals.

Mitigation and management measures, including speed limits, an unexpected finds procedure, pre-clearing surveys and other pre-clearing and clearing protocols have been provided (refer to **Section 12.8).** With the implementation of these mitigation and management measures, the likelihood of fauna injury or mortality impacts would be significantly reduced.

The potential for indirect injury to marine fauna during construction is discussed in **Chapter 11 Marine ecology**.

Noise, vibration and light

Increases in noise, vibration and light spill during construction may have the potential to result in indirect impacts to biodiversity. Noise and vibration impacts as a result of the Project are likely to affect fauna species that rely on sound to communicate or are nocturnal and sleep during the day when Project activities are at their peak. These may include bats and other nocturnal mammals and diurnal and nocturnal birds.

Generally, areas within the study area that may be subject to noise, vibration and light impacts during construction of the Project, already experience altered noise, vibration and light. This includes areas around the existing STP, Arthur Kaine Drive, the Merimbula Airport and the Pambula urban area. The construction of the Project would be concentrated in areas that are already highly disturbed and where fauna habitats are of lower quality. In addition, noise and vibration impacts would be temporary and are expected to be limited primarily to the construction phase.

As such, noise, vibration and light impacts are unlikely to have a significant effect on diurnal and nocturnal threatened birds and diurnal and nocturnal mammals in the study area. Regardless of this low risk, mitigation and management measures have been identified and are provided in **Section 12.8**.

Indirect noise impacts to marine fauna during construction are discussed in **Chapter 11 Marine ecology**.

Groundwater dependant ecosystems

The GDE risk assessment undertaken for the Project (refer **Appendix H** (Biodiversity Assessment Report)) determined the overall category of the GDE based on its ecological value and risk posed by an activity. The four groundwater dependent vegetation communities identified for the Project all fall into Category 2 (Moderate Ecological Value) GDEs. The groundwater dependent wetland is also a Category 2 GDE. The Category 1 risk rating is applicable where there is a low risk to the aquifer or GDE, or where there is no change or minor changes expected. The GDEs identified for the Project are considered to fall into the Category 1 risk rating.

Drilling for the proposed ocean outfall pipeline is the main activity with potential to impact GDEs in the Project area, but the risks of drilling is minor. The proposed ocean outfall pipeline would be installed by underground trenchless drilling, with the first 800 m travelling below vegetation communities, and the remaining length being below the beach or sea floor. Drilling clays would be used during the process to seal off the aquifer from the drilled hole and prevent leakage of drilling fluids. Consistency of drilling clays would be monitored at the surface during drilling to minimise the chance of aquifer contamination.

The external diameter of the pipeline would be 450 mm and would be located between 9.3 m and -19.5 m Australian height datum (AHD). The likely depth of drilling at various locations along the pipeline would vary depending on the topography of the overlying ground surface, and summarised as follows:

- the depth of drilling at Arthur Kaine Drive is expected to be about 10 m below ground surface;
- the depth midway between the STP and the shoreline would be about 8 m below ground surface; and
- the depth beneath the sand dunes would be about 10 m to 20 m below ground surface.

As the depth of drilling is expected to be greater than 8 m below the ground surface drilling activities are unlikely to intercept roots of groundwater dependent vegetation, and as such any damage would be minimal.

Drilling for the ocean outfall pipeline would also pass beneath the northern end of the wetland occurring east of the STP site. At this location, the pipeline would be approximately 6 m below the bottom of the wetland, and 5 m below the average water table. During drilling, integrity of the drill hole would be maintained by the use of drilling fluids, and the pipeline installed immediately or soon afterwards, so that the cavity is not left unsupported. This would minimise the risk of collapse around the bore cavity, and the subsequent loss of aquifer structure beneath the wetland. Drilling beneath the wetland is expected to pose a negligible threat to the wetland.

During construction, the main laydown areas would be at the Merimbula Pambula Golf Club grounds and Merimbula Beach, so most of the existing vegetation can be retained. None of the other areas mapped as groundwater dependent vegetation would be removed.

12.4 Potential impacts – operation

During operation, the Project would be mostly located underground and within the existing STP, an already disturbed and active worksite. For this reason, the majority of impacts that would be associated with the Project would occur during construction. Impacts during operation of the Project would be limited to the potential for noise, vibration and light spill directly adjacent to the STP. Some impacts during operation may also be associated with ongoing inspection or maintenance activities, where movement around the Project area may have the potential to spread weeds or pathogens between infected areas and uninfected areas.

Generally, the impacts of noise, vibration and light spill directly adjacent to the STP and risk of introduction and spread of pathogens and high threat weeds would be relatively consistent with existing conditions and would be unlikely to have a significant effect on species in the study area. Movement of vehicles, equipment and people during operation, could carry risk of introduction and spread of exotic vines and scramblers and perennial grasses (such as African Lovegrass) within the Project area, including invasion into areas of native vegetation. Appropriate mitigation and management measures listed in **Section 12.8** would be implemented to limit the spread and infestation of pathogens and weeds.

Impacts to marine fauna and habitat during operation are discussed in **Chapter 11 Marine ecology**.

12.5 Key Threatening Processes

A number of KPTs under the EPBC Act and BC Act have been identified as being relevant to the Project. **Table 12-4** discusses the extent to which each of these KTPs would either be likely to contribute to a KTP (known) or may potentially contribute to a KTP (potential).

Table 12-4 Known and potential Key Threatening Processes and impacts on biodiversity

Key Threatening Process	Legislation	Relevance to the Project	Unmitigated Project contribution to Key Threatening Process
Clearing of native vegetation	BC Act	The construction of the Project includes clearing of vegetation. Only a small amount of native vegetation (0.28 ha) would be cleared, much of which is already heavily modified. The proposed clearing would also be offset.	Known
Land clearance	EPBC Act		
Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands	BC Act	The construction of the Project could potentially impact mapped wetlands within and adjoining the study area (low risk when mitigated).	Potential
Infection of frogs by amphibian chytrid causing the disease chytridiomycosis	BC Act	Potential frog habitat occurs within the study area. Movement of vehicles, equipment and people during construction would carry a risk of introduction and spread of the chytrid	Potential

Key Threatening Process	Legislation	Relevance to the Project	Unmitigated Project contribution to Key Threatening Process
Infection of amphibians with chytrid fungus resulting in chytridiomycosis	BC Act EPBC Act	fungus in these habitats with potential to impact on frog species.	
Infection of native plants by Phytophthora cinnamomi	BC Act	Movement of vehicles, equipment and people during site establishment and construction would carry risk of introduction and spread of Phytophthora and Myrtle Rust. Presence of these pathogens within the study area is unknown and no evidence of dieback was recorded.	Potential
Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae	BC Act		
Invasion and establishment of exotic vines and scramblers	BC Act	Movement of vehicles, equipment and people during site establishment and construction, could carry risk of introduction and spread of exotic vines and scramblers, perennial grasses (such as African Lovegrass), Lantana and Bitou bush within the study area, including invasion into areas of native vegetation. Disturbing intact vegetation can also increase the risk of weed infestations.	Potential
Invasion of native plant communities by exotic perennial grasses	BC Act		
Invasion, establishment and spread of Lantana camara	BC Act		
Invasion of native plant communities by Chrysanthemoides monilifera (Bitou Bush)	BC Act		
Loss of Hollow-bearing Trees	BC Act	The construction of the Project could result in the removal of a hollow bearing tree (this risk is considered low with mitigation).	Known

Appropriate mitigation and management measures listed in **Section 12.8** would be implemented to reduce the considered risks to low.

12.6 Potential impacts requiring offsets

The BAR found that following implementation of the BAM and the BBCC, biodiversity offsets would be required. The extent of native vegetation, threatened species and threatened species habitat which would be directly impacted by the Project and require offsetting is in **Table 12-5**, along with the offset credits to be applied to mitigate impacts. The impacts to threatened species and threatened species are shown on **Figure 12-7**.

Table 12-5 Potential impacts requiring offsets

Item requiring offset	Area/habitat directly impacted (ha)	Credits	Credits per ha
Coast Banksia - Coast Wattle dune scrub of the Sydney Basin Bioregion and South East Corner Bioregion (Zone 1 - Excellent condition)	0.03	1	50
Coast Grey Box - Mountain Grey Gum - stringybark moist shrubby open forest in coastal gullies, southern South East Corner Bioregion (Zone 9 - Post disturbance re-growth shrub)	0.25	3	12
Cercartetus nanus (Eastern Pygmy-possum)	0.28 ha	6	18.52
Phascogale tapoatafa (Brush-tailed Phascogale)	0.28 ha	6	18.52

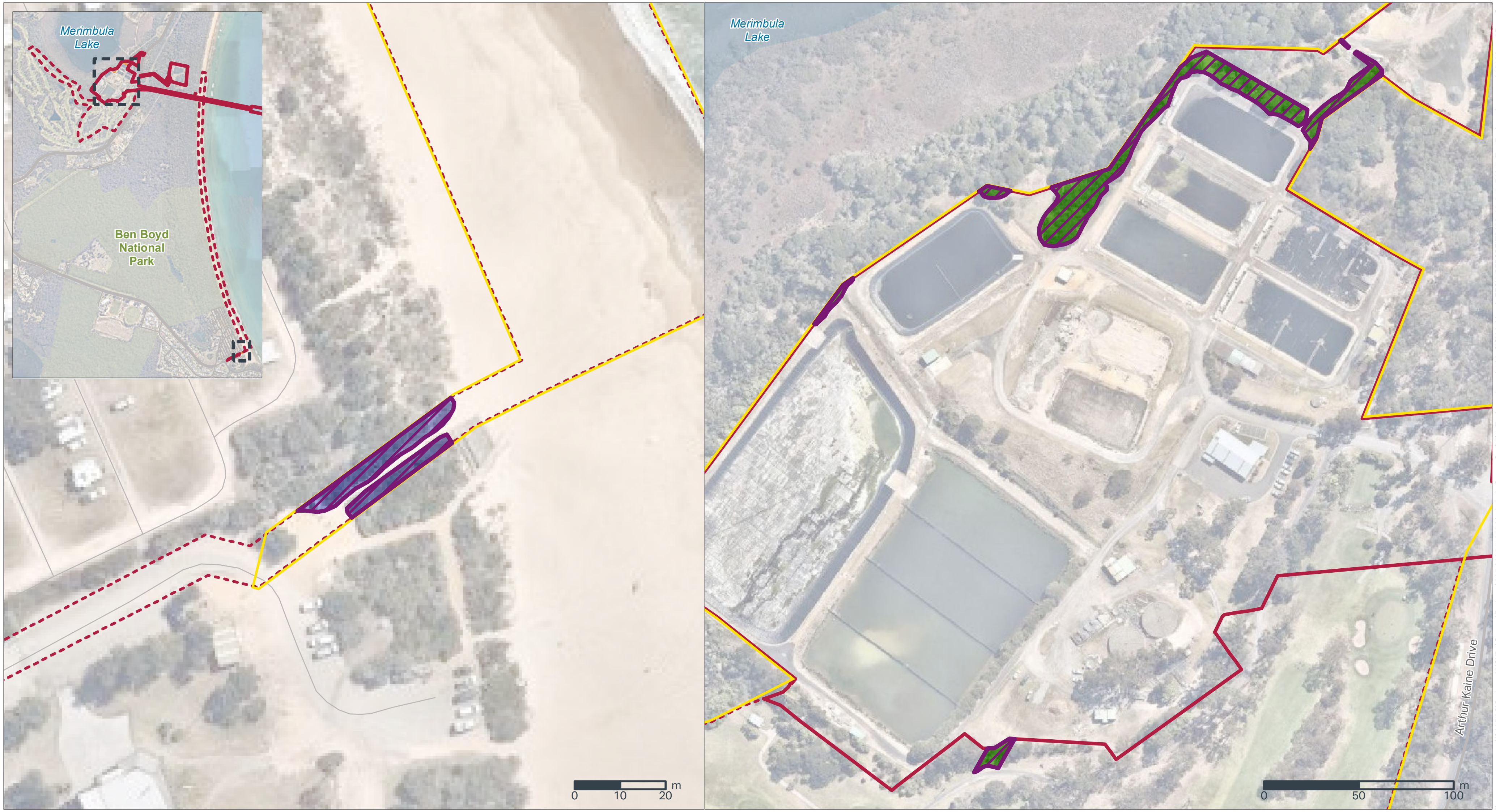

FIGURE 12-7: IMPACTS REQUIRING OFFSETS

Legend

- Project area
- Project area (temporary construction area)
- Study area
- Eastern Pygmy-possum and Brush-tailed Phascogale species
- Zone 1, Excellent condition Coastal Scrub
- Zone 9, Post disturbance regrowth scrub

N

Source: Nearmap, 2019

12.7 Matters for further consideration

Certain biodiversity impacts require further consideration by the consent authority under Section 9.2 of the FBA. These include:

- coastal wetlands;
- significant impacts on landscape features;
- impacts on endangered ecological communities that are likely to significantly affect the persistence or viability of that community; and
- impacts on critical habitat or on threatened species that are likely to significantly affect the persistence or viability of a population of a threatened species.

The Project area intersects with the mapped proximity area to the coastal wetland associated with Merimbula Lake (mapped under the Coastal Management SEPP 2018) (refer to **Figure 12-4**). The proposed underground trenchless drilling would also traverse below the coastal wetland and proximity area associated with the wetland that occurs in the hind dune swale behind Merimbula Beach and extends from the study area south to Pambula.

The water quality and groundwater assessments (refer **Chapter 8 Water quality, hydrology and flooding** and **Chapter 9 Groundwater** of this EIS respectively) and GDE impact assessment (ELA, 2020) undertaken for the Project (in **Appendix H** (Biodiversity Assessment Report)), have all concluded that it is unlikely that the proposed underground trenchless drilling for the ocean outfall pipeline would result in any subsidence or other direct or indirect impacts that would adversely affect the biophysical, hydrological or ecological integrity of the wetland in the eastern parts of the Project area, or affect the quantity or quality of surface or groundwater flows. Further, the underground drilling method is an important and effective impact avoidance strategy.

The Project has been designed to avoid impacts to biodiversity values as far as practicable. Where impacts are unavoidable, disturbed areas would be re-established to a pre-disturbance condition. During operation, future site maintenance policies and plans would consider the potential operational impacts of the Project described in **Section 12.4** and would include post-construction and operational management measures provided in **Table 12-6**.

Three threatened ecological communities occur within the study area in various condition states. The Project has been designed to avoid impacts on the TECs within the study area. No vegetation removal within TECs would be required, and therefore the viability of these plant communities would not be affected. The Project would not threaten the viability of any threatened species.

The Project would not impact on matters that require further consideration.

12.8 Management of impacts

The implementation of mitigation and management measures would reduce the potential ecological impacts of the Project to the greatest extent practicable.

The relevant ecological impacts and associated mitigation and management measures and protocols (standard and Project specific) are provided in **Table 12-6**.

It is anticipated that the standard mitigation and management measures such as inductions would be incorporated in a flora and fauna management plan which would comprise part of the Construction Environmental Management Plan (CEMP).

12.8.1 Performance outcomes

The terrestrial biodiversity performance outcomes for the Project are as follows:

- flora and fauna impacts not already identified in this EIS are avoided;
- flora and fauna habitat is retained/impacts avoided, or enhanced where possible; and
- biodiversity offsets are carried out in accordance with BBAM and the BBCC.

The Project would be designed, constructed and operated to achieve these performance outcomes.

12.8.2 Consideration of interaction between measures

Mitigation and management measures in other chapters that are relevant to the management of potential terrestrial ecology impacts include:

- **Chapter 8 Water quality, hydrology and flooding**, measures to mitigate potential water quality impacts during construction which would in turn mitigate and minimise impacts to threatened species who may utilise water habitats such as shorebirds and frogs, including the Green and Golden Bell Frog. These measures specifically include SFW1, SFW2, and SWF4 to address Impacts on water quality in the receiving environment; and
- **Chapter 9 Groundwater**, specifically measure GW1 to address drilling fluids affecting water quality.

12.8.3 Mitigation and management measures

Mitigation and management measures to address the potential impacts identified are described in **Table 12-6** below.

Table 12-6 Mitigation and management measures – Terrestrial ecology

Ref #	Potential impact	Mitigation and management measures	Timing
B1	General terrestrial ecology	A flora and fauna management plan would be prepared as part of the CEMP and include the following: • undertaking the underground trenchless drilling and other construction activities such that there are no adverse impacts on surface or subsurface hydrology; • undertaking pre-construction targeted surveys at the Pambula Beach construction access proposed, to ensure the affected areas are not being used by threatened shorebirds; • avoiding foredune and other vegetated parts of the beach for beach access; • rehabilitating the minor impacts on PCT 772 associated with construction access to Pambula Beach post construction; • designing construction access to the STP to avoid the hollow bearing and Yellow-bellied Glider feed trees that occur near the STP and to minimise or avoid the need to remove trees and native vegetation as far as is possible; • using flagging tape to delineate the boundary of the wetland in the central parts of the study area (Zone 4 and Zone 5) to protect it from any adverse impacts during construction (refer to **Figure 12-2**); • minimising the disturbance and clearance of native vegetation as far as is possible; • identifying exclusion zones to protect against accidental vegetation damage; • undertaking vegetation clearing in a manner which avoids impacts on adjoining retained vegetation; • managing weeds and pathogens (e.g. provide vehicle wheel wash upon entry and exit to site, vehicle inspections for weed, seed, plant	Prior to and during construction

Ref #	Potential impact	Mitigation and management measures	Timing
		material and records taken, regular visual inspections); • restoring disturbed areas to pre-disturbance condition; • carrying out preclearing fauna surveys (handling of fauna will be carried out by appropriately licenced or experienced person and in accordance with relevant guidelines); and • should unexpected potential threatened flora or fauna be located at any time during construction or during pre-construction surveys, any works underway will cease in the area. Should this occur, a suitably qualified ecologist will be engaged to provide advice regarding how the unexpected encounter should be managed as this may vary depending on the species in question and the manner in which it was encountered. Any fauna handling would be undertaken by an appropriately licenced person.	
B2	Potential displacement of fauna	The limits of the vegetation to be removed or modified for the Project will be clearly marked so workers undertaking any proposed clearing do not remove vegetation that should be retained	Prior to and during construction
		Pre-construction targeted surveys should be undertaken at the Pambula Beach construction access proposed, to ensure the affected areas are not being used by threatened shorebirds	
		Beach access will avoid the foredune and other vegetated parts of the beach	
		Truck movements will be speed limited to reduce the risk of vehicle strike or otherwise adverse impacts on fauna	
		Pre-construction targeted surveys should be undertaken prior to the decommissioning of the STP effluent pond to ensure the pond is not being used by threatened amphibians and particularly the Green and Golden Bell Frog	
B3	Potential interruption of critical life cycle events such as breeding or nursing	Pre-construction targeted surveys should be undertaken at the proposed Pambula Beach construction access to ensure the affected areas are not being used by threatened shorebirds	Prior to and during construction
B4	Potential for adverse hydrological impacts	Underground trenchless drilling and other construction activities should be undertaken such that there are no adverse impacts on surface or subsurface hydrology	Prior to and during construction
B5	Impacts to hollow bearing trees	Pre-clearing and clearing protocols should be incorporated into any clearing plan that may affect hollow-bearing trees	Prior to construction

Ref #	Potential impact	Mitigation and management measures	Timing
B6	Impacts as a result of soil disturbance including risk of sedimentation and water quality impacts	Clearing protocols should identify vegetation to be retained, prevent inadvertent damage and reduce soil disturbance; for example, removal of native vegetation by chainsaw, rather than heavy machinery, in situations where partial clearing is proposed	Construction and post construction
		Sediment and water control measures should be installed as necessary such as fencing and hay bales	
B7	Noise and light impacts	Work within the land-based footprint of the Project would be restricted to daylight hours except during the pipeline pulling	Construction
B8	Impacts to significant environmental features such as wetlands	Use flagging tape to delineate the boundary of the wetland in the central parts of the study area to protect it from any adverse impacts	Construction
B9	Potential spread of weeds and pathogens	Appropriate hygiene protocols should be incorporated into the Project to avoid the spread of weeds such as African Lovegrass and any pathogens such as Chytrid Fungus, Phytopthora and Myrtle Rust	During and post construction
		Known weed or invasive species should not be planted for landscaping purposes	
B10	Inadvertent adverse impacts to biodiversity values within Project area	Workers should be inducted as to the biodiversity values of the Project area and mitigation and management measures to protect these values	Construction
B11	Impacts to vegetation during operation	Retained vegetation should be managed sympathetically with its conservation status according to state and national legislation	Post construction and operation
		Any clearing, exotic plantings, or tree removal beyond what is proposed should be avoided	
		Restore vegetation in the eastern parts of the Project area	

12.8.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for terrestrial ecology and is provided in **Table 10-8**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental mitigation and management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Table 12-7 Environmental risk analysis with mitigation – Terrestrial ecology

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
General terrestrial ecology	Construction/ operation	B1	Minor	Unlikely	Low
Potential displacement of fauna	Construction	B2	Insignificant	Possible	Low
Potential interruption of critical life cycle events such as breeding or nursing	Construction/ operation	B3	Moderate	Rare	Low
Potential for adverse hydrological impacts	Construction	B4	Minor	Rare	Low
Impacts to hollow bearing trees	Construction	B5	Minor	Unlikely	Low
Impacts as a result of soil disturbance including risk of sedimentation and water quality impacts	Construction/ operation	B6	Insignificant	Possible	Low
Noise and light impacts	Construction	B7	Insignificant	Likely	Low
Impacts to significant environmental features such as wetlands	Construction	B8	Moderate	Rare	Low
Potential spread of weeds and pathogens	Construction/ operation	B9	Minor	Possible	Medium
Inadvertent adverse impacts to biodiversity values within Project area	Construction	B10	Moderate	Rare	Low
Impacts to vegetation during operation	Post-construction/ operation	B11	Insignificant	Rare	Low

13.0 Landform, geology and soils

This chapter assesses the potential impacts associated with landform, geology and soils (including contamination), as a result of the construction and operation of the Project. This chapter also outlines the proposed mitigation and management measures to address the impacts identified.

Note that the landform (bathometry), geology and soils of the marine-based portion of the Project area is addressed in **Chapter 10 Marine and coastal processes**.

Table 13-1 sets out the requirements as provided in the SEARs relevant to landform, geology and soils and where the requirements have been addressed in this EIS.

Table 13-1 SEARs – Landform, geology and soils

Ref	Assessment requirements	Where addressed in this EIS
9.1	The Proponent must verify the risk of acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Risk Map) within, and in the area likely to be impacted by, the Project.	**Section 13.2.5** verifies the risk of acid sulfate soils.
9.2	The Proponent must assess the impact of the Project on acid sulfate soils (including impacts of acidic runoff off-site) in accordance with the current guidelines.	**Section 13.3.3** and **Section 13.4** describe potential impacts associated with acid sulfate soils during construction and operation, respectively, in consideration of the current guidelines.
9.3	The Proponent must assess whether the land is likely to be contaminated and identify if remediation of the land is required, having regard to the ecological and human health risks posed by the contamination in the context of past, existing and future land uses. Where assessment and/or remediation is required, the Proponent must document how the assessment and/or remediation would be undertaken in accordance with current guidelines.	**Section 13.2.6** assesses the likelihood of contamination in the existing environment. **Section 13.3.4** assesses the risk of contamination impacts during construction; and **Section 13.5** outlines how these impacts would be mitigated.
9.4	The Proponent must assess whether salinity is likely to be an issue and if so, determine the presence, extent and severity of soil salinity within the Project area and the impacts of the Project and how it may affect groundwater resources and hydrology.	**Section 13.2.7** provides an assessment of the potential for salinity to be present; and **Section 13.3.5** and **Section 13.4** assess the potential impacts of the Project during construction and operation, respectively. An assessment of potential impacts to groundwater and hydrology is also provided in **Chapter 9 Groundwater**.
9.5	The Proponent must assess the impacts on soil and land resources (including erosion risk or hazard). Particular attention must be given to soil erosion and sediment transport consistent with the practices and principles in the current guidelines.	**Section 13.3.1** provides an assessment of the Project's impact on soil and land resources, with particular attention to erosion and sediment transport.

13.1 Assessment approach

The assessment provided in this chapter has been undertaken to address the relevant SEARs outlined above. The assessment was informed by a desktop review of information supported by field surveys to describe the existing environment as it relates to landform, geology and soils, and to determine the potential impacts of the construction and operation of the Project on soil erosion and sedimentation, acid sulfate soils, contamination and salinity.

This assessment has been undertaken with consideration of relevant legislation, policies and guidelines listed below.

13.1.1 Legislative and policy context

This landform, geology and soils impact assessment has been prepared with consideration to the following relevant legislation, guidelines and policies:

- *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) *and Volume 2* (NSW Department of Environment and Climate Change (DECC), 2008) (i.e. the “Blue Book);
- *Waste Classification Guidelines, Part 1: Classifying Waste* (NSW Environment Protection Authority (EPA), 2014);
- *Contaminated Land Management Act 1997* (NSW) (CLM Act);
- *Protection of the Environment Operations Act 1997* (NSW) (POEO Act);
- *Guidelines on the Duty to Report Contamination under the Contaminated Land Management Act 1997* (NSW EPA, 2015);
- *Acid Sulfate Soils Assessment Manual* (Acid Sulfate Soils Management Advisory Committee ((ASSMAC) 1998)*;*
- *Acid Sulfate Soils Assessment Guideline* (Department of Planning (DoP), 2008); and
- *Urban and regional salinity* (DLWC, 2002).

13.1.2 Methodology

This assessment was informed by a desktop assessment and geotechnical investigation undertaken for the Project, which are described further below.

Study area

The study area for this assessment comprises the land-based portion of the Project area, as well as the land-based construction footprint. The extent of all land-based portions of the Project area, as well as the temporary construction area (referred to as the study area for the purpose of this chapter) is shown on **Figure 2-1 Chapter 2 Project description**. Where it has been applicable to do so, the geographical scope of the assessment has considered areas that lie outside of the study area, such as where regional landscape and topographical features are considered.

Desktop assessment

A desktop assessment was undertaken which included a review of relevant data and background information, including:

- the NSW Environment Protection Authority (NSW EPA) Contaminated Land Record (NSW EPA, 2020); including contaminated lands notices that have been issued by the EPA, and the list of notified sites, which details sites that have been notified to the EPA as potentially contaminated;
- geological survey maps including the *Bega Valley Area Coastal Quaternary Geology 1:100,000 and 1:25,000 Geological Map* (Troedson A.L. & Hashimoto, 2013), and the *Bega-Goalen Point 1:100,000 Sheets* (Tulau, 1997);
- topographical maps and other publicly available spatial data;
- a review of the soil and geological data which has been collected as part of the *Geotechnical Interpretive Report* for the Project (**Appendix C** (Geotechnical Interpretive Report)); and

- identification and assessment of potential impacts from acid sulfate soil exposure using the NSW Department of Planning, Industry and Environment (DPIE) Environmental Planning Instrument – Acid Sulfate Soils map data.

Field surveys

A geotechnical investigation was undertaken for the Project in October and November 2018 to ascertain the geotechnical units and ground conditions likely to be encountered during the installation of the ocean outfall pipeline. During this investigation, six boreholes were drilled for analysis. In November 2019, an additional borehole was also drilled for analysis. The borehole locations are shown in **Figure 13-1**. These geotechnical investigations are described in **Appendix C** (Geotechnical Interpretative Report). This report also relied on several past geotechnical investigations, which were also used to inform the Geotechnical Interpretive Report. The locations of the past geotechnical investigations are shown on **Figure 13-2**.

Note that a heritage survey was also undertaken prior to drilling the boreholes, with test pits dug at the site of all boreholes (except one due to the presence of concrete) to survey for heritage items (refer **Chapter 14 Aboriginal heritage**).

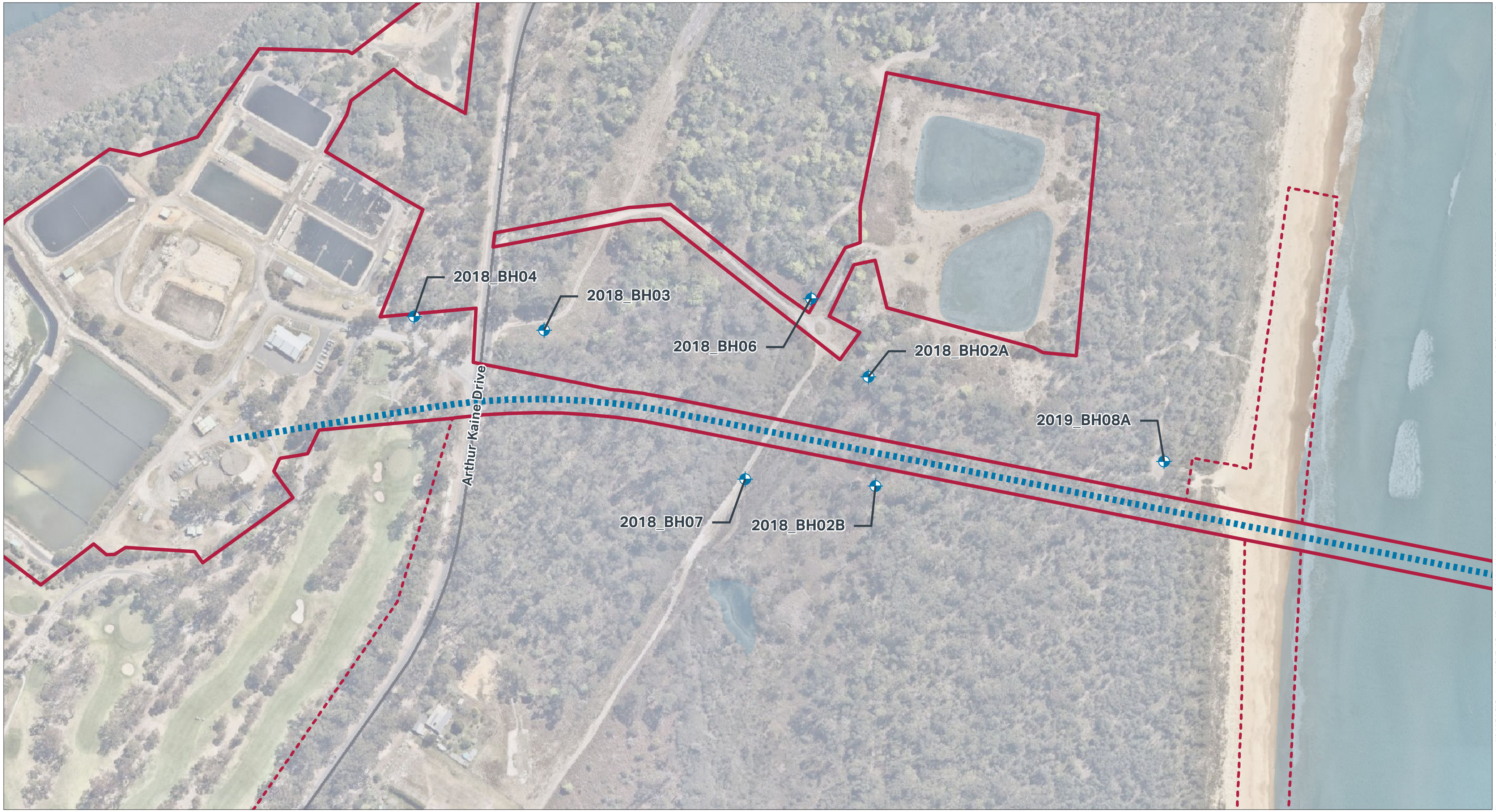

FIGURE 13-1: GEOTECHNICAL BOREHOLE LOCATIONS (2018/2019)

Legend
- Project area
- Project area (temporary construction area)
- Outfall pipeline – Section 1 (below ground)
- Borehole Location

N

0 50 100 m

AECOM

Source: Nearmap, 2019

FIGURE 13-2: HISTORICAL BOREHOLES

N
0 100 200 m

AECOM

Legend

- Project area
- Project area (temporary construction area)
- 1987 Council Monitoring Wells
- 1988 SI Boreholes
- 1991 SI MMA
- 2002 PPK Wells
- 2004 PB1
- Water New South Wales

Source: Department of Customer Service, 2020;

13.2 Existing environment

13.2.1 Topography

The study area is generally flat and low-lying. Typical ground elevation within the central portion of the STP site is about 7 m Australian Height Datum (AHD). Heading east of the STP site, ground elevation increases to between 10 m AHD and 15 m AHD between the exfiltration ponds and the coastal frontal dune feature of Merimbula Beach, before decreasing again toward the shoreline of Merimbula Beach. The construction access along Merimbula Beach is subject to a similar natural descending slope as part of Merimbula Beach.

13.2.2 Regional geology

Regional geological units identified on the *Bega – Mallacoota 1:250,000 Geological Map* (Lewis P.C & Glen R.A, 1995) that occur within the study area include:

- Quaternary (Holocene) alluvial and aeolian deposits (Qa);
- Tertiary fluvial sands and lacustrine clays (Ts); and
- Late Devonian bedrock comprising metamorphosed sandstone and conglomerate (Merimbula Group).

The regional geology in this coastal location is defined by prehistoric sea level changes and associated deposition, erosion and weathering. The region is known to have been dominated by a substantial paleo-valley, eroded in bedrock by the Pambula River during a period of low sea level that extended until about 120,000 years ago. This pre-Tertiary paleo-valley is infilled with a complex sequence of both partially consolidated/weathered tertiary material, and unconsolidated Holocene soils, which were deposited and weathered during periods of sea level rise and fall.

The east-facing Merimbula Beach barrier complex began accumulating about 7,000 years ago and stabilised in its present form about 5,000 years ago. The Merimbula Beach barrier complex is about 300 m wide, has a wide back-barrier flat and is relatively high. The beach barrier is crossed by a series of crests and swales parallel to the beach.

13.2.3 Local geology

Available geological reference materials indicate that the surface geology of the study area consists principally of marine barrier deposits of Holocene antiquity. Local geological units and bedrock outcrops underlying the study area, as identified on the *Bega Valley Area Coastal Quaternary Geology 1:100,000 and 1:25,000 Geological Map* (Troedson A.L. & Hashimoto, 2013) include:

- Holocene estuarine in-channel bar and beach: marine sand, silt, clay, shell, gravel, typically occurring to the west of the study area, around Merimbula Lake (Qhes/Qheb);
- Tertiary sediments: form a low ridge trending north-south behind the dunes of Pamula Beach (Ts);
- Holocene back-barrier flat: marine sand, silt, clay, gravel, shell, occurring in a 10 m to 20 m wide section, west of the exfiltration ponds of the STP (Qhbf);
- Holocene dunes: marine sand occurring from the exfiltration ponds of the STP to Merimbula Beach (Qhbd); and
- Holocene sandy beach: marine sand, shell, gravel occurring along the eastern most edge of Merimbula Beach (Qhbb).

These coastal barrier geological units correspond to the identifiable barrier landforms within the study area (i.e. beach, dune and backbarrier flat).

The hydrogeology of the Project area is described in **Section 9.2.4** of **Chapter 9 Groundwater.**

13.2.4 Soils

Soils within the study area, as mapped on the Soil Landscapes of the Bega-Goalen Point 1:100,000 Sheets (Tulau, 1997), are shown on **Figure 13-3**. A summary of the characteristics of each soil landscape found within the study area is provided as follows:

- Wallagoot Foredune - Beach: These soil landscapes are associated with the foredunes of Merimbula Beach and comprise very deep (more than 3 m), well-drained Siliceous Sands. Topsoils comprise loose, speckled brownish grey sands and are typically very thin (≤5 centimetres (cm)). These soils typically overlie several metres of yellowish brown sands (C horizon). In areas of foredune retreat, buried A soil horizons can occur;
- Tathra variant c (tac) - Aeolian: These soils are observed to occur in association with poorly drained flats and swales within the Merimbula Bay Barrier and comprise deep (>150 cm), imperfectly drained to poorly drained groundwater Podzols. Topsoils include loamy sands and sands and extend up to 15 cm below ground level (bgl). Seasonally high water tables are a defining characteristic of this landscape;
- Pambula (pa) - residual: Identified by locally occurring rises and hills underlain by Tertiary aged sediments. Topsoils in crest, summit and slope contexts consist of loamy sands of variable colour (e.g. brownish black, brownish grey, yellow brown) extending up to 25 cm bgl. In drainage lines, a silty clay A-B horizon is present from the surface and has a thickness of at least 80 cm;
- Nelson Lagoon (nl) - estuarine: This soil landscape type generally occurs on intertidal and supratidal flats adjacent to Merimbula Lake and comprises deep (>150 cm), very poorly drained alluvial soils and acid sulfate soils. Topsoils include fibric peats, light clays and sandy loams. Described topsoil and subsoil units are underlain by layered gritty, shelly sands to clays; and
- Karalu (ka) - residual: This soil type is typically associated with gently undulating plains to undulating rises on Tertiary sediments, in poorly drained locations. This soil landscape type comprises Tertiary fluvial sediments of clay and sandy clay layers between 10 - 50 cm thick which are interbedded with layers of fine to coarse sand with coarse gravels.

Generally, the Wallagoot Foredune and Tathra variant c soils correspond with the mapped distribution of marine barrier deposits within the study area. The Pambula soil group generally corresponds with the Tertiary Quandolo and Long Beach Formations in the study area and the Nelson Lagoon soils generally correspond with the saline swamp of deposits associated with Merimbula Lake.

- Borehole investigations undertaken for the *Geotechnical Interpretative Report* prepared for the Project (refer **Appendix C** (Geotechnical Interpretative Report) identified two geotechnical units within the Project area, from boreholes shown on **Figure 13-1**, as shown in **Table 13-2**.

Table 13-2 Geotechnical units identified in the *Geotechnical Interpretative Report* (AECOM, 2020)

Geological unit	Typical description	Typical density/consistency	Typical thickness (m)
Dune sand	Quartz sand, fine to medium grained, brown to dark brown, occasional organic odour, trace silt.	Variable - loose to dense	8 m to more than10 m
Interbedded sand and clay	Quartz sand medium to coarse grained, occasionally with silt. Occasional clay beds (approx.15%), up to 2 m thick, medium plasticity, pale brown, with fine to medium grained sand. Red-grey mottling at depth.	Dense to very dense (sands) very stiff to hard (clays)	Base not encountered

FIGURE 13-3: SOIL LANDSCAPES MAPPED IN THE PROJECT AREA AND SURROUNDS

N

0 250 500 m

Legend

- Project area
- Project area (temporary construction area)
- Jellat Jellat Flat - Alluvial
- Tathra variant c - Aeolian
- Wallagoot Foredune - Beach
- Kangarutha Point - Colluvial
- Yellow Pinch - Erosional
- Towamba River variant b - Estuarine
- Nelson Lagoon - Estuarine
- Kalaru - Residual
- Milligandi - Residual
- Pambula - Residual
- Penooka Swamp - Swamp

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

13.2.5 Acid sulfate soils

Acid sulfate soils are naturally occurring soils containing iron sulphides, which on exposure to air, oxidise and create sulfuric acid, and can also release iron, aluminium and heavy metals. In NSW, land is classified based on the likelihood of acid sulfate soils being present in particular areas and at certain depths.

In accordance with the *Guidelines for the Use of Acid Sulfate Soils Risk Maps (*Naylor, S.D et al, 1998), there are five acid sulfate soil classifications:

- Class 1: Acid sulfate soils are likely to be found on and below the natural ground surface. Any works would trigger the requirement for assessment and may require management;
- Class 2: Acid sulfate soils are likely to be found below the natural ground surface. Any works beneath the natural ground surface, or works which are likely to lower the water table, would trigger the requirement for assessment and may require management;
- Class 3: Acid sulfate soils are likely to be found more than 1 m below the natural ground surface. Any works that extend beyond 1 m below the natural ground surface, or works which are likely to lower water table beyond 1 m below the natural ground surface, would trigger the requirement for assessment and may require management;
- Class 4: Acid sulfate soils are likely to be found more than 2 m below the natural ground surface. Any works that extend beyond 2 m below the natural ground surface, or works which are likely to lower the water table beyond 2 m below the natural ground surface, would trigger the requirement for assessment and may require management; and
- Class 5: Acid sulfate soils are not typically found in Class 5 areas. Areas classified as Class 5 are located within 500 m of adjacent Class 1, 2, 3 or 4 land. Works in a Class 5 area that are likely to lower the water table below 1 m AHD on adjacent Class 1, 2, 3 or 4 land would trigger the requirement for assessment and may require management.

Within the study area, a small portion of the western side of the STP site is mapped as Class 3 acid sulfate soils, a portion of the adjacent Pambula Merimbula Golf Club (PMGC) grounds is mapped as Class 2 and Class 3, and a section of the proposed ocean outfall pipeline (east of the STP site) is mapped as Class 2 and Class 4 acid sulfate soils. Two boreholes drilled near the pipeline alignment (boreholes BH02A, and BH02B refer to **Figure 13-1**) were also recorded as having a strong organic odour, which may indicate the presence of acid sulfate soils; likewise Borehole BH02B also tested high for soil aggressivity (AECOM, 2020). Class 1 acid sulfate soils are mapped as occurring within Merimbula Lake, however these are about 110 m north west of the study area and would not be disturbed as part of the Project. Acid sulfate soils mapped in the study area are shown in **Figure 13-4.**

FIGURE 13-4: ACID SULFATE SOIL CLASS MAPPED IN THE PROJECT AREA AND SURROUNDS

N

0 250 500 m

AECOM

Legend

- Project area
- Project area (temporary construction area)

Acid Sulfate Soils Class

- Class 1
- Class 2
- Class 3
- Class 4

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User

13.2.6 Contaminated materials

A desktop assessment undertaken for contaminated materials showed that there is no known contamination within the study area, however potential exists for small scale contamination in the area (e.g. from any past accidental spills of fuel, oil or chemicals).

A search of the NSW EPA contaminated land register on 1 May 2020 did not identify any contaminated sites notified to NSW EPA (under section 58 of the *Contaminated Land Management Act 1997*) within the study area or within 500 m of the study area.

In considering unknown sources of contamination, it is unlikely that contaminated material would be present from the original development of the STP site (e.g. by use of contaminated fill material). A 1988 ground investigation consisting of 12 boreholes at the STP site found that the top 5 m to 10 m of the STP site was recorded as consisting of sand, silty sand, silty sand with traces of clay, and silty clayey sand; although a variable 1 m thick layer of natural fill material was also occasionally noted (AECOM, 2020). There is potential for leachate from the drying beds within the STP site to have penetrated the surrounding soils, particularly when mechanical dewatering is being undertaken and the drying beds are used in this process. As the drying beds are central within the STP site, the possibility of leachate passing into adjacent land is considered to be minor. This is particularly the case as the drying beds would comprise an impervious layer to prevent leaching and would have a drainage system specifically designed to direct any remaining liquid (underlying solids, separated during the drying process) back into the process treatment train. There is also potential for small scale contamination to occur within the STP site from any past/historic spills of fuel, oils or chemicals as part of the STP operation. However, this is considered unlikely as the STP has been operating with adequate spill management and clean up measures for decades.

There is potential for contamination to be present at/under Arthur Kaine Drive, if any contaminated fill material was used in the construction of the road base, and also from accidental fuel/oil leaks on or near the road. It is considered unlikely that any previous spills along the pipeline alignment would remain in-situ due to the sandy nature of the soils.

The exfiltration ponds are designed to release treated wastewater to land and are an authorised release point for treated wastewater (under the NSW EPA's Environmental Protection Licence for the STP site). The exfiltration ponds have not been used as consistently as in previous years (e.g. prior to beneficial re-use of treated wastewater began). It is likely that treated wastewater would be present in the sandy soils of the immediate area. A borehole drilled in 2018 near the exfiltration ponds (borehole BH06) was recorded as containing a strong sewage odour (AECOM, 2020), which indicates the likely presence of the treated wastewater released.

There is potential for contaminated land to occur surrounding the nearby Merimbula Airport (located about 1 kilometre north of the study area, with the airport runway extending to within 400 m of the STP site) due to activities over time at this site (e.g. from aviation/mechanical activities, accidental spills (e.g. oil, fuel or chemicals), or release of firefighting foam/chemicals). Groundwater level contours for the study area indicate that groundwater depth levels below Merimbula Airport are similar to those found at the Project area. For this reason, groundwater movement of potential contaminants from the airport to the Project area would be limited but possible.

13.2.7 Salinity

Salts naturally present in soil and rock are mobilised in the subsurface by the movement of groundwater. The concentration of salts within the soil is related to the geological unit from which the soil is derived. Salt concentrations within marine derived alluvium or alluvium that is tidally influenced, such as within the study area, are typically high. Under shallow groundwater conditions, saline groundwater may also be drawn to the ground surface, precipitating the salts as the water evaporates.

Chapter 9 Groundwater found that groundwater is present within the sedimentary deposits that lie beneath the Project area, and that the water table in the Project area near Merimbula Beach is influenced by the levels in the two exfiltration ponds, rainfall and tidal levels. Groundwater mapping along the ocean outfall pipeline indicates the depth to groundwater during a high rainfall period is about 1.1 m below ground surface and fluctuates by about 0.5 m seasonally. The hydrogeology of the Project area is described further in **Section 9.2.4**, and groundwater recharge, levels and flow are further described in **Section 9.2.6** of **Chapter 9 Groundwater**.

Groundwater in the Project area is described as typically fresh near the water table, becoming saline at depth. Higher salinity at depth is the result of natural processes whereby saline groundwater is more dense than fresh groundwater. Along the coastline saline groundwater of marine origin “wedges” underneath fresh groundwater that “floats” at the water table. The groundwater salinity (based on electrical conductivity measurements) along the proposed ocean outfall pipeline ranges between fresh at the water table; 220 microsiemens per centimetre (μS/cm) to brackish at 10 m depth; and 2,400 μS/cm (at borehole) 2018_BH02B) to saline (seawater, i.e. about 50,000 μS/cm) near the beach. This was also reflected in electrical conductivity results of soils samples taken across the study area (AECOM, 2020). Groundwater electrical conductivity across the Project area and surrounds is further shown in **Figure 3-7** of **Appendix D** (Groundwater Technical report). The results show that salinity is low at the water table and around the central area of the ocean outfall pipeline (near the wetland area), before increasing heading towards Merimbula Beach and also toward Merimbula Lake.

13.3 Potential impacts – construction

Potential construction impacts from the Project are described below, which includes soil erosion and sedimentation. Directional drilling may also encounter acid sulfate soils, however this spoil would be captured in the drilling process, removed from site and disposed of at a licensed facility. Mitigation and management measures are proposed to address these potential impacts along with other minor impacts identified.

13.3.1 Topography

Construction of the Project would require temporary and minor changes to the ground contours of some of the Project area and construction footprint, namely for safe site access to work areas and levelling of construction compound areas. For example, if the intermediate drilling station (and construction compound) on Merimbula Beach is required, this may require grading/levelling for the safe access of vehicles and machinery and laying down of materials. Similarly, drill pad site/s may require grading to setup the drill rig adequately. These areas would be returned to their original levels as much as possible at the conclusion of the use of each area for construction. Likewise, bulk earthworks/excavations required for proposed STP upgrades would be finished to the existing levels of the STP site at the conclusion of their installation, with the exception of those areas where permanent structures would be installed (such as the installation of new storage tank and new chlorine contact tanks).

13.3.2 Soil erosion and sedimentation

As described in **Section 13.2.4,** the Project area contains mostly sandy soils as well as clay/silty soils, which can be susceptible to erosion and sedimentation. Construction of the Project could cause erosion and sedimentation through the following activities:

- vegetation clearance which would expose soils: including within the STP site (for compound areas and the directional drilling site), and at the entrance to the temporary construction access at Pambula Beach;
- bulk earthworks and excavations (for pipes, new infrastructure) and stockpiling activities;
- operation of vehicles and machinery within the Project area: including those associated with deliveries and worker movements; and
- underground directional drilling: including establishment of drill pad/s and associated heavy vehicle movements.

Approximately 2,750 cubic metres (m^3) of spoil would need to be removed as a result of excavation required for new STP infrastructure and may be temporarily stockpiled within the STP site. Temporary stockpiles would be subject to erosion and sedimentation if not managed appropriately. Underground trenchless drilling for the ocean outfall pipeline between the STP and Merimbula Beach would also generate approximately 700 m^3 of spoil. As spoil would be mixed with drilling fluids, it would be captured in an above ground tank and recycled in a recycling unit as part of the drill rig set up where possible or otherwise removed from site and disposed of at a licensed facility (i.e. not stockpiled) (refer **Chapter 26 Waste** for further information).

The remainder of the ocean outfall pipeline would be installed above ground on the sea floor in Merimbula Bay. The potential for soil and erosion impacts to the marine environment during construction are addressed in **Chapter 10 Marine and coastal processes**.

There is a risk of soil subsidence along the alignment of the ocean outfall pipeline, however this risk would be addressed as far as possible in the detailed design and drilling plan by the drilling contractor (e.g. review of substrate and soil conditions, pipeline depths and angles, and drilling method), as is standard for pipeline installations of this nature. Sections of the ocean outfall pipeline alignment would be monitored where possible for significant subsidence and mitigation and management measures would be implemented if required (e.g. ground reinforcement measures, filling).

The construction activities listed above would expose soils in some cases and may weaken surface soil structure. This could lead to erosion within the Project area and sedimentation of the surrounding environment (including nearby waterbodies), particularly during periods of high wind or rainfall. Exposure and movement/release of any acid sulfate soil material into the receiving environment can also have detrimental impacts (refer **Section 13.3.3**). While no streams, rivers or creeks are located within the Project area, the Project would be located adjacent to a wetland, Merimbula Beach and Pambula Beach, which could be impacted by soil erosion and sediment input, if appropriate mitigation and management measures are not put in place.

Consistent with standard practice for civil construction projects and pipeline installation projects, erosion and sediment control measures would be implemented in and around areas of soil/ground disturbance (e.g. areas of excavation and vegetation removal), temporary stockpile sites (if required) and in other areas as required within the Project area. These control measures would be developed in accordance with the *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004) and *Volume 2* (NSW Department of Environment and Climate Change (DECC), 2008) (the Blue Book).

With adequate mitigation and management measures in place and regular monitoring of their effectiveness, soil erosion and sedimentation would be mitigated and controlled and would not result in a significant impact to the environment.

13.3.3 Acid sulfate soils

Disturbance of acid sulfate soils and/or potential acid sulfate soils can result in adverse impacts to the receiving environment, including surface and groundwater quality, flora and fauna, and degradation of habitats.

The construction of the Project would include shallow excavations within the STP site for new pipes, pits and wells, with the deepest excavation proposed being about 3 m in depth. The STP effluent storage pond within the STP site would cease to be used, which would involve dewatering and sludge removal. The locations of the STP infrastructure to be installed and the STP effluent storage pond are shown in **Figure 2-3** in **Chapter 2 Project description**.

Class 3 acid sulfate soils are mapped within the western extent of the STP site and within the Pambula Merimbula Golf Club laydown area within the Project area (refer **Figure 13-4**). No excavation is proposed in these areas, and the Pambula Merimbula Golf Club grounds would be used for storage and stockpiling and pipeline stringing and welding area only. The STP site has also been previously disturbed/constructed, which would further limit the possibility of encountering natural acid sulfate soils. Sludge from the cessation of the STP effluent storage pond would be loaded into truck/s and removed from site to a licensed waste disposal facility with no potential impacts to workers or the environment in the event that excavated material has acidic properties.

The construction of the ocean outfall pipeline between the STP and Merimbula Beach would occur through an area mapped as Class 2 and Class 4 acid sulfate soils. The ocean outfall pipeline would be installed using a trenchless, directional drilling method, at varying depths along the alignment (between about 9.3 to 19.5 m AHD). These works may encounter acid sulfate soils, however as this methodology does not involve an open trench, it limits potential impacts from acid sulfate soils to the capturing of drilling spoil being returned to the drill rig site. Drilling spoil/fluid would be captured in an above ground tank and removed from site, which would eliminate potential impacts from acid sulfate soils to the receiving environment. Drilling fluid may be recycled by the drilling contractor for further use in the drilling process and as a consequence the risk of converting potential acid sulfate soils into actual acid sulfate soils is minimised as the recycling process used would not expose the spoil to oxygen.

Any works which have the potential to encounter or lower the water table (‘draw down’) within areas mapped as acid sulfate soils (or in close proximity), would pose risks of acid sulfate soil mobilisation impacts. Groundwater in the study area has been recorded as being 1.1 m below natural ground surface and is anticipated to fluctuate as a result of rainfall and tidal influences. Installation of the ocean outfall pipeline has the potential to encounter groundwater, however as described in **Section 9.6.2** of **Chapter 9 Groundwater**, impacts related to draw down of the water table are not expected.

As acid sulfate soils that may be encountered during directional drilling would be contained and removed from site, and acid sulfate soil material is not expected to be encountered otherwise, an acid sulfate soil management plan in accordance with the *NSW Acid Sulfate Soils Manual* (Stone et al 1998) would not be required. However mitigation and management measures for dealing with acid sulfate soil material from drilling would be required and are included in **Section 13.5**.

13.3.4 Contamination

As identified in **Section 13.2.6**, there are no known sources of contamination within the Project area. Although not expected, there is potential for contamination to occur in association with the historic and existing use of the Merimbula STP, and the construction of Arthur Kaine Drive. Impacts related to Arthur Kaine Drive are limited to directional drilling under the road, however this is expected to be over 10 metres below the road surface, and therefore any contaminated material associated with construction of the road is unlikely to be encountered. There is also potential for contamination to occur at the nearby Merimbula Airport, however due to the distance from the Project area this area would not be disturbed. Any unknown contaminants may impact the surrounding environment if they are exposed and released or have human health effects from primary contact or odour. The primary means that contamination would be exposed is through excavation from within the STP site, and through directional drilling for the ocean outfall pipeline (although drilling spoil/fluids would be captured and removed from site to a licensed facility where they are not recycled by the drilling contractor).

Mitigation and management measures addressing unexpected finds of contamination would be included in the Construction Environmental Management Plan (CEMP) for the Project. It is considered unlikely that the areas to be excavated would require remediation, based on previous investigations carried out at the STP site, and current and former land uses (e.g. natural vegetation and sand dune habitat).

Construction of the Project also has the potential to introduce sources of contamination, through use of fuels, oil and chemicals, and use of drilling fluids. The risk of accidental spills and leaks of fuel, oils or other substances during construction would be minimised and managed through standard construction mitigation and management measures described in **Section 13.5**.

Directional drilling carries an inherent risk of frac-out, which is the un-intentional release of drilling fluids to the surface during directional drilling. This risk would be accounted for as much as possible during detailed design and completion of the drilling plan by the construction contractor (e.g. consideration of drilling fluids, pressure, angle and depth proposed, as well as substrate conditions). Mitigation and management measures would also be included in the CEMP in the event of frac out (e.g. spill management and bunding).

Section 13.5 describes mitigation and management measures which would be implemented to address potential risks associated with contamination.

13.3.5 Salinity

Construction of the Project has the potential to contribute to salinity through:

- clearance of any deep-rooted vegetation which can result in an increase of surface water migrating into the underlying groundwater table, as it is no longer being consumed by the overlying vegetation. This can cause a rise in the groundwater level, mobilising salt stored in soils to the surface, resulting in increased salinity;
- soil compaction at areas of surface disturbance, which can restrict groundwater flow and result in a concentrate of salt in one area; and
- mobilisation of salts within the alluvium during local dewatering or activities associated with the directional drilling works.

While vegetation clearance is proposed as part of the Project, this would be limited to an area of about 0.28 hectares (ha) of native vegetation, as shown on **Figure 12-6** in **Chapter 12 Terrestrial Ecology**

The areas of vegetation proposed to be removed are proportionally small when compared to the surrounding extent of vegetation. As a result, the potential for the construction of the Project to result in increased soil salinity due to vegetation clearance would be minor as this vegetation removal would be unlikely to impact on underlying groundwater levels. It is also noted that the areas of the Project area within close proximity to Merimbula Beach and marine influences would contain soils and vegetation that experience and are adapted to saline conditions. For example, plants identified during biodiversity field surveys for the Project, included numerous salt-adapted native species including but not limited to *Lomandra longifolia, Acacia longifolia subsp. Sophorae, Banksia integrifolia* and *Lepidosperma gladiatu* (flora species are considered further in **Chapter 12 Terrestrial Ecology**).

The risk of exacerbating salinity impacts through vegetation removal, compaction-related restriction of groundwater movements or impacts to tree roots is considered to be very low. Soil compaction could be caused by vehicles accessing construction areas, laying down of materials in compound areas, and establishment of directional drilling pad site/s. These activities would largely be confined to existing access/developed areas (such as the STP site and accesses) and would be temporary, at various times within the construction period. Activities in areas that are not developed (established or hard stand), such as the Pambula Merimbula Golf Club temporary construction laydown area and construction access along Merimbula Beach, would also be temporary, with a small number of construction vehicles expected (5 to 10 heavy vehicles per day), and would avoid vegetation. Vegetation exclusion zones would be implemented as described in **Chapter 12 Terrestrial ecology**, and the small magnitude activity is not expected to restrict the flow of groundwater throughout the area (refer **Section 9.2.6** of **Chapter 9 Groundwater** for groundwater mapping).

As discussed above, groundwater levels across the study area generally fluctuate around 1.1 m below the natural ground surface. No dewatering activities are proposed for the construction of the Project. The construction of the Project is not anticipated to involve any other activities which could raise the groundwater table above normal seasonal levels. As such, the potential for the construction of the Project to locally restrict ground water flow and result in localised salinity would be negligible to low. In addition, the close proximity of the Project to marine influences would indicate that the study area experiences naturally occurring, variable saline conditions. As such, naturally occurring vegetation in the study area would be adapted to saline soils, further limiting the potential for decreased plant growth, or increased vegetation dieback as a result of soil salt content.

13.4 Potential impacts – operation

Upon completion of construction and installation of all components of the Project, the Project would not affect the topography of the study area.

Erosion and sedimentation at the STP site is not expected to be an issue during operation. Drainage at the STP site would continue to operate similar to the current site, although there would be small changes and additions to drainage infrastructure to account for new infrastructure (e.g. drains around new above ground tanks). As per the construction stage, there is also a risk of soil subsidence along the alignment of the ocean outfall pipeline, particularly in the early stages of operation following installation. Periodic monitoring and auditing during operation would include subsidence monitoring and rectification where necessary (e.g. through ground protection or reinforcement measures, or filling).

As no ground disturbance would occur during operation, there would be no potential for exposure to or release of acid sulfate soil material to the receiving environment. **Section 9.7.2** of **Chapter 9 Groundwater** found that there would only be a small magnitude of change to groundwater flow and levels due to the presence of the ocean outfall pipeline and new below ground infrastructure within the STP. Therefore, any movement of below ground acid sulfate soil material from movement of the water table would be minor.

The Project infrastructure has been designed to be suitable for the soil properties expected to be encountered (e.g. suitable pipeline materials to deal with corrosion risk from soil salinity), to provide for the design life of the Project.

The potential for soil contamination as a result of general maintenance activities (e.g. accidental spills) is considered to be low, based on the low number of vehicles, equipment and plant requiring maintenance. This impact would be minimised by implementing spill management procedures in accordance with existing BVSC procedures.

The potential for soil contamination from handling additional chemicals as a result of the Project at the STP is also considered to be low. Chemical unloading, storage and handling would be carried out in bunded areas specifically designed for this use. Spill kits appropriate for the chemicals to be handled would also be in place, and the STP would be subject to existing procedures for chemical unloading, storage and handling (note that these procedures would be updated as necessary for the Project).

For these reasons, the operation of the Project would be unlikely to result in any significant impacts to landform, geology and soils.

Mitigation and management measures would be implemented to address the potential impacts described above (refer **Section 13.5**).

13.5 Management of impacts

The mitigation and management measures identified to help avoid and minimise the identified landform, geology and soils impacts are outlined in **Table 13-3,** and would be included in the CEMP for the Project and carried through to operation by BVSC where relevant.

13.5.1 Performance outcomes

The landform, geology and soils performance outcomes for the Project are as follows:

- the environmental values of land, including soils, subsoils and landforms, are protected;
- human health and ecological risks arising from the disturbance and excavation of land and disposal of soil are minimised, including erosion and sedimentation, subsidence risks and potential disturbance of acid sulfate soils; and
- accidental spills and leaks of fuel, oils or other chemical substances during construction and operation are contained and any contaminated material removed.

The Project would be designed, constructed and operated to achieve these performance outcomes.

13.5.2 Consideration of the interaction between measures

Mitigation and management measures in other chapters that are relevant to the management of potential landform, geology and soils impacts include:

- **Chapter 8 Surface water, flooding and hydrology**, specifically measures SWF1, SWF2 and SWF4 to address surface water quality impacts during construction and operation;
- **Chapter 9 Groundwater and geology,** specifically measure GW3 and GW4 which addresses potential groundwater quality impacts during construction and operation;
- **Chapter 16 Hazardous materials,** specifically measure HR1 which addresses storage and handling of dangerous goods and hazardous substances; and

- **Chapter 26 Waste,** specifically measure WM3 which addresses spoil management, including management of contamination spoil.

13.5.3 Mitigation and management measures

Mitigation and management measures to address the potential impacts identified are described in **Table 13-3** below.

Table 13-3 Mitigation and management measures

Ref #	Potential impacts	Mitigation and management measures	Timing
S1	Unexpected find of contamination	The CEMP would include a procedure for managing unexpected finds of contamination (e.g. during excavation works). Works would cease, worker health would be prioritised, and contaminated material would be contained, classified and disposed of according to the *Waste Classification Guidelines* (NSW EPA, 2014). Plans for ongoing work in the area would also be revised accordingly.	Construction
S2	Erosion and sediment control, and stockpile management	A Soil Erosion and Sedimentation Management Sub-Plan would be developed to manage potential soil and water issues relevant to the construction of the Project. This sub-plan would be part of the CEMP. The sub-plan would include detailed erosion and sediment control plans for each work site and would outline which erosion and sediment control measures would be implemented at each location or for specific works. These control measures would be developed with the management approaches outlined in *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004), and *Volume 2* (DECC, 2008) (as applicable) (the Blue Book).	Construction
S3	Erosion and sedimentation (subsidence)	The ocean outfall pipeline alignment would be monitored for subsidence, and mitigation and management measures would be implemented if required (e.g. ground reinforcement measures, filling).	Construction and operation

Ref #	Potential impacts	Mitigation and management measures	Timing
S4	Accidental spills	Spill mitigation and management measures would be included in the CEMP and there would be Standard Operating Procedures during operation, including: • machinery and equipment would be maintained in accordance with manufacturers requirements to minimise the risk of leaks or broken hoses, etc. Equipment would be not be used if there are any signs of fuel, oil or hydraulic leaks; • spill kits would be kept on-site at all times and in vehicles where appropriate. Any accidental spills would be contained, collected/excavated and disposed of at an appropriately licensed waste facility, and appropriate records kept; • specific provisions would be included in the CEMP for emergency measures in the event of frac out; and • spills would be subject to incident reporting under the CEMP, including notification under the *Protection of the Environment Operations Act 1997* where necessary.	All stages
S5	Acid sulfate soils	Any potential or actual acid sulfate soils would be managed in accordance with the *NSW Acid Sulfate Soils Manual* (Stone et al, 1998).	Construction

13.5.4 Environmental risk analysis

As outlined in **Chapter 7 Environmental Scoping Assessment**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for Landform, geology and soils and is provided in **Table 13-4**.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Following the implementation of the mitigation and management measures above, there would be a low to medium risk from the Project to landform, geology and soils. The Project is also not expected to contribute to cumulative impacts. Further consideration of cumulative impacts with regard to other environmental aspects of the Project are addressed in **Chapter 27 Cumulative impacts** of this EIS.

Table 13-4 Environmental risk analysis with mitigation– Landform, geology and soils

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Contamination impacts during ground disturbance activities	Construction	S1, S5	Minor	Unlikely	Low
Exposure to contaminated material	Construction	S1	Minor	Unlikely	Low
Erosion and sedimentation	Construction	S2, S3	Minor	Unlikely	Low
Release of acid sulfate soils	Construction	S5	Minor	Unlikely	Low
Accidental spills (including accidental release of drilling fluids)	Construction	S4	Moderate	Unlikely	Medium
Accidental spills	Operation	S4	Minor	Unlikely	Low

14.0 Aboriginal heritage

This chapter provides a summary of the Aboriginal heritage impacts associated with the Project as identified in **Appendix I** (Aboriginal Cultural Heritage Assessment Report (ACHAR)).

Table 14-1 sets out the SEARs relevant to Aboriginal heritage and where the requirements have been addressed in this EIS.

Table 14-1 SEARs – Aboriginal heritage

Ref	Assessment requirements	Where addressed in this EIS
8.1	The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of: a. Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines; b. Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan; c. environmental heritage, as defined under the *Heritage Act 1977*; and d. items listed on the National and World Heritage lists.	**Section 14.3**, **Section 14.4** and **Section 14.5**. Note that impacts to non-Aboriginal heritage are addressed in **Chapter 15 Non-Aboriginal heritage**.
8.3	The EIS must identify and describe the Aboriginal cultural heritage values that exist across the whole area that will be affected by the proposal and document these in an Aboriginal Cultural Heritage Assessment Report (ACHAR). This may include the need for surface survey and test excavation. The investigation, assessment and reporting of Aboriginal cultural heritage values must be conducted in accordance with the current Code of Practice and Guide. Impacts on Aboriginal cultural heritage values are to be assessed and documented in the ACHAR. The ACHAR must demonstrate attempts to avoid impact on cultural heritage values and identify any conservation outcomes. Where impacts are unavoidable, the ACHAR must outline measures proposed to mitigate impacts. Any objects recorded as part of the assessment must be documented and notified to OEH (now known as the NSW office of Environment, Energy and Science (EES)	An ACHAR has been prepared for the Project; it is summarised in this chapter and provided in full in **Appendix I**.
8.4	Consultation with Aboriginal people must be undertaken and documented in accordance with the current consultation requirements for proponents. The significance of cultural heritage values for Aboriginal people who have a cultural association with the land must be documented in the ACHAR.	**Section 14.1.7** and **Appendix I**. Note that consultation with Aboriginal people is also summarised in **Chapter 6 Engagement**.

14.1 Assessment approach

14.1.1 Legislative context

The Aboriginal heritage assessment has been undertaken in accordance with the following legislation and statutory planning instruments:

- *Aboriginal and Torres Strait Islander Heritage Protection Act 1984* (Commonwealth) (ATSIHP Act);
- *Native Title Act 1993* (Commonwealth) (NT Act);
- *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act);
- *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act);
- *Aboriginal Land Rights Act 1983* (NSW) (ALR Act);
- *National Parks and Wildlife Act 1974* (NSW) (NPW Act); and
- *Bega Valley Local Environmental Plan 2013* (Bega Valley LEP 2013).

14.1.2 Methodology

The methodology for the ACHAR was developed and undertaken in accordance with the Department of Premier and Cabinet's (former Office of Environment and Heritage's (OEH)) *Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW* (OEH, 2011), *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010a) and *Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales* (DECCW, 2010b).

The key requirements were:

- to conduct a search of the Aboriginal Heritage Information Management System (AHIMS);
- to review the landscape context of the study area (defined in **Section 14.1.3**), with specific consideration to its implications for past Aboriginal land use (and by extension, its Aboriginal archaeological record);
- to review relevant archaeological and ethnohistoric information for the study area and environs;
- to prepare a predictive model for the Aboriginal archaeological record of the study area;
- to undertake an archaeological field investigation;
- to identify, notify and register Aboriginal people who hold cultural knowledge relevant to determining the cultural significance of Aboriginal objects and/or places in the study area;
- to provide Registered Aboriginal Parties (RAPs) with information about the scope of the proposed works and Aboriginal heritage assessment process;
- to facilitate a process whereby RAPs can:
  - contribute culturally appropriate information to the proposed assessment methodology;
  - provide information that will enable the cultural significance of Aboriginal objects and/or places within the study area to be determined;
  - have input into the development of cultural heritage management options; and
- to prepare and finalise the ACHAR with input from RAPs.

14.1.3 Study area

The study area for the assessment is shown in **Figure 14-1** and comprises both the Project area and the associated temporary construction area which includes largely unmodified sections of the edge of Merimbula Bay Barrier (a frontal dune feature), and the proposed construction access along Merimbula Beach (an approximately 1.5 kilometre (km) long and 360 metre (m) wide section of adjoining foredunes and back barrier sand flat). Where appropriate, some surveys undertaken extended beyond the boundaries of this defined study area, as shown on **Figure 14-2**. The additional extent of these surveys was undertaken in consultation with, and under the supervision of the RAPs. Land within the study area falls wholly within the Bega Valley local government area (LGA). It is noted that there is an active Aboriginal Lands claim on lots 7308, 320 and 7307 (refer **Section 5.2** for further information).

FIGURE 14-1: ABORIGINAL CULTURAL HERITAGE ASSESSMENT STUDY AREA

N 0 250 500 m

AECOM

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Project area
- Project area (temporary construction area)

14.1.4 Desktop review

A desktop review of background literature was conducted to investigate the existing environment of the study area with particular reference to its implications for Aboriginal heritage, including information regarding the topographical, geological and hydrological setting of the study area. Historic aerial photography was also analysed to investigate the location and extent of any previously disturbed grounds in the study area and to assist in identifying areas of likely Aboriginal heritage potential.

The desktop review also included a review of relevant Aboriginal archaeological reports for the study area, as well as publicly available databases such as the AHIMS.

14.1.5 Archaeological survey

An archaeological survey was undertaken in 2018 to identify and record any existing surface evidence of past Aboriginal occupation within the study area. The archaeological survey also aimed to:

- re-locate and reassess previously recorded AHIMS sites 62-6-0173 and 62-6-0475 (described further in **Section 14.2.4**);
- sample all landform elements within the study area, with a particular emphasis on landforms of demonstrated archaeological potential;
- ground-truth levels of past land disturbance across the study area; and
- identify areas of subsurface Aboriginal archaeological sensitivity.

To achieve these aims, a survey strategy was developed based on a review of historical aerial photographs to identify areas that may have greater Aboriginal archaeological potential within the study area. As such, survey efforts were primarily focussed on areas of cleared land to the east of Arthur Kaine Drive. Transects were also completed to the west of Arthur Kaine Drive, within the fenced Merimbula STP site, as well as areas of remnant/regenerating vegetation to the east and west of this road.

The survey was conducted on foot, with a total of 15 transects completed. The coordinates of each transect location were recorded using a handheld GPS, as well as any relevant transect characteristics (such as levels of visibility and exposure). The location of the transects are shown on **Figure 14-2**.

All Aboriginal archaeological materials identified during the archaeological survey were recorded to the standard required by the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW*, with individual artefact locations captured by GPS. Attribute data for all identified Aboriginal objects were also entered using AECOM's standard digital open site recording form. All sites were photographed following artefact recording.

FIGURE 14-2: SURVEY TRANSECTS UNDERTAKEN DURING THE 2018 SURVEY

N

0 200 400 m

AECOM

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Legend

- Project area
- Project area (temporary construction area)
- Survey Transect

14.1.6 Test pit excavation program

In October 2018, AECOM's heritage team was tasked with 'clearing' nine proposed geotechnical borehole locations as part of the Project. All nine borehole locations were physically inspected as part of the archaeological survey (refer **Section 14.1.5** and **Section 14.2.5**), with no surface Aboriginal objects identified. Nonetheless, all but two borehole locations (BH004 and BH005) were assessed in the field as retaining potential for subsurface archaeological deposits (albeit of variable character and/or integrity). A program of archaeological test excavation (test pits) was therefore undertaken, focusing on seven (of the nine) proposed borehole locations: boreholes BH02A, BH02B, BH02C, BH03, BH06, BH07 and BH08. The location of the archaeological test excavation (test pits) is shown on **Figure 14-3** and the final selected borehole locations are shown on **Figure 13-1** in **Chapter 13 Landform geology and soils**.

All test pits were hand excavated in accordance with the *Code of Practice for Archaeological Investigation of Aboriginal Objects in NSW*, with all definite and potential Aboriginal objects collected with sieves and bagged by square and spit. Representative profiles in test pits were drawn and photographed, with test pit stratigraphy recorded on pro forma test pit recording sheets using standard sedimentological terms and criteria (after McDonald & Isbell, 2009). Observed soils and soil profiles within the seven test pits excavated were, in general, consistent with those described for their associated soil landscapes. All pits were backfilled after excavation.

Representatives from the Eden and Bega Local Aboriginal Land Councils (LALCs) were present during the test pit excavations.

FIGURE 14-3: TEST PIT LOCATIONS

Legend

- Project area
- Project area (temporary construction area)
- 10m Contour
- 2m Contour
- Test Pit Location

N

0 100 200 m

AECOM

Source: Nearmap, 2019

14.1.7 Aboriginal community consultation

Aboriginal community consultation for the current assessment was undertaken in accordance with *Aboriginal Cultural Heritage Consultation Requirements for Proponents* (DECCW, 2010a). A description of each consultation stage, as well as associated actions and outcomes is provided in **Table 14-2**.

Table 14-2 Aboriginal community consultation

Consultation stage	Aim	Actions and outcomes
Stage 1 – Notification and registration	Identify, notify and register Aboriginal people who hold cultural knowledge relevant to determining the cultural significance of Aboriginal objects and/or places in the study area.	The following agencies were contacted via letter or email sent on 26 February 2018 requesting information on relevant Aboriginal persons and organisations: • the former NSW OEH; • Eden LALC; • Office of the Registrar, Aboriginal Land Rights Act 1983 (NSW); • National Native Title Tribunal; • NTSCORP Limited (Native Title Service Provider for Aboriginal Traditional Owners in NSW and ACT); • BVSC; and • South East Local Land Services. Responses were received from three agencies, as follows: • the National Native Title Tribunal responded on 26 February 2018 advising the results of searches of the *Schedule of Applications (unregistered claimant applications)*, *Register of Native Title Claims*, *National Native Title Register*, *Register of Indigenous Land Use Agreements* and *Notified Indigenous Land Use Agreements*; • OEH responded on 9 March 2018 providing a list of Aboriginal parties for the Bega Valley LGA; and • the Office of the Registrar responded on 14 March 2018 advising the results of a search of the *Register of Aboriginal Owners.* Relevant Aboriginal organisations or persons with cultural heritage knowledge of the area were registered.
Stage 2 - Presentation of information about the Project	Provide Registered Aboriginal parties (RAPs) with information about the scope of the Project and the proposed cultural heritage assessment process.	Information about the scope of the Project and the proposed cultural heritage assessment process was provided to RAPs in the form of an Expression of Interest letter sent out on 14 March 2018, with more detailed information provided in the draft assessment methodology.

Consultation stage	Aim	Actions and outcomes
Stage 3 – Gathering information about cultural significance	Facilitate a process whereby RAPs can: • contribute to culturally appropriate information gathering and the assessment methodology; • provide information that will enable the cultural significance of Aboriginal objects and/or places within the study area to be determined; and • have input into the development of any cultural heritage management measures.	Consultation with RAPs regarding the cultural heritage values of the study area included: • a request with an expression of interest letter for any initial comments; • discussion of cultural heritage values during fieldwork; • the provision of a draft report to all RAPs for comment prior to finalisation; and • two RAPs - Bega LALC and Eden LALC - were invited to participate in the archaeological field investigation. Information on the cultural values of the study area and its environs was provided on 22 March 2018 by one RAP as part of its registration of interest in the Project. Written responses to the draft methodology were provided by four RAPs who all indicated that they supported the draft methodology. Bega LALC provided a single site officer and Eden LALC provided two site officers to attend the archaeological field investigation and assisted in identifying social or cultural values within the study area.
Stage 4- Review of draft assessment report	Prepare and finalise an ACHAR with input from RAPs.	In accordance with Section 4 of the *Aboriginal Cultural Heritage Consultation Requirements for Proponents*, a draft of the ACHAR was issued to RAPs for their review on 21 October 2020. The closing date for comments was 19 November 2020, which provided the required minimum 28 day period for review. Responses on the draft ACHAR were received from two RAPs following the formal closure of the comment period and have been included for full consideration. The two responses received are as follows: • a representative of Eden LALC responded on 1 December 2020 advising they are satisfied with the report and the thoroughness of the assessment; and • an individual responded on 2 December 2020 advising that fragmented human skeletal remains have previously been identified on and directly adjacent to a former track to the south of the dunal exfiltration ponds. They noted that provided this access track is not impacted they are happy for the Project to proceed. They also advised that the recorded scarred tree (62-6-0475) is an Aboriginal scarred tree that has been subsequently modified by Europeans. Additional mitigation measures have been provided in response to the issues raised in the RAP responses (refer to **Section 14.5**).

14.2 Existing environment

14.2.1 Physical characteristics of the study area

The existing biodiversity conditions in the study area are described in **Chapter 12 Terrestrial ecology**.

Hydrological features are described in **Chapter 9 Surface water and flooding** and existing topography, geology and soil conditions in **Chapter 14 Landform, geology and soils**.

14.2.2 Land disturbance

Review of historical aerial photographs spanning from 1962 to 1994 indicate a range of activities and associated ground surface works have occurred within and surrounding the Project area, including:

- native vegetation clearance;
- pre-1962 construction of an electricity easement about 30 m wide, parallel to Merimbula Beach;
- sand mining activities pre-1980;
- construction and evolution of the Merimbula STP from around 1979 (including associated infrastructure items);
- road construction;
- construction of the Pambula Merimbula Golf Club; and
- light vehicle track construction/use.

To varying degrees, all of these activities and associated ground impacts are relevant to the survival, integrity and identification of Aboriginal archaeological evidence within the study area.

Figure 14-4 provides a land disturbance map for the study area, which identifies three levels of disturbance: low, moderate and high. Areas of highly disturbed terrain are unlikely to retain evidence of past Aboriginal occupation in surface and subsurface contexts owing to the severity of past ground surface disturbances that have occurred within them. Areas of moderately disturbed terrain, in contrast, may retain such evidence. However, it is likely to have been disturbed to varying degrees. Any Aboriginal archaeological deposits present within areas of low disturbance are likely to exhibit a high degree of archaeological integrity.

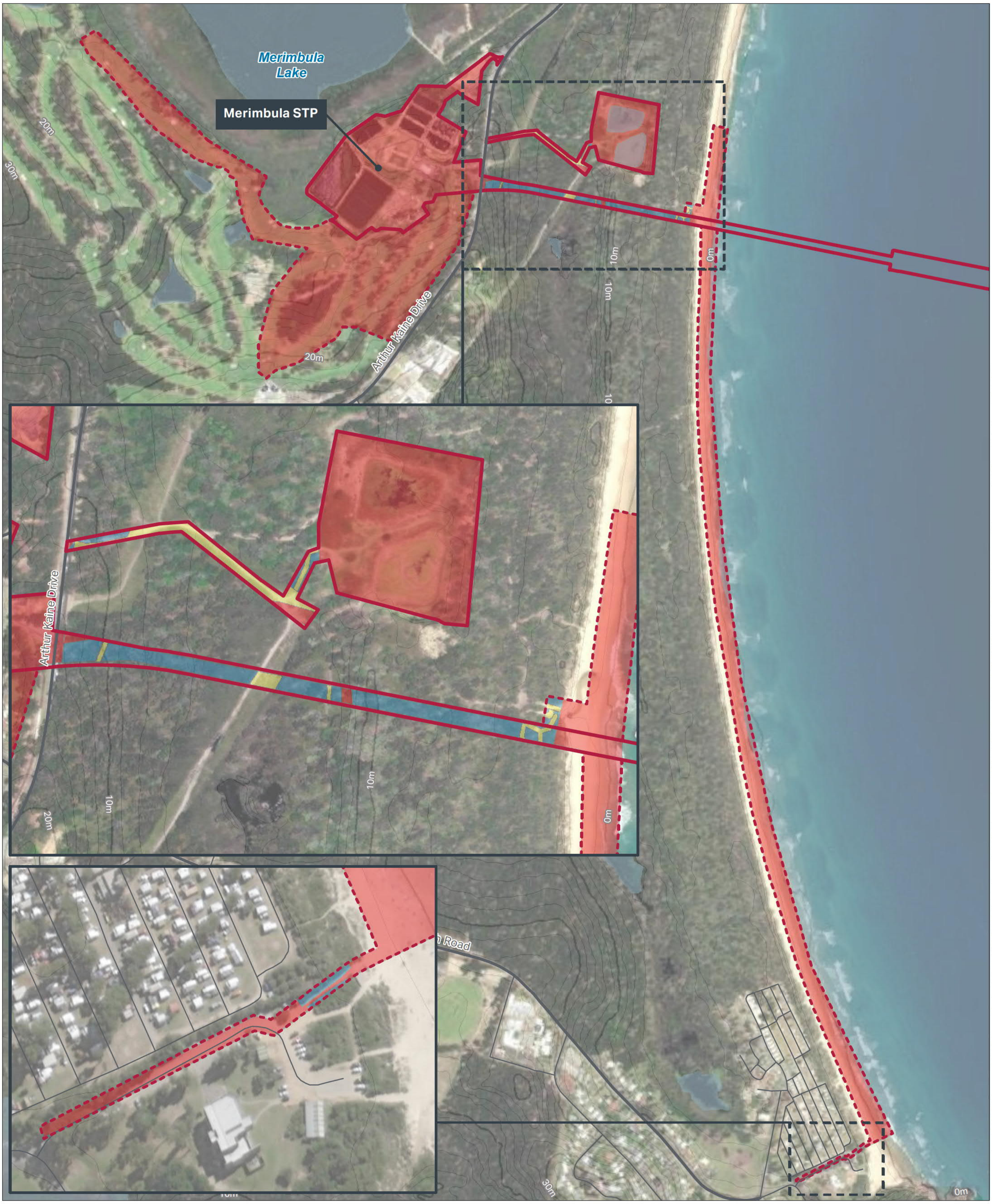

FIGURE 14-4: EXISTING AND HISTORICAL LAND DISTURBANCE WITHIN THE PROJECT AREA

N
0 250 500 m

AECOM

Legend

- Project area
- Project area (temporary construction area)

Land Disturbance

- High
- Moderate
- Low

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

14.2.3 Historical background

The Far South Coast region encompasses the traditional lands of the *Thaua*, *Djiringanj* and *Bidawal* “tribes” (Tindale, 1974). Several of Tindale’s South Coast “tribes” collapse into a single group, the “*Yuin*”. The Yuin tribes extended from Cape Howe to the Shoalhaven River and comprised two major internal social subdivisions including the *Kurial* in the north and the *Guyangal* in the south (Howitt, 1904). Both also include “sub-tribes” that were further subdivided into a total of six smaller ‘clans’. Each Yuin ‘tribe’ was controlled by a headman or ‘Gommera’ (also ‘Biamban’). These individuals were ‘aged’, had healing, fighting and magical skills and could speak several languages or dialects. Alongside their central role in male initiation ceremonies, Gommeras, who gained their power from Daramulan, were also responsible for maintenance of social order (i.e., adherence to the “old laws”) (Howitt, 1904).

Levels of residential mobility amongst the Aboriginal groups of the Far South Coast were reasonably high. Nonetheless, it has been suggested that the extent to which available accounts accurately reflect traditional settlement patterns is difficult to assess on the basis of available data (Attenbrow, 1976).

Further information on the ethnohistoric context of the region is provided in **Appendix I** (Aboriginal Cultural Heritage Assessment).

14.2.4 Australian Heritage Information Management System database

A search of the AHIMS database was conducted on 1 of March 2018, and again on 2 August 2021 for a 15 km x 15 km area centred on the study area. The results of the search returned 176 non-restricted site entries[8]. Shell middens make up the majority of sites, followed by open artefact sites. The AHIMS search results are summarised in **Table 14-3** and shown on **Figure 14-5**.

Excluding new sites identified as part of the current assessment (refer to **Section 14.2.7**), consideration of the location of previously recorded sites, including associated site cards and reports, indicates that two registered sites - open artefact site 62-6-0133 and burial site 62-6-0173 - are located either wholly (62-6-0133) or partially (62-6-0173) within the Project area.

An additional two sites - scarred tree 62-6-0475 and artefact scatter 62-6-0788 - are located within 50 metres of the Project area.

All four sites are listed on the AHIMS database as ‘Valid’. However, it is noted that a review of the site card for open artefact site 62-6-0133 indicates that this site should, in fact, be listed as ‘Destroyed’, with the two flaked stone artefacts comprising this site collected in 1979. Registration of the site was completed in 1983, four years after this collection. Attention is also drawn to the fact that the AHIMS registered coordinates for burial site 62-6-0173 and scarred tree 62-6-0475 are incorrect, with field observations and a review of associated site cards placing these sites at the coordinates shown on **Figure 14-5**.

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[8] Consultation with the AHIMS Registrar in December 2018 confirmed that four ‘Restricted’ sites present within the AHIMS search area are not located within or directly adjacent to the study area.

Table 14-3 AHIMS search results

Site type	Number of sites	Percentage of total sites in 15 km x 15 km AHIMS search area
Shell midden	98	55.7
Open artefact site	61	34.7
Scarred tree	5	2.8
Burial	5	2.8
PAD	3	1.7
Rockshelter	2	1.1
Fish trap	1	0.6
Grinding groove(s)	1	0.6
Total	**176**	**100**

\\na.aecomnet.com\lfs\APAC\Sydney-AUSYD1\Secure\Projects\605X\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR058_02_A4L_FX-19_AH_AHIMS_210806.mxd Date Saved: 9/08/2021

FIGURE 14-5: ABORIGINAL HERITAGE INFORMATION MANAGEMENT SYSTEM REGISTERED SITES

N

0 1 2 km

AECOM

Legend

- Project area
- Project area (temporary construction area)

Aboriginal Heritage Information Management System (AHIMS)

- Burial
- Fish trap
- Grinding groove(s)
- Midden
- Open artefact site
- Potential Archealogical Deposit (PAD)
- Rockshelter
- Scarred tree

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

14.2.5 Archaeological survey

An archaeological survey was carried out in the study area on 2 October 2018. The field investigation team included three RAP field representatives. The results of the survey are shown on **Figure 14-6** and described below. A total of three new Aboriginal archaeological sites were identified during the survey, consisting of two shell midden sites and one isolated artefact site. All are located on vehicle tracks within the Merimbula Barrier sand mass. The previously recorded scarred tree #62-6-0475 was also re-located during the survey. The scar on this tree has been reassessed as a European survey mark, as shown on **Plate 1**, however based on RAP feedback will be managed as an Aboriginal site.

The newly identified shell midden sites within the study area have been designated as ‘Merimbula STP SM1’ and ‘Merimbula STP SM2’, while the isolated artefact site has been designated as ‘Merimbula STP IA1’. Merimbula STP SM2 is located partially within the Project area, with the remaining two sites located wholly outside of it.

Merimbula STP SM1 contained only shell, however, Merimbula STP SM2 contained both flaked stone artefacts and midden shell. The shell species observed in Merimbula STP SM1 and Merimbula STP SM2 indicate an economic emphasis on the estuarine resources of Merimbula Lake. Cockle (*Anadara trapezia*) is the dominant species in both middens. Other less common species observed included mud whelk (*Pyrazus ebeninus*) and oyster (*Ostrea angasi* or *Saccostrea glomerata*).

Merimbula STP IA1 consists of isolated flaked stone artefact on a deeply incised east-west trending section of vehicle track to the north of the exfiltration ponds on Lot 1 DP853245. The artefact, which has been exposed by 4WD activity and is not *in situ*, consists of a quartz angular shatter fragment.

The recorded location of burial site #62-6-0173 was also inspected during survey. No definite or potential human remains, nor any other form of Aboriginal archaeological evidence were observed in this location. Given the advanced state of decay noted in 1988 when the site was recorded, it is likely any skeletal remains have been destroyed through natural weathering processes. Stone artefacts noted in the vicinity in 1988 may still be present, however, none were observed and may have been moved as a result of natural sand movement. Intact and predominantly intact dune ridges within the Project area, including those immediately surrounding the registered location of burial site #62-6-0173, are considered to retain high potential for additional Aboriginal burials.

In addition to the previously recorded scarred tree #62-6-0475, a further five modified trees were identified during the survey. However, four scars exhibit steel axe marks in combination with carved letters or nails, and all of these were assessed in the field as definite or probable European survey reference trees. Four scars exhibit steel axe marks in combination with carved letters or nails and all are located in the immediate vicinity of light vehicle tracks. The scar on Modified tree 5 is in very poor condition precluding a more definite assessment of its origin. On the basis of available evidence, however, a European origin seems likely.

Figure removed for cultural reasons

**Figure 14-6	Aboriginal sites**

Plate 1 Scarred tree 62-6-0475. Note steel axe marks at base of scar and carved cross with nail

14.2.6 Test pit excavation program results

Aboriginal objects, consisting exclusively of 84 flaked stone artefacts, were recovered from three of the seven test pits. Artefact-bearing test pits included test pits 3, 4 and 6, which were excavated at the sites of geotechnical boreholes BH002A, BH002B and BH002C respectively. All three test pits were located on an east-west trending spur or 'finger' dunes overlooking an area of freshwater wetland within the back-barrier sand flat unit.

A total of 63 flaked stone artefacts were recovered from test pit 6 (TP6) (at the site of BH002C) representing the majority of artefacts at about 75%.

A large subsurface artefact scatter site was identified during subsurface testing. This subsurface artefact scatter has been designated 'Merimbula STP OAS1' and is located partially within the Project area.

Vertical distribution data for recovered artefacts indicate that the majority (73.8%) occurred between 20 cm and 30 cm below ground level (BGL). with the deepest artefacts occurring between 50 cm and 60 cm BGL.

14.2.7 Summary of Aboriginal sites identified

In review of the results of the archaeological field investigation, as well the existing AHIMS data, a total of six Aboriginal archaeological sites have been identified within the study area. These include two shell midden sites, two open artefact sites, a registered burial site #62-6-0173 and a previously recorded scarred tree (#62-6-0475), which are shown on **Figure 14-6**.

The registered location of burial site #62-6-0173 was inspected as part of the archaeological survey undertaken for this assessment. The area consists of sparsely vegetated foredune to the immediate southeast of the STP's southern exfiltration pond. The foredunes are considered to retain high potential for additional Aboriginal burials although no definite or potential human remains, nor any other form of Aboriginal archaeological evidence (e.g., midden shell, flaked stone artefacts), was observed during survey.

A total of 84 flaked stone artefacts were recovered during the test pit excavation program, with the majority (n = 63, 75%) coming from TP 6 (BH002). Those identified are generally relatively small and light.

14.2.8 Statement of significance

Heritage sites hold value for different communities in a variety of different ways. All sites are not equally significant and as such, are not necessarily equally worthy of conservation and management (Pearson & Sullivan, 1995). One of the primary responsibilities of cultural heritage practitioners, therefore, is to determine which sites are worthy of preservation and management (Smith & Burke, 2007). This process is known as *the assessment of cultural significance* and incorporates two interrelated components. The first involves identifying physical or oral evidence, the elements that make a heritage site significant, as well as the type(s) of significance that may be associated with the site. The second involves determining the degree of value that the site holds for society (i.e. its cultural significance) (Pearson & Sullivan, 1995).

In Australia, the primary guide to the assessment of cultural significance is the Australian ICOMOS Charter for Places of Cultural Significance (2013), informally known as The Burra Charter, which defines cultural significance as the “aesthetic, historic, scientific, social or spiritual value for past, present or future generations” of a site or place (ICOMOS, 2013). Under the Burra Charter model, the cultural significance of a heritage site or place is assessed in terms of its aesthetic, historic, scientific and social values, none of which are mutually exclusive. Establishing cultural significance under the Burra Charter model involves assessing all information relevant to an understanding of the site and its fabric (i.e., its physical make-up) (ICOMOS, 2013). The assessment of cultural significance and the preparation of a statement of cultural significance are critical prerequisites to making decisions about the management of any heritage site or place (ICOMOS, 2013).

With respect to Aboriginal heritage, it is possible to identify two major streams in the overall significance assessment process: the assessment of scientific value(s) by archaeologists and the assessment of social (or cultural) value(s) by Aboriginal people. Each is defined in **Table 14-4**.

Table 14-4 Values relevant to determining cultural significance, as defined by The Burra Charter

Value	Definition
Aesthetic	“Aesthetic value includes aspects of sensory perception for which criteria can and should be stated. Such criteria may include consideration of the form, scale, colour, texture and material of the fabric; the smells and sounds associated with the place and its use” (ICOMOS, 2013).
Historic	“Historic value encompasses the history of aesthetics, science and society...[a] place may have historic value because it has influenced, or has been influenced by, an historic figure, event, phase or activity. It may have historic value as the site of an important event” (ICOMOS, 2013).
Scientific	“The scientific or research value of a place will depend on the importance of the data involved, on its rarity, quality or representativeness, and on the degree to which the place may contribute further substantial information” (ICOMOS, 2013).
Social	“Social value embraces the qualities for which a place has become a focus of spiritual, political, national or other cultural sentiment to a majority or minority group” (ICOMOS, 2013).

Scientific significance

An assessment of the scientific significance of the Aboriginal archaeological sites recognised within the study area was undertaken. Following AMBS (2009b, 2009c), a scored ranking system was employed for the assessment, with overall significance ratings based on a cumulative ‘score’ derived from a ranked assessment of the research potential, rarity and representativeness of each site on a local and regional scale according to Australian Museum Business Services (AMBS, 2009a; and AMBS, 2009b). The newly identified midden sites ‘Merimbula STP SM1’ and ‘Merimbula STP SM2’, and isolated artefact site ‘Merimbula STP IA1’, were all assessed as being of low scientific significance. Newly identified subsurface artefact scatter site ‘Merimbula STP OAS1’ and previously recorded burial site #62-6-0173 were assessed as being of moderate scientific significance. No sites of high archaeological significance were identified within the study area. However, it is recognised that such sites may exist in subsurface contexts.

Cultural values

Cultural values refer to the spiritual, traditional, historical and contemporary associations and attachments a place or area has for Aboriginal people. Accordingly, these values and their significance can only be identified through consultation with Aboriginal people.

Verbal and written advice received from the RAPs involved in the assessment identified a range of social or cultural values for the study area and Merimbula Barrier complex more broadly:

- the Merimbula Bay Barrier/dune system contains numerous Aboriginal archaeological sites, many of which are unregistered and as such do not appear on the AHIMS database;
- the study area is known to contain scarred trees and burials. One previously identified burial was located on a vehicle track and consisted of the top end or “head” of a humerus;
- newly identified shell midden sites Merimbula STP SM1 and Merimbula STP SM2 indicate visits to Merimbula Lake for shellfish collection;
- the landscape position of Merimbula STP SM1 and Merimbula STP SM2 suggest that people would have been seeking shelter from westerly winds blowing across Merimbula Lake;
- dunes within the study area retain high potential for additional Aboriginal burial sites;
- areas of freshwater wetland within the Merimbula Barrier, including those within the study area, would have been focal resource zones for Aboriginal people camping within the sand mass;
- elevated dune ridges providing ready access to the above would have been favoured camping locations;
- the concentration of flaked stone artefacts in test pit 6 (TP6) (at the site of BH002C) indicates the presence of a large ‘workshop’ in this area;
- stones used for flaked stone artefact manufacture in the study area are typical of the local area; and
- parts of the Merimbula Barrier sand mass were occupied by Aboriginal people into the early twentieth century, which may have included portions of the study area.

14.3 Potential impacts – construction

14.3.1 Impacts to known Aboriginal sites

Primary ground disturbance activities

Primary ground disturbance works within the Project area, defined here as bulk earthworks within the existing fenced STP complex and the installation of the underground section of the ocean outfall pipeline (Section 1), are not anticipated to result in any physical impacts to the three Aboriginal sites identified within the Project area.

Regarding potential subsidence impacts to these sites, and the Merimbula Barrier sand mass more broadly, it is noted that the water quality, groundwater and groundwater dependent ecosystem assessments undertaken for the Project (**Appendix D** (Groundwater Technical report) **Appendix E** (Water Quality Technical report), and **Appendix Q** (Dispersion Modelling report)) have all concluded that it is unlikely that the proposed underground trenchless drilling for the ocean outfall pipeline would result in any subsidence.

Temporary construction access

Several potential options for construction access have been considered for the Project. Initially, access routes off Arthur Kaine Drive, east of the STP, were considered, however, these were not chosen due to the risk of impacting known Aboriginal sites and ecological values. Access routes at various points at the northern end of Merimbula Beach were also considered but were likewise not chosen due to inadequate access for construction vehicles or impacts to public facilities and vegetation.

Temporary construction access from Pambula Beach to the laydown area on Merimbula Beach was selected to avoid these issues, primarily potential impacts to Aboriginal sites within the foredune and backbarrier flat components of the Merimbula Barrier sand mass and potential ecological impacts.

Construction access from Pambula Beach to the laydown area on Merimbula Beach is assessed as carrying a negligible Aboriginal heritage impact risk to known Aboriginal sites.

Ancillary ground disturbance activities

Ancillary ground disturbance activities for the Project, such as light and/or heavy vehicle movements, are assessed as carrying a low to moderate impact risk for identified Aboriginal sites within and immediately adjacent the Project area.

14.3.2 Impacts to previously unrecorded Aboriginal sites

Together with the results of the archaeological survey and test excavation works undertaken for this assessment, local and regional archaeological datasets indicate that dune ridges and areas of backbarrier sand flat within the eastern portion of the Project area are of high Aboriginal archaeological sensitivity. This assessment notwithstanding, installation of the underground section of the ocean outfall pipeline, which traverses both landforms, is considered to carry a negligible Aboriginal heritage impact risk. This assessment is made on the basis of drilling depths, which greatly exceed the probable depth of subsurface archaeological deposits in both contexts.

In case there are unrecorded Aboriginal heritage value/sites present, the removal of less than five metre-wide strips of vegetation to widen the Pambula Beach access track for construction would be carried out manually/using hand tools under the supervision of a minimum of one Registered Aboriginal Party (RAP) representative.

The mitigation and management measures described in **Section 14.5** would be implemented as part of the Project, and include measures related to unexpected/unrecorded Aboriginal site finds.

14.4 Potential impacts – operation

With the implementation of mitigation and management measures to protect the existing Aboriginal sites identified, it is not anticipated that operational activities would result in ongoing or additional impacts to Aboriginal heritage. Operational maintenance activities would be limited to the STP site and the submerged/marine section of the ocean outfall pipeline and diffuser, and therefore would not be required to access the locations of the Aboriginal sites identified.

14.5 Management of impacts

The mitigation and management measures identified to help avoid and minimise the identified Aboriginal heritage impacts of the Project are outlined in **Table 14-5**, and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

14.5.1 Performance outcomes

The Aboriginal heritage performance outcomes for the Project are as follows:

- no impacts to Aboriginal sites, objects or places identified in the assessment during construction;
- if an unexpected find is encountered during construction, relevant procedures are followed; and
- the Aboriginal Cultural Heritage Management Plan is developed and implemented adequately.

The Project would be designed, constructed and operated to achieve these performance outcomes.

14.5.2 Consideration of interaction between measures

Mitigation and management measures are provided in **Table 14-5**. No mitigation or management measures in other chapters are relevant to the management of potential Aboriginal heritage impacts.

14.5.3 Mitigation and management measures

To manage potential impacts to the known and potential Aboriginal cultural heritage values of the Project area and its immediate environs, an Aboriginal Cultural Heritage Management Plan (ACHMP) would be prepared for the Project. The ACHMP should be prepared in consultation with RAPs, the NSW EES and the Department of Planning, Infrastructure and Environment. The mitigation and management measures that would be included in the ACHMP are described below in **Table 14-5**.

0 1 2 km

FIGURE 14-5: ABORIGINAL HERITAGE INFORMATION MANAGEMENT SYSTEM REGISTERED SITES

Legend

- Project area
- Project area (temporary construction area)

Aboriginal Heritage Information Management System (AHIMS)

- Burial
- Fish trap
- Grinding groove(s)
- Midden
- Open artefact site
- Potential Archealogical Deposit (PAD)
- Rockshelter
- Scarred tree

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Ref #	Potential impact	Mitigation and management measures	Timing
AH1	Potential accidental site disturbance during construction	Newly identified surface sites Merimbula STP SM1, Merimbula STP SM2 and Merimbula STP IA1, as well as previously recorded burial site 62-6-0173 and scarred tree 62-6-0475, should be protected throughout the life of the Project via permanent stock-proof fencing and appropriate associated signage. All relevant workers should be made aware of the nature and location of these sites as well as BVSC's legal obligations with respect to them. Protected sites should be identified on all relevant site plans and designated as 'no-go' zones. Should BVSC and/or its contractors require use of the vehicle tracks upon which Merimbula STP SM1, Merimbula STP SM2 and Merimbula STP IA1 are located, alternative access arrangements should be investigated and detailed in the ACHMP. In view of its demonstrated archaeological and cultural sensitivity, should installation of Section 1 of the ocean outfall pipeline result in any surface impacts to the Merimbula Barrier sand mass, BVSC should consult with RAPs regarding the appropriate management of these impacts.	Prior to and during construction
AH2	Impacts to previously identified skeletal remains south of exfiltration ponds	While no potential or definite human skeletal remains were identified on the track in question (disused east-west trending vehicle track to the south of the STP's existing dunal exfiltration ponds) during the archaeological survey undertaken for the current assessment, as a precautionary measure, it is recommended this track be identified in the Project's CEMP and all relevant site plans as an environmental 'no-go zone'. Fencing with appropriate signage should be installed at the eastern and western ends of the track to ensure that it is not used by any Project-related machinery.	Prior to and during construction

Ref #	Potential impact	Mitigation and management measures	Timing
AH3	Impacts to previously unrecorded Aboriginal archaeological sites	Provisions regarding appropriate management action(s) for any previously unrecorded Aboriginal archaeological sites identified within the study area throughout the life of the Project should be incorporated into the ACHMP. Management action(s) will vary according to the type of evidence identified, its significance (both scientific and cultural) and the nature of potential impacts. Vegetation clearance proposed for the Pambula Beach construction access track is to be undertaken manually under the supervision of a minimum of one RAP representative.	During construction
AH4	Encountering human remains	In the event that potential human skeletal remains are identified within the study area at any point during the life of the Project, the following standard procedure, to be detailed in the ACHMP, should be followed: • all work in the vicinity of the remains should cease immediately; • the location should be cordoned off - work can continue outside of this area as long as there is no risk of interference to the remains or the assessment of the remains; • where it is instantly obvious from the remains that they are human, the Project Manager (or a delegate) should inform the NSW Police by telephone (prior to seeking specialist advice); • where uncertainty over the origin of the remains exists, a physical or forensic anthropologist should be commissioned to inspect the exposed remains in situ and ascertain the origin, ancestry (Aboriginal or non-Aboriginal) and antiquity (pre-contact, historic or modern) and: - if the remains are identified as modern and human, notify NSW Police; - if the remains are identified as pre-contact or historic Aboriginal, notify Department of Premier and Cabinet using its Environment Line (131 555); and - if the remains are identified as historic (non-Aboriginal), notify the NSW Heritage Division. An Aboriginal community representative must be present where it is reasonably suspected burials or human remains may be encountered. If human remains are unexpectedly encountered and they are thought to be	During construction

Ref #	Potential impact	Mitigation and management measures	Timing
		Aboriginal, the Aboriginal community must be notified immediately. Recording of Aboriginal ancestral remains must be undertaken by, or be conducted under the direct supervision of, a specialist physical anthropologist or other suitably qualified person. Archaeological reporting of Aboriginal ancestral remains must be undertaken by, or reviewed by, a specialist physical anthropologist or other suitably qualified person, with the intent of using respectful and appropriate language and treating the ancestral remains as the remains of Aboriginal people rather than as scientific specimens.	
AH5	Consultation protocols	Provisions regarding appropriate consultation protocols with RAPs should be incorporated into the ACHMP. Contact details and preferred contact methods for each RAP, as well other relevant stakeholders, should be specified.	Prior to and during construction
AH6	Aboriginal cultural heritage awareness training	An Aboriginal cultural heritage awareness training package should be developed for the Project. This package should be developed in consultation with RAPs and completed prior to the commencement of any ground disturbance works within the study area. A register of all persons having completed the training package should be maintained throughout the life of the Project. Aboriginal cultural awareness training should be mandatory for all workers whose roles may reasonably bring them into contact with Aboriginal sites and/or involve consultation with local Aboriginal community members. BVSC should ensure that the Project's standard environmental site induction includes an Aboriginal heritage component. At a minimum, this should outline current protocols and responsibilities with respect to the management of Aboriginal cultural heritage within the study area, provide an overview of the diagnostic features of potential Aboriginal site types and procedures for reporting the identification of Aboriginal archaeological sites.	Prior to and during construction
AH7	Reporting under the ACHMP	Any Aboriginal heritage management or mitigation works carried out should be documented to a standard comparable to that required by the *Code of Practice for Archaeological Investigation of Aboriginal Objects 2010*. Printed and/or digital copies of any associated reports should be made available to RAPs upon request.	Prior to and during construction

Ref #	Potential impact	Mitigation and management measures	Timing
		The ACHMP for the Project should be subject to periodic review to ensure that all management policies are being adhered to and are working effectively. Periodic reviews will also provide an opportunity to make modifications to existing policies and to add, where appropriate, new policies.	

Following the implementation of the mitigation and management measures above, there would be no residual impacts from the Project on Aboriginal heritage. Therefore, there are no cumulative impacts on Aboriginal heritage expected. Further consideration of cumulative impacts with regard to other environmental aspects of the Project is discussed in **Chapter 27 Cumulative impacts**.

14.5.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for Aboriginal heritage and is provided in **Table 14-6**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental mitigation and management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Table 14-6 Environmental risk analysis with mitigation – Aboriginal heritage

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Potential accidental site disturbance during construction	Construction	AH1	Major	Unlikely	Low
Impacts to previously identified skeletal remains south of exfiltration ponds	Construction	AH2	Major	Unlikely	Low
Impacts to previously unrecorded Aboriginal archaeological sites	Construction	AH3	Major	Unlikely	Low
Encountering human remains	Construction	AH4	Major	Unlikely	Low
Potential ineffective or inappropriate consultation with the Aboriginal community (Consultation protocols)	Construction	AH5	Minor	Rare	Low
Potential accidental site disturbance and / or potential ineffective or inappropriate consultation with the Aboriginal community (Aboriginal cultural heritage awareness training)	Construction	AH6	Moderate	Unlikely	Low
Insufficient reporting under the ACHMP	Construction	AH7	Moderate	Rare	Low

15.0 Non-Aboriginal (Historic) Heritage

This chapter discusses the historic heritage potential that may be present within the Project area and includes an assessment of the maritime archaeological potential that may exist within Merimbula Bay. It outlines the assessment approach, identifies the historic heritage values of the Project area and assesses the potential impacts of the Project on identified values. Mitigation and management measures are proposed to reduce and manage potential historic heritage impacts from the Project.

Table 15-1 sets out the requirements as provided in the SEARs relevant to non-Aboriginal and where the requirements have been addressed in this EIS.

Table 15-1 SEARs – Non-Aboriginal (historic) heritage

Ref	Assessment requirements	Where addressed in this EIS
8.1	The Proponent must identify and assess any direct and/or indirect impacts (including cumulative impacts) to the heritage significance of: e. Aboriginal places and objects, as defined under the *National Parks and Wildlife Act 1974* and in accordance with the principles and methods of assessment identified in the current guidelines; f. Aboriginal places of heritage significance, as defined in the Standard Instrument – Principal Local Environmental Plan; g. environmental heritage, as defined under the *Heritage Act 1977*; and h. items listed on the National and World Heritage lists.	Potential impacts to Aboriginal Places have been addressed in **Chapter 14 Aboriginal heritage** The potential for the Project to result in cumulative impacts is addressed in **Chapter 27 Cumulative impacts**
8.2	Where impacts to State or locally significant heritage items are identified, the assessment must: a. include a statement of heritage impact for all heritage items (including significance assessment); b. consider impacts to the item of significance caused by, but not limited to, vibration, demolition, archaeological disturbance, altered historical arrangements and access, visual amenity, landscape and vistas, curtilage, subsidence and architectural noise treatment (as relevant); c. outline measures to avoid and minimise those impacts in accordance with the current guidelines; d. be undertaken by a suitably qualified heritage consultant(s) (note: where archaeological excavations are proposed the relevant consultant must meet the NSW Heritage Council's Excavation Director criteria); and e. where potential archaeological impacts have been identified, develop an appropriate archaeological assessment methodology (terrestrial and maritime), including research design, to guide physical archaeological test excavations (as relevant) and include the results of these test excavations.	Potential impacts to State or locally significance heritage items, or potential heritage and archaeological sites are addressed in **Section 15.2.2** and newly identified sites are outlined in the site inspection in **Section 15.2.3**. Known and potential shipwrecks are addressed in **Section 15.2.2** and **Section 15.2.4**. Management recommendations are outlined in **Section 15.4**

15.1 Assessment approach

15.1.1 Legislative context

The Historic heritage assessment has been undertaken in accordance with the following legislation and statutory planning instruments:

- *Heritage Act 1977* (NSW);
- *Historic Shipwrecks Act 1976* (Commonwealth);
- *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act);
- *Environmental Protection and Biodiversity Conservation Act 1999* (Commonwealth) (EPBC Act); and
- *Bega Valley Local Environmental Plan 2013* (Bega Valley LEP 2013).

15.1.2 Methodology

The Historic heritage assessment was prepared with consideration of the NSW Heritage Manual (NSW Heritage Office & NSW Department of Urban Affairs and Planning, 1996) and the Burra Charter (Australia ICOMOS, 1999) using the following methodology:

- review of the relevant State and Federal heritage registers and listings to identify registered heritage sites in or directly adjacent to the Project area, including:
  - World Heritage List;
  - National Heritage List;
  - Commonwealth Heritage List;
  - NSW State Heritage Register;
  - NSW Shipwreck Database;
  - Bega Valley LEP 2013;
- review of relevant historic heritage reference materials (e.g., local histories, parish maps, historical aerial photographs);
- archaeological survey of the terrestrial component in or directly adjacent to the Project area (undertaken concurrently with Aboriginal heritage survey);
- assessment of the significance of relevant heritage sites in accordance with the Burra Charter (ICOMOS (Australia) 2013) and the NSW Heritage Office Assessing Heritage Significance (NSW Heritage Office 2001), as required;
- assessment of potential impacts on heritage values informed by relevant legislative, policy and planning instruments; and
- provision of management recommendations.

15.1.3 Study area

The study area for the assessment replicates the Project area (refer to **Figure 2-1** in **Chapter 2 Project description**). It includes largely unmodified sections of the edge of Merimbula Bay Barrier (a frontal dune feature), and the proposed construction access along Merimbula Beach (an approximately 1.5 kilometre (km) long and 360 metre (m) wide section of adjoining foredunes and back barrier sand flat). Land within the study area falls wholly within the Bega Valley local government area (LGA).

15.1.4 Desktop review

A desktop review of background literature was conducted to investigate the existing environment of the study area, including information regarding the topographical, geological and hydrological setting of the study area. Historic aerial photography was also analysed to investigate the location and extent of any previously disturbed grounds in the study area and to assist in identifying areas of likely historic heritage potential.

The desktop review also included a search of relevant historic heritage registers, both statutory and non-statutory, to identify any previously recorded historic heritage items/places located within or directly adjacent to the Project area.

15.1.5 Archaeological survey

An archaeological survey of the terrestrial component of the Project area was undertaken to identify and record any historic heritage within the study area. The archaeological survey was undertaken concurrently with the Aboriginal heritage survey, thus following a similar approach (refer to **Chapter 14 Aboriginal heritage**).

The archaeological survey aimed to:

- sample all landform elements within the study area, with a particular emphasis on landforms of demonstrated archaeological potential;
- ground-truth levels of past land disturbance across the study area; and
- identify areas of subsurface historic heritage archaeological sensitivity.

The survey strategy used was the same as that used for the Aboriginal heritage survey, based on a review of historical aerial photographs to identify areas that may have greater historic heritage archaeological potential within the study area. As such, survey efforts were primarily focussed on areas of cleared land to the east of Arthur Kaine Drive. Transects were also completed to the west of Arthur Kaine Drive, within the fenced Merimbula STP site, as well as areas of remnant/regenerating vegetation to the east and west of this road.

The survey was conducted on foot, with a total of 15 transects completed. The coordinates of each transect location were recorded using a handheld GPS, as well as any relevant transect characteristics (such as levels of visibility and exposure). The location of the transects are shown on **Figure 15-1**.

All historic heritage items identified during the archaeological survey were recorded and locations captured by GPS. Attribute data for all identified historic heritage were also entered using AECOM's standard digital open site recording form. All sites were photographed following artefact recording.

FIGURE 15-1: SURVEY TRANSECTS UNDERTAKEN DURING THE 2018 SURVEY

N
0 200 400 m

Legend

Project area

Project area (temporary construction area)

Survey Transect

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

\\na.aecomnet.com\lfs\APAC\Sydney-AUSYD1\Secure\Projects\605x\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR021_01_A4L_F15-2_SurveyTransects_210203.mxd Date Saved: 3/02/2021

15.2 Existing environment

15.2.1 Historical background

In 1797, Surgeon George Bass became the first European to formally explore the Far South Coast of NSW, voyaging along the region's coastline as part of his epic exploratory journey from Port Jackson to Westernport Bay in Victoria. It was during this initial voyage, on the 18 of December 1797, that Bass and his crew took shelter in the mouth of the Pambula River and subsequently explored its lower reaches, as well as Pambula Lake. Bass was clearly impressed by the natural beauty of the Pambula River, which he named Barmouth Creek, describing the lower part of the river in his journal as "one of the prettiest little harbours as to form that was perhaps ever seen" (Bass, 18 December 1797 in Bladen, 1895). Bass was similarly impressed by Twofold Bay, to the south of the Merimbula-Pambula district, venturing ashore here on his return journey and remarking in his journal that "…[t]he nautical advantages of this bay, notwithstanding the anchorage is but small, seem to be superior to any we have been in" (Bass,16 February 1798 in Bladen, 1895). Accompanied by Lieutenant Matthew Flinders, Bass was to return to the Far South Coast the following year, voyaging once again along the region's coastline as part of an exploratory journey that would see the duo circumnavigate Tasmania. Notably, both men are reported to have shared a particular interest in the flora and fauna of Twofold Bay and its environs (Swinbourne & Morris, 2012: 2). Bass and Flinders' early exploratory efforts aside, formal European settlement of the greater Merimbula-Pambula-Twofold Bay district can be traced to early 1800s, with Captain Thomas Raine establishing a shore-based whaling station at Twofold Bay in 1828. Raine was soon followed by brothers Peter, George and Alexander Imlay, who by 1835, had established whaling stations at two sites in Twofold Bay, as well as "Pamboola Station", close to present day Pambula. The Imlay brothers rapidly become the district's largest landholders, taking up multiple grazing runs that would ultimately encompass "most of the land from Broulee south, to, and beyond Twofold Bay, and west to the mountain escarpment" (Ferguson, 1971: 4). Utilising Twofold Bay as their port, the Imlays shipped cattle and sheep from their runs to various locations including Hobart, the penal settlement at Port Arthur and New Zealand (Higgins, 1982: 4). Pure-bred cattle and pedigreed horses were also imported. In 1839, then Commissioner of Crown Lands, John Lambie, described Pamboola Station as covering an area of seventeen square miles, with four slab huts, a stockyard and one hundred and fifty hectares of wheat and barley under cultivation (Higgins, 1982: 6).

Despite their initial successes, by the early 1840s, the Imlays' economic fortunes had greatly soured, with natural disasters, a downturn in the cattle market and a succession of poor seasons combining to put them deeply in debt. The Imlay's pastoral and agricultural interests were subsequently taken over by their financial backers, brothers James and William Walker, who in 1842 erected a homestead ("Oaklands") on what was formerly Pamboola Station. Alongside cattle rearing and grazing, the Walker brothers grew potatoes, wheat, maize, barley and oats and were also responsible for the establishment of boiling down works at Pambula, Merimbula and Eden (Ferguson, 1971: 6; Higgins, 1982: 9).

Captain John Lloyd, a veteran of the Battle of Trafalgar, was another prominent local landholder around this time. In 1844, Lloyd received a grant of 300 acres on the southern side of Pambula River in lieu of retirement pay and had his homestead, "The Grange", built at the northern end of South Pambula Hill, overlooking the river's floodplain. In 1845, a road connecting Eden to the Monaro Plains was built and passed through the village of Pambula, which had been planned by Government Surveyor Thomas Townsend only two years earlier. At this time, the village, was located on flat, low-lying terrain (i.e., floodplain) closer to the Pambula River. However, a major flood in 1851 devastated then fledging village, which included a school (opened in 1849), and resulted in its re-establishment on higher ground to the north/northeast of its original position. Like the Imlays before them, the economic fortunes of the Walker brothers in the district were short-lived , with the duo selling their leases in 1852 to the newly established Twofold Bay Pastoral Association (Swinbourne & Morris, 2012: 3).

By the mid-1850s, the Twofold Bay Pastoral Association, which was made up of James, William and Eyde Manning, Thomas Mort, Edwin and Robert Lucas-Tooth and John Croft, owned vast acreage between Moruya and Eden and were producing wool, beef cattle and horses for multiple Australian and overseas markets (Swinbourne & Morris, 2012: 5). The township of Merimbula commenced its life around 1853 as a private village owned and operated by the Association. Members of the Association were responsible for the commissioning and construction, in 1855, of a wharf, stores and other facilities near the entrance to Merimbula Lake, as well as that of a substantial flour mill at Merimbula in 1858, which went on to become part of Munn's Maizena Works (from 1867) and later still, the Merimbula Co-operative Bacon Company's factory (from 1922) (Higgins, 1982: 13; Swinbourne & Morris, 2012: 7, 17, 29). The establishment of the Illawarra Steam Navigation Company, later renamed the Illawarra and South Coast Steam Company, can likewise be attributed to members of the Association (Swinbourne & Morris, 2012: 9). The cargo service operated by this company, Swinbourne and Morris (2012: 9) note, "provided essential access to Sydney markets for wool, building timber and railway sleepers, kegs of butter, rounds of cheese, sides of home-cured bacon, wattle bark, corn, beef cattle, livestock and passengers". Passenger accommodation, at least initially, was basic at best, with the Bega Gazette in 1880 describing it as "wretched" and reporting passengers as "complaining of the horrors of insects attracted by the livestock and loss of sleep for the incessant squealing of pigs" (Swinbourne & Morris (2012: 9).

The passing of the Crown Lands Acts in 1861 brought an end to the Twofold Bay Pastoral Association, which disbanded as a result, but also attracted new settlers to the Pambula and Merimbula areas. Around the same time, the Kiandra Gold Rush of 1859-1861 provided a boost to the economies of both villages, with large numbers of miners arriving by ship at Merimbula, stocking up on provisions and travelling inland to the goldfields (Swinbourne & Morris (2012: 7). In 1867, Munn's Maizena Works in Merimbula was producing approximately three tonnes of corn flour ("Munn's Maizena") per week, with the works soon becoming the village's primary employer and remaining so for approximately half a century (Swinbourne & Morris (2012:18).

Further development of the townships of Merimbula and Pambula followed the 1888 discovery of gold on ridges along the Yowaka River, which led to the establishment of the Mount Gahan goldfield and Mount Gahan Gold Mining Company. While most miners camped in tents on the goldfield, their need for food and equipment served the economies of both towns well (Higgins, 1982: 26). The establishment of the goldfield also resulted in the launching, in 1892, of the district's first newspaper. Known colloquially as "The Pambula Voice", the full title of the paper was "The Pambula Voice and Eden, Wyndham, Wolumla, Rocky Hall, Towamba and Merimbula Advocate" (Higgins, 1982: 27). Further social and/or economic developments in the closing decades of the 19th century included the formation of the Pambula Progress Association (1884), which lobbied intensively for the construction and maintenance of local transport infrastructure, the opening of a six-bed cottage hospital in Pambula in 1897, the emergence, from 1891, of a local oyster farming industry focused on the Pambula River and the formation of the Pambula Co-operative Creamery and Dairy Company in 1897.

Reference to earliest parish map available for the Merimbula area, prepared in 1885, indicates that land within the Project area comprised part of two temporary commons fronting Merimbula Main Beach. The larger of the two, demarcated in green on **Figure 15-2**, extended westward from Merimbula Beach to the eastern edge of Merimbula Lake, around the southern edge of the lake and northward, toward Boggy Creek, for around 2.5 km. Two north-south trending tracks are visible (in the western portion of the Project area) at this time, as is an isolated section of "reserved road". From c.1920, this reserved road formed part of the then Princes Highway (now Arthur Kaine Drive). The "Old Cemetery" mapped to the north of the central portion of the Project area is also of note here. This cemetery is visible on all available parish maps up to 1942. However, consultation with the Merimbula-Imlay Historical Society has indicated that this cemetery was never gazetted and was likely never used (S.Bazley, Merimbula-Imlay Historical Society, pers. comm. July 2018). Local histories compiled by Ferguson (1971), Higgins (1982) and Swinbourne and Morris (2012) provide no further information on the cemetery.

The opening decades of the twentieth century saw the prosperity and populations of Pambula and Merimbula decline as a result of difficulties in the gold mining, dairying, maize and wattlebark industries. In Merimbula, the Merimbula Co-Operative Bacon Company, formed in 1922, replaced Munn's Maizena Works as the town's primary employer, with the fishing and oyster growing industries also important (Swinbourne & Morris (2012:27-38). Moving forward in time, to the 1960s, tourism emerged as one of Merimbula's key industries, assisted by the opening of the Merimbula Airport in 1959. Today, tourism remains one of the greater Merimbula and Pambula district's most important industries.

FIGURE 15-2: 1885 PARISH MAP

N 0 250 500 m

AECOM

\\na.aecomnet.com\lfs\APAC\Sydney-AUSYD1\Secure\Projects\605x\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR041_02_A4P_F15-1_ParishMap_201008.mxd Date Saved: 3/02/2021

Source: Nearmap, 2019; Historical land records viewer (HLRV), NSW Land Registry Services, 2020

Legend

- Project area
- Project area (temporary construction area)

15.2.2 Historic Heritage Registers

A search of relevant historic heritage registers, both statutory and non-statutory, was undertaken on 25 May 2020 to identify any previously recorded historic heritage items/places located within or directly adjacent to the Project area. The search results are provided in **Table 15-2**.

As indicated in **Table 15-2**, there are no previously recorded historic heritage items situated within or directly adjacent to the terrestrial component of the Project area.

A search of the NSW shipwreck database on 20 May 2020 identified two shipwrecks in the region of Merimbula Bay and one unknown entry. *Empire Gladstone* was wrecked on the southern side of Haystack Rock, in December 1950. The vessel was carrying car bodies and iron ore when it struck rocks in heavy seas. Most of the cargo was salvaged. This wreck site is known and is regularly dived on by local divers. This shipwreck is not protected by the NSW Heritage Act (https://www.environment.nsw.gov.au/maritimeheritageapp/ViewSiteDetail.aspx?siteid=1521).

The second shipwreck, *Margaret*, was a wooden hulled Brig built in Canada in 1837. The vessel was on a voyage from Melbourne to Sydney in July 1853, sailing “under ballast” when the vessel was reported wrecked at Merimbula. Limited information is available regarding the event, with two accounts mentioning the wreck was lost “on the beach” and “in the surf” at Merimbula. There is no information indicating the wreck was salvaged or considered a complete loss. The vessel was a 185 ton wooden carvel hull brig, 26 m long and had a beam of 6.2 m (https://www.environment.nsw.gov.au/maritimeheritageapp/ViewSiteDetail.aspx?siteid=1069).

The third listing on the NSW Heritage database has no information and may relate to the remains of a rudder that were found in Merimbula Bay in the 1960s. A fragment from the rudder from an unidentified wreck was noted to have been discovered in Merimbula Bay by fishermen when it was accidently snagged, possibly in netting. The exact location was not recorded, and the timber rudder was donated to the Eden Killer Whale Museum in the 1970s. The rudder is sheathed either in copper or Muntz metal. Analysis by the NSW Heritage Office in 1996 identified the rudder as coming from a timber schooner or similar vessel. A timber analysis was undertaken on a sample of the timber, and was identified to be Oak, originating from the northern hemisphere (NSW Heritage Office, 1996).

Table 15-2 Historic heritage registers - search results

Heritage register	Search results
World Heritage List	No relevant entries
National Heritage List	No relevant entries
Commonwealth Heritage List	No relevant entries
Register of National Estate	No relevant entries
NSW State Heritage Register	No relevant entries
Schedule 5 of Bega Valley LEP 2013	No relevant entries
NSW shipwreck database	Empire Gladstone (1950) Location known, not protected *Margaret* (1853), Location unknown, Protected Unidentified Listing, Location unknown.

15.2.3 Archaeological survey

The land associated with STP site has been highly disturbed during the original construction of the STP site, and the subsequent expansion of the STP facility. As such, the STP land is not expected to have any potential historical archaeological remains, including within the Project area within the STP site.

A total of six historic heritage items, consisting of five definite and one potential European survey reference or 'blaze' trees (Spooner & Shoard, 2016), were identified during survey. Identified trees include a previously recorded example that has been registered on the AHIMS database as an Aboriginal scarred tree (AHIMS ID# 62-6-0475). Previously recorded scarred tree 62-6-0475 was re-located during the survey. While the scar on this tree has been reassessed as a probable European survey mark, on the basis of Registered Aboriginal Party (RAP) feedback, it would be managed as an Aboriginal site (refer to **Chapter 14 Aboriginal heritage** and in particular management measure AH1). This tree is labelled as survey reference tree #6 on **Figure 15-3.**

Of the six trees, one (#4) is located within the Project area, four (#1, #2, #5, #6) nearby but outside of it and one directly adjacent to it (#3).

Four of the six tree scars exhibit steel axe marks in combination with carved letters or nails. All are located in the immediate vicinity of light vehicle tracks. The scar on survey reference tree #4 is in very poor condition precluding a more definite assessment of its origin. However, based on available evidence, a European origin seems likely.

Summary information on the identified trees is provided in **Table 15-3**, with locations shown on **Figure 15-3**.

Table 15-3 Historic heritage items identified during archaeological survey

Site Id	Location		Tree species	Living/ Dead	Number of scars	Steel axe marks (Y/N)	Carved numbers/ letters (Y/N)	Steel nail(s) (Y/N)	Survey Reference tree?	Plate
	MGAE	**MGAN**								
Survey reference tree #1	758384	5910161	Eucalyptus sp.	Dead	1	Y	Y	N	Definite	Plate 1
Survey reference tree #2	758144	5910278	E. pilularis or E. botryoides	Living	1	Y	Y	N	Definite	Plate 2 Plate 3
Survey reference tree #3	758380	5910314	Eucalyptus sp.	Dead	2	Y	N	N	Definite	Plate 4 Plate 5
Survey reference tree #4	758385	5910277	Eucalyptus sp	Dead	1	N	N	N	Potential	Plate 6 Plate 7
Survey reference tree #5	758541	5910116	B. integrifolia	Living	2	Y	N	Y	Definite	Plate 8 Plate 9
Survey reference tree #6 (AHIMS ID# 62-6-0475)	758289	5910304	E. pilularis	Living	1	Y	N	Y	Definite	Plate 11 Plate 12

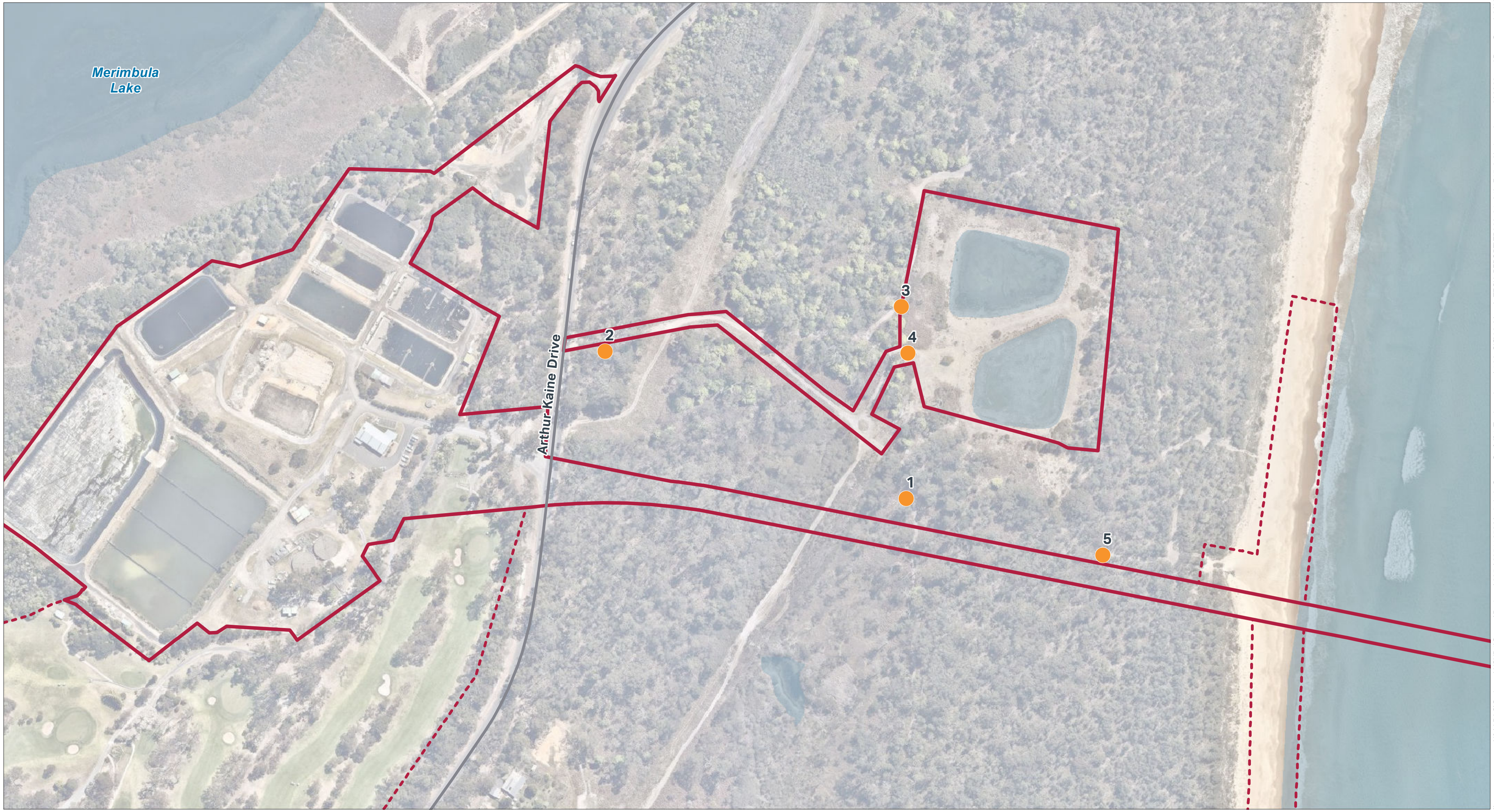


FIGURE 15-3: HISTORIC HERITAGE ITEMS IDENTIFIED WITHIN THE STUDY AREA DURING THE HERITAGE SURVEYS

N

0 50 100 m

AECOM

Source: Nearmap, 2019

Legend

- Project area
- Project area (temporary construction area)
- Survey Reference Tree Location

Plate 1 **Survey Reference Tree #1. Note carved lettering (Source: AECOM, 2018)**

Plate 2 **Survey Reference Tree #2 (Source: AECOM, 2018)**

Plate 3 **Close up of scar on Survey Reference Tree #2. Note steel axe marks at base and carved lettering (Source: AECOM, 2018)**

Plate 4 **Survey Reference Tree #3, Scar #1. Note steel axe marks at base (Source: AECOM, 2018)**

Plate 5 **Survey Reference Tree #3, Scar #2. Note steel axe marks at base (Source: AECOM, 2018)**

Plate 6 **Survey Reference Tree #4, facing north-northwest (Source: AECOM, 2018)**

Plate 7 **Close up of scar on Survey Reference Tree #4. Note poor condition (Source: AECOM, 2018)**

Plate 8 **Close up of Scar #2 on Survey Reference Tree #4. Note steel axe marks at base Source: AECOM, 2018)**

Plate 9 Survey Reference Tree #5, facing east (Source: AECOM, 2018)

Plate 10 Survey Reference Tree #5, Scar #1. Note nail in centre (AECOM, 2018)

Plate 11 Survey Reference Tree #6. Previously recorded Aboriginal scarred tree 62-6-0475, reassessed as European survey reference or blaze tree (). Note steel axe marks at base of scar and carved cross with nail (Source: AECOM, 2018). To be managed as an Aboriginal site, regardless.

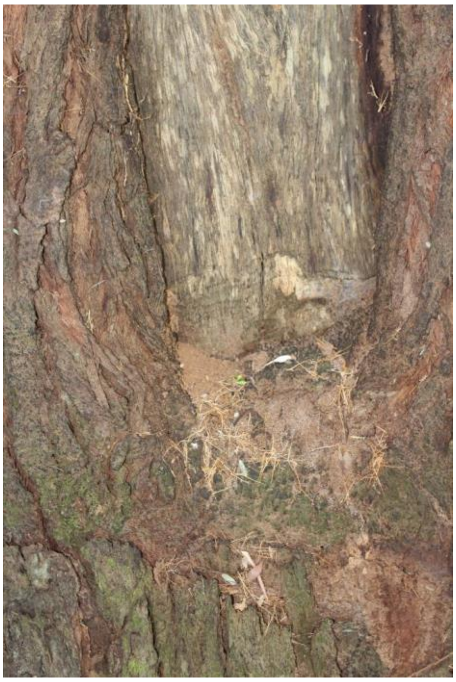


Plate 12 Close up of steel axe marks at base of scar on Survey Reference Tree #6 (Source: AECOM, 2018)

15.2.4 Review of maritime geophysical data

Side scan sonar (SSS) survey of Merimbula Bay was undertaken for the Project in 2018. The data was collected by Marine and Earth Sciences. The survey covered the greater part Merimbula Bay, including the area to the south of Haycock Point. The results of the survey have been reviewed by Chris Lewczak, maritime archaeologist with AECOM, who reviewed a 400 m buffer around the proposed ocean outfall pipeline. Drop-tow video footage collected by the Marine Ecological team was also reviewed to understand the sea floor type and composition. This assisted in understanding the results of the SSS survey.

The sea floor within Merimbula Bay consists of a sandy sea floor with exposed rock and rocky sea floor present in sections within the bay, predominately closer to Haycock Point. There are four areas where anomalies have been identified within a 400 m diameter area around the ocean outfall pipeline (**Figure 15-4**). Each of these sites are discussed in **Table 15-4** below and shown on **Figure 15-5** to **Figure 15-8**.

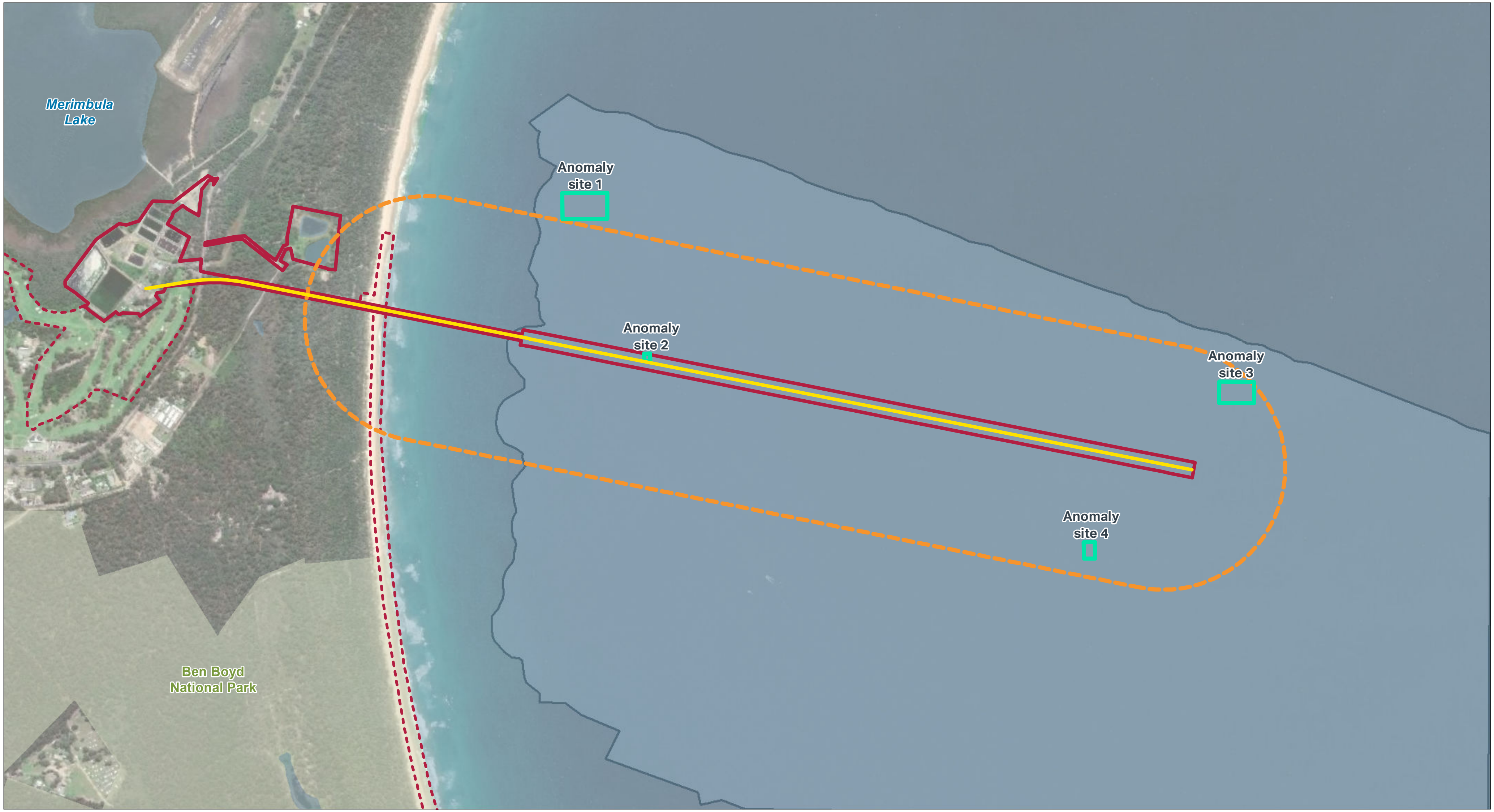


FIGURE 15-4: OVERVIEW OF THE SIDE SCAN SONAR DATA RESULTS

Legend

- Project area
- Project area (temporary construction area)
- Surveyed area
- Survey buffer (400m)
- Anomaly site
- Pipeline

N

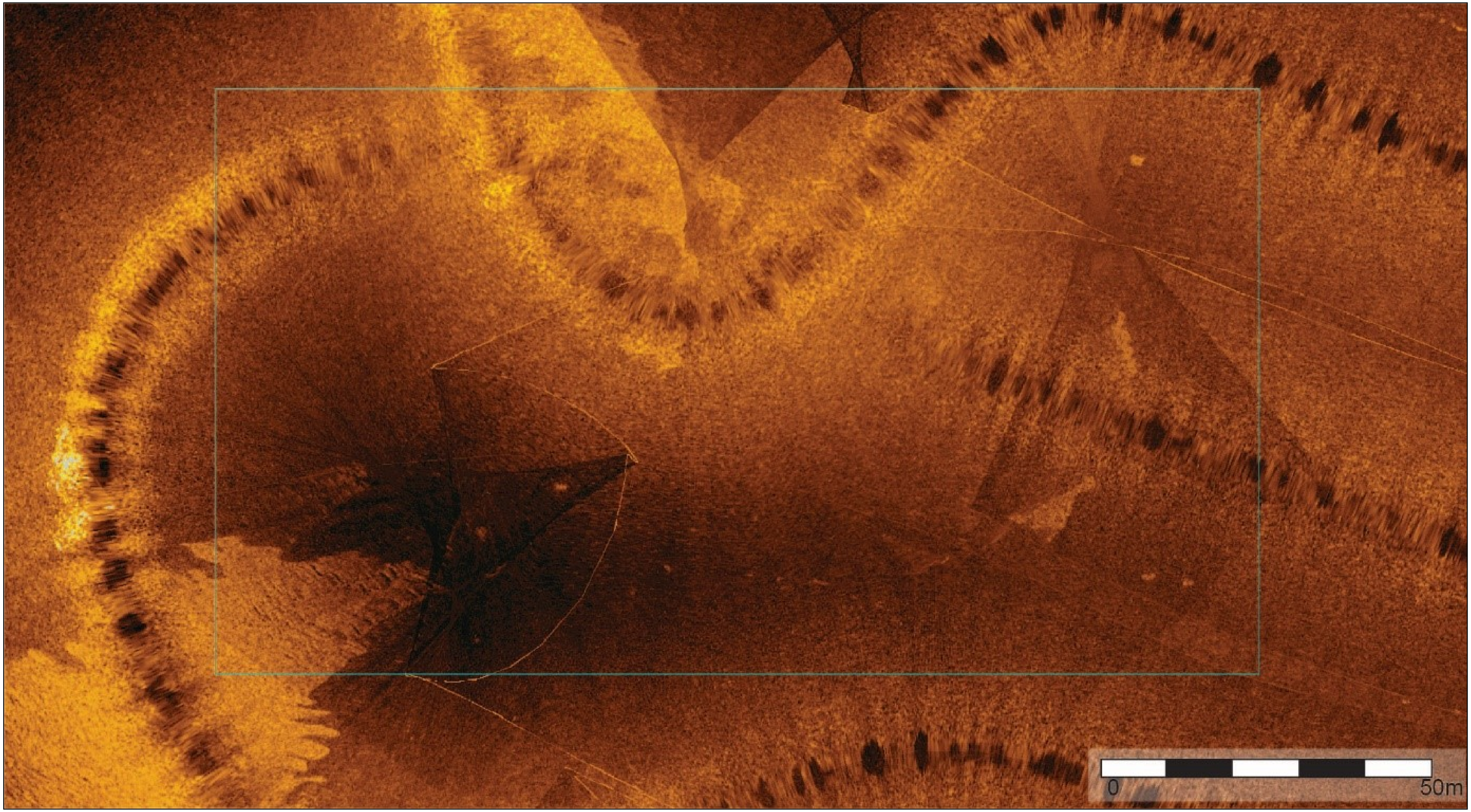
0 200 400 m

AECOM

Source: Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

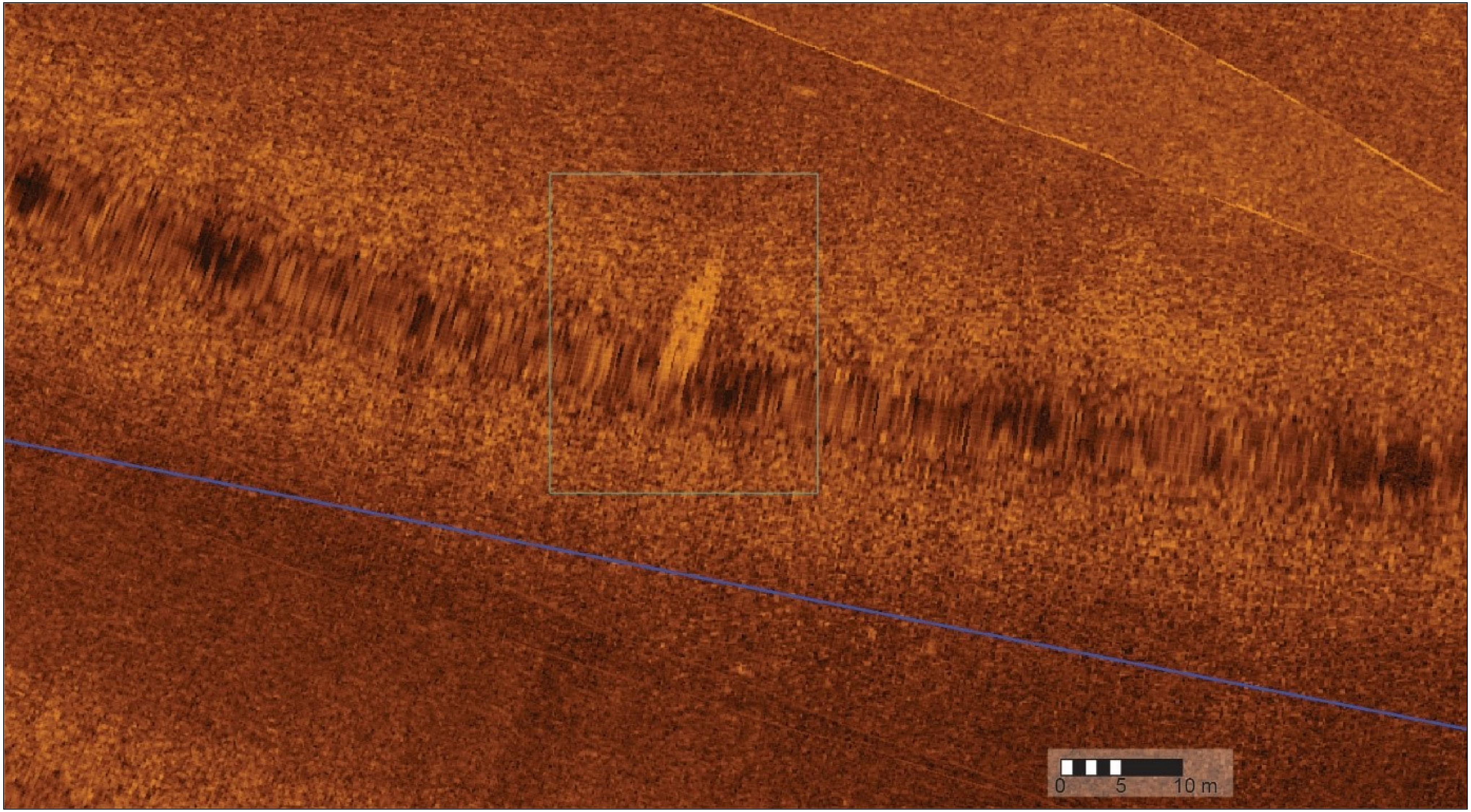
Table 15-4 Description of anomaly sites identified within a 400 m radius of the ocean outfall pipeline

Site Id	Location		Distance from shore	Distance from pipeline	Description of anomalies
	MGAE	MGAN			
Site 1	759353	5910409	600 m	400 m	The site is located where the survey boat was undertaking a turning manoeuvre for the next survey run. There are several objects between 2 m and 6 m in length, scattered over a 100 m area on top of the sandy sea floor (**Figure 15-5**)
Site 2	759551	5909917	900 m	20 m	The anomaly site appears as a raised object on the sea floor. 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 (**Figure 15-6**)
Site 3	761476	5909802	2700 m	270 m	This area includes several dark patches and elongated shapes on the sea floor. The dark patches may relate to marine growth on the sea floor. The elongated shape on the eastern (right) side of the image is 20 m long and is shadowed, meaning there is height to the anomaly. The surrounding sea floor area also appears to be a rippled sandy landform (**Figure 15-7**).
Site 4	761001	5909290	2300 m	300 m	This site consists of a single dark object that is surrounded by low topographical sandy sea floor. The feature is approximately 6 m in diameter (**Figure 15-8**).



ANOMALY SITE 1

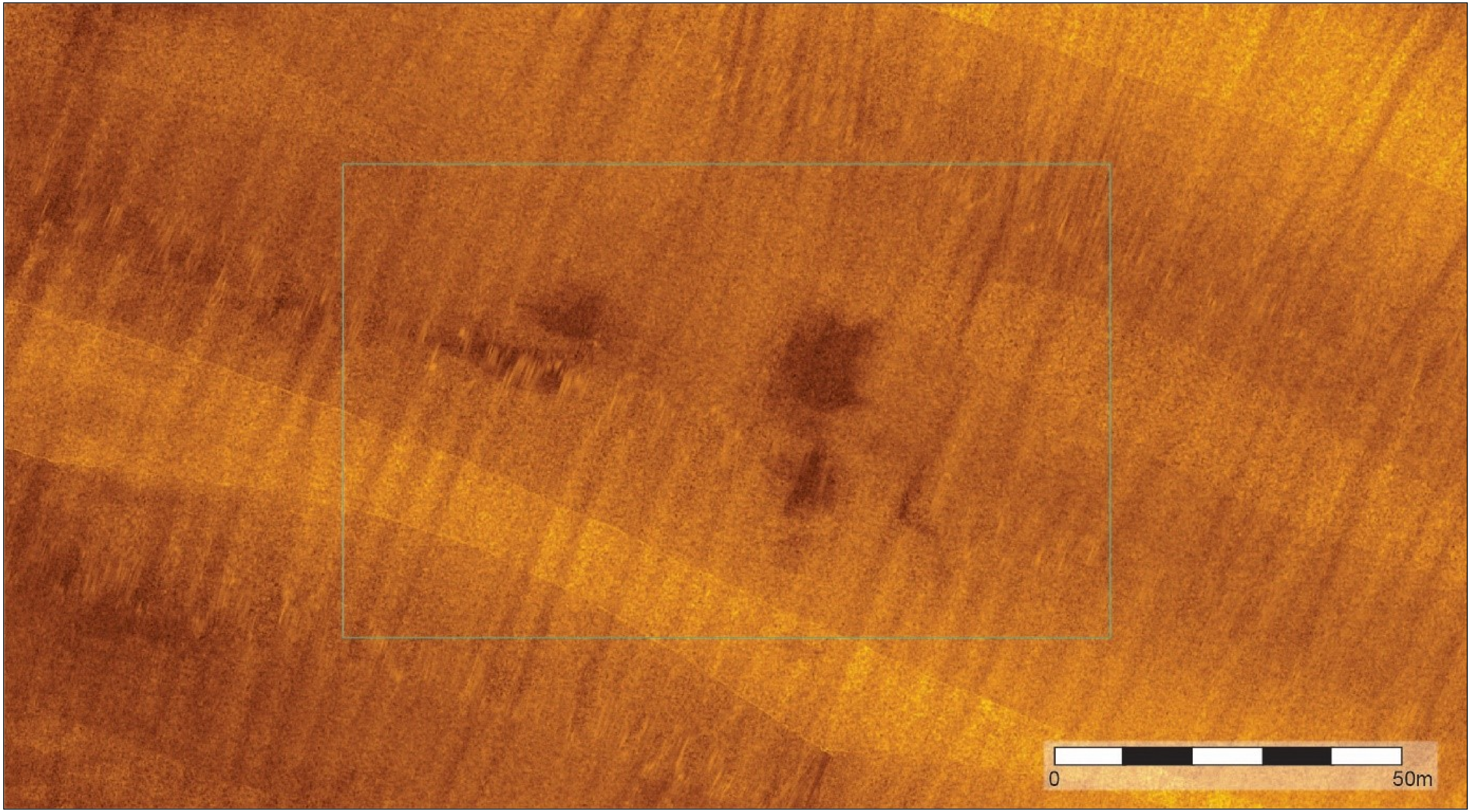
Source: Department of Customer Service, 2020



ANOMALY SITE 2

\\ausyd1fp001\Projects\605X\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR025_01_A4L_F15-6_Sonar_Anomaly2_200929.mxd Date Saved: 29/09/2020

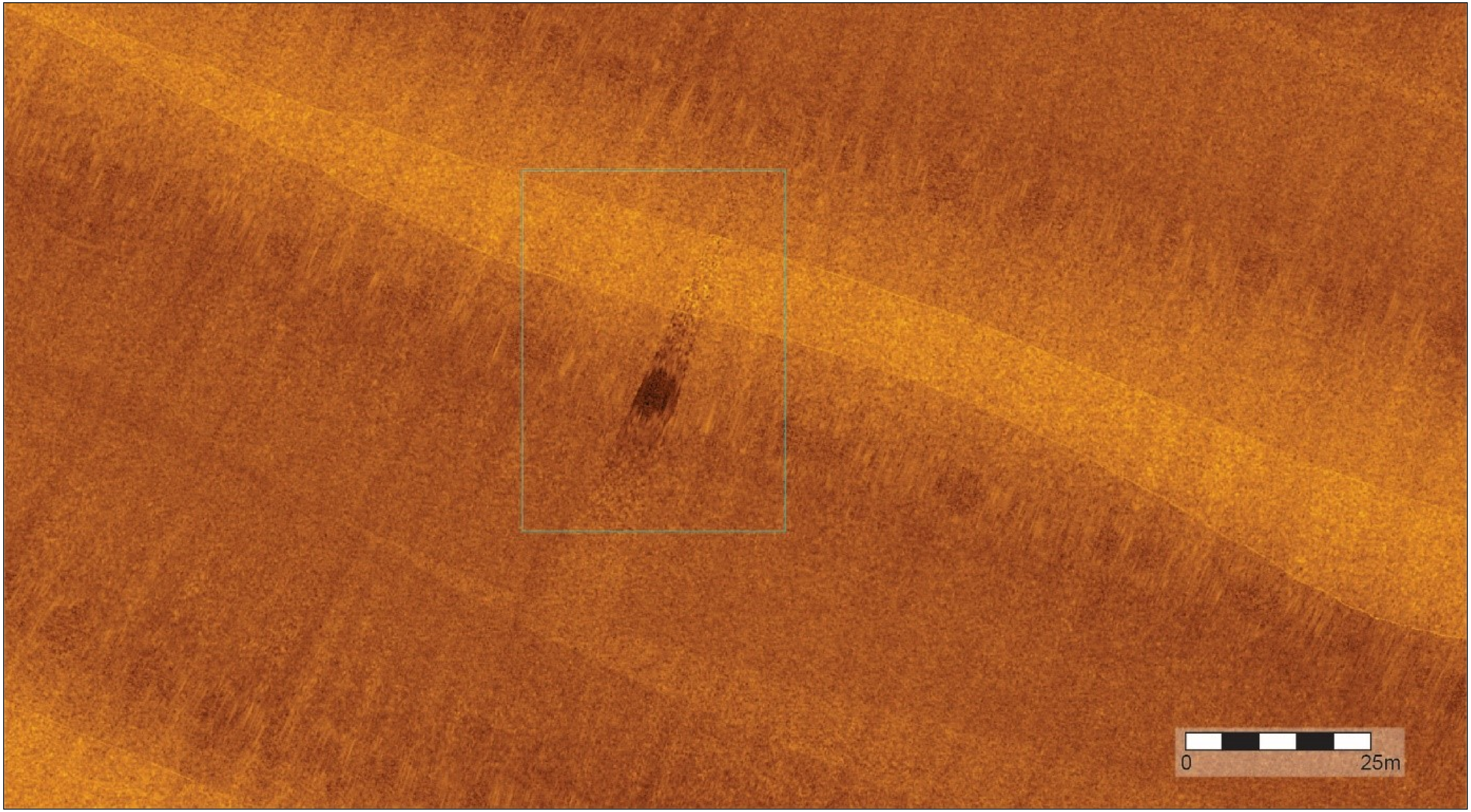
Source: Department of Customer Service, 2020



ANOMALY SITE 3

Source: Department of Customer Service, 2020

\\ausyd1fp001\Projects\605X\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR026_01_A4L_F15-7_Sonar_Anomaly3_200929.mxd Date Saved: 29/09/2020



ANOMALY SITE 4

Source: Department of Customer Service, 2020

15.2.5 Sea floor investigation of Anomaly 2

Based on the proximity of Anomaly 2 to the ocean outfall pipeline, additional sea floor investigations were carried out by Elgin Associates on 21 November 2020. The investigation was carried out via a drop tow video over the site of Anomaly 2. The site investigation noted the anomaly is situated in 14 m depth. The sea floor is uniform characterised by sand ripples. Within the area inspected, there is no evidence of a height difference in the sea floor to indicate a potentially buried structure, nor is there any evidence of a potential structure protruding from the sea floor surface (**Plate 13**).

Based on the results of the visual (drop tow video) inspection of the site of Anomaly 2, the anomaly site does not have any visible remains of a shipwreck or shipwreck related material present on the sea floor. There is the potential for the anomaly to be present below the sea floor, however, given the depth of the site (14 m) and sandy sea floor composition, it is unlikely that the anomaly in this area was related to a shipwreck that has been covered over.

Plate 13 Weighted buoy marking the location of Anomaly 2 showing the surrounding sea floor

15.2.6 Summary of anomaly sites

Four anomaly sites have been identified from the review of the SSS data within a 400 m radius of the ocean outfall pipeline. Three of the sites, Anomaly Sites 1, 3 and 4, are located greater than 250 m from the pipeline. At this distance, there are not expected to be any direct or indirect impacts, such as from construction, or changes to sediment rates (erosion or depositional events), associated with the installation or operation of the pipeline. No further heritage investigation, including construction or post construction investigations would be required for these sites.

Anomaly Site 2 is located approximately 20 m to the north of the ocean outfall pipeline and had the potential to be directly and/or indirectly impacted from pipeline construction works. Additional sea floor investigations across the site of Anomaly 2 identified no shipwreck or shipwreck related material present. The anomaly may be buried below the sea floor, but given the depth of the site and the sandy sea floor composition, it is unlikely the anomaly is a shipwreck that has become buried. The anomaly is likely to be a natural sea floor feature.

15.2.7 Significance assessment

An assessment of significance is generally undertaken to explain why a particular item is important and to enable appropriate mitigation and management measures to be implemented if an activity would impact on that heritage item. The process of linking this assessment with an item's historical context has been developed through the NSW Heritage Management System and is outlined in the guideline *Assessing Heritage Significance* (NSW Heritage Office, 2001). The Assessing Heritage Significance guidelines establish seven evaluation criteria under which a place can be evaluated in the context of State or local historical themes. An item will be considered to be of State or local heritage significance if it meets one or more of the seven evaluation criteria outlined in the Assessing Heritage Significance guideline.

Table 15-5 Significance assessment criteria

Criterion	Inclusions/Exclusions
Criterion (a) *– an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).*	The site must show evidence of significant human activity or maintains or shows the continuity of historical process or activity. An item is excluded if it has been so altered that it can no longer provide evidence of association.
Criterion (b) – an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local to area).	The site must show evidence of significant human occupation. An item is excluded if it has been so altered that it can no longer provide evidence of association.
Criterion (c) *– an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).*	An item can be excluded on the grounds that it has lost its design or technical integrity, or its landmark qualities have been more than temporarily degraded.
Criterion (d) *– an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.*	This criterion does not cover importance for reasons of amenity or retention in preference to a proposed alternative.
Criterion(e) *– an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area). Significance under this criterion must have the potential to yield new or further substantial information.*	Under the guideline, an item can be excluded if the information would be irrelevant or only contains information available in other sources.
Criterion (f) – an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).	An item is excluded if it is not rare or if it is numerous, but under threat. The item must demonstrate a process, custom or other human activity that is in danger of being lost, is the only example of its type or demonstrates designs or techniques of interest.
Criterion (g) *– an item is important in demonstrating the principal characteristics of a class of NSW's (or local area's):* - *cultural or natural places cultural; or natural environments.*	An item is excluded under this criterion if it is a poor example or has lost the range of characteristics of a type.

A significance assessment for the survey reference trees that are present within the Project area is in **Table 15-6** below.

Table 15-6 Significance assessment for the six survey reference trees

Criterion	Assessment
Criterion (a) *– an item is important in the course, or pattern, of NSW's cultural or natural history (or the cultural or natural history of the local area).*	The survey reference trees represent direct evidence of the original survey and division of lands that is represented in the 1885 parish map. The reference trees relate to the history of the local area and are considered to be of local significance under this criterion.
Criterion (b) – an item has strong or special association with the life or works of a person, or group of persons, of importance in NSW's cultural or natural history (or the cultural or natural history of the local to area).	The survey reference trees are associated with the expansion of economic development and settlement building associated with the Merimbula, south coast, region. As such, the survey reference trees are considered to be of local significance under this criterion.
Criterion (c) *– an item is important in demonstrating aesthetic characteristics and/or a high degree of creative or technical achievement in NSW (or the local area).*	The survey reference trees vary in condition and the inscription is of a utilitarian nature that does not have any notable outstanding aesthetic values. The survey reference trees have been assessed as not meeting the State or local listing under this criterion.
Criterion (d) *– an item has strong or special association with a particular community or cultural group in NSW (or the local area) for social, cultural or spiritual reasons.*	The survey markers were previously located; however, they are largely unknown to the wider Merimbula community. The survey reference trees have been assessed as not meeting the State or local listing under this criterion.
Criterion (e) *– an item has potential to yield information that will contribute to an understanding of NSW's cultural or natural history (or the cultural or natural history of the local area). Significance under this criterion must have the potential to yield new or further substantial information.*	The survey trees are considered to be of local heritage significance; however, the survey trees have limited research value relating to the early settlement and division of lands at Merimbula. As such, the survey reference trees are considered to be of local significance under this criterion.
Criterion (f) – an item possesses uncommon, rare or endangered aspects of NSW's cultural or natural history (or the cultural or natural history of the local area).	The six survey trees are a rare surviving example of marked trees relating to the division of lands in the early settlement at Merimbula. There may be other similar survey trees that have been protected by being located within the coastal reserve area at Merimbula. The trees are considered to be of local significance under this criterion.
Criterion (g) *– an item is important in demonstrating the principal characteristics of a class of NSW's (or local area's):* - *cultural or natural places cultural; or* - *natural environments.*	The initials "B M" and the "V" are distinct survey reference marks that are present on other similar survey trees in NSW, however, the nail that would originally have been in place at the base of the tree to represent the height datum is now absent. As these features are associated with trees used as a survey marker, the six trees are considered to be of local significance under this criterion.

Criterion	Assessment
Statement of Significance	The survey reference trees are a rare surviving example of marked trees that relate to the early division of lands in the Merimbula area. The trees roughly align with the formation of reserves in 1885. One of the trees used as a former benchmark, used a reference marker for the surrounding survey area. The survey reference trees have been assessed as being of local significance.

15.3 Potential impacts – construction

15.3.1 Terrestrial works

Primary ground disturbance works within the terrestrial component of the Project area, defined here as bulk earthworks within the existing fenced STP complex and the installation of the underground section of the ocean outfall pipeline (Section 1), are not anticipated to result in any physical impacts to the six survey reference trees identified within and adjacent to the Project area. The pipeline would be directionally bored underneath these trees at depth and would not have any direct impacts.

15.3.2 Ancillary ground disturbance activities

Ancillary ground disturbance activities within the terrestrial component of the Project area (e.g., light and/or heavy vehicle movements) are likewise not anticipated to result in any physical impacts to the six survey reference trees identified within and adjacent to the Project area. As there would be no works in the vicinity of these reference trees, there would not be any indirect (vibrational) impacts to these survey reference trees.

15.3.3 Marine works

There are no impacts to identified maritime heritage sites anticipated during the construction of the pipeline.

15.4 Potential impacts – operation

15.4.1 Terrestrial works

No impacts to identified historic heritage values are anticipated.

15.4.2 Marine works

There are no impacts to identified maritime heritage sites anticipated during the operation of the pipeline.

15.5 Management of impacts

The mitigation and management measures identified to help avoid and minimise the identified non-Aboriginal heritage impacts of the Project are outlined in **Table 15-7**, and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

15.5.1 Performance outcomes

The non-Aboriginal heritage performance outcomes for the Project are as follows:

- no impacts to non-Aboriginal sites, objects and places during construction; and
- if an unexpected find is encountered during construction, relevant procedures under an Cultural Heritage Management Plan are followed.

The Project would be designed, constructed and operated to achieve these performance outcomes.

15.5.2 Consideration of interaction between measures

Mitigation and management measures are provided in **Table 15-7**. No mitigation or management measures in other chapters are relevant to the management of potential historic heritage impacts.

15.5.3 Mitigation and management measures

Based on the results of the terrestrial and shipwreck research, information gathered from the site inspection and review of the side scan sonar data, the mitigation and management measures in **Table 15-7** are recommended.

Table 15-7 Mitigation and management measures – historic heritage

Ref #	Potential impacts	Mitigation and management measures	Timing
HH1	Unexpected discovery of a relic or potential relic during construction works	In the event that any potential archaeological 'relics' are discovered during construction works associated with this Project, all work in the area shall cease and the Project Archaeologist notified of the discovery. Once the archaeologist has gathered suitable information regarding the unexpected find, an appropriate course of action can be determined. This may include, but would not be limited to: • No further works required, or • Stop construction works in the area and notification to Heritage NSW, NSW Environment, Energy and Science, regarding the discovery of the relic and an outline of additional work and/or permitting requirements.	Construction

15.5.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using the BVSC *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for historic heritage and is provided in **Table 15-8**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental mitigation and management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Table 15-8 Environmental risk analysis with mitigation– Historic heritage

Summary of impacts	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Unexpected discovery of a relic or potential relic during construction works	Construction	HH1	Minor	Rare	Low

16.0 Hazardous materials

The objective of this chapter is to determine if the Project is potentially hazardous by undertaking a preliminary hazard and risk screening in accordance with the requirements of *State Environment Planning Policy No. 33 – Hazardous and Offensive Development* (SEPP 33). The chapter provid00es a summary of the identified hazards of relevance to SEPP 33, their potential impacts and the mitigation and management measures that would be adopted to minimise these impacts through appropriate safeguards.

Table 16-1 sets out the requirements as provided in the Secretary's Environmental Assessment Requirements (SEARs) relevant to hazards and risks and where the requirements have been addressed in this EIS.

Table 16-1 SEARs – Hazards and risks

Ref	Assessment requirements	Where addressed in this EIS
2.1	The Proponent must undertake a preliminary risk screening, with a clear indication of class, quantity and location of all dangerous goods and hazardous materials associated with the development. Should preliminary screening indicate that the project is "potentially hazardous" a Preliminary Hazard Analysis (PHA) must be prepared in accordance with the guidelines.	**Section 16.2.1** and **Section 16.5**

16.1 Assessment approach

16.1.1 Legislative and policy context

- SEPP 33;
- *Hazardous and Offensive Development Application Guidelines, Applying SEPP 33* (Applying SEPP 33);
- *Australian Code for the Transport of Dangerous Goods by Road and Rail, Edition 7.6, 2018*; and
- *AS/NZS ISO 31000 Risk Management – Guidelines* (AS/NZS ISO 31000).

16.1.2 Methodology

A risk screening assessment has been carried out in accordance with the guidance provided in Applying SEPP 33 to determine if the Project is potentially hazardous and whether or not SEPP 33 applies (refer to **Section 16.2.1**). The procedure is depicted in **Figure 16-1** below.

A review of the following information was undertaken as part of the risk screening process:

- list of all dangerous goods (DGs) and otherwise hazardous chemicals involved in the Project including raw materials, intermediates, and products;
- DGs classifications (including all subsidiary classes) for all DGs held on the existing Merimbula STP site;
- quantities of DGs and otherwise hazardous chemicals involved in the Project;
- distance from the STP site boundary for each hazardous chemical storage;
- weekly and annual number of deliveries (and the quantities) of DGs and otherwise hazardous chemicals to and from the STP site;
- the STP site layout plan as shown in **Figure 2-3** of **Chapter 2 Project description**; and
- locality plan showing immediate neighbours including residential properties and other sensitive land uses.

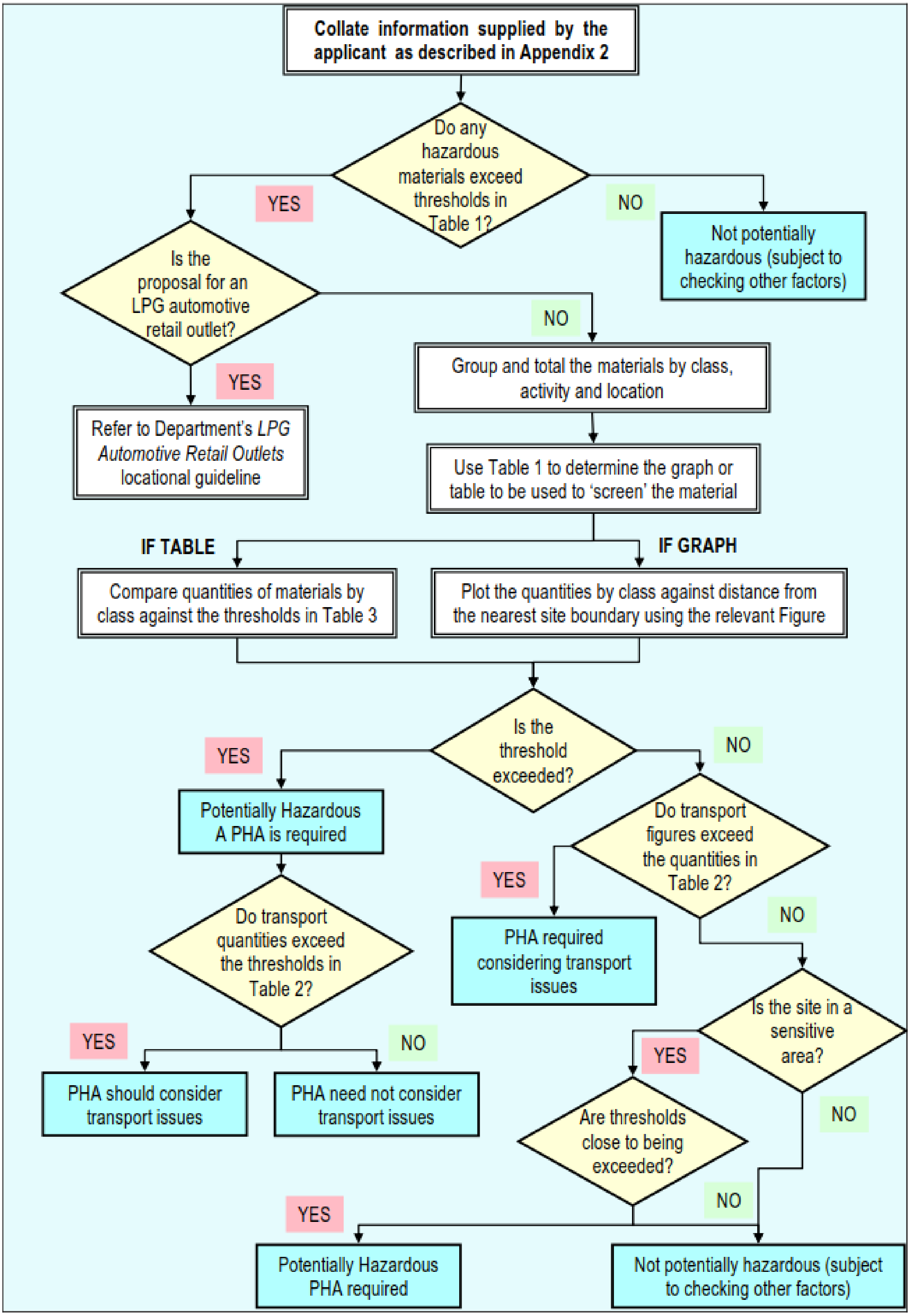


Figure 16-1 **SEPP 33 Risk Screening Procedure**

16.1.3 Study area

The existing Merimbula STP is located between Merimbula and Pambula on Arthur Kaine Drive, approximately 3.5 kilometres (km) south of the Merimbula town centre and 2.5 km north of Pambula village. The study area for the hazard and risk assessment encompasses the existing Merimbula STP site, the proposed ocean outfall pipeline alignment and the areas required for construction of the Project.

Land uses in the vicinity of the study area are described in **Chapter 19 Property and land use** comprising recreational, commercial and rural residential land uses along with environmentally sensitive dune, beach and lake areas.

16.2 Existing environment

16.2.1 Meteorological and topographical considerations

Meteorological data representative of the study area, particularly the wind direction and speed, were taken from the Merimbula Airport Weather Station (ID: 69147) situated approximately 1 km from the study area. Historical data from the Merimbula Airport Weather Station is presented in the Australian Bureau of Meteorology website (BOM, 2020). The following two broad dominant wind conditions relate to the study area:

- low wind speed in the mornings with a mean of 8 km per hour annually; and
- moderate wind speed in the afternoons with a mean of 15 km per hour annually.

These represent the mean wind speed conditions at 9am and 3pm from June 2019 to June 2020 at the study area. Detailed meteorological data can be found in **Appendix N** (Air Quality Technical report).

16.2.2 Nearest residential and sensitive receptors

Residential and sensitive receptors for the purpose of this chapter are as defined in Section 2.4 of the NSW *Hazardous Industry Planning Advisory Paper No 4, Risk Criteria for Land Use Safety Planning* and are people, who, if subject to short term exposure to the chemicals used on-site, can suffer immediate adverse physiological effects.

The nearest urban residential area is located approximately 1.5 km to the south west. In closer proximity are scattered rural residences to the south east of the study area. Pambula Hospital and aged care facility are approximately 1.3 km to the south west.

Five receptors representative of the surrounding land uses were included in the study based on a desktop review of the Project location (**Figure 16-2**) and reference to aerial images from Google Maps. Receptors R1 to R5 represent the nearest sensitive receptors as shown in **Table 16-2**.

Table 16-2 List of surrounding residential and sensitive receptors

Receptor ID	Easting (UTM z55H)	Northing (UTM z55H)	Type	Approximate distance and direction from study area (m) [1]
R1	756501	5909461	Pambula Hospital	1300 m SW
R2	756554	5909359	Aged Care Facility	1300 m SW
R3	758060	5909944	Residential	170 m SE
R4	758022	5909785	Residential	230 m SE
R5	757952	5909690	Residential	350 m SE

Notes:

[1] Measured between the closest points on the boundaries of the STP site and the residential or sensitive receptor property.

SW = south west

SE = south east

\\ausyd1fp001\Projects\605X\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR009_03_A4L_F16-2_SensitiveReceptors_210121.mxd Date Saved: 21/01/2021

FIGURE 16-2: RESIDENTIAL AND SENSITVE RECEPTOR LOCATIONS

0 200 400 m

Legend

Project area

Project area (temporary construction area)

Source: Nearmap, 2019

16.2.1 Preliminary risk screening

The screening assessment in Applying SEPP 33 (Department of Planning, 2011) for the storage and transport for the list of DGs outlined in **Section 16.2.2** is summarised in **Table 16-3** and **Table 16-4**, respectively. The tables demonstrate the Project is not potentially hazardous according to the requirements defined in Applying SEPP 33, having considered the quantity of DGs stored on-site and the transport frequency of those DGs between site and off-site locations. As such a formal Preliminary Hazard Analysis is not required.

Table 16-3 Applying SEPP 33 potentially hazardous screening assessment – On-site storage

Dangerous good	Dangerous good class	Approximate quantity	Approximate separation distance	Potential for off site impacts
Liquefied chlorine gas	2.3; 5.1; and 8 PGIII	1.84 tonne	N/A[1]	**Below the threshold:** The storage threshold for Class 2.3 chlorine stored as liquefied gas in containers >100 kg is 2.5 tonne. The quantity of Class 2.3 on-site is less than 2 tonne, which does not exceed the threshold quantity. The storage threshold for Class 5.1 is 5 tonne. The quantity of Class 5.1 on-site does not exceed the threshold quantity. The storage threshold for Class 8 PGIII corrosive substances is 50 tonne. The quantity of Class 8 PG III on-site does not exceed the threshold quantity. It can be considered that liquefied chlorine gas does not pose significant off-site risk during storage.
Sodium Hypochlorite (NaOCl)	8 PGIII	130 kg	N/A[1]	**Below the threshold:** The threshold for Class 8 PGIII corrosive substances is 50 tonne. It can be considered that sodium hypochlorite does not pose significant off-site risk during storage.

[1] Non applicable

Table 16-4 Applying SEPP 33 potentially hazardous screening assessment - Transportation movements

Dangerous good	Dangerous good class	Annual cumulative vehicle movements	SEPP 33 annual transport movement threshold
Liquefied chlorine gas	2.3; 5.1; and 8 PGIII	13	**Below the threshold:** The vehicle movement threshold for Class 2.3 is 100 movements or more a year. Similarly, the vehicle movement threshold for Class 5 and Class 8 is 500 movements or more a year. It can be considered that the quantity of liquified chlorine gas moved does not pose significant off-site risk during transportation movements.
Sodium Hypochlorite (NaOCl)	8 PGIII	13 (assuming 1 movement every 28 days)	**Below the threshold:** The vehicle movement threshold for class 8 is 500 movements or more a year. It can be considered that the quantity of sodium hypochlorite moved does not pose significant off-site risk during transportation movements.

16.2.2 Types and quantities of dangerous goods

Certain chemicals are classified as dangerous goods due to their potential for acute harmful physiochemical effects on living organisms upon exposure. In Australia the DGs of relevance to the assessment are any which are defined in the *Australian Code for the Transport of Dangerous Goods by Road and Rail, Edition 7.6, 2018*. The DGs which are likely to be stored and handled at the STP site are outlined in **Table 16-5** with storage locations shown on **Figure 16-3**.

Any STP requires minor quantities of hazardous chemicals for use in the site laboratory such as buffer solutions and chemical tests. The correct storage and separation of those hazardous chemicals which are classified DGs is governed by Australian Standards and would be managed according to site procedures within the BVSC safety management system. A safety management system provides a framework for the development of site and task-specific procedures, which also ensure that regulatory requirements are addressed.

The storage of minor quantities of DGs is not a significant contributor to the overall risk profile of the Project from a land use safety planning perspective. As a consequence, these hazardous chemicals have been excluded from the tables below. Chemical substances that are not subject to SEPP 33 requirements, which are also likely to be stored and handled at the Merimbula STP are presented in **Table 16-6**.

Table 16-5 Project hazardous materials

Hazardous materials	Maximum quantity stored on site	Dangerous goods class including subsidiary class(es)	Packing Group	UN No.	Chemical Abstract Number (CAS No.)	Physical and chemical properties	Type of storage	On site location[1]	Average number of road movements
Liquefied chlorine gas (Cl_2)	1840 kg	2.3; 5.1; and 8	PG III (for subsidiary class)	1017	7782-50-5	May cause severe skin burns, eye damage and respiratory irritation	920 kg steel storage drums	Chemical Storage Chlorination Shed (refer to **Figure 16-3**)	1 x 1.84 tonne delivery per month
Sodium Hypochlorite (NaOCl)	10,000 L	8	PG III	1791	7681-52-9	May cause severe skin burns, eye damage and respiratory irritation	Industrial plastic storage tanks Bulk Steel Storage Tanks	Chemical Storage Shed (refer to **Figure 16-3**)	1 x 7500 kilolitre delivery per month

Notes: [1]The final location of chemical storage is to be confirmed during detailed design, however the existing storage location has been used for the purpose of this assessment

Table 16-6 Other chemical substances not subject to SEPP 33 requirements

Chemicals Substances	Maximum storage quantity on site	Dangerous goods class	Type of storage	On site location[1]	Average number of road movements
Polyaluminium Chloride (PAC)	47 m^3	Not considered a DG (also not considered a Hazardous Chemical according to Safe Work Australia)	200 L plastic drums (also known as intermediate bulk container (IBC) plastic tanks, or pallet tanks)	Stored: Chemical storage shed and chemical storage area (refer to **Figure 16-3**)area Used for wastewater treatment	1 movement every 14 days

Notes: [1]The final location of chemical storage is to be confirmed during detailed design, however the existing storage location has been used for the purpose of this assessment

FIGURE 16-3: CHEMICAL STORAGE LOCATION PLAN

Legend

- Project area
- Project area (temporary construction area)

Chemical Storage Locations

- Chlorine (Cl_2 or NAOCl)
- Polyaluminium Chloride (PAC)

N

0 50 100 m

Source: Nearmap, 2019

16.3 Potential impacts – construction

During construction of the Project, minor quantities of hazardous chemicals such as paints, solvents, machinery lubricants and fuel are typically used. The correct storage and separation of these goods is governed by Australian Standards and would be managed through a Site Safety Management Plan prepared in accordance with BVSC's safety management system and the construction contractors Safety Management System. BVSC would review the Site Safety Management Plan prior to approving it. As per the *Work Health and Safety Act 2011,* the construction contractor would be the person conducting a business or undertaking, and as such would be responsible for the implementation of the Site Safety Management Plan.

The minor storage of construction DGs is not considered to be a significant contributor to the overall risk profile of the Project from a land use safety planning perspective and, as a result, these goods are excluded from **Table 16-7** below.

Construction of the ocean outfall pipeline would include a section of buried pipeline, which is proposed to be constructed using a horizontal directional drilling technique. A typical recipe for drilling fluid likely to be used during construction was examined. No ingredient chemicals were identified as DGs and were therefore excluded from the assessment.

16.4 Potential impacts – operation

The hazard analysis was carried out in accordance with the requirements of Applying SEPP 33. All hazardous chemicals were identified, assessed and a preliminary screening carried out. Two hazardous chemicals were identified as dangerous goods, being:

- liquefied chlorine gas; and
- sodium hypochlorite.

Wastewater would be treated in the STP by a combination of biological processes and dosing with poly aluminium chloride (PAC), ultraviolet light treatment, and disinfecting with chlorine (either in the form of chlorine gas or sodium hypochlorite). Treated wastewater would be beneficially re-used as irrigation water or disposed of via the ocean outfall pipeline. An overview of the proposed STP process is further detailed in **Chapter 2 Project description**.

The source of chlorine for disinfection is either chlorine gas or sodium hypochlorite but has not yet been decided at this stage of the Project. Therefore, storage and transport of both liquified chlorine gas and sodium hypochlorite to the STP site is considered.

The assessment found that the hazards associated with the use of these chemicals in the STP upgrade in the quantities planned are not significant with respect to land use safety planning criteria and that appropriate safeguards have been proposed to prevent and mitigate the hazards and risks associated with these hazardous chemicals within the Project area.

16.5 Project development dangerous goods risk management

16.5.1 Application of the risk management standard

In line with risk management principles described in AS/NZS ISO 31000, the objective of a risk assessment is to identify all hazards, assess the risks, identify controls, implement controls and review the effectiveness of the controls, to ensure that risks arising from the operation or maintenance of the Project are managed to an acceptable level. When selecting control methods to manage risk, the hierarchy of risk treatment methods is as follows:

- **elimination**: hazard is eliminated and the associated risk is removed;
- **substitution**: if hazard cannot be eliminated, minimise the risk through substitution of a substance or process that has less potential to cause injury;
- **isolation**: engineering, design, structural changes to the work environment, plant or equipment which shall isolate persons from the potential risk;

- **administration**: risk may be reduced through the provision of training, procedures, and other methods; and
- **personal protective equipment (PPE)**: this control should be used in conjunction with other controls and should not be relied upon in isolation.

The preceding sections of this chapter indicate that there is not a significant risk to off-site sensitive receptors as a result of the quantity of DGs transported to and stored on the site. Having due regard to this finding the following sections summarise management of the residual on-site risk of using the identified DGs.

16.5.2 Consequence and mitigation identification

The site consequence and potential mitigations for the DGs identified above are summarised in **Table 16-7**.

Table 16-7 Site risk management assessment

Event	Cause	Consequence	Mitigating factor
Chlorine gas			
Catastrophic failure of or leak from cylinder	• corrosion; and • mechanical damage.	• personnel exposure to toxic gas; • personnel asphyxiation; and • environmental emission.	• crash barriers to protect cylinder; • use of ACTDG-compliant cylinder; • design to AS2927; • cylinder certification currency check and visual inspection upon receipt on-site; • leak detection alarms to on-site personnel/off-site contact; • routine dosing system integrity checks; and • Emergency Response Plan.
Failure of or leak from dosing piping	• corrosion; and • mechanical damage.	• personnel exposure to toxic gas; • personnel asphyxiation; and • environmental emission.	• design to AS2927; • leak detection alarms to on-site personnel/off-site contact; • routine piping system integrity checks; and • Emergency Response Plan.
Sodium hypochlorite			
Catastrophic failure of or leak from tank	• corrosion; and • mechanical damage.	• personnel exposure to toxic vapour or skin contact; • personnel asphyxiation; and • environmental emission.	• store in a bunded area; • design to AS3780; • alarms for system failure to on-site personnel/off-site contact; • routine system integrity checks i.e. tank, bund wall, etc.; and • Emergency Response-Spill Response Plan.

Event	Cause	Consequence	Mitigating factor
Failure of or leak from piping	• corrosion; and • mechanical damage.	• personnel exposure to toxic vapour or skin contact; • personnel asphyxiation; and • environmental emission.	• design to AS3780; • alarms for system failure to on-site personnel/off-site contact; • chemical spill kits adjacent to system; • routine piping system integrity checks; and • Emergency Response-Spill Response Plan.

16.6 Management of impacts

The mitigation and management measures identified to avoid and minimise the identified hazard and risk impacts are outlined in **Table 16-8**, and would be included in the Project Risk Register as well as the Construction Environmental Management Plan (CEMP) for the Project, and carried through to operation by BVSC where relevant. Measures carried through to operation would form part of BVSC Operation and Maintenance Manuals for the Project.

16.6.1 Performance outcomes

The hazard and risk performance outcome for the Project is as follows:

- no impacts to the receiving environment form the storage or handling of dangerous goods (during construction or operation).

The Project would be designed, constructed and operated to achieve this performance outcome.

16.6.2 Consideration of interaction between measures

Mitigation and management measures in other chapters that are relevant to the management of potential hazard and risk impacts include:

- **Chapter 8 Water quality, hydrology and flooding**, specifically measures SWF1, SWF2 and SWF4 to address water quality risks;
- **Chapter 9 Groundwater**, specifically; measure GW2 to address construction impacts to groundwater;
- **Chapter 17 Human health**, specifically measure HH4 which identifies an incident response procedure;
- **Chapter 20 Noise and vibration (air)**, specifically measure NV1 which identifies a Construction Noise and Vibration Management Plan (air);
- **Chapter Noise and vibration (underwater)**, specifically measure NVU1 which identifies a Construction Noise and Vibration Management Plan (underwater);
- **Chapter 22 Air quality**, specifically measures AQ1 and AQ9 to address air quality and odour impacts; and
- **Chapter 26 Waste**, specifically measure WM1 to address general waste management.

16.6.3 Mitigation and management measures

Mitigation and management measures of relevance to the hazards scenarios documented in **Table 16-7** are summarised below in **Table 16-8**. Any chemical purchases made by or on behalf of BVSC as part of the Project would need to comply with the Globally Harmonised System and SafeWork Australia Government regulations and legislation.

Table 16-8 Mitigation and management measures - hazard and risk

Ref #	Potential impact	Mitigation and management measures	Timing
HR1	• corrosion; • mechanical damage; • personnel exposure to toxic gas; and • environmental emission	Safety in design -Locate chemical storage tanks and chemical containers (packages) at separation distances with specific reference to the applicable Australian Standards i.e. AS1940*The storage and handling of flammable and combustible liquids;* *AS4452 The storage and handling of toxic substances;* *AS4326 The storage and handling of oxidising agents; and* *AS3780 The storage and handling of corrosive substances.*	Detailed design phase
HR2	Potential hazards (and subsequent impacts such as injury, financial risks etc) associated with plant and machinery	Safety in design - Conduct a Hazard and Operability (HAZOP) study for the processes and plant items within the Project area to identify potential hazards and operational problems in terms of plant design and human error.	Detailed design phase
HR3	Potential hazards associated with the installation and operation of plant and machinery	Safety Instrumented Systems - Identify and implement Safety Instrumented Systems in line with AS IEC 61511.1, *Functional safety – Safety instrumented systems for the process industry sector.*	Detailed design phase
HR4	Potential impacts to humans and the environment as a result of incorrect handling chlorine gas including: • corrosion; • mechanical damage; • personnel exposure to toxic gas; and • environmental emission	Workers training and competency - Ensure workers have appropriate training and the necessary competencies for handling chlorine gas.	Pre-Operation phase
HR5		Safety Management Plan - Update the Site Safety Management Plan for the introduction of chlorine gas.	Pre-Operation phase
HR6		Emergency Response Plan - Update the Site Emergency Response Plan for the introduction of chlorine gas.	Pre-Operation phase
HR7	Potential impacts to humans and the environment as a result of operational failures	Workers training and competency - Undertake audits on operational activities, and address and communicate any findings to the relevant workers.	Operation phase
HR8		Perform appropriate preventive maintenance programs.	Operation phase

Ref #	Potential impact	Mitigation and management measures	Timing
HR9	Potential impacts to humans and the environment as a result of human error	Ensure all workers have appropriate training and necessary competencies.	Operation phase

16.6.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for hazard and risk and is provided in **Table 16-9**.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Table 16-9 Environmental risk analysis with mitigation - Hazard and risks

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
• corrosion; • mechanical damage; • personnel exposure to toxic gas; and • environmental emission	Pre-Operation	HR1	Minor	Unlikely	Low
Potential hazards (and subsequent impacts such as injury, financial risks etc) associated with plant and machinery	Pre-Operation	HR2	Minor	Unlikely	Low
Potential hazards associated with the installation and operation of plant and machinery	Pre-Operation	HR3	Minor	Unlikely	Low
Potential impacts to humans and the environment as a result of incorrect handling chlorine gas including: • corrosion; • mechanical damage; • personnel exposure to toxic gas; and • environmental emission	Pre-Operation	HR4	Minor	Unlikely	Low
Potential impacts to humans and the environment as a result of incorrect handling chlorine gas including: • corrosion; • mechanical damage; • personnel exposure to toxic gas; and • environmental emission	Pre-Operation	HR5	Minor	Unlikely	Low
Potential impacts to humans and the environment as a result of incorrect handling chlorine gas, including: • corrosion; • mechanical damage; • personnel exposure to toxic gas; and • environmental emission	Pre-Operation	HR6	Minor	Unlikely	Low
Potential impacts to humans and the environment as a result of operational failures	Operation	HR7	Minor	Unlikely	Low

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Potential impacts to humans and the environment as a result of human error	Operation	HR8	Minor	Unlikely	Low
Potential impacts to humans and the environment as a result of operational failures	Operation	HR9	Minor	Unlikely	Low

17.0 Human health risk

This chapter provides a summary of the human health risks associated with the Project.

A detailed human health risk assessment (HHRA) has been prepared for the Project and is included in **Appendix J**.

Table 17-1 sets out the requirements as provided in the SEARs relevant to human health risks and where the requirements have been addressed in this EIS.

Table 17-1 SEARs – Human health risk

Ref	Assessment requirements	Where addressed in this EIS
3.1	The Proponent must assess any change to the risk to human health and identify mitigation and management measures to ensure appropriate standards are met.	**Section 17.8** assess the potential risks to human health from the Project and **Section 17.9** identifies appropriate mitigations and management measures.

Potential human exposure to odours has been assessed separately in the air quality impact assessment, which is summarised in **Chapter 22 Air quality**.

17.1 Assessment approach

The HHRA assessed potential risks to human health associated with re-use of treated wastewater under current (pre-upgrade) and proposed (post-upgrade) conditions. Therefore, construction related impacts have not been assessed as part of the HHRA.

The assessment was informed by a desktop review of information to describe the existing environment as it relates to human health and to determine the potential impacts of the Project on human health.

17.1.1 Legislative and policy context

The HHRA was prepared with consideration of the following relevant legislation and guidelines:

- *Australian Guidelines for Water Recycling: Managing Health and Environmental Risks* (NHMRC, 2006);
- *Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards* (enHealth, 2012a);
- *Australian Exposure Factor Guide* (enHealth, 2012b);
- *Methodology for Valuing the Health Impacts of Changes in Particle Emissions* (EPA, 2013);
- *Health Impact Assessment: A practical guide* (NSW Health, 2007); and
- *Recycled Water Management System* (RWMS) (BVSC, 2019).

17.1.2 Methodology

The HHRA was undertaken in the five stages outlined below and is discussed in **Section 17.3** to **Section 17.7**.

- **Stage 1 – Issue identification (Section 17.3)**:
  - identification of the issue (or concern, problem or objective) to be assessed;
  - identification of relevant stakeholders and their objective (where relevant);
  - determination of the objective of the risk assessment; and
  - outline of the risk management decisions that need to be made.

- **Stage 2 – Data collection (Section 17.4)**:
  - identification of data that characterises potential hazards that warrant assessment;
  - identification of key data gaps and their potential significant to human health risk outcomes;
  - development of a conceptual site model (CSM), including a description of potential linkages between the source of potential hazards, potential migration pathways and groups of people that may be exposed to treated wastewater; and
  - where potentially complete source-pathway-receptor linkages are not identifies, there is considered to be no risk;
- **Stage 3 – Exposure assessment (Section 17.5)**:
  - qualitative assessment of the expected frequency, extent and duration of exposure to treated wastewater by human receptors via identified exposure pathways; and
  - consideration of current and proposed conditions, and the likelihood of exposure under these conditions;
- **Stage 4 – Hazard assessment (Section 17.6)**:
  - identification of the hazards to human health that may be associated with discharge or re-use of treated wastewater;
  - qualitative assessment of the potential health consequence of the identified hazards; and
  - consideration of current and proposed conditions and the potential consequence of exposure under these conditions;
- **Stage 5 – Risk characterisation (Section 17.7)**:
  - combination of the consequence and likelihood ranking for each hazard to characterise potential risks; and
  - identification of the change in risk profile between current and proposed conditions.

17.1.3 Key limitations on the HHRA

The assessment was limited to potential human exposure to treated wastewater and did not consider potential exposure of workers prior to treatment or any potential exposure to biosolids. It is considered that workers would be protected from exposure to chemical or biological hazards via the implementation of health and safety plans and safe work method statement;

It is assumed that biological hazards would be treated to comply with the Environment Protection Licence (EPL) criteria and therefore would not present an unacceptable risk following discharge via the ocean outfall pipeline; and

It is assumed that all Chemicals of Potential Concern (CoPC) are captured by those listed in the EPL.

17.2 Existing environment

17.2.1 Treated wastewater irrigation system

Treated wastewater from the Merimbula STP is currently directed to a recycled water storage pond within the STP boundary. From here it is pumped to the beneficial re-use irrigation areas or discharged to the ocean outfall pipeline or exfiltration ponds located behind the foredune at Main Beach, Merimbula.

Recycled water from the STP is used to irrigate:

- Pambula Merimbula Golf Club (PMGC) golf course (approximately 1.5 hectares (ha) of greens and 20 ha of fairways); and
- Oaklands Farm (approximately 40 ha of pastures for cattle feed).

Pambula Merimbula Golf Club

The PMGC is reliant on recycled water stored in the recycled water storage pond at Merimbula STP, with over half of the stored water reserved for the PMGC.

The PMGC pumps water from the recycled water storage pond to the golf course for irrigation. Irrigation of the PMGC golf course is programmed for between 6 pm and 4 am, with daily settings based on weather, season and the timing of high levels of golf course usage. The irrigation is programmed so that each surface receives one deep watering per week.

The PMGC is responsible for the management of the recycled water irrigation on the golf course, in accordance with the RWMS and Recycled Water Supply Agreement.

Oaklands Farm

The remaining water in the recycled water storage pond at Merimbula STP is available for pumping to Oaklands, as well as also being available for access by the PMGC.

Oaklands has a dedicated recycled water storage pond located in the north western corner of the farm. For most of the year, when the PMGC demand is low, surplus recycled water is available to be pumped to the pond at Oaklands, if it is below full capacity.

Pod systems are then used to irrigate a paddock on the northern side of the Pambula River and on the south-western part of the property on the opposite side of the river.

The property manager at Oaklands is responsible for management of recycled water irrigation at Oaklands, in accordance with the RWMS and the Recycled Water Supply Agreement.

17.2.2 Sensitive receptors

The Project area is surrounded by dunal areas, vegetated public spaces, Merimbula Beach and Merimbula Lake on the northern boundary. Merimbula Airport is located further afield to the north of the Project area. A residential area is located approximately 1.5 kilometre (km) to the south west of the Project area. In closer proximity, scattered rural residences can be found to the south east of the Project area, and Pambula Hospital and aged care facility are located to the south west. Surrounding sensitive receptors and their approximate distance from the Project area are shown in **Table 17-2**.

Table 17-2 List of surrounding sensitive receptors

Type	Approximate distance from Project area (m)/Direction
Merimbula Beach	200 m east
Pambula Hospital	1300 m south-west
Aged Care Facility	1300 m south-west
Rural Residential	170 m south-east
Rural Residential	230 m south-east
Rural Residential	350 m south-east

17.3 Stage 1 – Issue identification

The ongoing use of the existing Merimbula STP and beach-face outfall does not meet community expectations and presents unacceptable risks to public health, the environment and the regional economy.

Previously, the NSW Environment Protection Authority (NSW EPA) updated the conditions of the EPL for the Merimbula STP requiring BVSC to obtain the necessary approvals to construct and commission an ocean outfall pipeline for the disposal of treated wastewater from the plant.

Key stakeholders identified for the HHRA include:

- BVSC;
- NSW EPA;

- recreational users of Merimbula Beach;
- recreational users and landscape workers at the PMGC; and
- agricultural workers at the Oaklands Farm.

The overall objective of the HHRA in **Appendix J** is to undertake a qualitative assessment, based on the available data, of potential risks to the health of current and future receptors (namely recreational users, landscape workers and agricultural workers) associated with the presence of residual impacts identified in treated wastewater used for irrigation purposes.

While risk management is a separate process to risk assessment, the outcomes of the HHRA are relevant to subsequent risk management decisions.

17.4 Stage 2 – Data collection

17.4.1 Water quality monitoring

Water quality monitoring conducted off the coast of Merimbula relating to the operation of the beach-face outfall was provided by BVSC for the Project. Historical monitoring data from NSW EPA monitoring point 4 (EPL 1741) relating to the beach-face outfall was also used.

17.4.2 Tier 1 human health risk assessment

The Tier 1 HHRA provided an initial screening of available wastewater quality data, associated with pre-upgrade conditions, with relevant guidelines to determine whether further quantitative risk assessment was required.

CoPC identified, included:

- chemical stressors – ammonia;
- microbiological – faecal coliforms, E.coli and enterococci; and
- metals – iron and copper.

As post-upgrade treated wastewater quality data is unavailable, no Tier 1 screening assessment was undertaken for post-upgrade conditions. However, it is noted that the post-upgrade design discharge limits are expected to achieve the following:

- reduction in the total phosphorus for re-use wastewater;
- reduction of virus, bacteria and pathogens at the discharge point for re-use wastewater;
- potential to minimise impact of aluminium in final wastewater; and
- reduced load on downstream disinfection processes.

Hydrodynamic modelling of the study area (AECOM, 2019b) demonstrated that discharge of treated wastewater at the ocean outfall pipeline location, situated 2.7 km offshore in 30 metres (m) depth provides significant improvement in dispersion over the existing beach-face outfall (refer **Section 17.8** also).

17.4.3 Conceptual Site Model

A Conceptual Site Model (CSM)was prepared as part of the HHRA, identifying sources, receptors and potential pathways associated with CoPC.

Sources

Potential sources of contamination associated with the STP are discussed in **Section 17.6** and also in **Chapter 16 Hazards and risk.**

Receptors

Potential receptors identified, include:

- recreational users of the Merimbula Beach/Bay who may directly or indirectly contact treated wastewater;

- recreational and commercial fishermen (and customers) who may consume potentially contaminated aquatic biota;
- recreational users of the PMCG golf course who may directly or indirectly contact treated wastewater;
- landscape workers at the PMGC golf course involved in irrigation activities who may directly or indirectly contact treated wastewater; and
- agricultural workers of the Oaklands Farm who may directly or indirectly contact treated wastewater during irrigation activities.

Potential human exposure pathways

Potential pathways associated with exposure to treated wastewater are listed in **Table 17-3.**

Table 17-3 Potential human exposure pathways

Exposure Pathway[9]	Recreational users of the PMGC golf course	Landscape workers at the PMGC golf course	Agricultural workers at the Oakland agricultural area	Recreational users of the beach	Recreational/ commercial fishers (and seafood consumers)
Treated Wastewater					
Incidental ingestion of treated wastewater	✓	✓	✓	✓	X
Dermal contact with treated wastewater	✓	✓	✓	✓	X
Ingestion of potentially contaminate aquatic biota	X	X	X	X	X[(a)]

Table Notes:
✓ = potentially complete pathway
X = incomplete pathway
(a) = Not considered a potentially complete pathway. Potential operational related impacts and risk level to marine ecological receptors was assessed to be low or minimal (refer to ***Chapter 11 Marine ecology****).*

It is noted that with regard to ingestion of potential contaminated aquatic biota, the marine ecology Assessment in **Appendix G** (Marine Ecology Technical report) found an ocean outfall pipeline would result in improved dispersion of wastewater and would reduce the risk of entrapment in the surf zone and a reduction in the risk of nutrients associated with the wastewater entering the Merimbula or Pambula estuaries. Dispersion modelling predicted that a 5 m - 25 m diameter mixing zone would result in the required dilution factor of 100 to achieve all metal default guidance values (DGVs). The nearest rocky reef habitats for reef fish, abalone and other shellfish are located at least 1400 m away (Hunter Reef), fish aggregation artificial habitat at 1000 m distance (Merimbula OAR) and oyster aquaculture 2700 m to - 3000 m away (Merimbula and Pambula Lakes). The small mixing zone required for metal attenuation and the relatively large distances to these habitats indicates that the risk of bioaccumulative metals to fish, abalone and other shellfish is low and that the water quality objective of “bioaccumulation of contaminants – no change from natural conditions” would not be precluded by the Project.

[9] An exposure pathway is a mechanism by which an individual or group of individuals (receptors) may be exposed to the CoPC through mechanisms such as direct contact (incidental ingestion and dermal contact) and inhalation.

17.5 Stage 3 – Exposure assessment

The exposure assessment presented in the HHRA (refer to **Appendix J** (Human Health Risk Assessment) provides a qualitative estimate of exposure and intake of CoPC.

It is considered that the STP post-upgrade exposure parameters would remain generally unchanged for the recreational users of the PMGC golf course, and the landscape and agricultural workers. Moving the outfall from a beach-face outfall to an ocean outfall located approximately 2.7 km off-shore would increase dispersion and reduce the risk of entrapment in the surf zone. As such the potential exposure of treated wastewater to beach users or recreational users of Merimbula Bay is expected to be significantly reduced post-upgrade.

17.6 Stage 4 – Hazard assessment

The hazard assessment included a review of existing toxicological information from a variety of appropriate sources to describe the capacity of a specific agent to produce adverse health effects. A qualitative description of the following CoPC, which were assessed as part of the HHRA, is provided in **Appendix J**:

- ammonia;
- microbiological organism;
- iron; and
- copper.

17.7 Stage 5 – Risk characterisation

An overall risk ranking for each of the hazards was qualitatively selected after review of all the relevant data obtained. The full methodology and risk ranking process is provided in detail in **Appendix J,** HHRA. A summary of the overall risk ranking for each of the hazards is provided in **Table 17-4**.

Based on the approach recommended in NHMRC (2006) the following was conducted:

- identification of all potential health and environmental hazards for each of the CoPCs;
- identification of the hazardous events that may lead to the presence of the identified hazards; and
- assessing the level of risk based on the likelihood of these hazards causing harm and the severity of the consequences in exposed populations or receiving environments.

Risks were assessed at two levels in accordance with the NHMRC (2006), being:

- maximum risk (pre-upgrade scenario); and
- residual risk after consideration of post-upgrade preventative measures (post-upgrade scenario).

Table 17-4 Hazard identification and Risk Assessment for the use of treated wastewater

Hazard	Hazardous event	Maximum risk pre upgrade scenario	Residual risk post upgrade scenario
Ammonia, iron, copper, faecal coliforms, E.coli and enterococci	• irrigation with recycled water, spray drift beyond irrigation area, dermal contact and incidental ingestion by humans in adjoining properties or public access areas; or • spray drift and/or surface runoff reaching water courses, then incidental ingestion by humans during primary or secondary contact recreation.	Medium	Low

Hazard	Hazardous event	Maximum risk pre upgrade scenario	Residual risk post upgrade scenario
Ammonia, iron, copper, faecal coliforms, E.coli and enterococci	• STP process failure due to power outage, equipment failure, operator error, toxic shock loading; • recycled water leaving the outfall with levels of CoPC above the EPL, then ingestion of pathogens by recreational users of the beach during primary; or secondary contact recreation; or human infection; or ingestion of contaminated aquatic biota by recreational/commercial fisherman.	High	Low

17.8 Potential impacts – operation

The proposed STP upgrades are expected to result in improved wastewater quality, including:

- reduction in the total phosphorus for re-use water;
- reduction of virus, bacteria and pathogens at the discharge point for re-use water;
- potential to minimise impact of aluminium in final wastewater; and
- reduction of load on downstream disinfection processes.

Discharge of treated wastewater at the ocean outfall pipeline would provide substantial improvement in dispersion compared with the existing beach-face outfall. Based on the information available, it is considered that the possibility of direct contact with treated wastewater by recreational users of the beach is low. Further, it is assumed that biological hazards would be treated to comply with the EPL criteria and therefore would not present an unacceptable risk following discharge.

The Project is expected to result in improved wastewater quality, therefore the overall risk of impact to water quality is considered low. Based on the available information, it is considered that the human health risk associated with re-use of treated wastewater would be lower in post-upgrade conditions when compared with current (pre-upgrade) conditions.

More generally, the removal of the beach-face outfall discharge and the anticipated improvement in water quality would result in a number of benefits to the community within the study area by improving fishing and aquaculture conditions. The recreational and amenity benefits associated with improved water quality would also indirectly benefit the tourism sector as there would be a reduced potential for recreational beach users to come into contact with wastewater discharge.

17.9 Management of impacts

The mitigation and management measures identified to help avoid and minimise the identified human health impacts of the Project are outlined in **Table 17-5** and would be included in the relevant STP Aspect / Impact, Hazard / Risk Register, Standard Operating Procedures, and Emergency Response Plan which would be established for the operation of the Project.

17.9.1 Performance outcomes

The human health performance outcome for the Project is as follows:

- improvement to water quality during operation of the Project (including at Merimbula Beach, in Merimbula Bay, and at beneficial re-use sites) which would subsequently decrease human health risks.

The Project would be designed, constructed and operated to achieve this performance outcome.

17.9.2 Consideration of interaction between measures

Mitigation and management measures in other chapters that are relevant to the management of potential human health impacts include:

- **Chapter 16 Hazards and risk**, specifically measure HR8 to address preventative maintenance programs; and
- **Chapter 22 Air quality** specifically measures AQ8 to address potential odour impacts.

17.9.3 Mitigation and management measures

Preventative routine and incident mitigation and management measures for the hazardous events identified in **Table 17-4** are provided below in **Table 17-5**.

Table 17-5 Mitigation and management measures – human health risk assessment

Ref #	Potential impact	Mitigation and management measures	Timing
HH1	Human health impacts from irrigated wastewater	Irrigation routine management: • maintain buffer distances between irrigation areas and water courses of 40 m – 50 m; and • observe and track current and imminent weather conditions (wind) for pre-warning of cessation or commencement of irrigation.	Operation
HH2	Human health impacts from irrigated wastewater	Irrigation incident response: • cease irrigation if surface runoff is observed; • cease irrigation during strong winds that result in spray drift outside irrigation areas; and • if a human infection or public health incident occurs and a link with recycled water irrigation is suspected, assist with investigations and provide all required information to NSW Health and other relevant organisations.	Operation
HH3	Human health impacts at the STP site from proposed upgrades	Operations routine management: • schedule operation and maintenance of STP system components in accordance with a relevant STP Site Operations and Maintenance Plan, Job Safety and Environmental Analysis forms and Standard Operating Procedures; • implement routine mitigation and management measures in accordance with relevant STP Aspect/Impact and Hazard/Risk Register; • undertake routine STP operational monitoring and inspections; and • properly maintain generators and backup equipment on-site.	Operation

Ref #	Potential impact	Mitigation and management measures	Timing
HH4	Human health impacts at the STP site from proposed upgrades	Operations incident response: • implement incident mitigation and management measures in accordance with the relevant STP Aspect/Impact and Hazard/Risk Register, Standard Operating Procedures and Emergency Response Plan; • where/if incident response to STP process failure is not documented, key response measures to include: - seek to eliminate and mitigate against further environmental harm; - investigate cause of STP process failure; - seek advice from STP Process Engineers about restoring process control; - notify and discuss with BVSC Operations Superintendent, Water and Sewerage Services; - restart/restore STP process control; - reseed bioreactor tanks from another STP (if necessary, e.g., due to biomass depletion/kill); - advise EPA of STP process failure and seek advice; - notify public if recycled water disposal is likely to pose an elevated public health risk, or STP odours are likely to be objectionable and persistent; and • undertake regular monitoring in the aeration tanks and recycled water storage.	Operation

17.9.4 Environmental risk analysis

As outlined in **Chapter 7 Environmental scoping assessment**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for human health and is provided in **Table 10-8**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental mitigation and management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the impact after the proposed mitigation and management measures have been implemented.

Table 17-6 Environmental risk analysis with mitigation – human health risk assessment

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Human health impacts from irrigated wastewater	Operation	HH1, HH2	Minor	Unlikely	Low

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Human health impacts at the STP site from proposed upgrades	Operation	HH3, HH4	Minor	Unlikely	Low

18.0 Traffic and transport

This chapter provides a summary of the traffic and transport impacts associated with the Project. A detailed traffic and transport report has been prepared for the Project and is included in **Appendix K** (Traffic and Transport Technical report). **Table 18-1** sets out the requirements as provided in the SEARs relevant to traffic and transport and identifies where the requirements have been addressed in this EIS.

Table 18-1 SEARs – Traffic and transport

Ref	Assessment requirements	Where addressed in this EIS
10.1 (a)	The Proponent must assess construction transport and traffic (vehicle, pedestrian and cyclists), including: impacts, including, but not necessarily limited to: a considered approach to route identification and scheduling of transport movements;	Traffic management measures, haulage routes and construction traffic and access are discussed in **Section 18.3.1**
(b)	the number, frequency and size of construction related vehicles (passenger, commercial and heavy vehicles, including spoil management movements);	Details of construction-related vehicles are presented in **Section 18.3.1**
(c)	construction vehicle access arrangements to Merimbula Beach;	Construction access arrangements to Merimbula Beach are outlined in **Section 18.3.1**
(d)	construction worker parking;	Construction parking arrangements are discussed in **Section 18.3.2**
(e)	the nature of existing traffic (types and number of movements) on construction access routes (including consideration of peak traffic times and sensitive road users and parking arrangements);	The existing network performance is presented in **Section 18.2.4**
(f)	access constraints and impacts on public transport, pedestrians and cyclists; and	Construction impacts on public transport, pedestrians and cyclists are presented in **Section 18.3.3** and **18.3.4**
(g)	the need to close, divert or otherwise reconfigure elements of the road and cycle network associated with construction of the project.	Construction impacts on the road network and cycle network are presented in **Section 18.3.1** and **18.3.4**

18.1 Assessment approach

18.1.1 Overview

The Traffic and transport Technical report was undertaken to identify impacts on existing traffic and transport conditions and traffic and transport generation during construction and operation of the Project. The methodology for this assessment included:

- an overview of the existing environment in and around the Merimbula STP, haulage routes and Pambula Beach access location, including desktop assessment of the Project area and its surrounds based on available aerial photography and other geographic information system (GIS) mapping information;
- mid-block and intersection modelling for current conditions at key intersections surrounding the Project during the AM and PM peak;
- an assessment of the likely impacts on road users including general traffic, pedestrians, cyclists, public transport, parking and access at or around the Project area during construction and operation; and

- recommendations for mitigation and management measures to alleviate the identified traffic and transport impacts associated with the construction and operation of the Project.

The global COVID-19 pandemic led to public health officials recommending and enforcing social distancing as a method to minimise the risk of exposure to and potential spread of the virus. Due to the social distancing measures being practiced by the general population, the traffic volumes recorded on the road network around the Project area during preparation of the Traffic and Transport Technical report were not representative of normal conditions. As such, adjustments to the surveyed traffic volumes were made. These are discussed in **Section 18.1.3** and **18.1.4**

18.1.2 Study area

The study area for the traffic and transport assessment is a broad area encompassing the road network and land uses in its vicinity which may be impacted by the transport and access requirements of the Project. This includes:

- surrounding the Merimbula STP, in particular Arthur Kaine Drive;
- at Pambula Beach, particularly along Coraki Drive; and
- near Port of Eden, particularly along Imlay Street.

The study area consists of local roads, arterial roads and one primary road servicing the area around the Project area, as described in further detail in **Section 18.2.2**. The study area is outlined in **Figure 18-1**.

FIGURE 18-1: STUDY AREA - TRAFFIC AND TRANSPORT

N 0 2 4 km

AECOM

Legend

- Project area
- Project area (temporary construction area)
- Motorways and Primary roads
- Arterial, Sub-Arterial and Distributor roads
- Local Roads

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

18.1.3 Mid-block performance modelling

Traffic operational performance modelling was undertaken at a mid-block evaluating the capacity in traffic volumes or to travel routes. Mid-block counts were undertaken on Arthur Kaine Drive near the Project to assess the current capacity of sections of the road network. This was analysed using a Level of Service (LoS), indicating the road capacity performance through urban roads with interrupted facilities and the volume to capacity ratios (VCR). LoS capacities ranging from A to C, indicate free flowing to stable operations; D and E present substantial to significant increased delay in operations; and F is characteristic of extremely low speed operations.

To accommodate the effects of the COVID-19 pandemic, scaling factors were calculated and applied to the surveyed volumes to provide more realistic and representative traffic volumes. This was achieved by collecting traffic counts on Arthur Kaine Drive on the same dates as the intersection counts were undertaken in July 2020. A comparison with traffic counts provided by BVSC for one week in February 2020 determined an increase of 4% and 10% during the morning and evening peak traffic periods would be necessary to more accurately represent traffic conditions under pre COVID-19 conditions. No increase in traffic volumes is assumed during the weekend peak periods (as the July 2020 midblock counts were greater than those collected during February 2020).

Typically, traffic volumes in and around Merimbula are higher in the summer months than the winter months due to the influx of tourists. However, during February 2020 (typically the shoulder of the tourist season), traffic volumes were recorded as lower than that of previous years. This reduction in traffic during this month is likely due to the ongoing impacts of the summer 2019 / 2020 bushfires , continuing to affect tourism in the region. However, the assessment was considered to be more representative of ‘standard’ traffic volumes and patterns (outside of peak tourist season), and therefore more characteristic of when most of the construction work would be undertaken. Furthermore, the assessment undertaken indicates that there is sufficient capacity on the road network to accommodate additional traffic volumes within the study area. As such, the scaling factor adjustments are considered sufficient.

18.1.4 Intersection performance modelling

Traffic intersection count surveys were undertaken to establish existing conditions in traffic volumes at key intersections as follows:

- Toallo Street/Princes Highway;
- Coraki Drive/Pambula Beach Road/Culgoa Crescent; and
- Imlay Street/Mitchell Street.

Traffic count surveys were undertaken during the morning peak period (7:00 am to 9:00 am) and afternoon peak period (3:00 pm to 5:00 pm) on Friday 3 July 2020 and during the weekend peak period (10:00 am to 2:00 pm) on Saturday 4 July 2020. These counts were then multiplied by the scaling factor to adjust for the impacts of COVID-19 and obtained scaled volumes that are more realistic and representative of traffic volumes in the area outside of impacts from the COVID-19 pandemic.

Intersection performance of the current intersection conditions has been evaluated using SIDRA Intersection, a computer-based modelling package designed for calculating isolated intersection performance. The main performance indicators used in SIDRA include the average delay that vehicles encounter and provides a measure of the LoS. Detailed outputs of the SIDRA Intersection modelling results are provided in **Appendix K** (Traffic and Transport Technical report).

18.2 Existing environment

18.2.1 Regional context

The town of Merimbula is located within the Bega Valley Shire local government area, around 450 kilometres (km) south of the Sydney CBD and 370 km south of Wollongong. Merimbula is bounded by Tura to the north and Pambula to the south. The Port of Eden is located around 27 km to the south.

18.2.2 Road network

Key roads surrounding the Project include Arthur Kaine Drive, Pambula Beach Road, Toallo Street, Princes Highway, Coraki Drive and Imlay Street, as shown on **Figure 18-2**.

Arthur Kaine Drive

Arthur Kaine Drive is an arterial regional road running in a north-south direction and providing direct access to the STP. In close proximity to the Project, the road has one lane in each direction. Arthur Kaine Drive also provides direct access to Merimbula Airport to the north, and links Merimbula in the north to Pambula in the south. The speed limit is 70 kilometres per hour (km/hr), and kerbside parking is not permitted on either side of the road.

Toallo Street

Toallo Street is a regional road running off Arthur Kaine Drive in an east-west direction and intersecting with the Princes Highway to the west. The road provides one traffic lane in each direction. The speed limit is 50 km/hr. Kerbside parking with a two hour (2P) parking restriction (8:30 am to 6:00 pm Monday to Friday and 8:30 am to 12:30 pm on Saturday) is provided on both sides of the road, for 190 metres (m) between the Princes Highway and Merimbula Street.

Princes Highway

Princes Highway is a State road running in the north-south direction west of the Project, intersecting with Toallo Street. The road generally provides one traffic lane in each direction and an additional parking lane in each direction in close proximity to Toallo Street. The speed limit near the Project is 50 km/hr.

Coraki Drive

Coraki Drive is a local road running in an east-west direction and connecting to Pambula Beach Road in the west and Pambula Beach in the east, terminating in a car park. The road provides one traffic lane in each direction and would serve as a construction access route for the Project at Pambula Beach. The posted speed limit is 50 km/hr near Pambula Beach.

Imlay Street

Imlay Street is a local connector road in Eden running in a north-south direction. It connects to Princes Highway in the north and runs through Eden town centre, providing direct access to Port of Eden in the south. South of Princes Highway, the road generally provides one traffic lane in each direction and an additional parking lane in each direction. The road has a posted speed limit of 50 km/hr.

FIGURE 18-2: PROJECT AREA AND SURROUNDING ROAD NETWORK

N 0 500 1,000 m

AECOM

Legend

- Project area
- Project area (temporary construction area)
- Motorways and Primary roads
- Arterial, Sub-Arterial and Distributor roads
- Local roads

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

18.2.3 Surrounding traffic and transport environment

Table 18-2 provides a summary of the traffic and transport environment in the area around the Merimbula STP.

Table 18-2 Traffic and transport facilities around the Merimbula STP

Surrounding facilities	Description
Car parking	• 14 car parking spaces are currently provided within the existing STP for workers and visitors.
Coach services	Three coach services operate in the area including: • route 771: Eden to Canberra Civic via Merimbula, stopping in Merimbula town centre along Merimbula Drive, approximately 3.6 km from the Merimbula STP, as the crow flies; • route 700-1: Eden to Bomaderry via Merimbula, stopping in Merimbula town centre at Park Street, approximately 3.6 km from the Merimbula STP, as the crow flies; and • V-Line: Batemans Bay to Melbourne via Mallacoota and Genoa in Victoria, stopping in Merimbula town centre at Park Street, approximately 3.6 km from the Merimbula STP, as the crow flies. These services travel along Arthur Kaine Drive, past the Merimbula STP.
Regional and local bus services	Sapphire Coast Buslines operates regular bus routes in the area including: • route 790/890: Bega to Eden via Wolumla and Merimbula; • route 790/890: Bega to Eden via Kalaru and Tura Beach; and • route 790/890: Merimbula to Pambula Beach via Pambula (Loop Service). The frequency of public bus services in Merimbula is limited to 1 to 3 services per day. The closest bus stops to the Merimbula STP are located: • at the Pambula Merimbula Golf Club, located approximately 850 m south of the Project area; and • at Merimbula airport, located approximately 1.2 km north. The closest bus stop to the Port of Eden access is: • Eden Wharf, located approximately 50 m north-west on Imlay Street. The closest bus stop to the Pambula Beach access is: • Pambula Beach Bus Shelter, located approximately 300 m west along Pambula Beach Rd.
On demand bus services	One on demand bus service, Flexibus, runs three services including: • Bega service; • Tura Beach/Merimbula/Pambula service; and • Eden service. In Merimbula, the service operates between 9:30 am to 2:45 pm Monday to Friday, 9:30 am to 3:35 pm on Saturday with no services on Sunday or Public holidays. The Tura Beach/Merimbula/Pambula service includes bus routes along key roads for the Project including Arthur Kaine Drive, the Princes Highway and Pambula Beach Road. The Eden service includes bus routes along key roads for the haulage routes including Princes Highway and Imlay Street.

Surrounding facilities	Description
Cycling routes and facilities	On-road and off-road cycle routes in the area include: • the Bike Way – off-road shared path that traverses through Merimbula, providing links between Merimbula Airport, Merimbula Beach and Merimbula town centre; • the cycleway – located along Arthur Kaine Drive providing links to Pambula town centre in the south, to south Pambula and Pambula Beach, and links to the Bega Valley Cycleway in Merimbula in the north; and • Lake Street shared path – located adjacent to Lake Street in Merimbula, from Rotary Park to Merimbula Wharf via Bar Beach.
Pedestrian	Pedestrian access is provided via off-road shared paths, located to the west of Arthur Kaine Drive, linking to Merimbula town centre in the north and Pambula town centre in the south. Pambula Beach (near the Project area), and Eden Town Centre and Eden Wharf (south of the Project area) are high activity pedestrian areas, especially during summer.

18.2.4 Existing traffic conditions and road network performance

Mid-block analysis

Table 18-3 shows the mid-block traffic flows at each location alongside the estimated road capacity. The February 2020 scaled traffic volumes were used for this assessment representing the shoulder of the tourist season (refer to **Section 18.1.3**). While the peak holiday period may experience elevated traffic volumes, the majority of construction work would be undertaken outside of these periods.

Mid-block assessment of the traffic volumes presented in **Table 18-3** indicates there is currently spare capacity along the Arthur Kaine Drive in the vicinity of the Project during typical weekday peak hours.

Table 18-3 Mid-block analysis

Location	Direction	Theoretical capacity (pcu/h)*	AM Peak		PM Peak	
			Volume (pcu/h)	LoS	Volume (pcu/h)	LoS
Arthur Kaine Drive near the Project	North bound	900	358	B	616	C
	South bound	900	588	C	505	C

**pcu - passenger car unit*

Existing intersection performance

Analysis of the traffic survey data indicates that the morning peak hour occurs between 8:00 am and 9:00 am while the afternoon peak hour is between 3:00 pm and 4:00 pm. The weekend peak hour occurs between 11:00 am and 12:00 pm.

Table 18-4 presents a summary of the existing operation of local intersections using recorded traffic volumes scaled to compensate for the effects of the COVID-19 pandemic. **Table 18-4** indicates that all intersections analysed currently operate well at LoS A representing unimpeded and free traffic flow during all peak periods, with spare capacity.

Table 18-4 Existing intersection performance

Intersection	Degree of Saturation (DOS)	Average Delay (sec)	95^{th} Percentile Queue (m)	LoS
AM Peak				
Toallo Street/Princes Highway	0.26	6	9	A
Coraki Drive/Pambula Beach Road/Culgoa Crescent	0.04	2	1	A
Imlay Street/Mitchell Street	0.25	5	10	A
PM Peak				
Toallo Street/Princes Highway	0.46	7	19	A
Coraki Drive/Pambula Beach Road/Culgoa Crescent	0.07	2	1	A
Imlay Street/Mitchell Street	0.38	6	19	A
Weekend Peak				
Toallo Street/Princes Highway	0.33	6	11	A
Coraki Drive/Pambula Beach Road/Culgoa Crescent	0.07	2	1	A
Imlay Street/Mitchell Street	0.29	6	13	A

Note: For traffic signals, the average movement delay and LoS over all movements is taken. For roundabouts and priority control signals intersection (with stop and give way signs) the critical movement for level of service assessment with the worst movement delay is taken.

18.3 Potential impacts – construction

Potential impacts from construction of the Project to traffic and transport are described below. Identified impacts would be experienced at various times during the construction phase, as works progress and depending on the activity being undertaken. The indicative construction program and working hours are described in **Chapter 2 Project description**.

18.3.1 Traffic

The Project would generate only a marginal number of additional traffic movements (up to 20 light vehicles and up to 10 heavy vehicles per day) during peak construction. The frequency of these vehicle movements would be as required and would depend on the construction stage and activity being undertaken, with most of these movements anticipated from worker transport, delivery of equipment/materials during construction, concreting activities and also for removal of spoil/waste.

Heavy vehicles would generally follow established heavy vehicle routes to access the Project area and only use local roads where required to complete the trip. Access/haulage routes to the Project area include Arthur Kaine Drive, Princes Highway and Imlay street. Coraki Drive (via Pambula Beach Road and Bullara Street) would be used to access the Pambula Beach access for construction of the ocean outfall pipeline. Arthur Kaine Drive near the STP, Coraki Drive (at Pambula Beach), and Imlay Street (at the Port of Eden) are not approved for use by heavy vehicles such as B-doubles and similar. As such, the use of these roads for large construction vehicles would require approval by relevant authorities prior to the start of construction.

The local roads that would be used to access the Pambula Beach access generally have lower operating capacity, but also lower background traffic volumes. The impacts to travel time for drivers accessing Pambula beach and the surrounding area are not expected to be significant as these roads generally provide local access rather than a key through route for general traffic.

Traffic modelling completed for the current conditions indicate the area surrounding the STP performs well during peak periods. An increase in vehicle movement from the Project (up to 20 light vehicles and up to 10 heavy vehicles per day) is likely to be low. Intersection modelling based on hourly traffic volumes shows there is likely to only be a negligible impact, considering the forecast daily volumes generated by the Project. In the worst-case scenario of all the vehicles arriving in a single peak hour, the traffic volumes are still considered low. Therefore, it is expected that the additional traffic volumes would result in minimal impacts on existing traffic conditions.

The size of vehicles used for haulage would be consistent with the access route constraints, safety and any worksite constraints. The largest truck requiring access to the Project area would be the directional drilling rig truck, with the next largest being truck and dogs for delivery of materials, loading/unloading of spoil and waste removal. Concrete trucks would also be required. While the proposed access from Princes Highway onto Toallo Street via the roundabout is expected to be adequate for truck and dogs, depending on the size of the rig truck, upgrades to the roundabout at Princes Highway and Toalla Street may be required, or otherwise an alternative access route may be required. Access arrangements, including testing access routes, setting in place driver protocols to be observed and investigating whether infrastructure upgrades are required, would be defined in the Construction Traffic Management Plan (CTMP) prepared for the Project during subsequent design stages. An application would need to be made to the National Heavy Vehicle Regulator (NHVR) for an access permit during subsequent design stages prior to the commencement of the construction works.

No temporary diversions have been identified to accommodate the construction of the Project. Traffic control plans (TCP) would be prepared as part of the CTMP, which would also present the traffic mitigation and management measures applicable for the Project. The CTMP would provide details of construction vehicle activity, accredited site personnel, traffic, pedestrian and cyclist management and any required signage.

18.3.2 Parking

The Project would not impact public car parking facilities in the vicinity of the Project during the construction phase. All existing car parking facilities would remain open during the construction of the Project.

At Pambula Beach, construction vehicles would be required to access the construction site via the existing carpark off Coraki Drive. No impacts are anticipated to this car park as a result of the Project.

Construction worker parking would be provided for construction workers within the construction footprint. Construction of the Project would require a workforce of around 20 workers, with peak construction periods requiring up to 30 workers. Construction workers would be encouraged to car-pool during the construction period (e.g. when accessing Merimbula Beach). A small number of construction workers would require access to Port of Eden, with no car parking facilities provided specifically for the Project at this location. However, due to low parking requirements, it is anticipated that construction worker parking can be accommodated within on-street parking available nearby.

As such, additional parking impacts associated with construction worker parking are not anticipated. The CTMP would include provisions to manage construction worker parking.

18.3.3 Public transport

Bus services along Arthur Kaine Drive would continue to operate during construction activities, however they may experience minor impacts, such as delays due to construction vehicle movement towards the Merimbula STP and construction laydown area. There would be no changes to bus stop locations as a result of the Project. However, any unexpected changes to the location of a bus stop would be discussed with the bus operator and other relevant stakeholders and adequately communicated to the public via signage or appropriate methods.

Bus routes operating at Port of Eden along Imlay Street and at Pambula Beach along Coraki Road would not be impacted during construction of the Project given construction activities would be limited to access only at these sites.

18.3.4 Pedestrians and cyclists

During construction, works would be undertaken in a manner that would maintain pedestrian and cyclist routes surrounding the Project area. Impacts to pedestrians and cyclists would therefore be limited, and include the following:

- potential temporary disruptions to the shared path along Arthur Kaine Drive fronting the STP site, due to construction vehicles accessing the STP site. This has the potential for increased risk to the safety of pedestrians and cyclists due to potential interactions with construction plant and vehicles; and

- increased risk to the safety of pedestrians and cyclists around the Project area, from heavy and light construction vehicles.

On-road cycle lanes are provided on Pambula Beach Road. These facilities terminate at Coraki Drive and link Pambula Town Centre to Pambula Beach. Pambula Beach, Eden Town Centre and Eden Wharf are also high activity pedestrian areas, especially during summer. While the Project is not anticipated to impact the operation of existing cycling or walking facilities at Pambula Beach and the Port of Eden, the potential for increased interactions with construction vehicles represents a risk to safety in these areas also.

Appropriate signs and/or traffic controllers would be positioned to notify pedestrians and cyclists of the temporary arrangements during construction. Any interaction between construction vehicles and users of the existing walking and cycling networks would be managed and controlled by traffic controllers. Impacts during construction would be managed through the development and implementation of a CTMP. Wherever possible, the community would be notified in advance of any planned works which may impact pedestrian movements.

Mitigation and management measures would be subject to further consideration during construction planning in consultation with the relevant authorities.

18.3.5 Property access

The Project would not impact access to private properties near the Project during the construction phase. Property access at Port of Eden would also be maintained at all times.

At Pambula Beach, construction vehicles would be traversing the car parking facilities located at the end of Coraki Drive, down a temporary track and onto the beach. It is anticipated that public access to the beach as well as the car park would be maintained.

Access for emergency vehicles would also be maintained within the Project area in accordance with emergency vehicle requirements.

18.4 Potential impacts – operation

18.4.1 Traffic

Operation of the Project is not anticipated to generate significant traffic volumes, and therefore the road network and road users around the Merimbula STP are not expected to be impacted.

18.4.2 Parking

The Project would not impact on the provision of public parking spaces surrounding the Project.

18.4.3 Public transport

The Project would not impact on the operation (service operation or timetabling) of public transport in the vicinity of the Project. The Project includes improved operations of the Merimbula STP, with no forecast increase to workforce numbers. As such, increased bus patronage on the services operating near the Project is not expected.

18.4.4 Pedestrians and cyclists

The Project would retain the existing shared path facilities fronting the STP site on the western side of Arthur Kaine Drive. The Project would not result in changes to the operation of these facilities.

18.4.5 Property access

No changes to private property access would be required as part of the operation of the Project.

18.5 Management of impacts

The approach to managing potential traffic and transport impacts are described below, including mitigation and management measures that would be included in the CTMP prepared for the Project.

18.5.1 Performance outcomes

The traffic and transport performance outcomes for the Project are as follows:

- public access routes are maintained for pedestrians, cyclists and road users, including buses during construction;
- public access is maintained for all road users to Pambula Beach;
- access to residences and commercial properties is maintained;
- construction worker parking for the Project is contained to the STP site and construction laydown areas; and
- no road or cycle diversions or closures are required as a result of the Project.

The Project would be designed, constructed and operated to achieve these performance outcomes.

18.5.2 Consideration of interaction between measures

Mitigation and management measures in other chapters of this EIS were reviewed to identify any that may be relevant to the management of potential traffic and transport impacts. This review did not identify any other mitigation and management measures relevant to traffic and transport.

18.5.3 Mitigation and management measures

Mitigation and management measures to address the potential impacts identified are described in **Table 18-5** below.

Table 18-5 Mitigation and management measures – Traffic and transport

Ref #	Impact	Mitigation and management measure	Timing
T1	Road and pedestrian network changes or disruptions	Ongoing consultation would be carried out with BVSC, Transport for NSW, emergency services, bus operators and other relevant authorities to minimise transport impacts during construction.	Construction
T2	Road and pedestrian network changes or disruptions	Community consultation would be carried out and notifications would be issued in advance for any proposed road and pedestrian network changes or disruptions through appropriate channels and forms of communication.	Construction
T3	Temporary diversion and lane closures of pedestrian and cycle routes	Access to pedestrian routes and cycle paths would be maintained. Where this is not possible, alternative routes would be provided. Appropriate signage would also be provided to guide pedestrians and cyclists past the Project area and on the surrounding network where required.	Construction
T4	Increased risk of collision for pedestrians and cyclists	Vehicle access to and from the Project area would be managed to minimise safety risk to pedestrians, cyclists and motorists. All trucks would enter and exit construction sites within the Project area in a forward direction, where possible. At Pambula Beach, appropriate delineation, and/or traffic control measures would be used to direct and guide pedestrians, cyclists and motorists past the entrance to the Project area during oversized delivery and high usage times. Further arrangements for construction vehicle access at Pambula Beach would be identified in the CTMP during subsequent design stages.	Construction

Ref #	Impact	Mitigation and management measure	Timing
T5	Diversions for vehicles and space restrictions	Access to existing properties and buildings would be maintained, at all times, in consultation with property owners.	Construction
T6	Parking arrangements	The Project area would be managed to minimise construction worker parking on surrounding streets. Workers would be encouraged to carpool. Parking facilities would be provided.	Construction
T7	Traffic congestion	Construction traffic would be managed to minimise traffic impacts during the peak periods through scheduling construction vehicle movements outside the peak hours.	Construction
T8	Construction vehicle route	The proposed access from Princes Highway onto Toallo Street via the roundabout at this location would be tested for access suitability for the construction vehicles expected (including an adequate turning path) and to determine whether infrastructure upgrades are required. Alternative routes would be investigated in the event that upgrade works are required at the roundabout. These alternative haulage routes would be identified and confirmed in consultation with relevant authorities prior to the commencement of construction works. Testing would be carried out as part of the CTMP once plant and equipment and vehicles required to transport them are determined by the contractor.	Construction
T9	Beach Access Route	Public access to the beach as well as the car park (off Coraki Drive) would be maintained.	Construction

18.5.4 Environmental risk analysis

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented. A residual risk analysis was undertaken for traffic and transport and is provided in **Table 10-8**.

The residual risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact.

Table 18-6 Environmental risk analysis with mitigation – Traffic and transport

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Road and pedestrian network changes	Construction	T1, T2	Moderate	Almost certain	Low
Temporary diversion and lane closures of pedestrian and cycle routes	Construction	T3	Moderate	Almost certain	Low

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Increased risk of collision for pedestrians and cyclists	Construction	T4	Major	Low	Low
Diversions for vehicles and space restrictions	Construction	T5	Minor	Almost certain	Low
Parking arrangements	Construction	T6	Moderate	Unlikely	Low
Traffic congestion	Construction	T7	Minor	Almost certain	Low
Construction vehicle route	Construction	T8	Minor	Possible	Medium

19.0 Property and land use

This chapter provides an assessment of the property and land use impacts associated with the Project. **Table 19-1** sets out the Secretary's Environmental Assessment Requirements (SEARs) relevant to property and land use and where these requirements have been addressed in this EIS.

Table 19-1 SEARs – Property and land use

Ref	Assessment requirements	Where addressed in this EIS
5.2	The Proponent must assess impacts from construction and operation on potentially affected properties, businesses, recreational users and land and water users (for example, tourism, recreational and commercial fishers, aquaculture – existing and proposed), including property acquisitions/adjustments, access, amenity and relevant statutory rights.	An assessment of construction and operation impacts on potentially affected properties, businesses, and recreational land and water users regarding property acquisitions/ adjustments is provided in **Section 19.3** and **Section 19.4**. Assessments of construction and operation impacts on potentially affected properties, businesses, and recreational land and water users regarding access and amenity in **Chapter 18 Traffic and transport** and relevant statutory rights are provided

19.1 Assessment approach

The assessment of property and land use impacts involved:

- providing an overview of the existing environment with respect to land use and planning controls in and around the Project area, based on a review of existing land use zoning provisions from the *Bega Valley Local Environmental Plan 2013* (Bega Valley LEP 2013) and aerial imagery;
- assessing the potential impacts of construction and operation on existing land uses and properties in the Project area; and
- identifying appropriate mitigation and management measures to avoid or minimise impacts on land use and property.

19.2 Existing environment

Existing land uses in the vicinity of the Project area include the Pambula Merimbula Golf Club (PMGC) immediately to the south and west of the STP site, Merimbula Airport immediately to the north, Merimbula Beach and Bay immediately to the east, land zoned environmental conservation immediately to the north-east and Ben Boyd National Park around 900 metres (m) to the south of the STP site. There are also several commercial properties from approximately 350 m south of the STP site along Arthur Kaine Drive, including a car/boat wash facility, a building equipment hire business, a motel and a restaurant. The entrance to the PMGC is also located on Arthur Kaine Drive. The Project area is intersected by Arthur Kaine Drive, which is an arterial regional road managed by BVSC. The surrounding land zonings and land uses are shown in **Figure 19-1** and **Figure 19-2**, respectively.

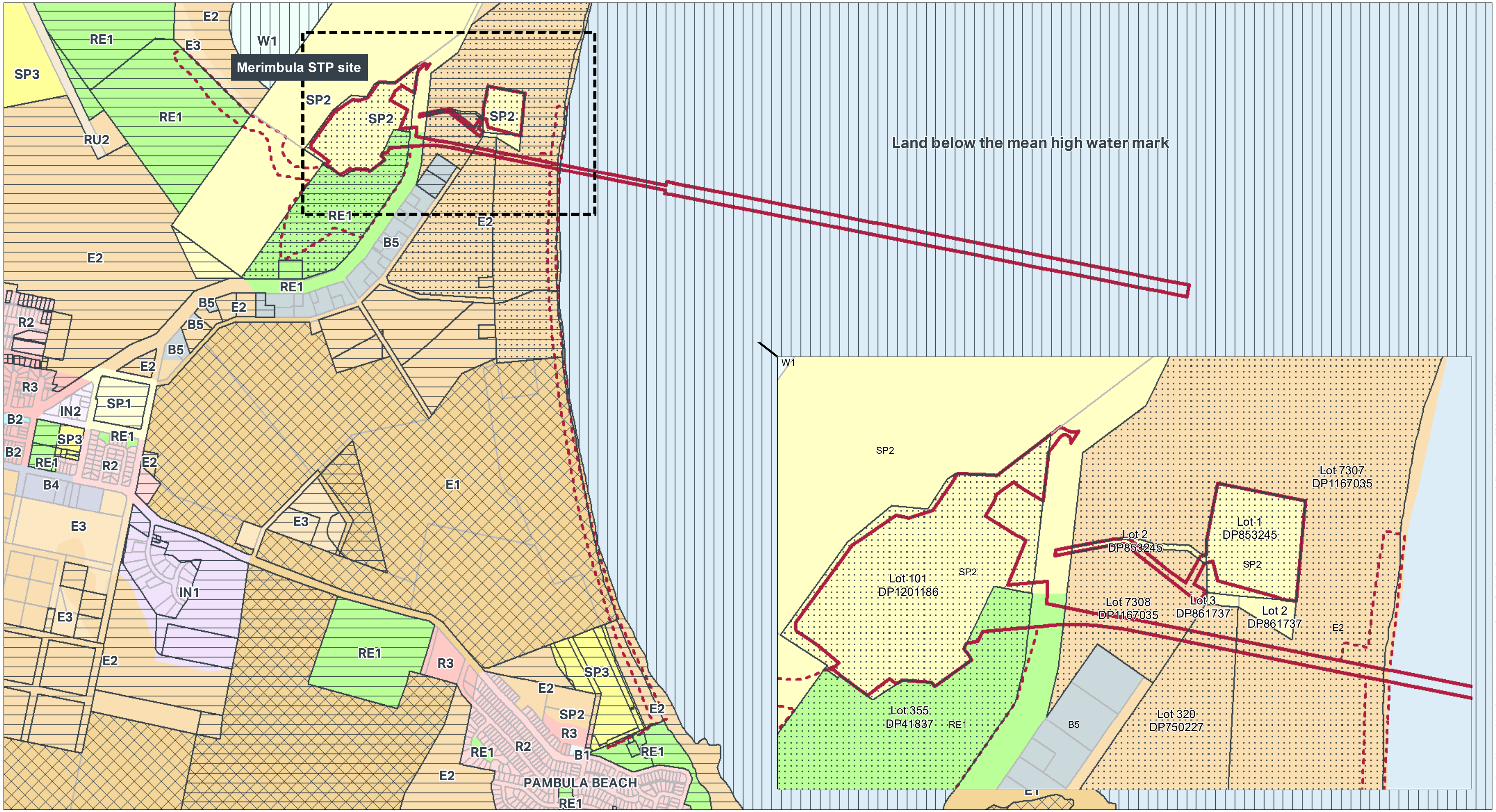


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FIGURE 19-1: LAND USE CATEGORIES

Legend

- Project area
- Project area (temporary construction area)
- Cadastre
- Impacted Lots
- Crown Parcel
- Crown Waterway
- National Parks
- B1 Neighbourhood Centre
- B2 Local Centre
- B4 Mixed Use
- B5 Business Development
- E1 National Parks and Nature Reserves
- E2 Environmental Conservation
- E3 Environmental Management
- IN1 General Industrial
- IN2 Light Industrial
- R2 Low Density Residential
- R3 Medium Density Residential
- RE1 Public Recreation
- RU2 Rural Landscape
- SP1 Special Activities
- SP2 Infrastructure
- SP3 Tourist
- W1 Natural Waterways

N

0 250 500 m

Source: Nearmap, 2019

\\na.aecomnet.com\lfs\APAC\Sydney-AUSYD1\Secure\Projects\605x\60541653 Merimbula Ocean Outfall\4. Tech work area\4.99_GIS\02_Maps_TECH_REPORT\TR001_02_A4P_F19-2_LandUses_210121.mxd Date Saved: 15/04/2021

FIGURE 19-2: STUDY AREA - WATER QUALITY, HYDROLOGY AND FLOODING

Legend

- Project area
- Temporary project area for construction
- Pambula Merimbula Golf Course
- Ben Boyd National Park

Source: Department of Customer Service, 2020; Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

The Project area and construction footprint is located over 14 parcels of land, which are described in **Table 19.2.** Corresponding land zonings under the Bega Valley LEP 2013, as well as land owners and existing land uses are also listed in **Table 19.2**.

As the Project has been declared State Significant Infrastructure (SSI), the Bega Valley LEP 2013 does not apply. This is discussed in more detail in **Chapter 5 Statutory context**. The land use zones under the Bega Valley LEP 2013 within the Project area are:

- E1 National Parks and Nature Reserves;
- E2 Environmental Conservation;
- RE1 Public Recreation; and
- SP2 Infrastructure (Sewerage System).

It is noted that there is an active Aboriginal land claim on lots 7308, 320 and 7307 (refer **Section 5.2** for further information).

Table 19-2 Project area and construction footprint land description

Property details	Zoning	Landowner	Existing land use	Project area/construction footprint component
Lot 101 DP 1201186	SP2	BVSC	Merimbula STP	Merimbula STP upgrade
Lot 355 DP41837	RE1	State of NSW Crown Land (leased to PMGC Ltd)	Golf course at PMGC	Construction access to STP site
Lot 102 DP 1201186	SP2	BVSC	Golf course at PMGC	Construction laydown area
Lot 356 DP 41837	RE1	State of NSW Crown Land (leased to PMGC Ltd)	Golf course at PMGC	Construction laydown area
Lot 1 DP 853245	SP2	BVSC	Dunal exfiltration ponds	Existing exfiltration ponds (including access from Arthur Kaine Drive)
Lot 2 DP 853245	SP2	BVSC	Access to dunal exfiltration ponds	Existing exfiltration ponds (including access from Arthur Kaine Drive)
Lot 7307 DP 1167035	E2	State of NSW Crown Land	Beach east of STP and existing exfiltration ponds (and access to ponds). Includes site of existing beach-face outfall pipeline head structure	Existing exfiltration ponds (including access from Arthur Kaine Drive) and ocean outfall pipeline - section one (below ground)
Lot 7308 DP 1167035	E2	State of NSW Crown Land	Access to dunal exfiltration ponds and vegetated public space	Existing exfiltration ponds (including access from Arthur Kaine Drive), and ocean outfall pipeline - section one (below ground)
Arthur Kaine Drive	RE1/SP2	BVSC (managed under delegation)	Road	Ocean outfall pipeline - section one (below ground) and STP site access
Lot 320 DP 750227	E2	State of NSW Crown Land	Vegetated public space	Ocean outfall pipeline - section one (below ground)

Property details	Zoning	Landowner	Existing land use	Project area/construction footprint component
Lot 7917 DP 1187854	E1	NSW National Parks and Wildlife Service	Jiguma Beach in Ben Boyd National Park	Beach access area for ocean outfall pipeline - section two construction (also includes Lot 7307 DP 1167035 described above)
Lot 7318 DP 1167151	E2	State of NSW Crown Land	Beach east of Discovery Park – Pambula Beach	Beach access area for ocean outfall pipeline - section two construction (also includes Lot 7307 DP 1167035 described above)
Lot 7019 DP 1122193	RE1	State of NSW Crown Land	Beach east of Pambula Surf Life Saving Club	Beach access area for ocean outfall pipeline - section two construction (also includes Lot 7307 DP 1167035 described above)
Land below the mean high water mark	N/A	State of NSW Crown Land	Ocean	Ocean outfall pipeline – section one and section two
Lot 1, Lot 2 DP861737	SP2	BVSC	Vegetated vacant land	These two lots would be located immediately south of the boundary of the existing exfiltration ponds; however, no part of the Project would be permanently located on either Lot 1 or Lot 2 of DP861737
Lot 7307 DP1167035	SP2	State of NSW Crown Land	Vegetated public space and access to existing exfiltration ponds from Arthur Kaine Drive	Beach access and laydown area for ocean outfall pipeline Access to existing exfiltration ponds from Arthur Kaine Drive.

Note: Land uses based on aerial imagery sourced from *Six Maps* (NSW Government, 2020)

19.3 Potential impacts – construction

Most of the construction footprint for the Project would be located within the permanent operational footprint of the Project, therefore minimising the need for property acquisition or temporary lease arrangements.

To enable construction access to the STP site, the Project would temporarily occupy part of a property zoned RE1 Public Recreation (Lot 355 DP 41837) used by the PMGC. BVSC would work with the PMGC to minimise impacts on the activities and operation of the PMGC grounds. BVSC has been engaged in ongoing consultation with PMGC, which is discussed in more detail in **Chapter 6 Consultation**. Generally, the result of this consultation to date indicates that PMGC is supportive of the Project and has requested that only one fairway be utilised during construction to limit the potential for the construction of the Project to impact the operation of the golf course at PMGC. Agreements would be negotiated for the temporary use of this portion of PMGC during construction, and the land would be returned to its original condition following construction or would be otherwise reinstated in consultation with the landowner.

Traffic control may be required at the access to the STP site during construction to allow heavy vehicles to safely enter and exit the site. This may cause temporarily impacts on Arthur Kaine Drive. Impacts to traffic and access is assessed in **Chapter 18 Traffic and transport**.

Construction of the ocean outfall pipeline would take place in two sections. Section one would use an underground trenchless drilling method launching from within the STP property to a location beyond the surf zone in Merimbula Bay. Construction impacts to property and land use would therefore be avoided by the underground trenchless drilling associated with the construction of section one of the ocean outfall pipeline.

Section two of the ocean outfall pipeline would involve laying of pipeline on the sea floor and covering with rock or concrete mattresses from beyond the surf zone to the diffuser location. This section of the ocean outfall pipeline (below the mean high water mark) is located within Crown land. Landowner consent from Crown Land is therefore required and approvals are required under the *Crown Land Management Act 2016* for both construction and operation of the Project (refer **Section 5.2**).

The construction of the ocean outfall pipeline would require access along the beach for construction vehicles via Pambula Beach. There may be temporary and minor disruptions to the Pambula Surf Life Saving Club, given its close proximity to the proposed beach access route. The beach area would also be used for pipe stringing, and short term laydown of materials associated with pipe stringing. It is also noted that the final location/s of the proposed drill rig pad would be confirmed by the drilling contractor during detailed design and in the finalisation of the drilling plan. There is a potential for the drill rig to be established in the temporary laydown area on Merimbula Beach.

The proposed construction access along the beach from Pambula Beach includes access along Jiguma Beach, which is part of the Ben Boyd National Park. BVSC has been involved in ongoing consultation with NPWS to seek approval from NPWS for access along Jiguma Beach during construction of the Project. As discussed in detail in **Chapter 5 Statutory context**, BVSC will have formally secured approval from NPWS prior to undertaking work in Ben Boyd National Park.

The construction footprint and proposed laydown areas are shown in **Figure 2-7** of **Chapter 2 Project description**.

Agreements would be negotiated with relevant landowners for the temporary use of property during construction. The impact on these properties would be temporary and the land would be returned to its original use following construction or otherwise in consultation with the relevant landowner/s. Associated temporary impacts to traffic/access and public amenity are assessed in **Chapter 18 Traffic and transport** and **Chapter 23 Social and economic** respectively.

Cessation of use of the existing exfiltration ponds would not result in construction impacts on existing land uses or properties in this part of the Project area.

19.4 Potential impacts – operation

The Project would not change the existing land use or impact on properties in the Project area during operation, with the exception of the lots currently zoned as infrastructure for access and operation of the dunal exfiltration ponds. The use of the dunal exfiltration ponds is proposed to cease under the Project, and as they would no longer operate, the land may be considered for another use into the future. Rehabilitation and re-purposing of the dunal exfiltration ponds would be subject to a separate project and environmental approval process.

The location of the ocean outfall pipeline would be signposted onshore.

19.5 Management of impacts

The mitigation and management measures identified to help avoid and minimise the identified property and land use impacts of the Project are outlined in **Table 19-3**, and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

19.5.1 Performance outcomes

The performance outcome for the Project in relation to land use and property include:

- maintain access to properties, businesses and community facilities during construction; and
- continue consultation with individual property owners/managers to identify individual concerns and develop and document strategies to address these concerns during construction.

The Project would be designed, constructed and operated to achieve these performance outcomes.

19.5.2 Consideration of interaction between measures

Mitigation and management measures are provided in **Table 19-3**. No mitigation or management measures in other chapters are relevant to the management of potential property and land use impacts.

19.5.3 Mitigation and management measures

Land use and property impact mitigation and management measures are outlined in **Table 19-3**.

Table 19-3 Mitigation and management measures – Property and land use

Ref #	Potential impacts	Mitigation and management measures	Timing
PL1	Use of Crown Land	A permit under *the Crown Land Management Act 2016* would be required prior to construction of the Project to allow occupation of Crown Land during both construction and operation.	Detailed design (i.e. construction and operation)
PL2	Temporary change in land use from construction access on beach	Agreements would be negotiated with relevant landowners for the temporary use of property during construction. Land would aim to be returned to its original condition following construction or otherwise reinstated in consultation with the landowner, and in accordance with any licence conditions.	Detailed design and construction
PL3	Temporary land use change for portion of PMGC grounds	BVSC would work directly with the PMGC to minimise impact on the activities and operation of the PMGC grounds and would limit use of the property to one fairway during construction where practical.	Detailed design and construction

19.5.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for property and land use and is provided in **Table 19-4**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental mitigation and management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Table 19-4 Environmental risk analysis with mitigation – Property and land use

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Use of Crown Land	Construction and operation	PL1	Minor	Almost certain	Low
Temporary change in land use from construction access on beach	Construction	PL2	Minor	Almost certain	Low
Temporary land use change for portion of PMGC grounds	Construction	PL3	Minor	Almost certain	Low

20.0 Noise and vibration (airborne)

This chapter provides a summary of the noise and vibration (airborne) impacts associated with the Project. A detailed Noise and Vibration Technical report has been prepared for the Project and is included in **Appendix L**.

Table 20-1 sets out the requirements as provided in the Secretary's Environmental Assessment Requirements (SEARs) relevant to noise and vibration and where the requirements have been addressed in this EIS.

Table 20-1 SEARs – noise and vibration (airborne)

Ref	Assessment requirements	Where addressed in this EIS
11.1	The Proponent must assess construction and operational noise and vibration impacts in accordance with current NSW noise and vibration guidelines including consideration of noise characteristics (tonal, intermittent and low frequency noise) and the impact on sensitive receivers.	**Section 20.1**, **Section 20.3** and **Section 20.4**
11.2	The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage).	**Section 20.3.5**
11.3	The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines if blasting is required.	No blasting is proposed as part of the Project

20.1 Assessment approach

20.1.1 Approach and methodology

The approach for the noise and vibration assessment was to:

- establish the existing background noise levels in the vicinity of the Project;
- establish construction noise management levels and vibration limits that would apply to the Project;
- predict noise and vibration levels at nearby residential and other sensitive receivers due to the construction of the Project;
- predict environmental noise and vibration levels at nearby residential and other sensitive receivers due to operation of the Project;
- predict noise levels from additional off-site construction traffic generated by the Project; and
- recommend mitigation and management measures, where necessary, to reduce and manage noise and vibration impacts from the Project to comply with established noise management levels and vibration limits.

20.1.2 Study area

The study area for this report comprises the areas within the Project area, the noise catchment areas (NCA) and the surrounding roads. The study area is shown on **Figure 20-1**. The NCAs were determined by reviewing existing land use and identifying groups of noise sensitive receivers which are likely to be exposed to a similar noise environment. The locations of noise monitoring undertaken for the Project are also shown on **Figure 20-1**.

FIGURE 20-1: NOISE CATCHMENT AREA

N 0 300 600 m

Legend

- Project area
- Project area (temporary construction area)
- Noise catchment area (NCA)
- Background noise monitoring location

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

20.1.3 Background noise monitoring

Unattended noise measurements

Unattended noise monitoring was conducted at three representative locations within each NCA as identified in **Figure 20-1** and **Table 20-2**. Noise monitoring affected by adverse weather conditions or extraneous noise events was excluded from the monitoring data.

Table 20-2 Noise monitoring details

Logger	Location
1	232 Arthur Kaine Drive, Merimbula
2	1 Narregol Street, Pambula
3	57 Green Point Road, Millingandi

The loggers measured the noise levels over the sample period and then determined L_{A1}, L_{A10}, L_{A90}, and L_{Aeq} levels of the noise environment. The L_{A1}, L_{A10} and L_{A90} noise levels are the levels exceeded for 1%, 10% and 90% of the measurement period respectively. The L_{A90} is taken as the background level. The L_{A1} is indicative of the maximum noise levels due to individual noise events such as the passing of a heavy vehicle. The L_{Aeq} level is the equivalent continuous sound level and has the same sound energy over the sample period as the actual noise environment with fluctuating sound levels.

The L_{A90} noise levels were analysed to determine a single assessment background level (ABL) for each day, evening and night period in accordance with the *Noise Policy for Industry* for each monitoring location. **Table 20-3** presents the existing overall representative L_{Aeq} ambient noise level and the rating background levels (RBL) L_{A90} noise levels for the day, evening and night-time periods, in accordance with the *Noise Policy for Industry.* The overall representative L_{Aeq} noise levels were determined by logarithmically averaging each assessment period for the entire monitoring period.

Table 20-3 Existing background (L_{A90}) and ambient (L_{Aeq}) noise levels

NCA	L_{A90} RBL, dB(A)			Log average noise (ambient) L_{Aeq} levels dB(A)		
	Day[1]	Evening[1]	Night[1]	Day[1]	Evening[1]	Night[1]
1	49	38	38[2]	58	54	51
2	41	33	30	55	47	46
3	35[3]	30[3]	30[3]	45	40	42

Notes:

1. *Day is defined as 7:00 am to 6:00 pm, Monday to Saturday and 8:00 am to 6:00 pm Sundays and Public Holidays. Evening is defined as 6:00 pm to 10:00 pm, Monday to Sunday and Public Holidays. Night is defined as 10:00 pm to 7:00 am, Monday to Saturday and 10:00 pm to 8:00 am Sundays and Public Holidays.*
2. *Night-time RBL adjusted to the same as the evening RBL in accordance with the Noise Policy for Industry. This is because the community generally expects greater control of noise during the more sensitive night-time periods than during the evening period.*
3. *Set to minimum RBL in accordance with the Noise Policy for Industry.*

Attended noise measurements

Attended noise measurements were conducted at the three unattended monitoring locations in **Table 20-4**. The daytime measurements indicated that residential receivers are affected by existing industrial noise and road traffic noise. Additional assessment of measured sound power levels was undertaken at the existing STP as shown in **Table 20-5**. Each measurement was conducted over a 15 minute period.

Table 20-4 Attended noise measurements

NCA	L_{Aeq} dB(A)	L_{A90} dB(A)
NCA1	58	52
NCA2	53	48
NCA3	44	38

Table 20-5 Summary of L_{Aeq} sound power levels – Existing STP plant

Source	Overall SWL dB(A)
Aerators (x3)	97
Pump 1	79
Pump 2	78
Pump 3	70

20.1.4 Construction noise and vibration criteria

Interim Construction Noise Guideline

The potential risk of adverse impact of construction noise on a receiver is determined by the extent of its emergence above the existing background noise level, the duration of the event and the characteristics of the noise.

The *Interim Construction Noise Guideline* (ICNG) is a NSW Government document that sets out ways to deal with the impacts of construction noise on residences and other sensitive land uses. It presents assessment approaches tailored to the scale of the construction project and identifies practices to minimise noise impacts. As the proposed works are expected to continue for a period of more than three weeks and are within relatively close proximity to noise sensitive receivers, a quantitative assessment, based on 'reasonable' worst case construction scenarios, has been carried out for these works.

Noise levels resulting from construction activities are predicted at nearby noise sensitive receivers (e.g. residences, schools, hospitals, places of worship, passive and active recreation areas) and are compared to the levels provided in the ICNG.

Noise Management Levels (NML) for residential receivers are calculated relative to existing background noise levels and consider whether construction activities are proposed to be carried out during or outside standard construction hours. The ICNG also identifies the level at which a residential receiver is considered to be 'highly noise affected' (noise exceeding 75 dB(A)).

The method for calculating construction NMLs from existing noise levels (RBL) for residential receivers is summarised in **Table 20-6**. Further details of this calculation are provided in **Appendix L** (Noise and Vibration Technical report) and in the ICNG.

Where an exceedance of the NMLs is predicted, the ICNG advises that receivers can be considered 'noise affected' and the proponent should apply all feasible and reasonable work practices to minimise the noise impact. The proponent should also inform all potentially affected residents of the nature of the works to be carried out, the expected noise level and duration, as well as contact details should they wish to make a complaint.

Where construction noise levels at the receiver reach 75 dB(A), residential receivers are considered to be 'highly noise affected' and the proponent should, in consultation with the community, consider restrictions to the hours of construction to provide respite periods.

The ICNG defines what is considered to be feasible and reasonable as follows:

- *"Feasible*

  A work practice or abatement measure is feasible if it is capable of being put into practice or of being engineered and is practical to build given project constraints such as safety and maintenance requirements

- *Reasonable*

  Selecting reasonable measures from those that are feasible involves making a judgment to determine whether the overall noise benefits outweigh the overall adverse social, economic and environmental effects, including the cost of the measure."

Table 20-6 ICNG residential noise management levels

Time of day	NML, $L_{Aeq,15min}$, dB(A)[1]	How to apply
Recommended standard hours: Monday to Friday 7:00 am to 6:00 pm Saturday 8:00 am to 1:00 pm No work on Sundays or public holidays	Noise affected RBL + 10 dB	The noise affected level represents the point above which there may be some community reaction to noise: • where the predicted or measured $L_{Aeq\ (15\ min)}$ is greater than the noise affected level, the proponent should apply all feasible and reasonable work practices to meet the noise affected level; and • the proponent should also inform all potentially impacted residents of the nature of works to be carried out, the expected noise levels and duration, as well as contact details.
	Highly noise affected 75 dB(A)	The highly noise affected level represents the point above which there may be strong community reaction to noise: • where noise is above this level, the relevant authority (consent, determining or regulatory) may require respite periods by restricting the hours that the very noisy activities can occur, taking into account: - times identified by the community when they are less sensitive to noise (such as before and after school for works near schools, or mid-morning or mid-afternoon for works near residences; and - if the community is prepared to accept a longer period of construction in exchange for restrictions on construction times.
Outside recommended standard hours	Noise affected RBL + 5 dB	• a strong justification would typically be required for works outside the recommended standard hours; • the proponent should apply all feasible and reasonable work practices to meet the noise affected level; • where all feasible and reasonable practices have been applied and noise is more than 5 dB(A) above the noise affected level, the proponent should negotiate with the community; and • for guidance on negotiating agreements see section 7.2.2 of the ICNG.

Notes:

1. Noise levels apply at the property boundary that is most exposed to construction noise, and at a height of 1.5 m above ground level. If the property boundary is more than 30 m from the residence, the location for measuring or predicting noise levels is at the most noise-affected point within 30 m of the residence. Noise levels may be higher at upper floors of the noise affected residence.

The construction NMLs for residential and other sensitive land uses are detailed in **Table 20-7** and **Table 20-8**.

Table 20-7 Construction noise management levels – residential receivers

NCA	Period	RBL, L_{A90} dB(A)	Standard construction hours noise management levels, $L_{Aeq,15min}$, dB(A)	Out of hours noise management levels, $L_{Aeq,15min}$, dB(A)
1	Day	49	59	54
	Evening	38	-	43
	Night	38	-	43
2	Day	41	51	46
	Evening	33	-	38
	Night	30	-	38
3	Day	35	45	40
	Evening	30	-	35
	Night	30	-	35
Pambula Beach Caravan Park (Discovery Parks – Pambula Beach)	Day	35	50[1]	45[1]
	Evening	30	-	40[1]
	Night	30	-	40[1]

Notes:

1. *The NMLs for Pambula Beach Caravan park have been set to the NMLs for NCA3 + 5 dB*

Table 20-8 Construction noise management levels – Other receivers

Land use	Noise management levels, LAeq,15min (applies when properties are in use)
Active Recreation	65 dB(A)
Commercial premises (including offices, retail outlets)	70 dB(A)
Industrial Premises	75 dB(A)

Sleep disturbance guidelines

The ICNG requires a sleep disturbance analysis where construction works are planned to extend over more than two consecutive nights. The L_{A1} noise levels and number of expected L_{A1} noise events should be predicted in order to determine the likelihood of potential sleep disturbance.

The NSW EPA recommends that to minimise the risk of sleep disturbance during the night-time period (10.00 pm to 7.00 am), the $L_{A1(1\ min)}$, noise level outside a bedroom window should not exceed the $L_{A90\ (15\ minute)}$ background noise level by more than 15 dB. If this screening criterion is found to be exceeded, then a more detailed analysis must be undertaken and include the extent that the maximum noise level exceeds the background noise level and the number of times this is likely to happen during the night-time period.

Sleep disturbance research presented in the *Road Noise Policy* (RNP) concludes that *'Maximum internal noise levels below 50-55 dB(A) are unlikely to cause awakening reactions'*. Therefore, given that an open window provides approximately 10 dB in noise attenuation from outside to inside, external noise levels of 60-65 dB(A) are unlikely to result in awakening reactions.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in **Table 20-9**.

Table 20-9 Sleep disturbance criteria

NCA	RBL (L_{A90}), dB(A)	Sleep disturbance criteria	$L_{A1(1\ minute)}$, dB(A)
		Screening level	Awakening reaction
1	38	53	65
2	30	45	65
3	30	45	65

Construction traffic noise criteria

Noise from construction traffic on public roads is assessed under the *RNP*. Where the predicted noise increase is 2 dB(A) or less, then no further assessment is required. However, where the predicted noise level increase is greater than 2 dB(A), and the predicted road traffic noise level exceeds the road category specific criterion, then noise mitigation and management measures should be considered for those receivers affected. The *RNP* does not require assessment of noise impact to commercial or industrial receivers.

Construction vehicles are expected to access the Project area using the following routes:

- Arthur Kaine Drive via Toallo Street and Princes Highway;
- Merimbula Beach via Coraki Drive, Pambula Beach Road and Princes Highway; and
- Port of Eden via Princes Highway and Imlay Street.

Construction vibration criteria

Vibration criteria are set primarily according to whether the particular Project activities are continuous in nature or intermittent, whether they occur during the daytime or night-time and the type of receiver to be assessed (e.g. industrial, commercial or residential). The effects of vibration in buildings can be divided into the following categories:

- those in which building damage may occur (i.e. structural damage); and
- those in which the occupants or users of the building are inconvenienced or possibly disturbed, (i.e. human disturbance or discomfort).

Vibration, at levels high enough, has the potential to cause damage to structures and disrupt human comfort. Vibration and its associated effects are usually classified as continuous, impulsive or intermittent as follows:

- continuous vibration continues uninterrupted for a defined period and includes sources such as machinery and continuous construction activities;
- impulsive vibration is a rapid build up to a peak followed by a damped decay. It may consist of several cycles at around the same amplitude, with durations of typically less than two seconds and no more than three occurrences in an assessment period. This may include occasional dropping of heavy equipment or loading activities; and
- intermittent vibration occurs where there are interrupted periods of continuous vibration, repeated periods of impulsive vibration or continuous vibration that varies significantly in magnitude. This may include intermittent construction activity, impact pile driving, jack hammers.

Therefore, vibration levels at sensitive receiver locations must be controlled so as to prevent discomfort and regenerated noise, and in some extreme cases, structural damage. The relevant standards and guidelines utilised for the assessment of construction vibration for the Project are:

- structural damage: German Standard DIN 4150 – *Part 3 – Structural Vibration in Buildings – Effects on Structures* (DIN 4150); and
- human comfort (tactile vibration): *Assessing Vibration: A Technical Guideline* (Department of Environment and Conservation, 2006).

Table 20-10 provides the maximum levels of vibration that reduce the likelihood of building damage (structural damage) caused by vibration, as recommended by German Standard (DIN 4150) (noting that DIN 4150 states that buildings exposed to higher levels of vibration than recommended limits would not necessarily result in damage).

Table 20-10 DIN 4150: Structural damage safe limits for building vibration

Group	Type of structure	At foundation Less than 10 hertz (Hz)	At foundation 10 Hz to 50 Hz	At foundation 50 Hz to 100 Hz[1]	Vibration at the horizontal plane of the highest floor for all frequencies
1	Buildings used for commercial purposes, industrial buildings and buildings of similar design	20 millimetres per second (mm/s)	20 to 40 mm/s	40 to 50 mm/s	40 mm/s
2	Dwellings and buildings of similar design and/or use	5 mm/s	5 to 15 mm/s	15 to 20 mm/s	15 mm/s
3	Structures that because of their particular sensitivity to vibration, do not correspond to those listed in Lines 1 or 2 and have intrinsic value (e.g. buildings that are under a preservation order/heritage listed)	3 mm/s	3 to 8 mm/s	8 to 10 mm/s	8 mm/s

Notes:

1. At frequencies above 100 Hz, the values given in this column may be used as minimum values

The assessment of intermittent vibration outlined in the NSW EPA guideline A*ssessing Vibration: A Technical Guideline* is based on Vibration Dose Values (VDVs). **Table 20-11** provides the maximum and preferred VDVs for intermittent vibration arising from construction activities. The VDV criteria are based on the likelihood that a person would be annoyed by the level of vibration over the entire assessment period, or in the case of 'critical areas'. Sites containing equipment sensitive to vibration or where delicate tasks are being carried out, require more stringent criteria than the typical human comfort criteria. Examples of critical areas may include hospital theatres or precision laboratories where sensitive operations are occurring.

Table 20-11 Preferred and maximum vibration dose values for intermittent vibration ($m/s^{1.75}$)

Location	Daytime[1]		Night time[1]	
	Preferred	Maximum	Preferred	Maximum
Critical areas	0.10	0.20	0.10	0.20
Residences	0.20	0.40	0.13	0.26
Offices, schools, educational institutions and places of worship	0.40	0.80	0.40	0.80
Workshops	0.80	1.60	0.80	1.60

Notes:
1. Day is defined as 7:00 am to 10:00 pm. Night is defined as 10:00 pm to 7:00 am

20.1.5 Operational noise criteria

The NSW *Noise Policy for Industry* provides guidance in relation to acceptable noise limits for industrial noise emissions, which includes, but is not limited to, noise emissions from mechanical plant.

The assessment procedure in the *Noise Policy for Industry* has two components:

- controlling **intrusive** noise impacts in the short term for residences; and
- maintaining noise level **amenity** for residences and other land uses.

Both components are assessed at the boundary of the noise sensitive receiver site, or if the site boundary is more than 30 metres (m) from the noise sensitive building, a distance of 30 m from the noise sensitive building.

Intrusive noise impacts

The *Noise Policy for Industry* states that the noise from any single noise source should not be greatly above the prevailing background noise level. Industrial noise sources are generally considered acceptable if the A-weighted equivalent continuous sound pressure level of noise from the source, measured over a 15 minute period ($L_{Aeq,15 min}$) does not exceed the RBL by more than 5 dB(A) for the period under consideration. This is termed the Intrusiveness Criterion.

The RBL and the respective intrusive criteria for the day, evening and night periods are provided in **Table 20-12**.

Table 20-12 Intrusive criteria

NCA	Period	RBL (L_{A90}), dB(A)	Intrusive criteria (RBL+5), dB(A)
1	Day	49	54
	Evening	38	43
	Night	38	43
2	Day	41	46
	Evening	33	38
	Night	30	35
3	Day	35	40
	Evening	30	35
	Night	30	35

Given the distance between Pambula Beach Caravan Park and the STP (> 2 kilometres), operational noise levels would be insignificant and therefore no further consideration of noise impacts to this land use is required.

Protecting amenity

To limit continuing increase in noise levels, the maximum ambient noise level within an area from all industrial noise sources should not normally exceed the acceptable noise levels specified in Table 2.1 of the *Noise Policy for Industry*. That is the noise level should not exceed the level appropriate for the particular locality and land use. This is often termed the “background creep” or “amenity criterion”.

In order to provide protection against impacts to amenity, the *Noise Policy for Industry* recommends suitable maximum L_{Aeq} noise levels for particular land uses and activities during the daytime, evening and night-time periods. These are summarised in **Table 20-13**.

The project amenity noise levels applicable to the Project are provided in **Table 20-13**. The Project amenity level for a project is equal to the recommended amenity level minus 5 dB(A). Therefore, the relevant noise amenity level from **Table 20-13** is assigned as the project amenity noise level. The project amenity level is then converted to a 15 minute period by adding 3 dB(A).

The Pambula Beach Caravan Park is unlikely to be affected by operational noise from the Project and therefore its criteria is not included below.

Table 20-13 Project amenity noise levels

Type of receiver	Indicative noise amenity area	Time of day	Project amenity noise level, dB(A)	
			$L_{Aeq\ (period)}$	$L_{Aeq\ (15\ minute)}$
Residential receivers	Suburban	Day	50[1]	53
		Evening	40[1]	43
		Night	35[1]	38
Residential receivers	Rural	Day	45[1]	48
		Evening	40[1]	43
		Night	35[1]	38
Commercial premises	All	When in use	65	68
Active recreation area	All	When in use	55	58

Notes:
1. *Recommended amenity level minus 5 dB.*
2. *External noise levels are based upon a 10 dB reduction from outside to inside through an open window.*

Maximum noise level assessment for sleep disturbance

A maximum noise level event assessment was undertaken where night-time noise levels at a residential location exceed the following screening levels:

- $L_{Aeq,15min}$ 40 dB(A) or the prevailing RBL plus 5 dB, whichever is the greater; and/or
- L_{AFmax} 52 dB(A) or the prevailing RBL plus 15 dB, whichever is the greater.

The detailed assessment should cover the maximum noise level, the extent to which the maximum noise level exceeds the RBL, and the number of times this happens during the night-time period.

Based on the measured background noise levels during the night, the sleep disturbance criteria for the nearest noise sensitive residential receivers are presented in **Table 20-14**.

Table 20-14 Operational night-time sleep disturbance screening levels

Location	Measured night time RBL, $L_{A90,\ 15\ mins}$ dB(A)	Sleep disturbance screening levels	
		$L_{Aeq,15min}$, dB(A)	L_{AFmax}, dB(A)
NCA1	38	43	53
NCA2	30	40	52
NCA3	30	40	52

20.2 Existing environment

The Project is located within a mixed use environment. Merimbula Airport is located to the north of the Project area, Merimbula Lake lies to the north-west, Pambula Merimbula Golf Club (PMGC) is located to the south and the area to the east is mostly bushland. The closest residential receivers are located to the south-east along Arthur Kaine Drive. For suburban environments ambient noise levels in these areas are typically influenced by transport infrastructure and noise generating industry.

20.2.1 Existing background noise levels

Long term unattended and short term attended noise measurements undertaken to establish the existing ambient and background noise environment at potentially affected receivers around the Project are provided in **Table 20-3** and **Table 20-4**.

20.2.2 Existing operation noise

Based on these measurements and observations and existing plant sound power levels in **Table 20-5**, a SoundPLAN noise model of the STP was developed. The noise levels predicted using the noise model have been compared to the noise levels measured at logging location 2 for the daytime period. **Table 20-15** shows the existing modelled noise levels from the STP at the nearest receivers for each NCA.

Table 20-15 Existing modelled operational noise levels of the STP

NCA	Closest receiver	Distance from Project (m)	Sound pressure level, L_{Aeq} dB(A)
1	232 Arthur Kaine Drive, Merimbula	180	34
2	3 Narregol Street, Pambula	1,500	< 20
3	75 Green Point Road, Millingandi	1,200	27
-	PMGC	50	49

20.3 Potential impacts – construction

20.3.1 Construction staging and equipment

The construction stages and each noise emitting plant/ equipment to be used in the Project construction are presented in **Table 20-16**.

Table 20-16 Construction scenarios

Stage	Noise emitting plant/equipment involved	Sound power level, dB(A)	Duration	Timing[1]
Stage 1A – Utility works/relocations	Demolition saw	115[2]	1 month	Standard construction hours
	Small excavator	94		
	Hand tools	94		
	Vacuum truck	103		

Stage	Noise emitting plant/equipment involved	Sound power level, dB(A)	Duration	Timing[1]
	Trucks (semi-trailer and tipper)	108		
Stage 1B – Site establishment	Hand tools	94	0.5 month	Standard construction hours
	Bobcat	104		
	Generator	101		
	Crane trucks (semi-trailer and tipper)	104		
	Heavy trucks for floating equipment to Project area	108[3]		
	Lighting tower	95		
	Grader	109		
	10t Excavator	94		
	Light vehicles	90		
	Bulldozer 10-15 t	109		
Stage 3 – STP upgrade works within STP site	Grader	109	10 months	Standard construction hours
	Excavators 2 x 20t	98		
	Demolition saw	115[2]		
	Telehandler	92		
	Franna crane	93		
	Hand tools/welding equipment	101		
	Grinder	108		
	Generators	101		
	Jackhammer	108		
	Forklift	93		
	Scissor lift	100		
	Cement trucks	105		
	Bobcat	104		
	Vacuum truck	103		
	Plate compactor	104		
	Jacking rig	102		
	Roller	105		
	Trucks (semi-trailers and tipper)	108		
	Concrete pump	106		
Stage 4 – Pipeline butt welding and stringing Note there are 2 options for Stage 4[4]	Heavy trucks for pipes	108[3]	3 months	Standard construction hours
	Welding gear/hand tools	101		
	Excavator 5 t (with attachment to lift pipes)	94		
	Trucks-welding	108		
	Light vehicles	90		

Stage	Noise emitting plant/equipment involved	Sound power level, dB(A)	Duration	Timing[1]
	Generator	101		
	Telehandler	92		
Stage 5 – Ocean outfall pipeline construction (land-based operations including land-based drill rig) Note there are 3 options for Stage 5[5]	Excavator 20t	98	2.5 months, up to 4.5 months depending on drilling method/ locations used	Standard construction hours, plus out of hours work (evening and night-time work) for pulling (i.e. 48 hours continuous)
	Grader	109		
	Directional drill rig	108		
	Drilling fluid recycling unit	108		
	Tip truck	108		
	Hand tools	94		
	Vacuum truck	103		
	Light vehicles	90		
	Generators	101		
	Heavy trucks for delivering rig, rods, mud separation/recycling	108[3]		
	Welding gear/hand tools	101		
Stage 6A – Offshore pipeline riser/exit works	Welding gear/hand tools	101	3 months	Standard construction hours and out of hours work (evening and night-time works)
	Jack-Up barge (only required for exit casing (or if directional drilling operation is marine based))	104		
	Micro-piling rig on barge	103		
	73 m barge	105		
	55 m supply barge Anchor handling tug supply (AHTS) vessel	105		
Stage 6C – Lay pipe strings for above ground offshore section[6]	73 m barge with crane/pipe handler to lower pipe	105	1 month	24 hours[6]
	2 x small self-propelled vessels to assist	105		
	Excavator with attachment (to load pipes onto barge)	94		
Stage 6D – Cover above-ground offshore pipeline[6]	73 m barge	105	1 month	24 hours[6]
	55 m barge	105		
	Anchored vessel/small barge	105		
Stage 6E – Diffuser works[6]	73 m barge	105	<1 month	24 hours[6]
	55 m barge	105		
	Anchored vessel/small barge	105		
Stage 7 – Commissioning (all new components)	Pump stations, sand filters	92	2 to 5 months	Standard construction hours
	Barge (up to 120 ft) with tug or self-propelled dive vessel	105		
	Small service trucks, light trucks	103		

Stage	Noise emitting plant/equipment involved	Sound power level, dB(A)	Duration	Timing[1]
	Hand tools	94		

Notes:

1 Certain works may need to occur outside standard daytime hours for the safety of workers and in accordance with transport licence requirements. Activities to be carried out during these periods may include oversized load deliveries. Approval would be required for any out of hours work and the affected community would be notified.

2 Assumes construction equipment is operating 33% of the time in any 15 minute period.

3 Assumes one heavy vehicle movements in any 15 minute period

4: Option A includes pipeline welding/stringing within the PMGC compound area and the STP site. Option B includes pipeline welding/stringing at Merimbula Beach intermediate site/compound area.

5: Option A includes drill rig located on Merimbula Beach and pipe strings located on beach/floated out to beyond surf zone. Option B includes drill rig located on Merimbula Beach and pipe strings located on PMGC/STP site. Option C includes drill rig located at STP drill pad site (drilling eastbound) and pipes located at Merimbula Beach, for this option a temporary noise barrier has been assumed to be located around the drill rig. Note that Option A and Option B would cover the possibility of a drill rig located offshore (about 150 metres from the shore line, where the underground section of pipeline is expected to join to the aboveground section of pipeline) at drilling westbound, as noise impacts would be greater on Merimbula Beach which is closer to noise sensitive receivers.

6: Marine work in Stages 6C, 6D and 6E may require extended hours and weekend work to take advantage of favourable conditions.

A number of stages may overlap. These scenarios are presented in **Table 20-17**. Note that these scenarios are considered to be conservative, as for example, if two of the Stage 5 options are required during construction (i.e. two different directional drilling sites are required), it is unlikely that both of the drilling sites would be operating at the same time; the drill rig is more likely to finish drilling and pulling pipes at one site, and then mobilise to the next site.

Table 20-17 Construction scenarios based on stages that may overlap

Scenario
3 and 6A
3, 4B, 5A and 5C
4A, 4B, 5A and 5B
4B, 5A and 5C
4B and 5C
6C and 6D

20.3.2 Impacts to residential receivers

During construction it is likely that all equipment would not be operating simultaneously at all times and in the one location, which would result in reduced noise levels compared with those predicted. As some construction stages may occur simultaneously, a cumulative noise impact has been undertaken.

Construction noise levels at the closest receivers in each NCA are presented in **Table 20-18**.

There would be no construction noise exceedance for the majority of construction scenarios with the exception of Stage 1B – Site establishment (day), where the construction noise levels at Pambula Beach Caravan Park at 56 dB(A) exceed the criteria by 6 dB(A), as a consequence of heavy vehicle movements along the Pambula Beach construction access.

Table 20-18 Construction Noise Levels – NCA locations

Construction Scenario	Predicted Noise Level dB(A)	NML Criteria[1]	Exceedance	Predicted Noise Level dB(A)	NML Criteria[1]	Exceedance	Predicted Noise Level dB(A)	NML Criteria[1]	Exceedance	Predicted Noise Level dB(A)	NML Criteria[1]	Exceedance
	NCA 1 232 Arthur Kaine Drive, Merimbula			NCA2 3 Narregol Street, Pambula			NCA3 75 Green Point Road, Millingandi			Pambula Beach Caravan Park		
1A – Day	48	59	-	< 35	51	-	< 35	45	-	< 35	50	-
1B – Day	55	59	-	< 35	51	-	39	45	-	56	50	**6**
3 – Day	52	59	-	< 35	51	-	42	45	-	< 35	50	-
3 and 6A – Day	52	59	-	< 35	51	-	43	45	-	< 35	50	-
3, 4B, 5A and 5C – Day	57	59	-	< 35	51	-	44	45	-	< 35	50	-
4A and 4B and 5A and 5B – Day	50	59	-	< 35	51	-	< 35	45	-	< 35	50	-
4B and 5A and 5C – Day	56	59	-	< 35	51	-	42	45	-	< 35	50	-
4B and 5C – Day	56	59	-	< 35	51	-	42	45	-	< 35	50	-
5 (worst case) – Night	42	43	-	< 35	38	-	< 35	35	-	< 35	40	-
6A – Night	38	43	-	< 35	38	-	< 35	35	-	< 35	40	-
6C and 6D – Night	36	43	-	< 35	38	-	< 35	35	-	< 35	40	-
6E – Night	36	43	-	< 35	38	-	< 35	35	-	< 35	40	-
7 – Day	39	59	-	< 35	51	-	< 35	45	-	< 35	50	-

Note:

1. *from **Table 20-7** – Construction NML at residential receivers.*

20.3.3 Construction work hours

The majority of works would be undertaken during standard daytime construction hours where reasonable and feasible to do so. Standard construction hours are:

- Monday to Friday 7:00 am to 6:00 pm;
- Saturday 8:00 am to 1:00 pm; and
- No work on Sundays and public holidays.

Some works would be required to be undertaken outside of standard daytime hours due to weather, for the safety of workers and in accordance with transport licence requirements (e.g. oversized load deliveries and laying of the pipeline within Merimbula Bay). Construction works in Merimbula Bay may need to occur seven days a week to maximise works during periods of calm weather.

Table 20-18 shows construction noise levels are not expected to exceed the noise management levels during standard hours or outside of standard hours at any noise sensitive receivers, with the exception of Pambula Beach Caravan Park where the NMLs may be exceeded by up to 6 dB(A) at times.

20.3.4 Construction traffic noise

The numbers of construction vehicle movements have been estimated to be up to 20 light and 10 heavy vehicles per day during peak construction periods for delivery of materials, loading of spoil and waste and concreting activities.

The existing traffic flows on all the roads provided in **Table 20-18** with residential receivers is substantially greater than the proposed construction traffic numbers. Therefore, the additional traffic would have a minor impact on existing road traffic noise in the area with traffic noise levels during construction expected to increase by less than 2 dB.

20.3.5 Vibration assessment

Vibration intensive works may include the use of the following items of equipment:

- vibrating rollers; and
- jackhammers.

As discussed in **Chapter 14 Aboriginal heritage** there are a total of six Aboriginal sites recognised within and immediately surrounding the Project area, including two shell midden sites, two open artefact sites, a registered burial site 62-6-0173 and a previously recorded scarred tree 62-6-0475.

The minimum working distances of the vibration intensive items of equipment from vibration sensitive receivers are shown in **Table 20-19** which is based on recommendations of the TfNSW *Construction Noise and Vibration Strategy*. If these minimum working distances are complied with, no adverse impacts from vibration intensive works are likely in terms of human response or cosmetic damage.

Based on the indicative construction activities assessed for the Project, it is not considered likely that works would occur within the minimum working distances. If, however, vibration intensive works are required within these minimum working distances, mitigation and management measures to control excessive vibration would be implemented as outlined in **Section 20.5**.

Table 20-19 Minimum working distances of vibration intensive equipment

Plant	Rating/ description	Cosmetic damage		Human response
		Residential/ commercial	Heritage and other sensitive structures (DIN 4150)	
Vibratory roller	< 50 kilonewton (kN) (typically 1-2t)	5 m	8 m	15 m
	< 100 kN (typically 2-4t)	6 m	10 m	20 m

Plant	Rating/ description	Cosmetic damage		Human response
		Residential/ commercial	Heritage and other sensitive structures (DIN 4150)	
	< 200 kN (typically 4-6t)	12 m	20 m	40 m
	< 300 kN (typically 7-13t)	15 m	25 m	100 m
	> 300 kN (typically 13-18t)	20 m	30 m	100
	> 300 kN (> 18 t)	25 m	38 m	100 m
Jackhammer	Handheld	1 m (nominal)	1 m (nominal)	Avoid contact with structure

20.4 Potential impacts – operation

Table 20-20 presents the sound power levels which were used in the operational noise model. These sound power levels are based upon measurements that AECOM took on 27 September 2019 at the STP (existing plant) and AECOM's library of sound power data (proposed plant). There would also be small pumps associated with the Poly Aluminium Chloride (PAC) dosing system, however these would not be significant noise source and therefore have not been included in the operational noise model.

Table 20-20 Summary of L_{Aeq} sound power levels – Existing and proposed plant

Source	Existing or proposed plant	Overall SWL[1] dB(A)
Aerators (3 off)	Existing	97
Pump 1	Existing	79
Pump 2	Existing	78
Pump 3	Existing	70
Ocean outfall pump station (45 kilowatt (kW) Pump)	Proposed	85
Storage tank pump station (<45 kW Pump)	Proposed	85
Chemical sludge pump station (<45 kW Pump)	Proposed	85
Filter pump station (if required) (<45 kW Pump)	Proposed	85

Note:

1. *Where SWL = Sound power level*

20.4.1 Site operational noise

The predicted noise levels and noise level increase due to the Project have been compared to the *Noise Policy for Industry* criteria in **Table 20-21**. The comparison shows the L_{Aeq} level from the operation of the STP is under the Project trigger level. The likely increase in L_{Aeq} noise emissions due to the Project is a maximum increase of 0.5 dB(A). The *Noise Policy for Industry* notes that such a minor increase should not increase the overall noise emissions from the STP site. In addition, the L_{Amax} and L_{Aeq} noise levels for sleep disturbance associated with the typical operation of the Project were well under the Project sleep disturbance criteria (refer **Table 20-9** for criteria).

Table 20-21 Predicted operational noise levels and noise level increases at noise sensitive receivers

Receiver	Weather conditions	Distance of the worst affected receiver from the Project (m)	Sound power level, L_{Aeq} dB(A)[1]			Sound power level, L_{Amax} dB(A)		
			Operation STP	Project trigger level	Exceedance	Current	Proposed	Increase
232 Arthur Kaine Drive, Merimbula	Night neutral conditions	180	20	38	-	34	34	0.2
	Night 3m/s wind		25	38	-	38	39	0.2
	Night temperature inversion		25	38	-	38	39	0.2
3 Narregol Street, Pambula	Night neutral conditions	1,500	<20	35	-	16	16	0.5
	Night 3m/s wind		<20	35	-	23	23	0.3
	Night temperature inversion		<20	35	-	23	23	0.3
75 Green Point Road, Millingandi	Night neutral conditions	1,200	<20	35	-	26	27	0.2
	Night 3m/s wind		<20	35	-	34	34	0.1
	Night temperature inversion		<20	35	-	34	34	0.1
PMGC	Night neutral conditions	50	35	58	-	49.3	49.4	0.1
	Night 3m/s wind		36	58	-	49.9	50	0.1
	Night temperature inversion		36	58	-	49.9	50	0.1

Note: 1 – derived from plant in ***Table 20-20***

20.5 Management of impacts

The mitigation and management measures identified to help avoid and minimise the potential airborne noise and vibration impacts of the Project are outlined in **Table 20-22**, and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

Generally, construction noise levels have been predicted to be below construction noise management levels with the exception of heavy vehicle movements along the Pambula Beach construction access.

In order to minimise construction noise at receivers. This section discusses the performance outcomes and noise and vibration mitigation and management measures for the Project.

20.5.1 Performance outcomes

The airborne noise and vibration performance outcomes for the Project are as follows:

- minimise adverse impacts on acoustic amenity during construction; and
- community consultation/notifications in relation to construction noise are undertaken where necessary, in a timely fashion.

The Project would be designed, constructed and operated to achieve these performance outcomes.

20.5.2 Consideration of interaction between measures

Mitigation and management measures in other chapters that are relevant to the management of potential airborne noise and vibration impacts include:

- **Chapter 21 Noise and vibration (underwater)**, specifically measure for the preparation of a Construction Noise and Vibration Management (CNVMP) Plan.

20.5.3 Construction Noise and Vibration Management Plan

A CNVMP would be developed for the Project and implemented prior to commencement of construction activities as part of the Construction Environment Management Plant (CEMP).

The CNVMP should include all reasonable and feasible safeguards to manage the noise emissions from the Project area and any complaints which may occur due to construction noise. The CNVMP should include, the following:

- identification of nearby residences and other sensitive land uses;
- description of approved hours of work;
- description and identification of all construction activities, including work areas, equipment and duration;
- description of what feasible and reasonable work practices (generic and specific) would be applied to minimise noise and vibration;
- a complaints handling process;
- noise and vibration monitoring procedures, including for heritage structures; and
- overview of community consultation required for identified high impact works, and any associated construction noise exceedances.

Construction works should be planned and carried out during standard construction hours wherever possible.

20.5.4 Mitigation and management measures

Mitigation and management measures to address the potential impacts identified are described in **Table 20-22** below.

Table 20-22 Mitigation and management measures – Noise and vibration (airborne)

Ref #	Potential impacts	Mitigation and management measure	Timing
NV1	General noise and vibration management	A CNVMP would be prepared as part of the CEMP and would include general feasible and reasonable work practices as identified in 'Section 6 Work practices' of the ICNG (Department of Environment and Climate Change (DECC), 2009).	Construction

Ref #	Potential impacts	Mitigation and management measure	Timing
NV2	Construction noise emissions at nearby sensitive receptors (particularly during Stage 5)	During construction Stage 5, if Option C is undertaken, a temporary noise barrier should be located around the drill rig to shield residential properties to the south-east on Arthur Kaine Drive.	Construction
NV3	Construction related traffic noise emissions (particularly during Stage 1B)	Vehicle movements will be routed away from sensitive receivers and scheduled during less sensitive times where feasible and reasonable.	Construction
NV4		The speed of vehicles will be limited, and the use of engine compression brakes limited.	Construction
NV5		On-site storage capacity will be maximised to reduce the need for truck movements during sensitive times.	Construction
NV6	Vibration minimum working distances	If vibration intensive equipment is to be used within the minimum working distances for cosmetic damage, it is recommended that attended vibration measurements are undertaken when work commences, to determine “site specific minimum working distances”.	Construction
NV7		Vibration intensive work should not proceed within the site specific safe working distances, unless a permanent vibration monitoring system is installed approximately 1 m from the building footprint, to warn operators (e.g. via flashing light, audible alarm, SMS) when vibration levels are approaching the peak particle velocity objective.	Construction

20.5.5 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using the BVSC *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for noise and vibration (airborne) and is provided in **Table 20-23**.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Following the implementation of the mitigation and management measures above, there would be low to medium risks from noise emissions from construction of the Project.

With residual impacts, the Project also has potential to contribute to cumulative impacts. Consideration of cumulative impacts with regard to noise and vibration and other environmental aspects of the Project are addressed in **Chapter 27 Cumulative impacts**.

Table 20-23 Environmental risk analysis with mitigation – Noise and vibration (airborne)

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
General noise and vibration management	Construction	NV1, NV3	Minor	Unlikely	Low
Construction noise emissions causing nuisance at nearest sensitive receivers (particularly during Stage 5)	Construction	NV1, NV2	Minor	Possible	Medium
Construction related traffic noise emissions (particularly during Stage 1B)	Construction	NV1, NV3	Minor	Likely	Medium
Vibration minimum working distances	Construction	NV1, NV4, NV5	Minor	Unlikely	Low

21.0 Noise and vibration (underwater)

This chapter provides a summary of the noise and vibration (underwater) impacts associated with the Project. A detailed underwater noise and vibration Technical report has been prepared for the Project and is included in **Appendix M** (Underwater Noise Technical report).

Table 21-1 sets out the requirements as provided in SEARs relevant to noise and vibration and where the requirements have been addressed in this EIS.

Table 21-1 SEARs – noise and vibration (underwater)

Ref	Assessment requirements	Where addressed in this EIS
11.1	The Proponent must assess construction and operational noise and vibration impacts in accordance with current NSW noise and vibration guidelines including consideration of noise characteristics (tonal, intermittent and low frequency noise) and the impact on sensitive receivers	This chapter and **Chapter 11 Marine Ecology** Airborne noise is addressed in **Chapter 20 Noise and vibration (airborne)**
11.2	The assessment must include consideration of impacts to the structural integrity and heritage significance of items (including Aboriginal places and items of environmental heritage)	**Chapter 14 Aboriginal heritage** and **Chapter 15 Non-Aboriginal heritage** and
11.3	The Proponent must demonstrate that blast impacts are capable of complying with the current guidelines, if blasting is required	N/A – no blasting is required

Vibration impacts resulting from the construction of the ocean outfall are not considered likely to result in significant impacts to the marine environment and therefore are not considered further in this chapter.

21.1 Background to underwater noise

The ocean is a noisy place, comprised of sounds from both natural and anthropogenic sources. Natural underwater noise occurs from marine life and naturally occurring events such as waves, storms and underwater earthquakes. Anthropogenic noise sources result from activities such as vessel noise, seismic exploration, underwater construction and military activities. Increases in anthropogenic activities globally are resulting in dramatic increases in underwater noise levels.

Sound travels faster and further in the ocean than in air due to water being denser than air. It's speed and distance depends on the density of the water (determined by temperature, salinity, and depth) and the frequency of sound. Some sounds, particularly those of low-frequency, can cover vast distances (NOAA, 2020).

Anthropogenic noise generation is primarily defined as either an impulsive or non-impulsive noise source:

- **Impulsive** – sounds produced are typically transient, brief (less than one second), broadband and consistent of high peak pressure with rapid rise time and rapid decay (NOAA, 2018). This noise source is associated with activities such as pile driving, seismic activities and underwater blasting and results in some of the most powerful sounds produced underwater (Gordon *et al*. 2004, cited in Hastie *et al*. 2019).
- **Non-impulsive** – sounds produced can be broadband, narrowband or tonal, brief or prolonged, continuous or intermittent and typically do not have the high peak sound pressure with rapid rise/decay times that impulsive sounds do (NOAA, 2018). This noise source is associated with activities such as dredging, vessel noise, drilling and some construction activities.

The ambient underwater soundscape tends to be consistent and widespread across large areas of ocean, however, anthropogenic noise generating activities can often form localised noise sources. These localised noise sources, if sufficiently loud, may be detrimental to certain marine species under some circumstances. The degree of impact is influenced by many factors, including the sound's persistence, amplitude and frequency, the distance between the sound source and marine life, and the sensitivity of marine life to the combination of these factors.

21.1.1 Underwater noise and marine fauna

Sound is essential to many types of marine animals, with hearing a primary sense for many marine vertebrate species. Hearing is used to detect signals from; prey, predators, conspecific (same species) social interactions, competitors and the environment, and is a key life function of many marine fauna species, such as cetaceans (whales and dolphins) and pinnipeds (seals). Marine animals, such as these, have evolved to send and receive a variety of complex sounds and they rely on sound to undertake a number of life functions including communication with each other, navigation, foraging and avoidance of predators (NOAA, 2020).

Exposure to anthropogenic underwater noise can interfere with a marine mammal's key life function (*i.e.* foraging, mating, nursing, resting, migrating), by impairing hearing sensitivity. Depending on the type of underwater noise, duration and location, this exposure has the potential to impact marine mammals by causing one or more of the following:

- **acoustic interference** (masking of vocalisations), which can impact conspecific communication within family groups (e.g. pod of whales), predator avoidance and mother and calf communications;
- **auditory damage** including both permanent and temporary damage, the degree of hearing damage would be dependent on exposure time and proximity to the noise source; and
- **behavioural changes** due to physiological stress and/or injury resulting in avoidance, displacement (from preferred habitat) and possible deviation from normal navigational routes.

Sensitivity to underwater noise varies within species of marine life. An animals exposure to anthropogenic underwater noise may result in temporary and/or permanent hearing losses, referred to as either Temporary Threshold Shift (TTS) or Permanent Threshold Shift (PTS). TTS is a short-term reversible loss of hearing, whereas PTS is an irreversible loss of hearing. The potential risk of auditory damage (both TTS and PTS) form the basis of most underwater noise impact assessments.

The reactions of an individual animal to a particular stimulus is impacted by many factors, including life-history stage, nutritional state (hungry or satiated), behavioural state (foraging, resting, migrating, etc.), reproductive state (pregnant, lactating, juvenile, mature), location, and conditioning from previous exposure history. Short-term behavioural responses may become biologically significant, if animals are exposed for sustained periods of time (Bejder et al., 2006). For these reasons, caution should be exercised when assessing the potential for behavioural disturbance.

Marine mammals do not hear equally well at all frequencies; therefore, the effects of noise frequency on hearing loss/damage are incorporated by using auditory weighting functions, to emphasise noise where a species is more sensitive and de-emphasize noise at frequencies where susceptibility is low (Finneran, 2016). These frequency-weighting functions are commonly applied in assessing the potential for the detection of a sound at a specific frequency, and more commonly, for assessing potential noise impacts.

To account for the difference in species hearing capabilities and sensitivities to certain frequencies, marine mammal species have been defined into hearing groups, based on the relevant frequency-weighting function. The hearing groups of the marine mammals likely to occur in the Project area are included in **Table 21-2**.

Table 21-2 Marine mammal hearing groups (adapted from Southall et al. 2019)

Marine mammal hearing group	Auditory weighting function	Genera/species included
Low frequency Cetaceans	Low Frequency (LF)	Baleen whales such as Humpback whale and Southern right whale
High frequency cetaceans	High Frequency (HF)	Members of dolphin family such as orca and bottlenose dolphins
Other marine carnivores in water	Other marine carnivores in water (OCW)	Eared seals (sealions/fur seals)

Fish species vary in their abilities to detect and utilise underwater sounds and therefore potential susceptibility to hearing damage is also likely to vary between species. The most important factor in fish susceptibility to sound exposure is the presence or absence of a swim bladder (Popper et al. 2014). The presence of a swim bladder makes fish more susceptible to pressure-meditated (sound pressure and barotrauma) injury to auditory functions and tissue damage than those without swim bladders. Therefore, fish species with swim bladders are included within underwater noise impact assessments. The effects of underwater noise on marine fauna is complex and no definitive models are available to predict the precise nature of, and potential for, injury, due to a broad range of variables relating to bathymetric and environmental conditions and the varying sensitivity of the range of species potentially exposed.

Characteristics of sound at a receiver (such as a whale), rather than at the noise source are relevant considerations in determining impacts. However, understanding these physical characteristics in a dynamic system with receivers moving over space and time is difficult (NOAA, 2018).

21.2 Existing environment

The ocean outfall pipeline would be constructed in two sections:

- 'Section one' – STP to a location beyond the surf zone constructed via underground trenchless drilling method; and
- 'Section two' – Location beyond the surf zone to offshore termination point approximately 2.7km offshore in Merimbula Bay. This section would be installed by laying the pipeline on the sea floor and covering with rock or concrete mattresses.

The Marine ecology assessment undertaken for the Project (refer **Chapter 11 Marine ecology** and **Appendix G** (Marine Ecology Technical report) provided a comprehensive review of marine fauna and the likelihood of occurrence in the Project area. A summary of the marine fauna considered likely to be found around the Project area is in **Table 21-3**.

Table 21-3 Threatened marine fauna likely to occur around Project area

Species name	Common name	Likelihood of occurrence[2]	Auditory weighting function[1]
Eubalaena australis	Southern right whale	High	LF
Megaptera novaeangliae	Humpback whale	High	LF
Orcinus orca	Killer Whale (Orca)	Moderate	HF
Delphinus delphis	Common Dolphin	High	HF
Tursiops truncatus	Bottlenose Dolphin	High	HF
Arctocephalus forsteri	New Zealand fur-seal	High	OCW
Arctocephalus pusillus	Australian fur-seal	High	OCW
Epinephelus daemelii	Black Cod	Moderate	Fish – swim bladder involved in hearing
Thunnus macocoyii	Southern bluefin tuna	High	Fish – swim bladder involved in hearing
Syngnathiformes	Seahorses, pipefish, pipehorses, sea moths	Moderate	Fish – swim bladder involved in hearing

Notes: [1] - LF – low frequency; HF – high frequency; OCW - Other marine carnivores in water
[2] See section 13.3 of Appendix G (Marine Ecology Technical report)

It should be noted that the likelihood of occurrence ratings are based on a set of pre-determined criteria (refer to **Chapter 11 Marine Ecology** and Section 13 of **Appendix G** (Marine Ecology Technical report)) and as such some species may be classified as having a high to moderate likelihood of occurrence, due to a small number of previous recorded sightings in the area. However, despite the high to moderate rating, there are a number of species where the frequency of occurrence is very low and therefore the likelihood of encountering these species during project construction are considered rare, these include:

- Southern right whale - Smith (2001) has estimated the total number of Southern right whales now visiting NSW in any one year to be less than ten. There are several records of the species occurring within Merimbula Bay with the most recent sighting in 2016. For the most part, sighting a southern right whale in Merimbula Bay could be considered a rare occurrence.
- Killer whale - The last sighting of a killer whale in the region was Twofold Bay in 2015, therefore this species is not expected to be a regular visitor to the Project area.
- Black cod - With only four confirmed sightings since 1972, the occurrence of a local viable population of black cod in the BVSC region can be considered rare, however suitable habitat is present within the Project area.
- Southern bluefin tuna - The species is usually observed in deep offshore waters along the continental shelf and rarely sighted within Merimbula Bay. However, in January 2018, a solitary Southern bluefin tuna was observed in the Pambula broadwater likely having followed baitfish up the river (Merimbula News Weekly, 16 January 2018).
- Syngnathiformes - Two species that may occur on the rocky reef habitats of Merimbula Bay include the Big-belly seahorse (*Hippocampus abdominalis)* and Weedy seadragon (*Phyllopteryx taeniolatus)*. The nearest reported population of the Weedy seadragon is from *Posidonia* seagrass and algal habitats in East Boyd Bay (Wilson *et al.,* 2016), approximately 30 km south of the study area. Syngnathiformes were not observed in marine ecology field surveys undertaken for this Project.

A precautionary approach has been applied to the underwater noise assessment, to include all species determined as having a high or moderate likelihood of occurrence despite a low frequency of occurrence (as detailed above). Periods of the year coinciding with when protected species detailed in **Table 21-3** (with a high likelihood of occurrence) may be encountered within the Project area are included in **Table 21-4**. This includes key ecological windows, such as breeding, foraging and migration.

Table 21-4 Key environmental sensitivities and timings for fauna (indicative)

Southern right whale – southern migration (June to August).												
Humpback whale – southern migration (August to November).												
Common dolphin												
Bottlenose dolphin												
New Zealand fur seal												
Australian fur seal												

Key: Peak occurrence May be encountered during these months

It should also be noted that Merimbula Bay is popular with tourists and therefore December, January and April will also be sensitive time periods for construction activities.

The Project area and wider Merimbula Bay is already exposed to non-impulsive steady state noise sources, due to frequent use of the area by recreational, charter and commercial vessels. It can therefore be assumed that marine fauna that frequent the area are/or have been exposed to similar noise levels as those expected to be generated by the Project.

21.3 Assessment approach

21.3.1 Construction noise sources considered in underwater noise model

Noise disturbance from the Project would comprise vessel and equipment noise during construction activities. These include vessel movements, establishing the pipeline and diffuser infrastructure on the sea floor, and anchoring the pipeline with protective concrete mattress or rock armour. Noise from these activities is classified as non-impulsive, steady-state continuous noise as opposed to impulsive noise such as from activities involving pile driving, explosions, and airgun shots.

A summary of the noise sources used in the underwater noise model is provided in **Table 21-5**. This combination of noise sources is a worst-case scenario and is considered conservative as it represents the loudest sound power levels that would be experienced at any one time with respect to the construction stages described in **Table 21-6**.

Table 21-5 Noise sources used in underwater noise model (worst case total sound power level)

Noise source	Activity	Depth	Reference
Directional Drilling, micro piling	Drilling	Sea floor	Hannay et al. 2004
73 m barge	Supporting operations	Near surface	McCauley 1998
55 m barge	Supporting operations	Near surface	Patterson et al. 2007
Anchor Handling Tug Supply Barge	Performing anchor pull	Near surface	Hannay et al. 2004

Only those construction stages that would contribute to underwater noise emissions have been considered in this assessment. The construction stages and each noise emitting plant equipment of the Project are presented in **Table 21-6**.

Table 21-6 Project construction stages

Stage	Noise emitting plant/equipment involved	Duration	Timing[1]
Stage 5 (Option D) [2] –Directional drilling and pulling	• directional drill rig on jack up barge; • drilling fluid recycling unit on barge; • hand tools/welding gear; and • generators.	2.5 months, up to 4.5 months depending on drilling method/ locations used	Up to 24 hours[1]
Stage 6A – Offshore pipeline riser/exit works	• welding gear/hand tools; • jack-up barge (only required for exit casing (or if drill rig operation is marine based)); • micro-piling rig on barge; • 73 m barge; • 55 m supply barge; Anchor handling tug supply (AHTS) vessel; • Excavator; and • drill rig.	3 months	Standard construction hours
Stage 6C – Lay pipe strings for above ground offshore section	• 73 m barge with crane/pipe handler to lower pipe; • 2 x small self-propelled vessels to assist; and • excavator with attachment (to load pipes onto barge).	1 month	Up to 24 hours[1]
Stage 6D – Cover above-ground offshore pipeline	• 73 m barge; • 55 m barge; and • anchored vessel/small barge.	1 month	Up to 24 hours[1]
Stage 6E - Diffuser works	• 73 m barge; • 55 m barge; and • anchored vessel/small barge.	<1 month	Up to 24 hours[1]
Stage 7 – Commissioning (all new components)	• hand tools; and • barge (up to 120 ft) with tug or self-propelled dive vessel.	2 to 5 months	Standard construction hours

Note: 1. Marine work in Stages 5, 6C, 6D and 6E may require extended hours and weekend work to take advantage of favourable offshore conditions.

2. There are four options for the drill rig location. Three of which are land based and were therefore not used in the assessment. Option D involves the drill rig located offshore (on a barge) drilling westward, with pipe strings located in the temporary laydown area on Merimbula Beach or at the Pambula Merimbula Golf Club laydown area.

Due to a scarcity of data available for underground drilling activities and micro-piling activities, noise data for drilling in the context of oil and gas activities was used in the noise model as an approximation. This is a conservative approach as it is not expected that noise levels from micro piling and underground drilling in this Project would exceed those for drilling in the context of oil and gas projects and activities.

21.3.2 Marine fauna exposure criteria

Marine mammals

Section 21.2 provides information on the listed threatened and protected marine mammals that may be encountered within the Project area and are known to be sensitive to noise (see **Table 21-3**). These include whales, dolphins and seals (refer to **Chapter 11 Marine ecology** for more information).

Table 21-7 shows the hearing groups of the species with a high likelihood of occurrence in the Project area and the TTS and PTS-onset thresholds for these species exposed to non-impulsive noise: Sound exposure levels (SEL) thresholds in dB re 1 µPa^{2}s (weighted) as detailed in Southall et al 2019.

Table 21-7 TTS and PTS threshold levels for non-impulsive for species likely to occur in Project area as derived from Southall et al 2019.

Marine Mammal Hearing Group	TTS onset: SEL (weighted) dB re 1 µPa^{2}s	PTS onset: SEL (weighted) dB re 1 µPa^{2}s
LF Cetaceans Whales	179	199
HF Cetaceans Dolphins	178	198
OCW Seals (in water)	199	219

Fish species

Fish species are grouped according to the biological mechanism used for hearing:

- fish – no swim bladder;
- fish – swim bladder is not involved in hearing; and
- fish – swim bladder is involved in hearing.

For the study the criteria proposed for fish species is the ‘fish - swim bladder involved in hearing’, as it is the most stringent for all scenarios and represents a conservative approach. Noise impacts on fish in the Project area have therefore been assessed according to the ‘fish – swim bladder involved in hearing’ criteria.

Criteria for mortality/potential mortal injury, masking and behavioural changes are classified according to distance from the noise sources. Three groupings of distances used as per Popper et al, 2014 include:

- near: within tens of metres of the sound source;
- intermediate: within hundreds of metres of the sound source; and
- far: within thousands of metres of the sound source.

Criteria for recoverable injury and TTS are expressed in terms of exposure to root mean square (rms) sound pressure levels over a given time period. **Table 21-8** sets out the relevant criteria for fish species.

Table 21-8 Criteria for noise effects on fish species (source: Popper et al, 2014 - Table 7.7)

Type of animal	Mortality and potential mortal injury	Impairment			Behaviour
		Recoverable injury	TTS[5]	Masking	
Fish: swim bladder involved in hearing (primarily pressure detection)	(Near[1]) Low (Intermediate[2]) Low (Far[3]) Low	170 dB rms[4] for 48 hour	158 dB rms for 12 hour	(Near) High (Intermediate) High (Far) High	(Near) High (Intermediate) Moderate (Far) Low

Notes:
1.near: within tens of metres of the sound source;
2.intermediate: within hundreds of metres of the sound source;
3.far: within thousands of metres of the sound source;
4.RMS – root mean square; and
5.Temporary Threshold Shift (TTS) – short term reversible hearing.

21.3.3 Modelling and software

Underwater sound levels were modelled to determine sound level contours through a range of factors, including:

- distance between the source and receiver;
- basic ocean parameters, including depth and bathymetry;
- geoacoustic properties of sediment type; and
- temperature-depth sound speed profile (SSP).

The modelling was performed using two available dBSea algorithms: a low-frequency acoustic algorithm based on modes, followed by a high frequency ray tracing algorithm. The crossover frequency was set at the default of 500 hertz (Hz) with the overall modelling frequency bandwidth set from 12.5 Hz to 10 kilohertz (kHz).

Bathymetry contours in the local area around the ocean outfall pipeline were provided by the Project team. Bathymetry contours at a resolution of 50 m for deep-water areas, 30 km from the coastline, were obtained from an Australian Government database.

The two bathymetry sources were combined, and contours between the two datasets were interpolated. This bathymetry dataset was then used in the dBSea underwater noise model.

Based on the data available, the sea floor was modelled as sand with infinite thickness. As sand is reflective in shallow water, this is considered to be a conservative approach.

Default values for salinity (35 parts per thousand (ppt)), temperature (8°C) and SSP (constant 1500 metres per second (m/s) to depth) were assumed as no detailed information for these parameters was available. Assumption of these values are reasonable given the shallow water depth in the Project area.

Ambient noise levels from Merimbula Bay were not available at the time of modelling, however it is understood that the ambient underwater acoustic environment within Merimbula Bay comprises existing non-impulsive noise from recreational, commercial and charter vessel traffic transiting through the bay. Therefore, the modelling results present a worst-case scenario as it does not take into consideration the existing ambient noise levels.

21.4 Potential impacts – construction

21.4.1 Impacts of noise on marine mammals

Modelling results indicate that there is a potential for marine fauna to be exposed to underwater noise levels that may result in physiological stress and/or injury if no mitigation and management measures are implemented.

Table 21-9 shows the distance at which the threshold level for specific hearing groups would be met. These distances inform the appropriate safety/exclusion zones for PTS, and TTS and potential behavioural change that should be implemented as part of mitigation and management measures. These distances are also shown on **Figure 21-1**.

Table 21-9 Summary of PTS and TTS zones for marine mammals

Species weighting group	Permanent threshold shift (PTS) distance from noise source	Temporary threshold shift (TTS) distance from noise source	Behavioural change zone
Low-frequency (LF)	170 m	2.3 km	16 km
High-frequency (HF)	N/A	85 m	16 km
Other marine carnivores in water (OCW)	N/A	70 m	16 km

The results show for species in the low-frequency range (humpback and southern right whales), Project noise (as detailed in **Section 21.3.1**) would be above the PTS threshold within 170 m of Project activities; the TTS threshold would be exceeded within 2.3 km and the behavioural threshold would be exceeded within 16 km.

For species in the high-frequency range (common and bottlenose dolphins and killer whales), Project noise would not exceed the PTS threshold and the TTS threshold would be exceeded within 85 m and the behavioural threshold within 16 km.

For other marine carnivores in water (Australian and New Zealand fur seals), Project noise would not exceed the PTS threshold and the TTS threshold would be exceeded within 70 m and the behavioural threshold within 16 km.

Due to the mobile nature of marine mammals, any occurrence in the area is likely to be short term and transient in nature. Therefore, with the appropriate mitigation and management measures detailed in **Section 21.6.3** implemented, the risk of the non-impulsive underwater noise generating activities listed in Table 21-6 negatively impacting marine fauna is considered low.

21.4.2 Safety zones for marine fauna

The criteria and underwater noise sources presented in **Section 21.3** were used in the underwater noise model, which subsequently generated the appropriate safety zones (either exclusion or watch zones) for marine fauna.

Safety zones aim to minimise the likelihood of hearing injury to occur to marine mammals, they do not intend to prevent behavioural response to audible but non-traumatic noises (DPTI, 2012). It is likely that an animal within the zone of potential responsiveness would demonstrate an avoidance reaction to the noise source, therefore reducing the potential for animals to enter the zone of potential hearing injury (DPTI, 2012).

The zones of potential noise impact for TTS and PTS auditory response are shown as distance radii modelled from source noise and illustrated in **Figure 21-1**. These distance radii apply to construction activities occurring along the entire 2.7 km pipeline, not just the end of diffuser and represent the following safety zones:

- **Zone of potential hearing injury (Exclusion zone)** – An exclusion zone is based on the threshold for PTS onset. If a LF cetacean (Southern right and Humpback whales) is observed swimming towards or within the designated exclusion zone, work would immediately cease, until the animal has cleared the area. Potential for physiological impact such as PTS to LF cetaceans is modelled to potentially occur within a 170 m radius of the noise source (shown in red on **Figure 21-1**). This exclusion zone would only be applicable during the period LF cetaceans are likely to be encountered in the Project area (June to November). PTS thresholds for HF cetaceans and other marine carnivores are not anticipated to be exceeded as result of the Project. Therefore, for works undertaken outside of June to November each year, no exclusion zone would be required.
- **Zone of potential responsiveness (Watch zone)** – A watch zone is based on the threshold for TTS onset. For LF cetaceans this zone is 2.3 km (shown in blue on **Figure 21-1**). Outside of the LF cetacean occurrence (June to November), the watch zone would be a conservative 500 m (shown in orange on **Figure 21-1**). If a marine mammal is observed swimming within the watch zone it's behaviour and direction of travel would be monitored and if seen swimming into the exclusion zone work, would be ceased (when it is safe to do so), until the animal is clear of the exclusion zone. For HF cetaceans (dolphins) and other marine carnivores (seals) behaviour within this zone would be monitored and recorded, no shut down of activities would be required.

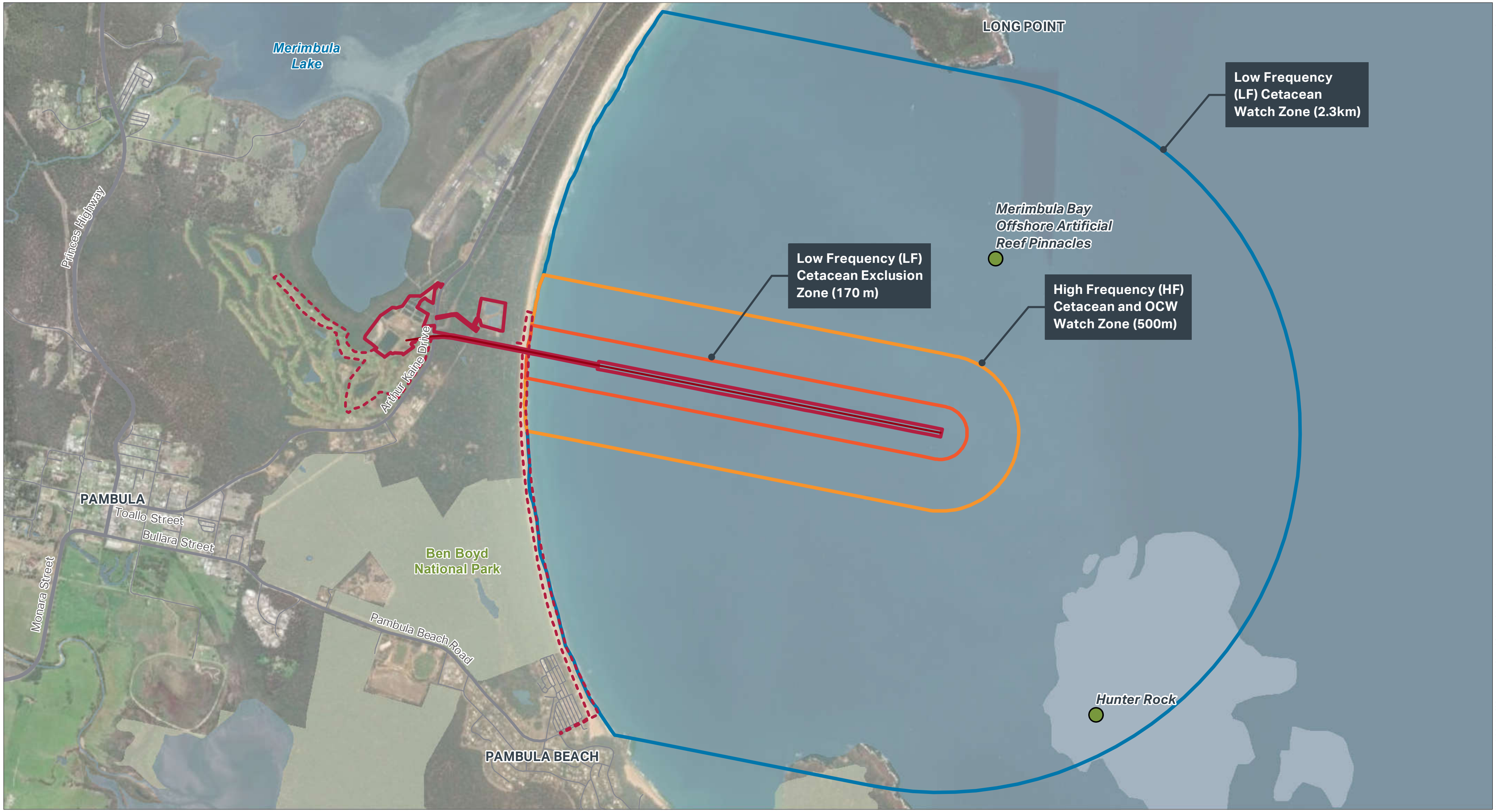
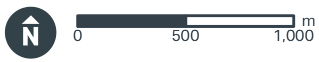


FIGURE 21-1: PROJECT SPECIFIC UNDERWATER NOISE SAFETY ZONES



Legend

- Project area
- Project area (temporary construction area)
- Approximate extent of reef
- Low Frequency (LF) Cetacean Exclusion Zone (170 m)
- High Frequency (HF) Cetacean and OCW Watch Zone (500m)
- Low Frequency (LF) Cetacean Watch Zone (2.3km)

Source: Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

21.4.3 Impact on fish

Fish with swim bladders are sensitive to noise disturbance although the physiological effects from noise are not yet well understood (Hawkins and Popper, 2017; Popper and Hawkins, 2019). The Project does not intercept any critical fish habitat (such as reef) with 84% of the Project area being considered *Type 3 – minimally sensitive key fish habitat* (refer to **Chapter 11 Marine ecology**). Noise levels from proposed construction methods are not expected to be outside the range of ambient noise already occurring in Merimbula Bay from recreational, charter and commercial vessels.

Noise effects would be short-term, localised and fish within the vicinity of construction activities would avoid or move away from the area as required. The risk of noise disturbance to fish is considered minimal.

21.5 Potential impacts – operation

During operation, a pump would be used to push treated wastewater down the pipeline, however this would not be located underwater, and would be located at the western extent of the pipeline within the STP site. The pump would also be within housing designed for noise mitigation. For these reasons the ocean outfall pump is not expected to generate any notable underwater noise emissions during operation of the ocean outfall.

21.6 Management of impacts

The mitigation and management measures identified to avoid and minimise the identified noise impacts(underwater) are outlined in 21.6.3**,** and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

21.6.1 Performance outcomes

The underwater noise performance outcome for the Project is as follows:

- safety zones are implemented during construction to mitigate hearing injury to marine mammals.

The Project would be designed, constructed and operated to achieve this performance outcome.

21.6.2 Consideration of interaction between measures

Mitigation and management measures in other chapters that are relevant to the management of potential underwater noise impacts include:

- **Chapter 11 Marine ecology**, the results of this underwater noise assessment have been incorporated into the Marine Ecology Assessment (**Appendix G** (Marine Ecology Technical report)). Associated mitigation and management measures for marine ecology are found in **Section 11.7**; and
- **Chapter 20 Noise and vibration (airborne)**, specifically measure NV1 for the preparation of a Construction Noise and Vibration Management Plan (CNVMP).

21.6.3 Mitigation and management measures

Mitigation and management measure ME5 in **Chapter 11.0 Marine Ecology** is applicable to minimise underwater noise impacts from the construction and operation of the pipeline.

Mitigation and management measure ME5 requires that for the construction of the Project, a CNVMP will be prepared as part of the Construction Environmental Management Plan (CEMP), and will include measures for minimising underwater noise emissions. The CNVMP should include general feasible and reasonable work practices as identified in 'Section 6 Work practices' of the *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change (DECC), 2009).

The CNVMP will include the following measures as a minimum:

- undertake works during standard construction hours where practicable;
- works undertaken during June to November during the whale migration period (southern right and humpback whale southern migrations) will be avoided where possible, or otherwise minimised. If

work is required within this period adopt a safety shut-down zone of 170 m and a watch zone of 2.3 km where work activity would either be temporarily halted or varied in event that a LF cetacean occurs within these zones;

- works undertaken outside of June to November, will implement a watch zone of 500 m where marine mammals (dolphins and seals) will be observed and recorded. No shut down zone is required;
- vessels are to have a trained marine mammal observer onboard during all underwater noise generation activities, to record observations of when a cetacean or pinniped enters the 2.3 km watch zone. All marine fauna sightings are to be recorded;
- prior to commencing noise disturbance activities, the watch zone is to be clear of marine mammals for a period of at least 10 minutes; all injured marine mammals should be immediately reported to ORRCA (02 94153333) and National Parks and Wildlife Service Merimbula office (02 64955000); and
- implement vessel speed limits to reduce vessel noise.

21.6.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using the BVSC *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for noise and vibration (underwater) and is provided in **Table 21-10**.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Following the implementation of the mitigation and management measures above, there would be low risks from noise emissions from construction of the Project.

With residual impacts, the Project also has potential to contribute to cumulative impacts. Consideration of cumulative impacts with regard to noise and vibration and other environmental aspects of the Project are addressed in **Chapter 27 Cumulative impacts**.

Table 21-10 Environmental risk analysis with mitigation – Noise and vibration (underwater)

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
General underwater noise	Construction	ME5	Minor	Unlikely	Low

22.0 Air quality

This chapter provides a summary of the air quality impacts associated with the Project. A detailed air quality Technical report (air quality impact assessment (AQIA)) has been prepared for the Project and is included in **Appendix N** (Air Quality Technical report).

Table 22-1 sets out the requirements as provided in the Secretary's Environmental Assessment Requirements (SEARs) relevant to air quality and where the requirements have been addressed in this EIS.

Table 22-1 Secretary's environmental assessment requirements – Air quality

Ref	Assessment requirements	Where addressed in this EIS
13.1	The Proponent must undertake an air quality impact assessment (AQIA) for construction and operation of the project in accordance with the current guidelines.	Summarised in **Section 22.3**, **Section 22.4** and **Section 22.5** and **Appendix N**
13.2	The Proponent must ensure the AQIA demonstrates the ability to comply with the relevant regulatory framework, specifically the *Protection of the Environment Operations Act 1997* and the *Protection of the Environment Operations (Clean Air) Regulation 2010.*	Summarised in **Section 22.3**, **Section 22.4** and **Appendix N**

The SEARs require that that the AQIA for construction and operation of the Project in accordance with the current guidelines. The relevant guidelines are as follows:

- the NSW Technical Framework and Technical Notes (The Odour Policy) under the *Protection of the Environment Operations Act 1997* (NSW) (POEO Act); and
- the NSW Approved Methods for Modelling and Assessment and CALPUFF User Guidelines under Part 5 Division 2 Clause 35 of *the Protection of the Environment Operations (Clean Air) Regulation 2010* (NSW).

NSW EPA Odour Assessment Criteria under the Approved Methods is further discussed in Section 3.1 of the AQIA provided in **Appendix N**.

22.1 Assessment approach

The AQIA assessed the potential air quality impacts associated with the construction and operation of the Project. The assessment methodology involved:

- a qualitative construction impact assessment (**Section 22.1.1**, **Section 22.1.2**, and **Section 22.1.3**); and
- a quantitative operational impact assessment (**Section 22.1.4**).

22.1.1 Construction odour assessment methodology

A qualitative assessment of potential odour impacts was carried out for construction works associated with the Project. Potential sources of odour that were assessed included both ceasing the use of existing wastewater infrastructure (the 17 megalitre (ML) effluent storage pond within the STP site, the dunal exfiltration ponds and the existing beach-face outfall), and potential disturbance of acid sulphate soils (ASS).

22.1.2 Construction dust assessment methodology

The qualitative assessment of potential dust impacts on both human and ecological receptors from construction works used the UK Institute of Air Quality Management (IAQM), 2014 *Guidance on the assessment of dust from demolition and construction.* This provides a qualitative risk assessment process for the potential unmitigated impact of dust generated from demolition, earthmoving and construction activities on surrounding sensitive receptors. Consideration is given to the impacts of dust soiling and dust emissions on human and ecological receptors.

The assessment provides a classification of the risk of dust impacts which then allows the identification of appropriate mitigation and management measures commensurate with the level of risk.

The IAQM process is a four-step risk-based assessment as detailed in the AQIA in **Appendix N** (Air Quality Technical report).

22.1.3 Construction vehicle emissions

A qualitative assessment of potential vehicle emissions arising from the combustion of diesel fuels by heavy vehicles and mobile construction equipment was carried out. Dust impacts associated with tracking of soil off-site (track out) were also assessed in accordance with the IAQM methodology described above.

22.1.4 Operation assessment methodology

A quantitative assessment of potential odour impacts used the CALPUFF dispersion model in accordance with the *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2017). Four modelling scenarios were considered when assessing the existing and potential impacts, including two scenarios for the existing STP configuration and two scenarios for the upgraded configuration. The two scenarios for each configuration involved different emission rates (maximum emission rates (MER) and realistic worst case (RWC)).

A description of each modelled scenario is presented in **Table 22-2**.

Table 22-2 Modelled scenarios

Scenario ID	Scenario Name	Description
Scenario 1a	**Existing Operations** (MER)	• operation of existing STP operations; and • odour emission rates based on maximum emission rates and provides a very conservative estimate of operations; which is likely to be representative of upset conditions.
Scenario 1b	**Existing Operations** (RWC)	• operation of existing STP operations; and • odour emission rates based on 75th percentile emission rates and represents an outcome that can be reasonably projected to occur based on day to day operations.
Scenario 2a	**Proposed Operations** (MER)	• operation of proposed STP operations including: - removal of Maturation Pond and Exfiltration Pond Emissions; - inclusion of Storage Tank and Chlorine Contact Tank Emissions; and • odour emission rates based on maximum emission rates and provides a very conservative estimate of operations; which is likely to be representative of upset conditions.
Scenario 2b	**Proposed Operations** (RWC)	• operation of proposed STP operations including: - removal of Maturation Pond and Ex-Filtration Pond Emissions; - inclusion of Storage Tank and Chlorine Contact Tank Emissions; and • odour emission rates based on 75th percentile emission rates and represents an outcome that can be reasonably projected to occur based on day to day operations.

A summary of the data and parameters used as inputs to the computer models: TAPM; CALMET; and CALPUFF are shown in Section 5.4.3 of the AQIA provided in **Appendix N** (Air Quality Technical report). The CALMET and CALPUFF settings have been chosen in accordance with the following documents:

- *Generic Guidance and Optimum Model Settings for the CALPUFF Modelling System for Inclusion into the Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (Barclay & Scire 2011); and
- *Approved Methods for the Modelling and Assessment of Air Pollutants in New South Wales* (EPA 2017).

Meteorological data used by the CALPUFF model to estimate the dispersion of air pollutants is in annex A of **Appendix N** (Air Quality Technical report).

22.2 Existing environment

22.2.1 Meteorology

The nearest Bureau of Meteorology (BoM) meteorological station is the Merimbula Airport Automatic Weather Station (AWS) (Station ID 069147) located approximately 1.1 kilometres north north-east of the STP. Meteorological data from the Merimbula Airport AWS is considered representative of meteorological conditions within the Project area.

Wind speed and direction are important variables in assessing potential air quality impacts, as they dictate the direction and distance air pollutant plumes travel. Seasonally in 2017, the highest average wind speeds were observed during spring and the lowest average wind speeds occurred in autumn. In 2017, annual and seasonal wind roses also showed that calm wind conditions occurred almost 20% of the time. Calm conditions are relevant as they generally result in poorer dispersion of air pollutants and nearfield odour impacts.

Data from Merimbula Airport AWS for 2017 were used in the meteorological model CALMET.

22.2.2 Climate

The Merimbula Airport AWS records climate data for a range of meteorological parameters for the local area including, temperature, humidity, rainfall, wind speed and wind direction. A summary of the long-term data recorded at this station between 1998 and 2019 is presented in **Appendix N** (Air Quality Technical report).

A summary of the data is outlined below:

- warmest temperatures are in the summer months;
- July is the coldest month;
- February is the wettest month;
- September is the driest month;
- humidity is higher in the morning compared to the afternoon; and
- wind speeds are higher in the afternoon compared to the morning.

Meteorological data for Merimbula Airport AWS along with prognostic data was used to define the meteorology for the Project.

22.2.3 Existing air quality

Air Pollutants

The BVSC's State of Environment Report 2012 – 2016 (SoER) was used to assess the existing regional air quality. The SoER states that regional air quality within the Bega Valley Shire local government area (LGA) is generally good. The region has very few heavy industries and the primary source of air emissions is generally from wood smoke from wood heaters during the winter months and vegetation burning. The main sources of air pollutants from wood smoke are particulates, carbon monoxide, nitrogen oxides and volatile organic compounds (VOCs).

Despite no long-term monitoring data available in Merimbula, a snapshot of particulate concentrations (PM_{10} and $PM_{2.5}$) at Merimbula was available from an emergency monitoring station installed during the bushfires in late 2019 and early 2020. On 1 March 2020 (in a period after the bushfires), the 24-hour average concentration for $PM_{2.5}$ and PM_{10} was found to be below the 24 hour Maximum and annual average criteria for $PM_{2.5}$ and PM_{10}. These concentrations are considered likely to be fairly typical of annual average concentrations observed within a rural coastal area with limited sources or air pollution within the regional airshed.

Odour

BVSC has advised that there have been no odour complaints logged with Council relating to the operation of the existing STP.

As described in more detail in **Chapter 13 Landform geology and soils**, some locations around the Project area are mapped as having a potential risk for the presence of acid sulfate soils (ASS). ASS, when disturbed, can release a sulfuric odour when sediments are disturbed (due to the high level of organic content within the sediments).

22.2.4 Terrain

Terrain data were captured from National Aeronautics and Space Administration (NASA's) Shuttle Radar Topography Mission (SRTM), which produces terrain information for the entire globe. The Merimbula STP site lies in a low-lying area just off the coastline to the east approximately one to 10 metres (m) above sea level, with higher elevations to the west.

Given the nature of the terrain around the STP, topography is not expected to heavily influence air quality the dispersion patterns.

22.2.5 Land use and sensitive receptors

Existing Land use and sensitive receptors

The Merimbula STP is located off Arthur Kaine Drive and is bound by the Merimbula Airport to the north and Pambula Merimbula Golf Club to the east, south and west. There are several residential and commercial properties located to the south-east of the STP on Arthur Kaine Drive, with the nearest sensitive receptor being about 220 m away.

The remaining land use between properties on Arthur Kaine Drive and Merimbula and Jiguma Beaches is characterised as predominantly natural vegetation and includes endangered Bangalay Sand Forest. The Project area also includes a large strip of land extending from Pambula Beach to Merimbula Beach. With the exception of residential and commercial properties situated in Pambula, the land use adjacent to the western boundary of the Project is primarily native vegetation.

A total of 16 discrete receptors were identified and considered representative of nearby sensitive receptor locations as shown in **Figure 22-1**.

FIGURE 22-1: LOCATION OF MODELLED DISCRETE RECEPTORS

N
0 200 400 m

AECOM

Legend

Project area

Project area (temporary construction area)

Modelled discrete receptors

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

22.3 Potential impacts – construction

22.3.1 Odour Impacts

Potential odour impacts from the Project area during construction would be temporary in nature. Potential sources of odour would include both ceasing the of use of existing wastewater infrastructure and potential disturbance of ASS.

Construction of the STP upgrade is predicted to take approximately 12 to 24 months. During construction, there is the potential for a change in the overall site odour profile due to ceasing the use of the 17 ML effluent storage pond at the STP site, the beach-face outfall, and the dunal exfiltration ponds. The cessation of the use of these features would all be expected to decrease the odour emitted from the site during construction. This change to the overall site odour profile would continue through to operation (as discussed in **Section 22.4**).

As discussed in **Chapter 13 Landform geology and soils**, there is a minor potential that ASS would be encountered during the construction of the Project. Odour impacts can occur from the potential disturbance of ASS during excavation works. When exposed to air the iron sulphides in the ASS react with oxygen and water and generally produce odour. Most of the Project area is not mapped as containing ASS; however, there is the potential to encounter ASS during ground disturbing works for the proposed ocean outfall pipeline. With the drilling method proposed (i.e. trenchless) and adequate mitigation and management measures during the drilling process, odour impacts from any acid sulphate soils encountered are expected to be localised and minor. The mitigation and management measures for the Project also propose that spoil from directional drilling is captured, recycled in the drilling process where possible and otherwise removed from the Project area and disposed of at a licensed facility. Further, ground disturbance within the construction laydown area within the Pambula Merimbula Golf Club would be avoided.

Potential impacts and mitigation and management measures for ASS are discussed in greater detail in **Chapter 13 Landform, geology and soils**. Potential odour impacts during construction would be temporary in nature and not expected to be significant.

22.3.2 Dust impacts

The magnitude of the unmitigated dust emissions from construction were rated as small for track out works and medium for both earthworks and construction due to the expected extent of construction activities. There are no demolition works proposed as part of the Project. The sensitivity of the surrounding area to dust soiling, human health effects and ecological impacts arising from construction activities was assessed as low for dust soiling and human health impacts due to particulate matter effects and medium for impacts due to deposition of dust on ecological areas.

Table 22-3 Summary of risk assessment for construction footprint

Activity	Dust emission magnitude	Sensitivity of area			Risk of dust impacts		
		Dust soiling	Human health	Ecological	Dust soiling	Human health	Ecological
Demolition	Small	Low	Low	Medium	Negligible	Negligible	Negligible
Earthworks	Medium	Low	Low	Medium	Low	Low	Medium
Construction	Medium	Low	Low	Medium	Low	Low	Medium
Track out	Small	Low	Low	Medium	Negligible	Negligible	Negligible

The potential unmitigated dust soiling and human health risks were found to be low to negligible, whereas the potential unmitigated ecological risks were found to be negligible to medium. Therefore, the unmitigated risk rating for construction of the Project ranged from negligible to medium.

22.3.3 Vehicle emissions

Vehicle emissions during construction would be from the combustion of diesel fuel by heavy vehicles, mobile construction equipment and emissions from stationary equipment such as diesel generators. Emissions are expected to depend on the nature of the emissions source i.e. size of the equipment, usage rates, duration of operation etc. Construction traffic would include approximately five to 10 heavy vehicles and 10 to 20 light vehicles per day.

Given the typically transitory nature of the construction equipment, low vehicle numbers, limited sensitive receptors in the receiving environment and the commonly applied mitigation and management measures expected to be incorporated into the operation of the equipment, adverse air quality impacts from the construction of the Project are not expected.

22.4 Potential impacts – operation

Predicted ground level 99th percentile odour concentrations at the 16 sensitive receptors are provided in **Table 22-4** for the modelled scenarios described in **Section 22.1.4** using the estimated odour emission rates.

Table 22-4 Predicted 99th Percentile Odour Concentrations

Sensitive Receptor ID	Predicted 99th Percentile Odour Concentration (OU)				Estimated Odour Concentration Reduction	
	Existing		Proposed			
	MER (Scenario 1a)	RWC (Scenario 1b)	MER (Scenario 2a)	RWC (Scenario 2b)	MER	RWC
R1	**4.9**	2.5	3.8	1.5	22%	41%
R2	2.4	1.3	1.8	0.7	25%	45%
R3	3.5	1.7	2.7	1.0	22%	41%
R4	**4.7**	2.2	3.7	1.4	20%	38%
R5	**6.2**	2.9	**5.1**	1.9	18%	35%
R6	**7.1**	3.2	**6.0**	2.2	16%	32%
R7	2.4	1.2	1.8	0.7	24%	43%
R8	2.1	1.1	1.5	0.6	25%	45%
R9	1.8	0.9	1.3	0.5	26%	46%
R10	1.6	0.9	1.2	0.5	27%	46%
R11	**6.8**	2.7	**6.2**	2.2	8%	18%
R12	3.6	1.5	3.3	1.2	9%	20%
R13	2.4	1.0	2.2	0.8	10%	22%
R14	3.2	1.3	2.9	1.0	10%	20%
R15	1.3	0.7	1.0	0.4	26%	45%
R16	0.6	0.3	0.5	0.2	24%	44%
EPA Criterion (OU)	**4.0**	**4.0**	**4.0**	**4.0**		

**Bold text denotes exceedances of the EPA criterion*

Four modelling scenarios were considered when assessing the existing and proposed impacts from the STP. Two scenarios were modelled for the existing STP configuration and two scenarios modelled for the upgraded configuration. The first emission scenario; based on MER; was representative of upset conditions but was found to be overly conservative and not representative of existing plant conditions based on the history of odour complaint records in the surrounding area i.e. no odour complaints on record. Given the lack of representativeness of the worst-case data, a second emission scenario was adopted which used more RWC emissions to assess the potential odour impacts from the upgraded STP. Based on the RWC scenario modelling results, there were no predicted exceedances of the 99th percentile 4 OU criterion for existing or proposed operations from the Merimbula STP.

Predicted off-site odour concentrations are expected to decrease as a result of the STP upgrade due to the removal of existing large area sources; namely the removal of the effluent storage pond and cessation of the use of the dunal ex-filtration ponds. Given the compliance with the odour criterion, no adverse impacts in relation to ground level odour concentrations are anticipated from the proposal.

Treated wastewater from the upgraded STP would be treated to a higher standard; with treated wastewater discharged via a new ocean outfall away from the beach. Improvements to the quality of the treated wastewater in addition to the remote location of the treated wastewater discharge point, would result in improved air quality with regards to odour emissions. During the operation of the Project, it is anticipated that there would be lower odour concentrations within the vicinity of the existing onshore outfall and there would be an overall improvement in the amenity of the beach with regards to odour.

22.5 Management of impacts

The mitigation and management measures identified to help avoid and minimise the identified air quality impacts are outlined in **Table 22-5,** and would be included in the Construction Environmental Management Plan (CEMP) for the Project.

22.5.1 Performance outcomes

The air quality performance outcomes for the Project are as follows:

- visible dust is managed during construction to minimise the release beyond the Project area boundaries;
- no unnecessary vehicle combustion emissions;
- no soil track-out onto public roads;
- no complaints from receptors in relation to dust emissions; and
- no odour complaints from receptors during construction works; and
- temporary impacts of odour are appropriately mitigated and managed.

The Project would be designed, constructed and operated to achieve these performance outcomes.

22.5.2 Consideration of interaction between measures

Mitigation and management measures in other chapters that are relevant to the management of potential air quality impacts include:

- **Chapter 13 Landform, geology and soils**, specifically measure S5 which addresses potential odour impacts from acid sulfate soils encountered during directional drilling.

22.5.3 Mitigation and management measures

A list of mitigation and management measures to be implemented during construction of the Project are provided below in **Table 22-5**. Note that this list of mitigation and management measures represents a minimum requirement for the Project and additional measures may be needed to further reduce potential dust and odour emissions. As predicted odour concentrations are expected to comply with the EPA criteria, no operational mitigation and management measures are proposed.

Table 22-5 Mitigation and management measures – Air quality

Ref	Impact	Mitigation and management measures	Timing
AQ1	Air quality impacts	Daily construction activities should be planned to consider the expected weather conditions for each workday. Undertake regular dust observations of active excavation, earthmoving works or stockpiling areas, with the aim is to ensure visible dust is not moving off-site and that any areas needing additional measures are identified early. Compile records of observations to enable the demonstration that dust is being managed in an ongoing manner. Records should include (as a minimum) the following: • observation date and time; • area being inspected; • level of dust being generated; • meteorological conditions when observation occurred; and • mitigation/management measures undertaken.	Construction
AQ2	Dust impacts	Minimise exposed surfaces, such as stockpiles and cleared areas, including partial covering of stockpiles with materials such as dust mesh where practicable.	Construction
AQ3	Dust impacts	Water exposed soil surfaces using water trucks or sprinklers during demolition and construction.	Construction
AQ4	Dust impacts	Establish defined site entry and exit points to minimise tracking of soil on surrounding roads. Use wheel washes or shaker grids where the risk of off-site track out of soil is identified.	Construction
AQ5	Dust impacts	Cover heavy vehicles entering and leaving the Project area to prevent material escaping during transport.	Construction
AQ6	Dust impacts and vehicle and equipment emissions	Keep vehicles and construction equipment operating on-site well maintained and turned off when not operating (minimise idling on the site).	Construction
AQ7	Dust impacts	Minimise the handling of spoil when excavating and loading of vehicles.	Construction
AQ8	Odour impacts	Prior to commencement of construction works for the Project, deliver information flyers to the surrounding community; noting there may be some potential temporary odour impacts arising from the Project (e.g. when excavating spoil/sludge from site from the decommissioning of the existing effluent storage pond). Provide contact information directing the community to the operator-run complains management system.	Construction

22.5.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for air quality and is provided in **Table 22-6**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental mitigation and management measures have been recommended to manage impacts to acceptable levels.

The residual risk presented below is the risk of the environmental impact after the proposed mitigation and management measures have been implemented. Following the implementation of the mitigation and management measures above, there would be low to medium risks from the Project on air quality during construction, however these impacts would be temporary.

Table 22-6 Environmental risk analysis with mitigation– Air Quality

Summary of Impact	Construction/operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Dust emissions causing nuisance to neighbours	Construction	AQ1, AQ2, AQ3, AQ5, AQ7,	Minor	Unlikely	Low
Odour impacts during construction	Construction	AQ7	Insignificant	Possible	Low
Adverse impacts to sensitive receptors from vehicle emissions	Construction	AQ6	Insignificant	Rare	Low

23.0 Social and economic

This chapter provides a summary of the potential social and economic impacts associated with the Project. A detailed social impact assessment technical report has been prepared for the Project and is included in **Appendix O** (Socio-Economic Impact Assessment).

Table 23-1 sets out the requirements as provided in the Secretary's Environmental Assessment Requirements (SEARs) relevant to social and economic impacts and where the requirements have been addressed in this EIS.

Table 23-1 SEARs – Social and economic

Ref	Assessment requirements	Where addressed in this EIS
5.1	The Proponent must assess social and economic impacts in accordance with the current guidelines.	The assessment has been undertaken in accordance with the *Environmental Impact Assessment Practice Note – Social and economic assessment (EIA-N05)* (Transport for NSW, 2013). This is summarised in **Section 23.1** and explained further in Section 3 of **Appendix O** (Socio-Economic Impact Assessment).
5.2	The Proponent must assess impacts from construction and operation on potentially affected properties, businesses, recreational users and land and water users (for example, tourism, recreational and commercial fishers, aquaculture – existing and proposed), including property acquisitions/adjustments, access, amenity and relevant statutory rights.	Potential social and economic impacts on affected receivers during construction and operation are discussed in **Section 23.3** and **Section 23.4.** Refer to **Chapter 19 Property and land use** of the EIS for assessment of property and land use impacts, and **Chapter 18 Traffic and transport** for assessment of access impacts.
5.3	The Proponent must provide 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.	Potential social and economic benefits of the Project to recreational fishing and the oyster industry are discussed in **Section 23.3** and **Section 23.4**.
6.1	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: (l) existing, safe access to and along the foreshore, beach, headland or rock platform for members of the public, including persons with a disability;.	Public access is assessed in **Section 23.3.5** and **Section 23.4.5** (refer also **Chapter 18 Traffic and transport**)
6.1	(n) use of the surf zone	Impacts on the use of the surf zone is addressed in **Section 23.3.5** and **Section 23.4.5.** Refer also to **Chapter 10 Marine and coastal processes**

23.1 Assessment approach

23.1.1 Overview

The social and economic impact assessment (SEIA) has been prepared to assess the impacts of the Project in accordance with the *Environmental Impact Assessment Practice Note – Social and economic assessment (EIA-N05)* (The Practice Note) (Transport for NSW, 2013). These guidelines contain a methodology which can be applied to major infrastructure projects (i.e. not transport projects exclusively). The assessment has also considered *Social Impact Assessment Guidelines for State significant mining, petroleum productive, and extractive industry development* (Department of Planning and Environment) (DPE), 2017) (herein referred to as the 'DPE guidelines') and principles and methods endorsed by the International Association for Impact Assessment (IAIA) (Vanclay, 2003 and Vanclay F, et al, 2015).

The Practice Note provides guidance on the steps to be undertaken when completing a SEIA, including the relevant reporting requirements. This includes identification of the level of assessment appropriate for a particular project. For a project of this scale, the Practice Note requires a 'moderate assessment', which applies to projects with several impacts or impacts of a moderate nature. A moderate assessment was chosen because:

- the Project would generally be an improvement to the baseline situation. It, however, still has the potential to result in a number of perceived and actual adverse impacts on the environment;
- the surrounding environment is highly valued by the community due to its biodiversity values, and the range of recreational and economic opportunities it provides. The Project therefore has the potential to result in impacts to a large variety of people for an extended duration; and
- the Project does not require any permanent property acquisition or severance to individuals within the community.

Further rationale for the level of assessment (scale and magnitude of impact) and the expectations around a moderate SEIA are provided in Table 3-1 of **Appendix O** (Socio-Economic Impact Assessment).

Given socio-economic impacts are interrelated with a range of other impacts (including those associated with amenity, the natural environment and traffic and transport), a socio-economic impact assessment is informed by a range of studies, environmental investigations and community engagement. These assessments were referred to and informed the SEIA.

To determine the socio-economic impacts assessed in this report, the following steps were undertaken:

- definition of the study area (refer **Section 23.1.2**);
- identification and consultation with local communities and stakeholders who could be affected by the Project (refer to **Chapter 6 Engagement** and **Section 23.2.5**);
- development of a baseline profile of the existing social and economic environment for the study area, based on information available from the Australian Bureau of Statistics (ABS), relevant local, regional and State policies and plans, as well as the outcomes of consultation undertaken for the Project;
- identification and assessment of the potential construction, operational and cumulative impacts of the Project (both positive and negative) on social and economic matters, including an assessment of the significance of these impacts (as discussed in **Section 23.3** and **23.4**); and
- identification of measures for managing and monitoring the potential social and economic impacts of the Project.

This social and economic impact assessment has been informed by the outcomes of other technical reports and chapters undertaken as part of the EIS for this Project.

23.1.2 Study area

The study area for the social and economic impact assessment follows the Australia Bureau of Statistics (ABS) geographic boundary Statistical Area Level 2 (SA2) for Merimbula – Tura Beach (the study area). The study area is shown in **Figure 23-1**, and it extends south to Pambula Lake, west to the Bald Hills, and north to Bournda, including the townships of Pambula and Merimbula. The study area covers the Project footprint which includes the geographic extent of the Project.

This study area has been chosen based on the Project's area of social influence, which considers both local community impacts and those on a larger scale such as impacts on business and industry. As wastewater is pumped to the Merimbula STP from pump stations in Merimbula, Pambula and Pambula Beach, these areas are included in the geographic boundary of the study area.

Demographic data from the Bega Valley Local Government Area (referred to as the Bega Valley LGA) has been provided for comparison with the existing baseline demographic profile for the study area.

23.1.3 Assessment methodology

Once the relevant environmental assessments undertaken for the Project had been reviewed and potential impacts identified, they were evaluated based on the likelihood of occurrence and the consequence of the potential social and economic impact. The overall significance of impacts was then determined by combining the likelihood and consequence. The overall significance of impacts presented in this chapter includes consideration of the implementation of mitigation measures and is therefore effectively a residual significance rating.

Further details on the impact significance rating process including a description of key terms are provided in Chapter 3 Methodology of **Appendix O** (Socio-Economic Impact Assessment) and summarised below.

Level of consequence

The level of consequence is based on the extent, duration and severity of the socio-economic impact. The consequence criteria are described in **Table 23-2**.

Table 23-2 Consequence criteria

Consequence levels	Consequence descriptors
Catastrophic	Irreversible, wide-spread and long-term, with limited response to mitigation.
Major	Large change to baseline condition usually resulting in medium to long-term effects. Spatial extent is generally at an LGA or regional level with the potential for substantial effects on the social or economic environment. Negative impacts would require extensive mitigation.
Moderate	Medium change to baseline condition that may be short, medium, or long term. The spatial extent may vary; however impacts would usually respond to mitigation or enhancement.
Minor	Small change to baseline condition, generally short-medium term, confined to a locality or suburb and are able to be mitigated or enhanced.
Insignificant	No discernible positive or negative changes to baseline condition.

Likelihood

Likelihood the impact will occur, based on the criteria described in **Table 23-3**.

Table 23-3 Likelihood criteria

Likelihood	Description	Probability of occurrence (for operational phase of the Project)
Almost certain	Expected to occur in most circumstances	Within 1 year
Likely	Will probably occur in most circumstances	Within 2 years
Possible	Might occur at some time	Within 3-5 years
Unlikely	Could occur at some time	Within 10-20 years
Rare	May occur in exceptional circumstances	More than 20 years

Socio – economic significance of impact

The socio-economic significance of impact matrix is provided in **Table 23-4**. The significance of social and economic impact is determined with consideration of the following:

- consequence of the impact, based on the extent, duration and severity of the impact; and
- likelihood of the impact occurring.

Table 23-4 Assessment matrix for determining the significance of socio-economic impacts

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	High	High	Very High	Very High
Likely	Medium	Medium	High	High	Very High
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

Socio-economic impacts may be experienced by individuals and communities as **positive**, **neutral** or **negative**, depending on individual circumstances, vulnerabilities and attitudes in relation to particular changes (RMS, 2013). For example, the overall significance of impact upon the socio-economic environment for a particular issue could be neutral (if no positive or negative impacts are anticipated), ‘low-negative’ (if minor impacts are anticipated) or ‘low-positive’ (if minor benefits are anticipated).

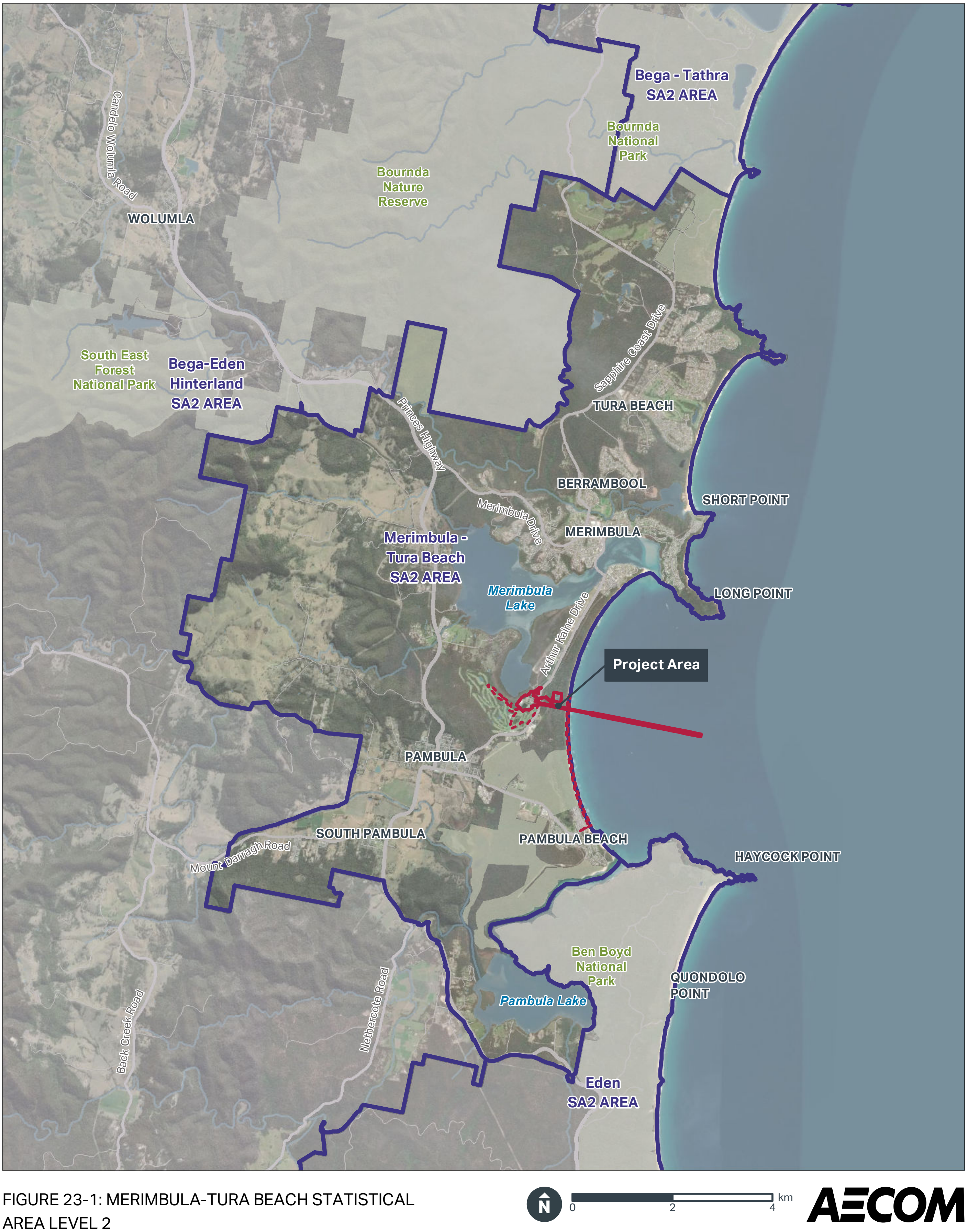


FIGURE 23-1: MERIMBULA-TURA BEACH STATISTICAL AREA LEVEL 2

Legend

- Project area
- Project area (temporary construction area)
- Statistical Area Level 2 (SA2) boundary

23.2 Existing environment

The existing social and economic context of the study area is summarised in the following sections. Further detail is provided in **Appendix O** (Socio- Economic Impact Assessment).

The existing Merimbula STP is located between Merimbula and Pambula on Arthur Kaine Drive, approximately 3.5 kilometres (km) south of the Merimbula town centre and 2.5 km north of Pambula village.

The Project area encompasses the existing Merimbula STP site, the proposed outfall pipeline route, and the areas required for construction of the Project, which include a temporary laydown area on Merimbula Beach and associated temporary access via Pambula Beach, and a temporary laydown area within a portion of the Pambula Merimbula Golf Club (PMGC) grounds.

23.2.1 Demographic profile

The demographic profile, relating to the study area has been informed by statistics sourced from the ABS Census 2016. This demographic profile forms the socio-economic baseline against which potential impacts are assessed. **Table 23-1** summarises the demographic profile of the local study area with comparisons to the Bega Valley LGA.

Table 23-5 Demographic information for the local study area and Bega Valley LGA (ABS, 2016)

Characteristics	Merimbula Tura Beach SA2 (i.e. "Local study area")	Bega Valley LGA
Population and age distribution	• Population of 10,618 • Median age of 54 • 14% of residents under the age of 15 • 32% of residents over the age of 65 • 24% of residents within the young working family demographic of 15-44 years	• Population of 33,253 • Median Age of 51 • 16% of residents under the age of 15 • 26% of residents over the age of 65 • 26% of residents within the young working family demographic of 15-44 years
Unemployment and household conditions	• The unemployment level was 4.6% in 2016 • An IRSD[10] index of 3, indicating the study area has an average number of residents with low income, no qualifications or are in low skill positions	• The unemployment level was 5.4% in 2016 • An IRSD index of 3, indicating the Bega Valley LGA has an average number of residents with low income, no qualifications or are in low skill positions
Cultural diversity	• 21.6% of residents born overseas • 89.5% of residents only spoke English at home • 1.8% of residents are Aboriginal and Torres Strait Islander people	• 20.5% of residents born overseas • 89.5% of residents only spoke English at home • 3.6% of residents are Aboriginal and Torres Strait Islander people
Dwellings and household composition	• In 2016, there were around 5,492 private dwellings. • 69.3% were separate houses • 27.4% were apartment or townhouse style dwellings	• In 2016, there were around 16,263 private dwellings • 82.7% were separate houses • 14.2% were apartment or townhouse style dwellings

[10] The Index of Relative Socio-economic Disadvantage (IRSD) is a general socio-economic index that summarises a range of information about the economic and social conditions of people and households within an area. Unlike the other indexes, this index includes only measures of relative disadvantage.

Characteristics	Merimbula Tura Beach SA2 (i.e. “Local study area”)	Bega Valley LGA
Household composition, tenure and income	• Total 4,347 households: - 66.2% are family households - 31.4% are single person households • 46.7% of residents owned their home outright • 25.4% of residents had a mortgage • 23.2% of residents rented. • The median weekly household income was $1,014	• Total 13,214 households: - 67.2% are family households - 30.4% are single person households • 45.5% of residents owned their home outright • 27.5% of residents had a mortgage • 22.7% of residents rented • The median weekly household income was $986
Employment	• In 2016, 50.1% of residents aged over 15 were employed fulltime, and 38.5 % were employed part time • The top four employment industries were: - Technicians and trades workers (16.4%) - Professionals (15.7%) - Mangers (13.3%); and - Community and personal service workers (13.3%).	• In 2016, 50.1% of residents aged over 15 were employed fulltime, and 38.1 % were employed part time • The top four employment industries were: - Professionals (16.0%) - Technicians and trades workers (15.4%) - Labourers (13.8%); and - Mangers (13.6%)
Business and Industry	• At the end of the 2018-2019 financial year, there were 1,014 registered businesses. The top four industries for business were: - construction (213 businesses) - rental hiring and real-estate services (101 businesses) - accommodation and food services (95 businesses) - retail and trade (90 businesses)	• At the end of the 2018-2019 financial year, there were 3,106 registered businesses. The top four industries for business were: - construction (604 businesses); - agriculture, forestry and fishing 550 businesses) - professional, scientific and technical services 254 businesses) - rental hiring and real-estate services (247 businesses)
Journey to work	• For employed residents within the study area: - 71.3% drove to work in a car as either driver or passenger - 0.7% used public transport to get to work - 11.3% walked or worked from home	• For employed residents within the Bega Valley LGA: - 69.9% drove to work in a car as either driver or passenger - 0.7% used public transport to get to work - 12.3% walked or worked from home
Vehicle ownership	• Of occupied private dwellings: - Around 40.9% had one registered motor vehicle garaged or parked at their address - Around 36.3% had two registered motor vehicles and 18.2% had three or more registered motor vehicles - Around 4.6% per cent did not have a vehicle	• Of occupied private dwellings: - Around 36.8% had one registered motor vehicle garaged or parked at their address - Around 37.7% had two registered motor vehicles and 21.1% had three or more registered motor vehicles - Around 4.4% per cent did not have a vehicle

Characteristics	Merimbula Tura Beach SA2 (i.e. "Local study area")	Bega Valley LGA
Population and employment forecast	The New South Wales 2016 State and Local Government Area Population Projections[11] estimate a population of 33,200 in the Bega Valley LGA by 2036, resulting in a 0.2% net decrease compared to the 2016 census population data.	

23.2.2 Social infrastructure

Social infrastructure refers to community facilities, services and networks that are used for the physical, social, cultural or intellectual development or welfare of individuals, families, groups and the community. Social infrastructure can often be considered a sensitive receiver and may be affected by a project. Examples of social infrastructure may include public libraries, schools, sporting fields, public parks, medical facilities, and community centres.

The area directly surrounding the Project area is generally coastal, and includes conservation areas and national parks and as a consequence there are limited populated areas within the vicinity of the Project area (refer to **Chapter 19 Property and land use** in the EIS for a description of surrounding land use).

The spatial extent used to identify social infrastructure in the vicinity of the Project area is shown in **Figure 23-2**. This represents the social infrastructure that has the potential to be most affected by the Project (e.g. indirect impacts from construction activities such as amenity impacts). The beaches and lakes of Merimbula and Pambula also form an important (and natural) social infrastructure function, supporting opportunities for recreation and leisure for residents and visitors to the area.

[11] https://www.planning.nsw.gov.au/-/media/Files/DPE/Factsheets-and-faqs/Research-and-demography/Population-projections/2019-Bega.pdf

FIGURE 23-2: SOCIAL INFRASTRUCTURE

N 0 500 1,000 m

AECOM

Legend

Project area

Project area (temporary construction area)

Social Infrastructure

Source: Department of Customer Service, 2020; Source: Esri, Maxar, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

23.2.3 Business and industry

The closest cluster of businesses to the Project area are located along Arthur Kaine Drive, which consist of a range of small to medium sized businesses including:

- a boat washing business (300 m southeast);
- a packaging and bulky good retail business (350 m southeast);
- building equipment hire (400 m southeast);
- Fairway Motor Inn (500 m south) and;
- a seafood eatery (600 m south).

The PMGC is also located immediately south of the STP site, and contains a club house with restaurant and café. At present, the area between the boat washing business and building equipment hire is under development (about 350 m southeast) and is anticipated to accommodate a packaging and bulky goods retail business.

Approximately 1.5 km southwest of the STP site is the town of Pambula which includes a mixture of small to medium commercial, retail, and industrial land uses typical of a small town.

The town of Pambula Beach is also located near the proposed temporary construction beach access, and contains a number of businesses including holiday houses, holiday units and camping grounds, the Pambula Surf Life Saving Club, general store and café.

Merimbula is a popular and accessible tourism destination for both domestic and international visitors. A number of strategic documents prepared for the BVSC (e.g. the *Bega Valley Community Strategic Plan 2040*) have indicated the importance of tourism to the local economy, as well as specifying the significant opportunity tourism brings to the economy in the future.

A number of oyster farming businesses operate within the Merimbula and Pambula area through oyster leases within Merimbula Lake, Pambula Lake and nearby estuaries. Whale watching charters operate out of Merimbula, as well as recreational fishing charters which operate from Merimbula, Pambula and Eden (refer below for further information).

In the 2016 census year, the local study area had a population of 10,618, of which 4,296 people were recorded as being in the labour force. In 2019, BVSC released a Labour Force Capabilities Report[12] relating to the Bega Valley LGA, outlining the occupation, skills and employment environment within the Bega Valley LGA, as well as outlining key challenges and opportunities to sustain and grow jobs.

The Labour Force Capabilities Report reported (between the 2011 and 2016 Census periods) a growth in jobs in the following industries in the Bega Valley LGA:

- administrative and support services – total of 428 jobs, up by 89 jobs (26%);
- arts and recreation services – total of 218 jobs, up by 25 jobs (13%);
- health care and social assistance – total of 1,895 jobs, up by 187 jobs (11%);
- agriculture, forestry and fishing – total of 924 jobs, up by 66 jobs (8%);
- information media and telecommunications – total of 113 jobs, up by 5 jobs (5%); and
- construction – total of 1,202 jobs, up by 61 jobs (5%).

The Agriculture, Forestry and Fishing Industry was outlined as an existing area of strength for the BVSC economy (up 8% between 2011 and 2016).

[12] Jobs & Skills Bega Valley, Labour Force Capabilities Report & Practical Resources Guide (BVSC, 2019)

Tourism

Tourism is a key economic driver for the local study area. Merimbula is a tourist destination for domestic and international travellers, with its proximity to the major city centres of Sydney, Melbourne and Canberra, as well as having accessibility by air (Merimbula Airport) and cruise ship (Port of Eden).

Merimbula Bay, and Merimbula and Pambula Lake and surrounding estuaries are important assets to the coastal townships because of their natural amenity and ecological values, and are among the most popular estuaries within the Bega Valley LGA for recreational use. Some of the recreational activities popular within the vicinity of the Project area include swimming, water sports, recreational fishing, whale-watching, walking/hiking, bird-watching and dining on local seafood (e.g. oysters and abalone). It is noted there are a number of marine protected areas within the local study area, which prohibit/restrict these activities.

The *Bega Valley Economic Development Strategy 2016-2021* recognises tourism as being critical for the local economy, and recognises that the local visitor economy is worth approximately $223 million per annum, and that there are about 797,000 domestic visitors and 22,000 international visitors per annum.

Fishing and aquaculture

Within the South Coast of NSW, the recreational fishing sector generates approximately 1800 full-time jobs and contributes approximately $395 million to the economy each year. **Appendix G** (Marine Ecology Assessment) of the EIS provides information on the recreational fishing industry within the vicinity of the Project. Numerous businesses offer charter fishing options within and around Merimbula due to the wide variety of areas and fish habitat accessible including estuarine, coastal and offshore environments.

Commercial fisheries also operate off the coast of the local study area. These include the abalone fishery, lobster fishery, sea urchin and turban shell fishery, ocean haul fishery, ocean trawl fishery, ocean trap and line fishery and estuary general fishery.

The ocean haul fishery is the most productive for the region. Species such as the Australian salmon and Australian sardine are targeted. The abalone fishery also is a significant fishery within the region. The ocean trawl fishery also operates within the Merimbula/Pambula region (however Merimbula Bay is an exclusion zone for trawling), and targets a range of species including snapper, yellow tail, silver trevally and tuna. Various other commercial fishing vessels also operate throughout the South Coast.

A number of recreational and commercial fishing groups have been consulted with during the preparation of this EIS and matters raised are outlined in **Chapter 6 Consultation**.

Oyster farming has occurred in Merimbula Lake since the 1920's and Pambula Lake for over 100 years. It is based primarily around the farming of the Sydney rock oyster. Approximately 125.8 hectares of Marimbula Lake and approximately 97.3 hectares of the Pambula estuary are designated as a priority oyster aquaculture area. It is a significant contributor to the local economy with a positive impact on employment, economic growth and tourism. Within NSW, the oyster aquaculture industry is the largest aquaculture industry by production value and accounts for approximately 32% of the State's total commercial fisheries production (OISAS, 2016).

Abalone is commercially fished and predominantly sold as a seafood delicacy. The abalone fishery within NSW targets the blacklip abalone**,** which is predominantly found in two rocky reef systems located in the vicinity of the Project; Long Point reef (located off the headland bounding Merimbula Bay to the north) and Haycock Point reef (located off the headland bounding the bay to the south). These reefs are commercially harvested for blacklip abalone. Abalone are harvested from rocky reefs off the coast of Merimbula and Pambula Bay by divers and are mostly found close to the shore in shallower waters. They are particularly susceptible to adverse changes in water quality. If the water quality is poor, then abalone would become stressed and grow slowly, which increases the cost of production.

COVID-19 pandemic and bushfire impacts

The 2019-2020 bushfires engulfed much of the South Coast resulting in many businesses and homes being destroyed. Following the bushfires, the global pandemic of COVID-19 emerged resulting in lockdown restrictions with significant economic consequences for the local study area, particularly those associated with the tourism industry. These impacts represent a data gap regarding the projections and statistics outlined within this chapter and the SEIA report. In the short term, it can be expected that forecasted economic growth in the local study area would be halted, and tourism would be primarily from domestic travellers.

23.2.4 Access and connectivity

A detailed description of the existing transport and traffic environment in the study area is provided in **Chapter 18 Traffic and transport** and **Appendix K** (Traffic and Transport report).

The Project area can be accessed by several means of transport:

Road network

The existing road network within the vicinity of the Project includes Arthur Kaine Drive, Toallo Street and the Princes Highway.

Public transport

Public transport within the local study area is limited with bus services in Merimbula limited to one or two services per day. The nearest bus corridor is located on Arthur Kaine Drive.

An on demand bus service operates in Merimbula providing customers with the ability to book a service at a convenient location 20 minutes prior to their trip.

Active transport

Cycleway facilities within the study area include on-road and off-road cycle routes. The Bike Way, an off-road shared path extends close to the Project area along the western side of Arthur Kaine Drive.

Pedestrian access in Merimbula is generally provided through off road shared paths. Pedestrian access near the STP site is provided along the western side of Arthur Kaine Drive, linking to Merimbula town centre in the north and Pambula town centre in the south.

Shared pedestrian and cycling facilities in the study area are being improved to encourage active travel within the area. The strategy for the improvement of the facilities is outlined in the Bega Valley Bike Plan.

In the vicinity of the Project area, beach access is also provided at various points to Pambula Beach, Jiguma Beach and Merimbula Beach. A key public beach access point is at the Pambula Surf Life Saving Club.

23.2.5 Community values

An identification of the community’s values and goals can assist in the assessment of potential social and economic impacts by providing an insight into how the community may perceive these impacts. Community values are those that are shared by residents and visitors about a particular area, contributing to quality of life or sense of place, and relate to things such as:

- the amenity and character of a place based on the physical and natural environment (including heritage and cultural features, air quality, noise levels);
- health and safety;
- access to employment and community services;
- environmental values and natural features enjoyed by local communities; and
- view of the future.

The community values the natural attributes of the local study area (being the coastal and marine environment), and also values how people perceive their community, how safe the areas is, and their ability to provide for the physical, social and economic wellbeing.

The goals of the local community were identified through a review of the *Bega Valley Shire Community Strategic Plan 2040*. The strategic plan identifies a number or priority outcomes, including sustainable living and liveable places. In addition, the *Local Strategic Planning Statement 2040* (LSPS) is a planning tool that provides direction for land use in the Bega Valley LGA through to 2040. The LSPS indicates maintaining the balance between development and environmental protection is of high importance to residents. It also indicates that tourism is a planning priority for the future, where natural and cultural assets of the area can be enhanced to create a year-round tourism industry to support the local economy.

Community consultation was conducted prior to, and during the preparation of this EIS. Key issues and/or themes, identified through the community consultation, related to social and economic impacts include property, amenity, human health, environment and business impacts.

23.3 Potential impacts – construction

This section outlines the potential social and economic impacts that may result from construction of the Project. Potential impacts have been identified in the context of the social baseline discussed in **Section 23.2** and based on an initial screening process.

The social and economic impacts considered can be grouped into the following categories and are assessed in the sections below:

- population and demography;
- property and land use;
- business and industry;
- economy;
- access and connectivity;
- environmental values; and
- local character, identity and amenity.

Mitigation and management measures that would be implemented to manage the identified socio-economic impacts are provided in **Section 23.5**.

23.3.1 Population and demography

Construction of the Project would require a workforce of around 20 workers, with peak construction periods requiring up to 30 workers. This workforce would represent a negligible to small change to the local residential population and demographics profile.

The severity of impact of the Project on the population and demography of the study area is expected to be neutral to small; and therefore the consequence would be insignificant. The likelihood of impacts occurring is rare. Considering this, the overall significance of impact is low-neutral, or low-positive (where construction workers can be sourced from the local area, therefore increasing employment).

23.3.2 Property and land use

Property impacts are detailed in **Chapter 19 Property and land use**. Most of the STP-related construction activities would be contained within the existing STP site. This would minimise the need for property acquisition or temporarily lease arrangements. The Project would not impact access to private properties.

The temporary use of a portion of the PMGC grounds would be required for a temporary construction laydown area. BVSC would negotiate terms of agreement and work directly with the PMGC for the temporary use of this land to minimise impact on the activities and operation of the golf club, before returning the land for use as a golf course following construction.

Section one of the ocean outfall pipeline construction would be undertaken using an underground trenchless drilling method launching from within the STP property to a location beyond the surf zone in Merimbula Bay. Construction impacts to property and land use would therefore largely be avoided. However, a portion of Merimbula Beach may be required for the temporary construction laydown area/intermediate directional drilling site, and the temporary access from Pambula Beach via Jiguma Beach would also be required. A section of Jiguma Beach forms part of the Ben Boyd National Park and therefore, BVSC requires separate approval from the NSW National Parks and Wildlife Service for construction access along Jiguma Beach (refer **Chapter 19 Property and Land use** and **Chapter 5 Statutory context**).

Note that some of the Project area also contains Crown Land, and an approval from Crown Lands would be required for construction and operation of the Project (refer **Chapter 19 Property and Land Use** of the EIS for further information).

Effects upon property and land use would be of a short-medium duration, limited to the duration of construction, during which there would be small changes to baseline conditions. While temporary impacts are likely, the consequence would be minor. As such, the overall significance of impact would therefore be medium-negative

23.3.3 Business and industry

Construction activities have the potential to impact upon businesses and industry within the local study area as a result of the presence of construction sites, construction vehicles accessing the Project area, impacts to the normal enjoyment of parts of Pambula Beach and Merimbula Beach (due to temporary construction laydown and vehicle access), and changes to delivery arrangements. Some local businesses such as takeaway shops/cafes may also experience positive benefits from construction workers visiting them. There is also potential for construction equipment and materials to be sourced from local businesses, however this would be confirmed during detailed design of the Project.

As discussed in **Section 23.3.2**, the construction laydown areas would require temporary use of a portion of the PMGC grounds, whilst temporary access is also required along Pambula Beach and Merimbula Beach to facilitate construction activities. There may be temporary and minor disruptions to the Pambula Surf Life Saving Club and Pambula Beach Caravan Park, given their close proximity to the proposed beach access route.

Construction of the Project would not impact upon activities within Merimbula Lake or Pambula Lake, therefore aquaculture or fishing opportunities within these environments would be unaffected. As outlined in **Section 23.3.6**, marine ecology would not be significantly impacted within Merimbula Bay with the implementation of appropriate mitigation.

Effects on businesses are generally confined to the PMGC, Pambula Beach Surf Life Saving Club and Pambula Beach Caravan Park, in which negotiations undertaken with these business would minimise impacts as far as practicable. The likelihood of construction effecting the operations of these business is likely, with the consequence minor. Considering this, the overall significance of social and economic impact is medium-negative at the most affected businesses. Other businesses in the study area would be less affected.

23.3.4 Economy

Construction activity associated with a project can potentially inject economic stimulus benefits into the local economy. This is through direct employment, associated workforce spending, and provision of goods and services required for construction.

Given the low number of workers required to deliver the Project, there is anticipated to be a minimal impact upon the local economy from direct stimulus from construction workers and supplies.

Considering this, the overall significance of social and economic impact from construction activities on the local economy would be low-positive.

23.3.5 Access and connectivity

Impacts to access and connectivity are addressed in **Chapter 18 Traffic and transport**. The impacts identified would be experienced at various times during the construction phase of the Project as works progress and depend on the construction activity being undertaken. The indicative construction program and proposed working hours are described in **Section 2.4.4** of **Chapter 2 Project Description**.

Impacts relating to access and connectivity may be associated with the following issues: traffic, parking and public transport, pedestrians and cyclists, and beach access. Each of these issues are discussed below, and a summary of the overall impact rating has been provided.

Traffic, parking and public transport

Increased traffic volumes can impact on a community's ability to freely travel. This can cause delays on roads and impact on accessibility around the community, including to community services.

Transport access impacts or delays (including for private vehicles and public transport) on the road network surrounding the Project area may occur as a result of the temporary increase in traffic from construction vehicles. However the construction traffic volumes expected to be generated are small, and the traffic assessment (refer **Chapter 18 Traffic and transport**) found that traffic impacts would be minor, even in a worst case scenario. Although impacts would be possible, the consequence of this additional traffic in terms of a socio-economic impact would be insignificant. The overall significance of impact would therefore be low-negative.

There would be no loss of any car parking spaces to private residences or the public. Direct impacts to parking provision associated with construction activities are not anticipated.

Parking impacts associated with construction worker parking are anticipated to be limited, due to the low number of construction workers expected at any one time, and the number of offsite parking spaces required would be low (as parking would be provided within construction sites also). In addition, the CTMP would contain provisions to manage construction worker parking and minimise parking impacts in the wider area. Construction workers would also be encouraged to park away from residential areas where possible.

The CTMP would include measures to manage construction worker parking to mitigate any potential impact. Given the limited impacts anticipated, the overall impact upon parking would be low-negative.

Active transport

Pedestrian and cyclist routes surrounding the Project area would be maintained during construction. However pedestrian or cyclist access impacts have the potential to occur, including delays and/or increased safety risk due to the presence of construction vehicles (e.g. construction vehicles entering and exiting the STP site, causing delays at the cycle path along Arthur Kaine Drive). As detailed in **Chapter 18 Traffic and transport**, traffic management would be implemented (including signs and/or traffic controllers) to control traffic and notify pedestrians and cyclists of the temporary arrangements. Impacts during construction would be managed through the CTMP, and the community would be notified in advanced of any planned works that would potentially affect pedestrian and cyclist routes within the study area.

Given there is potential for impacts to last the duration of construction (approximately 24 months), the effects would reflect a short-medium change from the baseline pedestrian and cyclist environment. With mitigation in place, the consequence of these changes is minor with the likelihood of impacts occurring unlikely. The overall significance of impact would therefore be low-negative.

Beach and surf zone access

Beach access would remain available to the public throughout construction, however, sections of the beach occupied by construction related activities would be unavailable to the public. At Pambula Beach, construction vehicles would travel along Coraki Drive and down a temporary access track onto Pambula beach. Construction vehicles would then travel north along the beach to the construction laydown near the existing beach-face outfall at Merimbula Beach. The temporary laydown area on Merimbula Beach may prevent pedestrian/beach-goer access from one side of the laydown to the other.

Access to some parts of the surf zone in front of the laydown area on Merimbula Beach is also likely to be impacted at times, if barges are operating in this area (e.g. transporting pipe strings).

There would be a minor and temporary disruption to the community's access to some sections of Pambula Beach and Merimbula Beach given the presence of construction related vehicles, which may also disrupt people's (including tourists') normal enjoyment of the beach. These impacts would be temporary, of limited magnitude (i.e. construction vehicle numbers are expected to be low), and experienced intermittently.

The effects would reflect a short-medium change from the baseline environment. The consequence of these changes is minor and the likelihood of impacts is possible. The overall significance of socio-economic impact would therefore be medium-negative, localised to the Pambula Beach access and laydown area on Merimbula Beach, and experienced intermittently.

Access and connectivity conclusion

In summary, the greatest impacts to access and connectivity would be medium-negative, brought about by the construction laydown on Merimbula Beach and associated beach access from Pambula. Other potential impacts would either be avoided or have a low-negative impact.

23.3.6 Environmental values

Impacts to environmental values were identified as a key issue raised by stakeholders during consultation for the Project. The marine environment within the local study area supports tourism, recreational and commercial fishing opportunities and supports oyster aquaculture, and is therefore highly valued by the community.

Impacts to environmental values could lead to socio-economic impacts including impacts to tourism, marine-based commercial and recreational activities and amenity. Impacts to environmental values during construction would be predominantly associated with poorly maintained vessels, accidental spillages of chemicals/fuels or other materials, accidental release of sediment/or dirty stormwater runoff, noise and air emissions, or inadequate implementation of environmental mitigation and management measures.

Potential impacts to the marine environment and terrestrial environment are discussed below, and a summary of the overall impact rating on environmental values has been provided.

Marine environment

Potential impacts to marine ecology are assessed in the EIS in **Appendix G** (Marine Ecology Assessment) and summarised in **Chapter 11 Marine ecology**. The assessment indicates impacts to marine ecology are primarily associated with installation of Section two of the pipeline (i.e. the above-ground section of pipeline on the seabed).

If mismanaged, construction could cause impacts related to the following:

- Introduction of invasive marine pests - overall the risk of introducing an invasive marine pest during construction phase activities is low with the adoption of standard environmental mitigation and management measures.
- Underwater construction noise - any noise impacts to marine fauna would be short-term and localised. It is anticipated that mobile species such as fish would avoid or move away from the area if noise is experienced, and noise upon any marine mammals would be mitigated with mitigation and management measures, including implementation of safety zones and exclusion zones. With the implementation of appropriate mitigation and management measures, the risk is anticipated to be low.
- Vessel strike - the risk of vessel strike during vessel mobilisation/movement is most likely to involve slow moving marine mammals such as whales and has the potential to cause injury and death. The risk of vessel or cable strike would be reduced by adopting mitigation and management measures during construction activities, and is considered low risk.

- Accidental spills - there is the potential for substances such as fuels and oils from construction vessels to accidentally enter the water through spills or leaks, which would have the potential to impact marine flora and fauna. The potential risk would be reduced to low through the implementation of standard mitigation measures to protect water quality.
- Disturbance and loss of soft sediment habitat - the offshore pipeline construction would involve laying the pipeline directly on the seafloor and anchoring along its length, resulting in an insignificant loss of soft sediment habitat, however, the concrete/rock mattresses would provide an artificial reef formation, introducing new habitat. This would potentially result in a positive impact to species diversity and abundance.
- **Future marine waters aquaculture - c**onstruction activities are not expected to impact on the potential for future aquaculture opportunities given the short-term nature of activities. Additionally, with effective mitigation and management this would be considered low risk.

With mitigation and management measures in place, socio-economic impacts related to impacts to the marine environment are unlikely, and the consequence minor. The overall the risk would be low-negative.

Terrestrial environment

Chapter 12 Terrestrial Ecology provides an assessment of the potential impacts to terrestrial ecology as a result of construction activities. Approximately 0.28 hectares of native vegetation is required to be cleared to facilitate construction, however due to the construction methodology chosen (trenchless drilling for the outfall pipeline), largely avoids impacts to important biodiversity values. Indirect impacts (e.g. potential introduction of invasive species and pathogens, fauna injury and mortality, and noise, vibration and light emissions) have been assessed as being low risk. The assessment also found that risks of significant changes to the water table elevation and quality of groundwater that supports nearby wetlands / groundwater dependant ecosystems are also considered to be low. Mitigation and management measures have been recommended to address potential impacts identified.

With mitigation and management measures in place, socio-economic impacts related to impacts to the terrestrial environment are unlikely, and the consequence minor. The overall the risk would be low-negative.

Environmental values conclusion

It is considered that with the relevant mitigation and management in place, impacts on environmental values from construction activities would be low risk, leading to a low risk of related socio-economic impacts.

Any potential impacts would be over a short period of time representing a small to medium change from the baseline environment. With effective mitigation in place, it is unlikely that impacts would occur, and the consequence would be minor. The overall impact would therefore be low-negative.

23.3.7 Local character, identity and amenity

The preservation of local character and identity is of high importance to the community and is linked with the preservation of a high-quality natural environment. The protection of Aboriginal and non-Aboriginal heritage, as well as the protection of the amenity and accessibility of open space and recreation areas are also rated highly.

The local character, identity and amenity impacts that may occur during construction have been grouped into the following categories and are assessed in the sections below:

- natural environment;
- landscape and visual amenity;
- noise and vibration;
- air quality;
- changes to access and connectivity (addressed in **Section 23.3.5**); and
- Aboriginal heritage and non-Aboriginal heritage.

Natural environment

The Project has been designed to avoid the important biodiversity values recorded nearby within the area, with the proposed loss of vegetation considered relatively small given the abundance of vegetation surrounding the Project area. As such, socio-economic impacts related to the natural environment were assessed to be unlikely and insignificant, giving a low-negative impact overall.

Landscape and visual amenity

Visual amenity is an important part of an area's character and can offer a wide variety of benefits to communities in terms of quality of life and wellbeing, whilst also being positive for economic activity (i.e. tourism). The construction of the Project would result in temporary changes to landscape and visual amenity through loss of vegetation required for the Project and from the presence of construction sites, vehicles and equipment. It is considered that impacts to visual amenity as a result of the construction phase of the Project would be insignificant to minor, with the most noticeable change being the presence of the construction laydown area on Merimbula Beach (and associated access track from Pambula Beach), and the laydown area on the PMGC grounds. Impacts are likely and the overall impact would be medium-negative.

Noise and vibration

Noise and vibration arising from construction activities has the potential to affect a community's ability to enjoy a place and can impact upon human health and wellbeing. It is noted that the STP site is largely isolated from populated areas, therefore limiting potential to create adverse amenity impacts from construction activities.

Appendix L (Noise and Vibration Technical report) details the potential noise and vibration impacts during the construction phase of the Project and is summarised in **Chapter 20 Noise and vibration (airborne)**. This assessment indicates there would be a small noise exceedance of applicable criteria of up to 6 dB(A) (at times) relating to the Pambula Beach Caravan Park. The assessment also indicates that provided safe working distances are complied with, there would be no adverse impacts from vibration intensive works. Overall impacts would be minor and unlikely for most receptors, and therefore low-negative; however for the caravan park at Pambula Beach impacts would be possible, and therefore the worst-case impact would be medium-negative.

Air quality

Dust and odour have the potential to affect human health, reduce the amenity of an area and generate nuisance potentially deterring people from using spaces, visiting businesses or enjoying residential amenity. Potential dust and odour impacts have been assessed as temporary and insignificant during construction in **Chapter 22 Air quality**. Impacts are unlikely, and the consequence would be insignificant. Overall the impact would be low-negative.

Heritage

Heritage reveals the history of a place and safeguards and enriches community ties and belonging to an environment. The loss of heritage items can potentially diminish the sense of place and identity valued by the community.

Aboriginal heritage

Earthworks within the Project area (including directional drilling) are not anticipated to result in any physical impacts to identified Aboriginal sites. Vehicle movements are assessed as carrying a low to moderate significance of impact for identified Aboriginal sites within and immediately adjacent the Project area. When considering the implementation of mitigation and management measures described in **Chapter 14 Aboriginal heritage**, impacts are unlikely and there would be a low risk to Aboriginal heritage as a result of construction activities. The overall impact to local character and identity with respect to Aboriginal values would be neutral (no impacts expected).

Non-Aboriginal heritage

Chapter 15 Non-Aboriginal heritage describes potential impacts upon non-Aboriginal heritage as a result of construction activities. Earthworks activities are not anticipated to result in any physical impacts to the six survey reference trees identified within and adjacent to the Project area. The proposed ocean outfall pipeline would be directionally bored underneath these trees at depth and would not have any direct impacts. Similarly, vehicle movements are not anticipated to result in any impacts. **Chapter 15 Non-Aboriginal heritage** also indicates there would be no impact to marine heritage sites from the Project (including shipwrecks). The overall impact to local character and identity with respect to non-Aboriginal heritage values would be neutral (no impacts expected).

Local character, identity and amenity conclusion

Overall, it is considered that impacts upon local character, identity and amenity during construction would be minor and mostly possible, with amenity impacts near the beach access likely. The overall significance of social and economic impact to local character, identity and amenity of the socio-economic environment would therefore be low to medium-negative with mitigation and management measures in place.

23.3.8 Summary of socio-economic impact from construction of the Project

Table 23-6 provides and overall summary of the significance of each socio-economic impact identified for the construction of the Project.

Environmental mitigation and management measures recommended in this EIS would be implemented to address environmental impacts from construction of the Project that may also contribute to the socio-economic impacts identified (refer **Table 23-8**). Consultation would also be undertaken with the community and stakeholders in accordance with the *Community and Stakeholder Engagement Plan* (CSEP) (AECOM, 2017) prepared for the Project, to provide information about the Project and feedback channels, and assist in minimising impacts.

Table 23-6 Summary of the significance of the socio-economic impacts during construction

Socio economic impact	Overall significance of impact
Population and demography	Low-neutral or low-positive
Property and land use	Medium-negative
Business and industry	Medium-negative
Economy	Low-positive
Access and connectivity including consideration of traffic, parking and public transport, active transport, and beach access	Medium-negative (for the beach laydown and access), or otherwise low-negative
Environmental values including consideration of the marine environment and terrestrial environment	Low-negative
Local character, identity and amenity • including consideration of the natural environment, landscape and visual amenity, noise and vibration, air quality, changes to access and connectivity, Aboriginal heritage and non-Aboriginal heritage.	Low to medium-negative

23.4 Potential impacts – operation

This section describes the potential social and economic impacts that may result during operation of the Project. These potential impacts have been identified in the context of the social baseline discussed in **Section 23.2.**

The potential social and economic impacts from operation of the Project can be grouped into the following categories and are assessed in the sections below:

- population and demography;
- property and future land use;
- business and industry;
- economy;
- access and connectivity;
- community values; and
- local character, identity and amenity.

Similar to **Section 23.3**, outcomes of the assessments are discussed according to the significance of social and economic impact matrix shown in **Table 23-4**.

23.4.1 Population and demography

Operation of the Project would not require new employees and is not likely to affect population or the demographic profile of the area. Impacts would therefore be neutral (no impacts).

23.4.2 Property and land use

As detailed in **Chapter 19 Property and land use**, operation of the Project would not change the existing land use or impact on properties in the Project area, with the exception of the land currently used for access and operation of the dunal exfiltration ponds. The Project proposes to cease the use of the existing dunal exfiltration ponds (however this site would continue to be maintained by BVSC in the short term). The location of the onshore, underground section of the ocean outfall pipeline would be signposted to notify the community in relation to its location. It is noted that access arrangements are required with Crown Land for ongoing access during operation (e.g. for maintenance).

Socio-economic impacts on property and land use would be neutral with no discernible effect given the Project would occupy the existing STP site only, with no permanent acquisition of additional land required.

The change from the existing baseline environment would be neutral and the consequence of change would be insignificant, and it is unlikely impacts would occur. The overall significance of social and economic impact would therefore be low-neutral.

23.4.3 Business and industry

As highlighted in **Section 23.2**, tourism is a major contributor to the local economy, with recreational fishing, commercial fishing and aquaculture being a significant contributor. The marine environment is therefore not only of importance to the community for their well-being but is also highly valuable to the community as a source of employment and income.

Impacts upon marine ecology have been assessed as an improvement compared to the baseline. Therefore, business and industry operating in the study area, namely recreational fishing, commercial fishing, aquaculture and abalone (which are dependent on the quality of the marine environment) would not be adversely impacted by the Project. Further, the ocean outfall pipeline and diffuser may have a positive effect on species diversity and abundance. The pipeline infrastructure would constitute a change from sandy seabed habitat to hard substrate habitat for a range of colonising sessile invertebrates, effectively resulting in the creation of an artificial reef. This may result in a net positive effect on species diversity and/or abundance in the central region of Merimbula Bay, which may also equate to improved recreational fishing opportunities.

In terms of impacts to future aquaculture opportunities, **Chapter 11 Marine ecology** found that the Project would reduce the area of Merimbula Bay available for future marine aquaculture by approximately 50% (as the *NSW Marine Waters Sustainable Aquaculture Strategy* (DPI, 2018) requires that aquaculture must not occur within 1 km of sewage outfall pipelines). Given that aquaculture has been focused around oysters for the last 100 years within the lake and estuarine environments however, it is unlikely that aquaculture would extend into Merimbula Bay in the short or medium term. Additionally, **Chapter 11 Marine ecology** highlights that the Project would not jeopardise future recreational or other commercial fishing opportunities within the study area.

The Project provides the study area with much needed infrastructure, which is a significant improvement to the existing STP infrastructure, and which has a lifespan of approximately 100 years. The Project therefore has the capacity to serve the residents and visitors to the region for years to come, whilst also maintaining water quality and the integrity of the natural environment.

Overall it is considered that the consequence of impact upon business and industry within the study area would be minor, given the improvement of wastewater quality, and the increased distance of the discharge from the surf zone in Merimbula Bay. This would result in an improvement in water quality and marine ecology. Impacts to business and industry would be unlikely (i.e. could occur at sometime within the timeframe of decades, refer **Table 23-4**) and minor, however would be positive. This would result in an overall low-positive impact for business and industry within the local study area.

23.4.4 Economy

Operation of the Project and the benefits it would bring (specifically from the removal of the beach-face outfall) may bring about a positive effect to how the Merimbula Beach area is viewed by the community and tourists alike (relative to the current situation), resulting in a longer term, indirect and positive impact to tourism and the local economy. The Project is also a vital upgrade to an essential piece of infrastructure required for the communities in the area, which may also have a positive effect to the profile of the region as a place for people to stay, move to or invest in.

The likelihood of these impacts is assessed as unlikely, and the consequence would be insignificant. The overall significance of impact from operation on the Project on the local economy would be low-neutral or low-positive.

23.4.5 Access and connectivity

Operation of the Project is not anticipated to generate significant traffic volumes, therefore the road network and road users within the vicinity of the Project are not expected to be impacted. The Project does not impact on the provision of parking spaces. The Project does not include changes to bus or coach services and there is no forecasted increase to workforce numbers utilising this service, therefore, increased bus patronage is not expected. The Project would retain the existing shared path facilities along Arthur Kaine Drive. No changes to private property access would be required as part of the operation of the Project. Access to Crown land would be required with approval (from Crown lands) to access Project elements (e.g. ocean outfall pipeline) during operation for periodic maintenance activities.

As the ocean outfall would be installed underground to out beyond the surf zone, the pipeline would not be visible or affect public access to the beach or surf zone.

The severity of the associated socio-economic impacts would be neutral as there no discernible change to baseline socio-economic condition and the consequence insignificant. As it is rare that impacts would occur, the impact would be low-neutral in accordance with the assessment matrix in **Table 23-4**).

23.4.6 Community values

The marine environment within the local study area supports tourism, recreational and commercial fishing opportunities and supports oyster aquaculture, and is therefore highly valued by the community. As detailed in **Chapter 6 Consultation**, potential water quality impacts from the discharge of treated wastewater into the marine environment has been highlighted by the community as an issue of primary concern, due to its potential to impact on activities valued by the community, as well as impact on their health and safety. Potential impacts to environmental values and health and safety, and therefore community values, are discussed below.

Environmental values

The replacement of the beach-face outfall with the ocean outfall and the upgrades to the STP would result in improvements in the quality of the treated wastewater being discharged into the environment, and would also increase the distance of this discharge to approximately 2.7 km into the bay. This substantially increases the point of discharge from beach-goers compared to the existing beach-face outfall. Conversely, some sensitive ecological receptors within Merimbula Bay would be closer to the proposed ocean outfall discharge than previously. This includes the Merimbula Offshore Artificial Reef approximately 1,000 m to the north-east, followed by Hunter Reef, Haycock Point, and Long Point. However, Marine Water Quality Objectives are expected to be met outside of a 25 m mixing zone at the pipeline diffuser under typical conditions (and extending to 200 m under a worst case scenario). Water quality is assessed further in **Chapter 8 Water quality, hydrology and flooding**, and marine ecological receptors and values likely to experience operational impacts are discussed in **Chapter 11 Marine ecology**.

Chapter 9 Groundwater, indicates ceasing the use of the exfiltration ponds would likely result in a net benefit to the receiving environment over time, as treated wastewater would cease to be released from this location into the environment (and subsequently into groundwater).

Overall, impacts to environmental values of importance to the community, particularly recreational fishing, commercial fishing, abalone fishery, aquaculture and the recreational value of the marine environment would be an improvement compared to the baseline condition given that the quality of the wastewater being discharged would be improved, and seepage from the exfiltration ponds would cease. The duration of operational effects on environmental values would be long term, with the severity of change from the existing baseline condition, small to medium. The likelihood of the impacts on environmental values from the operation of the Project is possible, with the consequence moderate. Considering this, the overall significance of social and economic impact relating to environmental values from the operation of the Project would be a medium-positive.

Health and safety

The community highlighted the risk to human health from the operation of the Project as a primary concern. This is because the discharge of treated wastewater into the marine environment could potentially render seafood unsuitable for human consumption. Additionally, the community considered that treated wastewater discharged near the surf zone of Merimbula Bay could adversely impact on the health of recreational beach users. These impacts simultaneously impact upon the community’s ability to enjoy the natural amenity of the marine environment.

Chapter 17 Human health indicates that the possibility of direct contact with treated wastewater by recreational users of the beach is low. The human health risk associated with re-use of treated wastewater would be lower in post-upgrade conditions when compared with current (pre-upgrade) conditions.

Chapter 16 Hazard and risk indicates that the STP would require minor quantities of hazardous chemicals. The storage of minor quantities of hazardous chemicals is not a significant contributor to the overall risk profile of the Project from a land use safety planning perspective. A standard safety management system would be incorporated to mitigate any health risk associated with the storage and use of these hazardous substances.

Overall, health and safety would be improved compared to the baseline condition given that treated wastewater is no longer discharged directly on the beach (instead it would be discharged 2.7 km offshore) and so is unlikely to come into contact with recreational beach users. The quality of the treated wastewater being discharged would also be improved by the STP upgrades. The duration of operational effects on environmental values would be for the long term, and the consequence moderate (positive). The likelihood of the impacts is possible. The overall significance of social and economic impact related to human health from the operation of the Project would be medium-positive.

Community values conclusion

In consideration of community values overall, of relevance is that the beach-face outfall would no longer be associated with Merimbula Beach and the exfiltration ponds would also be removed. These elements would effectively be replaced with the ocean outfall pipeline, which is expected to have a limited environmental impact, with Marine Water Quality Objectives being met outside of the modelled mixing zones. Overall, operation of the Project is expected to have a medium-positive impact on community values.

23.4.7 Local character, identity and amenity

The preservation of local character and identity is of high importance to the community and is inextricably linked with the preservation of a high-quality natural environment. The community within the study area are likely to take pride in their coastal towns, and highly value their natural environment, which is also likely to contribute to their wellbeing. Preservation of the natural environment is therefore intimately linked with the community's sense of identity.

Amenity can be impacted by noise, air quality and access impediments. Of particular relevance to the Project is the potential for unsightliness or offensive odours, which can be actual or perceived by the community.

The significance of potential socio-economic impacts relating to components which comprise local character, identity and amenity during operation of the Project are outlined below.

Natural environment

Chapter 8 Water quality hydrology and flooding assesses the impacts to water quality from operation of the Project, finding that the quality of treated wastewater discharging into Merimbula Bay would be improved, and also that Marine Water Quality Objectives would be met at the boundary of a 25 m mixing zone from the pipeline diffuser under typical conditions (increasing to a 200 m mixing zone under a worst case scenario) (noting that these results are based on modelling undertaken using existing treated wastewater quality values, and therefore would be improved under the improved treated wastewater quality as a result Project).

Chapter 11 Marine ecology outlines potential impacts to marine ecology, being low risk given the improvement in the quality of the treated wastewater discharge, and the increased distance of the discharge to sensitive ecological receptors. **Chapter 12 Terrestrial ecology** outlines the operation of the STP would not impact surrounding land uses including extensive natural environments of Ben Boyd National Park and Merimbula Beach.

The natural environment is primarily expected to be improved from the current situation, with an increase in quality of treated wastewater discharged from the STP, and removal of the beach-face outfall from Merimbula Beach.

The duration of operational effects on the natural environment would be long term, and the severity of change from the existing baseline condition would be small to medium. The impacts would be possible, with the consequence moderate. Considering this, the overall impact on local character, identify and amenity from the operation of the Project would be medium-positive.

Noise and vibration

Chapter 20 Noise and vibration (airborne) indicates a minor increase in noise (up to 0.5 decibels) from operation of the upgraded STP during operation, which is expected to be indiscernible and is below applicable noise criteria. Noise emissions during operation are therefore not expected to impact amenity of the local area including nearby sensitive receivers.

Given the above, any amenity impact resulting from operational noise and vibration would be long term, the consequence would be insignificant, and the likelihood of impacts rare. The overall impact on local character, identity and amenity from operational noise and vibration is considered low-negative.

Air quality

Chapter 22 Air quality details the potential operational air quality impacts from the Project. Predicted offsite odour concentrations are expected to decrease as a result of the STP upgrade, due to the removal of odour inducing sources (i.e. the STP effluent pond and exfiltration ponds). The duration would be long term, the consequence would be insignificant, and the likelihood of impacts rare. The overall socio-economic impact as a result of air quality impacts, is considered low-positive.

Local character, identity and amenity conclusion

Overall it is considered that impacts to local character, identity and amenity during operation would represent a long term change from the baseline environment. The potential severity of this change would be small to medium, and the consequence level would range up to minor. Impacts are possible, and overall the impact to local character, identity and amenity is expected to be low to medium, and positive.

23.4.8 Summary of socio-economic impact from operation of the Project

Table 23-7 provides and overall summary of the significance of the socio-economic impacts identified for the operation of the Project. Environmental mitigation and management measures recommended in this EIS would be implemented to address environmental impacts from construction of the Project that may also contribute to the socio-economic impacts identified (refer **Table 23-8**).

Table 23-7 Summary of the overall significance of the socio-economic impacts during operation

Socio economic Impact	Overall significance of impact
Access and connectivity	Low-neutral
Property and land use	Low-neutral
Community values • including consideration of environmental values and human health.	Medium-positive
Local character, identity and amenity • including consideration of impacts to the natural environment, noise and vibration and air quality	Low to Medium positive
Business and industry	Low-positive
Population and demography	Neutral
Economy	Low-neutral or low-positive

23.4.9 Project benefits

As highlighted in **Table 23-7** there would be a number of potential benefits as a result of the Project.

The Project would cease the disposal of treated wastewater at the current beach-face outfall and to the dunal exfiltration ponds. Water quality risks associated with those methods of disposal would be eliminated. Removal of the beach-face outfall discharge and an improvement in water quality would result in a number of benefits to the socio-economic environment within the study area by improving recreational fishing, commercial fishing and aquaculture. The recreational and amenity benefits associated with improved water quality would also indirectly benefit the tourism sector. There would also be a reduced potential for recreational beach users to come into contact with wastewater discharge, which at present, is periodically discharged directly onto Merimbula Beach. The improved treatment of wastewater also provides additional opportunities for beneficial re-use options into the future.

The benefits are summarised below:

- the Project would result in improved treated wastewater quality. This reduction in risk means there are potential benefits to the health and values of both estuaries, including recreational use and fishing;

- the quality of treated wastewater discharge is improved and the distance of this discharge to sensitive receivers, notably Merimbula and Pambula Lake where aquaculture is located, is increased. The ocean outfall pipeline would allow treated wastewater to disperse away from Merimbula Beach;
- ceasing disposal of treated wastewater to the dunal exfiltration ponds is likely to improve groundwater quality beneath the ponds over time, including the component of groundwater that flows westwards and discharges to Merimbula Lake. This again would be beneficial to water quality within Merimbula Lake and its associated uses. The exfiltration ponds are generally found in an area containing Aboriginal heritage values, and so ceasing their use may also carry benefits in protecting these values due to their proximity; and
- the ocean outfall pipeline and diffuser may have a positive effect on species diversity and abundance. The pipeline infrastructure would constitute a change from sandy seabed habitat to hard, effectively resulting in the creation of an artificial reef. This may result in a net positive effect on species diversity and/or abundance in the central region of Merimbula Bay, which may also equate to improved recreational fishing opportunities.

23.5 Management of impacts

The mitigation measures identified to help avoid and minimise the identified social and economic impacts are outlined in **Table 23-9,** and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

23.5.1 Performance outcomes

The social and economic performance outcomes for the Project are as follows:

- construction impacts on businesses and industry are minimised through adequate mitigation and consultation; and
- environmental and cultural values of importance to the community, tourists and commercial operators (commercial fishing) and the recreational value of the marine environment (for recreational fishing, swimming) are improved.

The Project would be designed, constructed and operated to achieve these performance outcomes.

23.5.2 Consideration of interaction between measures

As discussed throughout this chapter, the assessment of social and economic impacts considers a range of inputs from other technical environmental assessments undertaken for the EIS, including their respective mitigation and management measures, as other environmental impacts can bring about socio-economic impacts. Mitigation and management measures in other EIS chapters that are relevant to the management of socio-economic issues include those listed in **Table 23-8**.

Table 23-8 Mitigation and management measures from other EIS assessments relevant to socio-economic impacts

Socio economic issue	Relevant EIS assessment (including mitigation and management measures)
Access and connectivity	• Chapter 18 Traffic and transport
Property and land use	• Chapter 19 Property and land use
Community values and environmental values	• Chapter 8 Surface water and flooding • Chapter 9 Groundwater • Chapter 10 Marine and coastal processes • Chapter 11 Marine ecology • Chapter 12 Terrestrial ecology • Chapter 13 Land, geology and soils • Chapter 17 Human health

Socio economic issue	Relevant EIS assessment (including mitigation and management measures)
Local character, identify and amenity	• Chapter 14 Aboriginal heritage • Chapter 15 Non-Aboriginal heritage • Chapter 18 Traffic and transport • Chapter 21 Noise and vibration (airbourne) • Chapter 22 Air quality
Population and demography	• Chapter 24 Sustainability
Economy	• Chapter 24 Sustainability
Business and industry	• Chapter 18 Traffic and transport • Chapter 19 Property and land use • Chapter 21 Noise and vibration (airbourne) • Chapter 22 Air quality • Chapter 24 Sustainability

Other mitigation and management measures to be implemented to address socio-economic impacts are presented in **Table 23-9**.

Table 23-9 Mitigation and management measures - Social and economic

ID	Impact	Mitigation measure	Timing
SE1	Lack of community involvement	Continued consultation with the community throughout the assessment, approval and construction phases (and post construction) of the Project in accordance with the *Community and Stakeholder Engagement Plan* (CSEP) (AECOM, 2017). Using a variety of engagement tools and methods, the aims of communications and consultation are to provide the community with: • accurate and accessible information regarding the processes and activities associated with the Project; • appropriate avenues for the community to provide comment or raise concerns; and • responsiveness to issues and concerns raised.	Construction and Operation
SE2	Lack of community involvement	In conjunction with mitigation measure SE1, a socio-economic impact monitoring framework would apply throughout the construction phase of the Project (and three months post construction) to: • monitor the communities experience and perception of impacts; • monitor the effectiveness of the identified mitigation and management measures outlined in the various EIS chapters prepared for the Project; and • monitor complaints and public enquiries.	Construction and Operation

ID	Impact	Mitigation measure	Timing
SE3	Impact to areas used for construction laydown and access, including impacts to nearby businesses	The construction laydown area on Merimbula Beach and associated access would be planned to minimise impacts on beach users. Public access to Pambula beach would be maintained at all times. Establishment and use of the laydown area and access track would consider public safety and maintaining safe access around the site. Signage would be erected at the access to, and along the length of, Pambula Beach with the purpose of informing the public of the location of construction activities.	Construction
SE4	Impacts to visual amenity	All construction sites would be maintained to minimise visual amenity impacts, including keeping sites tidy, litter-free, and with well-maintained fences/bunting, signage, erosion and sediment controls, and entrances and access tracks. Hoarding may also be used (where appropriate).	Construction
SE5	Population and demographics and impacts related to economy	BVSC would investigate opportunities to source construction workers, equipment and materials from the local community.	Construction

23.5.3 Environmental risk analysis

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented. A residual risk analysis was undertaken for socio-economic issues and is provided in **Table 23-10.**

Note that positive impacts are not mitigated against and have not been included, except where noted. All of the socio-economic impacts from operation of the Project were found to be neutral, or otherwise positive.

The residual risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact.

The construction activity at and immediately surrounding the project would result in residual (negative) social construction impacts, post mitigation. However, these changes would be temporary.

Table 23-10 Environmental risk analysis with mitigation - Social and economic

Summary of Impact	Construction/ operation	Management and mitigation ID reference	Consequence	Likelihood	Residual risk
Access and connectivity: Impacts associated with construction traffic and the beach access and laydown area	Construction	SE1, SE2, SE3	Minor	Possible	Medium
Property and land use: Impacts to property and land use associated with construction areas required	Construction	SE1, SE2, SE3	Minor	Likely	Medium
Community values: Impacts to Environmental values	Construction	SE1, SE2	Minor	Unlikely	Low
Local character, identify and amenity	Construction	SE1, SE2, SE4	Minor	Possible	Medium
Economy: Impacts to the local economy	Construction	SE5	Insignificant	Possible	Low-positive
Business and industry: Impacts to nearby businesses	Construction	SE1, SE2, SE3, SE4	Minor	Possible	Low

23.6 Conclusion

This chapter summarises the assessment of potential socio-economic impacts from construction and operation of the Project contained in **Appendix O** (Socio-Economic Impact Assessment), and reproduces the mitigation and management measures recommended to address the impacts identified.

The key socio-economic impacts associated with the Project are related to construction and the temporary use of the PMGC grounds and Merimbula Beach for temporary laydown areas (including construction access along Pambula Beach, Jiguma Beach and Merimbula Beach). Agreements would be negotiated with relevant landowners and businesses for the temporary use of property during construction and land would be returned to their original use and a similar pre-construction condition following construction (or as otherwise agreed to with the relevant landholder). The community would be made aware of temporary changes through consultation during the construction period, and measures onsite such as signage and traffic management.

During operation the Project would improve the marine environment from the baseline condition (existing beach-face outfall) and provide the local study area with an essential piece of infrastructure, resulting in improved treated wastewater quality and benefits to the marine environment enjoyed by the community. Benefits of the Project are further described in **Section 23.4.9**.

24.0 Sustainability

This chapter describes and presents the approach to sustainability for the Project and how specific objectives, initiatives and considerations are being incorporated into the development of the Project.

This chapter also identifies how performance outcomes and mitigation and management measures for other environmental aspects (e.g. biodiversity, water quality) would contribute towards the sustainability performance of the Project.

The climate change risk assessment for the Project is closely linked with the sustainability assessment and is summarised in **Chapter 25 Climate change risk**.

24.1 Secretary environmental assessment requirements

Table 24-1 sets out the requirements as provided in the SEARs relevant to sustainability and where the requirements have been addressed in this EIS.

Table 24-1 SEARs – Sustainability

Ref	Assessment requirements	Where addressed in this EIS
15.1	The Proponent must assess the sustainability of the project in accordance with the Infrastructure Sustainability Council of Australia (ISCA) Infrastructure Sustainability Rating Tool and recommend an appropriate target rating for the project.	**Section 24.6**
15.2	The Proponent must assess the project against the current guidelines including targets and strategies to improve government efficiency in use of water, energy and transport.	**Section 24.3**

The following sections describe the sustainability principles and policies underpinning and supporting achievement of the SEARs, key sustainability objectives, risks and opportunities of this Project and an evaluation of the Project's potential sustainability performance against ISCA's Infrastructure Sustainability (IS) Rating Tool and current guidelines.

24.2 Sustainability principles (ecologically sustainability development)

Ecologically sustainable development (ESD) refers to 'using, conserving and enhancing the community's resources so that ecological processes, on which life depends, are maintained and the total quality of life, now and in the future can be increased' (Commonwealth of Australia, 1992).

Four principles have been identified to assist in achieving ESD which are defined in the *Environmental Planning and Assessment Regulation 2000* (NSW) (Part 3 of Schedule 2) and in the *Protection of the Environmental Administration Act 1991* (NSW). These include:

- the precautionary principle - where there are threats of serious or irreversible environmental damage, lack of full scientific certainty should not be used as a reason for not implementing mitigation and management measures or strategies to avoid potential impacts;
- inter-generational equity - the present generation should ensure that the health, diversity and productivity of the environment are equal to or better for the future generations;
- conservation of biological diversity and ecological integrity - ecosystems, species and genetic diversity within species should be maintained; and
- improved valuation and pricing of environmental resources - economic values for services provided by the natural environment should be determined, such as the atmosphere's ability to receive gaseous emissions; cultural values; and visual amenity.

The principles of ESD for other environmental matters are provided in **Chapter 28 Project synthesis** of this EIS.

24.3 Sustainability governance and policy

24.3.1 Overview

An assessment of the Project against current guidelines including targets and strategies to improve government efficiency in use of water, energy and transport, is provided below, including:

- the NSW Government sustainability commitments;
- BVSC sustainability commitments;
- Merimbula Sustainability Policy;
- Merimbula Sustainability Strategy; and
- ISCA – IS Rating Tool.

24.3.2 NSW Government sustainability commitments

At the state level, there are a range of policies and legislative mechanisms to improve the sustainability and resilience of government including providing for energy efficiency and resource use. The sustainability initiatives and targets developed for this Project as described in **Section 24.4** would serve to support key policies including:

- NSW *Climate Change Policy Framework* – which aims to set out the NSW Government's role in reducing carbon emissions and addressing the risks posed by climate change. Aspirational objectives of this Framework are to achieve net-zero emissions by 2050 and to help NSW become more resilient to a changing climate;
- NSW Government's *Government Resource Efficiency Policy* (GREP) – which aims to reduce operating costs and increase the efficiency of the resources used across government. The Policy addresses key challenges including rising costs of energy, water usage, improving air quality and waste management and driving resource-efficient technology and services through purchasing power;
- NSW *State Infrastructure Strategy 2018-2038* – which sets out the NSW Government's priorities for sustainable growth over the next 20-years including a commitment to improve infrastructure resilience to shocks and stressors including natural hazards such as floods, bushfires, and storms; and
- Transport for NSW (TfNSW) *Sustainability Design Guidelines version 4* (TfNSW SDGs) (TfNSW, 2017) – which seek to deliver sustainable development practices by embedding sustainability initiatives into the planning, design, construction, operations and maintenance of transport infrastructure projects. The methodology provided in these guidelines is transferable to other types of infrastructure projects. The guidelines have been effectively used and applied more widely to other projects in NSW and can also be applied to the Project. The Project is also seeking an IS rating, a widely recognised national sustainability benchmark that is aligned to the aim of the TfNSW SDGs to embed sustainability into projects and assist projects to reach their full potential in terms of sustainability.

24.3.3 Bega Valley Shire Council sustainability commitments

Community Strategic Plan 2040

The BVSC *Community Strategic Plan 2040* (CSP), is the main strategic document for the Bega Valley Shire and aims to build a stronger and better community. The CSP was developed following engagement with individuals, community groups, government agencies and other organisations. The CSP outlines the community vision, six outcomes, 12 goals and 30 strategies to help achieve the desired future for the shire. A number of these goals and strategies are relevant to the Project, including the 'Sustainable living' goal and associated strategy to achieve this goal, which is to 'adopt sustainable design principles in the planning of our urban areas and infrastructure provision and encourage sustainable buildings and lifestyles'.

Climate Resilience Strategy 2050

The *Bega Valley Shire Climate Resilience Strategy 2050* (BVSC, 2020) puts forward a resilience approach to address the projected impacts of climate change across the local government area (LGA). The draft strategy was on public exhibition from 4 November 2019 to 16 December 2019 and was finalised in October 2020. Key response areas, measures and targets of relevance to the Merimbula STP in the strategy include:

- natural systems – coasts and marine: Increase in estuarine health; and
- energy security – net zero emissions (with interim target of 100% renewable electricity by 2030).

The Project would seek to limit its impact on greenhouse gas emissions and resource use, and this is reflected in the Project sustainability objectives (refer to **Section 24.4**). Climate change risk and resilience for the Project is assessed in **Chapter 25 Climate Change risk**.

Clean Energy Plan 2019 – 2030

BVSC's *Clean Energy Plan 2019 – 2030* (BVSC, 2019) has been developed with support from NSW Department of Planning, Industry and Environment (DPIE) and builds on BVSC's existing commitment to greenhouse gas emissions reduction. The plan provides a framework for improvements to BVSC's operational energy efficiency, transition to renewable energy and energy storage. The Merimbula STP is identified as accounting for 7% of BVSC total emissions in the period 2017 – 2018.

Short, medium and long term implementation actions are identified out to 2030. Several opportunities are identified to reduce consumption including energy efficiency measures, replacement of plant, new or amended operational controls and consumption of renewable energy.

Implementation actions relevant to Merimbula include:

- short term (2020 – 2021 financial years):
  - implementation of solar photovoltaic energy at Merimbula STP and investigation of options to achieve 100 per cent renewable generation by BVSC;
  - implement one third of remaining energy efficiency potential, focused on building lighting and STP motor systems (e.g. optimising dissolved oxygen and aerator systems at Merimbula STP);
- medium term (between 2021 – 2022 and 2023 – 2024 financial years): Implement second third of remaining energy efficiency potential, focused on building lighting and STP motor systems;
- long term (between 2024 – 2025 and 2029 – 2030 financial years):
  - 100% renewable energy either from BVSC-generated energy or purchase of renewable energy; and
  - implement final third of remaining energy efficiency potential, focused on building lighting and STP motor systems.

As one of the largest energy consuming sites, Merimbula STP presents significant opportunity for energy improvement through the review of equipment and operating processes including pumps, UV systems, and treated wastewater re-use, and optimising these while meeting EPA licence requirements.

24.3.4 Merimbula Sustainability Strategy

The *Merimbula Sustainability Strategy* (Bega Valley Shire Council, 2020) is a project-specific document that sets out how sustainability will be embedded into the Project during design, construction and operation. The Sustainability Strategy defines the vision for the Project and the supporting Project objectives, which align with *Bega Valley Shire Climate Resilience Strategy 2050*. It seeks to provide overarching direction on how the Project can achieve sustainability outcomes and meet the requirements of the *Environmental Planning and Assessment Act 1979* (NSW) (EP&A Act).

The strategy states that for the Project, sustainability means considering impacts and providing benefits across environmental, social and economic drivers to deliver an outcome that addresses both present and future requirements of the Bega Valley Shire. In order to achieve this vision, the strategy identifies the following sustainability objectives:

- improve and enhance the water quality of waterways and groundwater by meeting the requirements of the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZECC Guidelines) (ANZECC, 2000);
- manage and limit impacts to areas of ecological sensitivity and minimise detrimental impacts to marine ecology;
- manage and limit impacts to sensitive areas of European heritage and Indigenous cultural significance;
- maintain and enhance the public's liveability, amenity and enjoyment of Merimbula's waterways, beaches and green open spaces;
- provide the opportunity for the restoration of the dune systems in the future;
- support and enhance the local and regional economy through the delivery of benefit to aquaculture; agriculture and tourism;
- design and deliver infrastructure that is responsive and resilient to the impacts of climate change; and
- explore options for construction innovation to optimise Project constructability and reduce construction program and costs.

These objectives would be developed further and incorporated into the detailed design, construction and operation phases of the Project. They also form the basis of sustainability objectives outlined in **Section 24.4**.

24.3.5 ISCA IS Rating Scheme

ISCA is the authoritative body that administers the IS Rating Scheme, seeking to promote infrastructure sustainability through the development and operation of all infrastructure projects. The IS Rating Scheme encompasses the IS Rating Tool, a comprehensive evaluation of sustainability performance designed to help infrastructure meet its full sustainability potential across all project stages.

In line with the SEARs, BVSC has committed to pursue an IS Rating, targeting a Design Rating of 'Excellent', under version 1.2 of the Design and As Built IS Rating Tool. An IS Design Rating is considered a 'temporary' rating, applicable for a two-year period following award. In order to maintain an IS Rating, BVSC would be required to pursue an As Built Rating, assessable during the construction period of the Project.

An Excellent Rating requires between 50 and 74 verified points to be achieved from a possible 110 (which includes 10 bonus innovation points). Points are gained through the achievement of IS credits, which cover numerous aspects of sustainability including governance and procurement, stakeholder engagement and community wellbeing, urban design, resource use, climate change, heritage and ecology. The assessment of sustainability and ability to pursue the Excellent Rating is further described in **Section 24.6**.

24.4 Sustainability objectives

Sustainability objectives which have been identified for the Project are included in **Table 24-2**. Objectives are grouped according to the sustainability categories identified within the IS Rating Tool, to complement the sustainability assessment described in **Section 24.6**. Potential supporting sustainability targets and initiatives are also identified in **Section 24.6**.

These targets would be further refined as part of the design process and incorporated into the detailed design, construction and operation phases of the Project.

Table 24-2 Sustainability objectives

Sustainability category	Sustainability objective
Management systems	• demonstrate leadership through implementation of sustainability objectives and embedding these objectives into decision making for the Project; • demonstrate a high level of performance against objectives and appropriate benchmarks; and • be accountable and report publicly on sustainability performance.
Procurement and purchasing	• influence contractors, subcontractors and materials suppliers to adopt these objectives in their works and procurement.
Climate change adaptation	• design and deliver infrastructure that is responsive and resilient to the impacts of climate change.
Energy and carbon	• explore options for construction innovation to optimise Project constructability and reduce construction program and costs (applicable across energy, water and materials); • reduce energy use and carbon emissions during construction and operation; and • support innovative and cost-effective approaches to energy efficiency, low-carbon and renewable energy sources and energy procurement.
Water	• maximise opportunities for re-use of rainwater, stormwater, wastewater and groundwater; and • minimise use of potable water.
Materials	• reduce financial costs associated with resource consumption across assets and activities; • minimise waste through the Project lifecycle; • reduce materials consumption; • consider embodied impacts in materials selection; and • maximise beneficial re-use of spoil.
Discharges to Air, Land and Water	• improve and enhance the water quality of waterways and groundwater by meeting the requirements of the ANZECC Guidelines; and • reduce sources of pollution and optimise control at source to avoid environmental harm.
Land	• maximise re-use of land that has been previously developed; and • assess and manage any contamination through sustainable remediation.
Waste	• see 'Materials' objectives above
Ecology	• manage and limit impacts to areas of ecological sensitivity and minimise detrimental impacts to marine ecology; and • provide the opportunity for the restoration of the dune systems in the future.
Community, Health, Wellbeing and Safety	• maintain and enhance the public's liveability, amenity and enjoyment of Merimbula's waterways, beaches and green open spaces; and • support and enhance the local and regional economy through the delivery of benefit to aquaculture; agriculture and tourism.
Heritage	• manage and limit impacts to sensitive areas of European heritage and Indigenous cultural significance.
Stakeholder participation	• engage and collaborate with the community and local stakeholders in the development of the Project.
Innovation	• promote innovation and generate opportunities for BVSC to engage the community and attract funding.

24.5 Sustainability risks and opportunities

Table 24-3 provides a summary of potential sustainability risks and opportunities that could develop over the course of the Project. While this is a preliminary list, sustainability risks and opportunities would continue to be reviewed and addressed throughout the Project's development and in line with the Project's risk framework. This approach also supports achievement of the risk management credit under the IS Rating Tool (Man-2 credit, described in **Section 24.6** below). which would be developed as part of the Project's Sustainability Management Plan (refer to **Section 24.7.2**). These opportunities have been developed in alignment with the sustainability guidelines and ISCA IS target for the Project as well as in response to the identified sustainability risks.

Table 24-3 Sustainability risks and opportunities

Category (per table 20 2)	Risk/Opportunity
Management systems	**Risks** • that management systems are not in place to manage sustainability appropriately, resulting in poor sustainability outcomes and/or opportunities not realised; and • that Project risks and opportunities would not be comprehensively captured.
	Opportunities • for BVSC to integrate sustainability objectives and common processes into this Project and for future works; and • for BVSC to demonstrate leadership in sustainability for STP and water sector infrastructure.
Procurement and purchasing	**Risk** • that the Project uses non-sustainable materials and products or misses opportunities to establish sustainability criteria and requirements with suppliers as part of procurement process.
	Opportunity • to engage sustainable suppliers and promote the use of sustainable products and suppliers.
Climate change adaptation	**Risk** • that the Project is susceptible to physical risks associated with climate change, including extreme weather events.
Energy and carbon	**Risk** • that the Project results in the release of greenhouse gas emissions that could have been avoided.
	Opportunity • to support innovative and cost-effective approaches to energy efficiency, low-carbon and renewable energy sources and energy procurement. (such as the installation of solar panels).
Water	**Risk** • that the Project uses more water than is anticipated or required.
	Opportunity • that the Project incorporates the facilities to produce treated wastewater that would be suitable for an increased number of beneficial re-use applications in the future. This would ultimately have the potential to improve water resource use on a regional scale.
Materials	**Risk** • selecting materials with high embodied energy, resulting in high attribution of greenhouse gas emissions associated with the Project.
	Opportunity • to explore options for construction innovation to optimise Project constructability and reduce construction program and costs.

Category (per table 20 2)	Risk/Opportunity
Discharges to Air, Land and Water	**Risk** • that the Project results in environmental impacts (e.g. to air, land and water) that could have been avoided
Land	**Opportunity** • to utilise existing brownfield land for the Project and avoid greenfield development.
Waste	**Risk** • that the Project produces waste that could have been avoided.
	Opportunity • to review waste streams and collection methods to promote re-use and reduce waste to landfill.
Ecology	**Risk** • that the Project results in impacts to ecological values associated with the site that could have been avoided.
	Opportunity • to explore options for the Project that would minimise impacts to ecological values, through the adoption of non-intrusive construction techniques, and a design layout that would avoid areas of ecological sensitivity as far as practicable
Community, Health, Wellbeing and Safety	**Risk** • that the Project is detrimental to community welfare.
	Opportunity • to improve community health and wellbeing by improving water quality at Merimbula Beach
Heritage	**Risk** • that opportunities to conserve or facilitate appreciation of heritage values are not released, or heritage values are otherwise diminished (for both Aboriginal and non-Aboriginal heritage).
Stakeholder participation	**Risk** • that Project stakeholders aren't adequately identified or engaged with.
	Opportunity • for early and effective engagement with Project stakeholders.
Innovation	**Opportunity** • to explore options for construction innovation to optimise Project constructability and reduce construction program and costs.

24.6 Sustainability assessment

In support of BVSC's commitment to pursue an Excellent Design Rating, **Table 24-4** describes how the Project intends to achieve the various requirements of the IS Rating Tool. This is a preliminary assessment of how sustainability would be achieved in the Project and should be continually reviewed throughout the Project's development, as initiatives and targets are refined according to design and construction progress. The achievement of credit requirements also contributes to the achievement of the Project's sustainability objectives, previously described in **Section 24.4**.

These initiatives and targets would be further refined as part of the design process and committed to in a Sustainability Management Plan and included in the contract documents for all detailed design, construction and operations contracts.

Table 24-4 provides detail/evidence of how these targets would be integrated into the Project or where they have been addressed in the EIS.

Table 24-4 Preliminary sustainability assessment

Category	Credit ID and name	Indicative or actual initiative to achieve credit requirements	Where it is addressed in the EIS/public domain	Considerations for future stages of the Project's development
Management systems	Man-1 Sustainability leadership and commitment	Sustainability objectives are described within a Project sustainability strategy, as well as broader BVSC strategies and plans, which have application to all BVSC infrastructure, including this Project. The objectives of the Merimbula Sustainability Strategy cover environmental, social and economic aspects and the Strategy has been endorsed by BVSC senior management.	More information is available on BVSC's Climate change and sustainability webpage, available at: https://begavalley.nsw.gov.au/cp_themes/default/page.asp?p=DOC-QBD-34-18-80#sustainability	Implement Sustainability Strategy and other BVSC strategies and policies
	Man-2 Risk and opportunity management	A risk and opportunity register will be implemented as part of the requirements of a Sustainability Management Plan. The register should be framed against BVSC's enterprise risk framework.		
	Man-4 Inspection and auditing	Inspections and audits are regularly scheduled and detailed as part of the Sustainability Management Plan.		
	Man-5 Reporting and review	Reporting on sustainability performance is conducted in line with the goals and outcomes identified in the *Community Strategic Plan 2040*.		
	Man-6 Knowledge sharing	Sustainability will form part of regular Project management meetings to share sustainability knowledge, risks and opportunities throughout the Project's development. In addition, it is proposed that design and construction contractors adopt knowledge forums (e.g. workshop or presentation) on material sustainability issues and how the Project has addressed those issues. Such presentations could then be shared e.g. with other BVSC projects.		

Category	Credit ID and name	Indicative or actual initiative to achieve credit requirements	Where it is addressed in the EIS/public domain	Considerations for future stages of the Project's development
	Man-7 Decision-making	Design teams carry out formal Value Management (VM) for the Project, recording and formalising decisions. Options selection and design development for the Project involved multi-criteria analysis and workshops, including meetings with the Community Working Group (CWG). The multi-criteria analysis considered sustainability (emissions reduction, climate resilience, adaptive capacity) alongside other environmental, social and economic aspects. Some Project alternatives considered (and not progressed) involved high emissions options such as inland re-use and storage schemes which would have involved energy use for the pumping of treated wastewater over larger distances.	**Chapter 4 Project development and alternatives**	
	Pro-1 Commitment to sustainable procurement	BVSC is a member of a Local Government sustainable procurement program that provides resources to assist in embedding sustainability into procurement processes and policies.	BVSC's procurement policy is available on BVSC's website https://begavalley.nsw.gov.au/cp_themes/default/page.asp?c=322	
	Pro-2 Identification of suppliers	The Project would conform to BVSC's existing procurement processes which require tenderers to and contractors to respond to established sustainability criteria, including submitting their environment and sustainability policies.		

Category	Credit ID and name	Indicative or actual initiative to achieve credit requirements	Where it is addressed in the EIS/public domain	Considerations for future stages of the Project's development
Climate Change	Cli-1 – Climate change risk assessment	A climate change risk assessment has been completed in accordance with the IS credit requirements for this category.	**Chapter 25 Climate Change risk**	The climate change risk assessment and adaptation actions should be continually reviewed throughout the Project's development, to reflect and respond to updates to design and embed adaptation measures into the asset's operation and maintenance.
	Cli-2 Adaptation options	Adaptation measures have been identified, with no residual very high or high risks on the basis of implementation of the proposed actions.		
Energy	Ene-1 Energy and carbon monitoring and reduction	Energy use and carbon monitoring has not been completed as part of the concept design for the Project but could be calculated during detailed design. Opportunities for energy use reduction could also be explored, for example use of Power Factor Correction (PFC) and light-emitting diode (LED) lighting.		A sustainability objective for the Project is to support innovative and cost-effective approaches to

Category	Credit ID and name	Indicative or actual initiative to achieve credit requirements	Where it is addressed in the EIS/public domain	Considerations for future stages of the Project's development
	Ene-2 Renewable energy	Opportunities for the use of renewable energy at the STP site could be explored in future as part of the implementation of the Sustainability Management Plan.		energy efficiency, low-carbon and renewable energy sources and energy procurement. Opportunities for this can be investigated during detailed design as part of the implementation of Sustainability Management Plan.
Water Use	Wat-1 – Water use monitoring and reduction	Treated wastewater would continue to be beneficially re-used as irrigation water on the adjacent Pambula Merimbula Golf Club grounds and Oaklands agricultural area. In future, BVSC would also consider beneficially re-using treated wastewater at additional locations.	**Chapter 2 Project description**	Targets for water reduction, re-use and use of non-potable water would be investigated and developed in subsequent stages of design and construction and referenced within the Sustainability Management Plan.
	Wat-2 – Replace potable water	Use of non-potable water would be maximised during construction. Tertiary filters may be installed as part of the filtration treatment upgrade at the STP. If this option is confirmed (during further design development), tertiary filters would have a back-washing system which uses treated wastewater. This opportunity would be explored in subsequent design stages for the Project.		

Category	Credit ID and name	Indicative or actual initiative to achieve credit requirements	Where it is addressed in the EIS/public domain	Considerations for future stages of the Project's development
Water Quality	Dis-1 – Received water quality	Mitigation and management measures have been identified throughout this EIS to address potential water quality impacts during construction. Water quality impacts are expected to be manageable and not significant. Water quality risks during operation are considered to be low (refer **Chapter 8 Water quality, hydrology and flooding**).	**Chapter 8 Water quality, hydrology and flooding** and **Appendix E** (Water Quality Technical report)	Water quality mitigation and management measures proposed in this EIS to be implemented during construction and operation. Water sensitive urban design features, such as detention basins on-site, would need to be incorporated in further stages of design development.
Noise	Dis-2 – Noise	Baseline airborne noise monitoring was undertaken for the noise and vibration assessment for the Project. Mitigation and management measures have been identified to address potential airborne and underwater noise impacts during construction and operation. These includes the development of a Construction Noise and Vibration Management Plan (CNVMP) in line with the *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change (DECC), 2009).	**Chapter 20 Noise and vibration (airborne)** and **Chapter 21 Noise and vibration (underwater)** provides a summary of the noise and vibration assessments undertaken (including baseline monitoring) for the Project and identifies mitigation and management measures.	Airborne and underwater noise and vibration mitigation and management measures proposed in this EIS are to be implemented during construction and operation.

Category	Credit ID and name	Indicative or actual initiative to achieve credit requirements	Where it is addressed in the EIS/public domain	Considerations for future stages of the Project's development
Air Quality	Dis-4 – Air quality	Mitigation and management measures to minimise adverse air quality impacts to local air quality during construction and operation have been identified.	**Chapter 22 Air quality** provides a summary of the air quality assessment undertaken for the Project and identifies mitigation and management measures.	Air quality mitigation and management measures are to be implemented during construction and operation.
Conservation of on-site resources	Lan-1 – Previous land use	The majority of the construction footprint for the Project is located within the permanent operational footprint of the Project, therefore minimising the need for property acquisition or temporary lease arrangements. The Project does not change the existing land use or impact on properties in the Project area during operation, with the exception of the lots currently zoned as infrastructure for access and operation of the dunal exfiltration ponds. The use of the dunal exfiltration ponds is proposed to cease under the Project, and as they would no longer operate, the land may be considered for another use into the future.	**Chapter 19 Property and land use**	Further construction planning to minimise footprint outside of existing STP site (e.g. along Merimbula Beach and Pambula Merimbula Golf Club grounds).
Waste	Was-1 – Waste management	Estimated waste quantities are provided for spoil. EIS contains mitigation and management measures that include the requirement for waste management plans during construction and operation, which would require application of the waste hierarchy, waste tracking, auditing and monitoring at appropriate intervals	**Chapter 26 Waste**	Waste mitigation and management measures will be implemented during subsequent stages of design and as part of the CEMP.
	Was-3 – Deconstruction/ disassembly/ adaptability	Project mitigation and management measures include a deconstruction plan and consideration of the *10 principles of Design for Deconstruction* (Guy, 2006) to be considered for the ocean outfall pipeline.		

Category	Credit ID and name	Indicative or actual initiative to achieve credit requirements	Where it is addressed in the EIS/public domain	Considerations for future stages of the Project's development
Ecology	Eco-1 – Ecological value	The Project has been designed to avoid, minimise, mitigate and offset impacts on the marine and terrestrial ecological values of the Project area and the receiving environment, including Merimbula Bay. Some potential ecological impacts have been identified as medium risk. Further design development and the implementation of the identified mitigation and management measures would assist in minimising and avoiding these potential impacts. Offsets would be provided consistent with the NSW Biodiversity Offsets Policy for Major Projects and the Project SEARs.	**Appendix G (**Marine Ecology Technical report) and **Appendix H** (Biodiversity Assessment Report)	Biodiversity mitigation and management measures will be implemented during subsequent stages in accordance with specific plans i.e. CEMP, CNVMP, flora and fauna management plan, Biodiversity Offset Strategy.
Heritage	Her-1 – Heritage management and assessment	Consultation with the local historical society has been undertaken at the commencement of the heritage assessments. Aboriginal cultural heritage and non-Aboriginal heritage values beyond those on government registers have been identified and considered. The Aboriginal cultural heritage assessment report (ACHAR) for the Project has involved a comprehensive program of Aboriginal community consultation. Management recommendations have been identified to minimise adverse impacts identified and potential Aboriginal cultural heritage sites, and historical and maritime archaeological sites within the Project area.	**Chapter 14 Aboriginal heritage** and **Chapter 15 Non-Aboriginal heritage.** The ACHAR provides a management strategy for the identified Aboriginal cultural heritage values of the Project area. This would be detailed in an Aboriginal Cultural Heritage Management Plan (ACHMP) for the Project, which would be prepared in consultation with Registered Aboriginal Parties (RAPs), Department of the Premier and Cabinet (DPC) and DPIE.	An Aboriginal Cultural Heritage Management Plan (ACHMP) and other Aboriginal heritage mitigation and management measures would be implemented during construction and operation.

Category	Credit ID and name	Indicative or actual initiative to achieve credit requirements	Where it is addressed in the EIS/public domain	Considerations for future stages of the Project's development
Community Health, Wellbeing and Safety	Hea-1 – Community health and wellbeing	The Project addresses a primary public health risk and related community concern associated with the current treated wastewater disposal practice via the beach-face outfall (by providing the new ocean outfall) and improves the aesthetic and recreational values of Merimbula Bay and surrounds (for the local community and visitors). These two outcomes improve social, physical and economic wellbeing for the community.	**Chapter 23 Social and economic**	Outcome is a by-product of the Project. Ongoing consultation would also be undertaken with the community to reduce impacts to community health and wellbeing during construction.
Stakeholder Engagement	Sta-1 - Stakeholder engagement strategy	The Community and Stakeholder Engagement Plan (CSEP) for this stage of the Project has been prepared by a suitably qualified professional	**Chapter 6 Consultation** describes the engagement strategy, lists stakeholders consulted and details the activities undertaken to solicit feedback.	BVSC would continue community and stakeholder consultation to ensure stakeholders and the community are informed about the Project and have
	Sta-2 – Level of engagement	The CSEP outlines that the IAP2 level of engagement with the community is Collaborate.		
	Sta-3 – Effective communication	The Project has been informed by consultation with the community and stakeholders, and consultation would continue to be undertaken during and after the public exhibition of the EIS.		

Category	Credit ID and name	Indicative or actual initiative to achieve credit requirements	Where it is addressed in the EIS/public domain	Considerations for future stages of the Project's development
	Sta-4 – Addressing community concerns	Questions and issues were raised by stakeholders and community members during the preparation of the EIS. These were captured at stakeholder briefings, community information sessions and phone calls and emails to the Project team. The issues raised have been considered in Project design development and through conducting specialist studies for the EIS, which involves the identification of relevant mitigation and management measures (refer to **Table 6-7** of **Chapter 6 Consultation**). Consultation would also be ongoing following public exhibition of the EIS. Complaints about any aspect of the Project can be provided in person, in writing, by email, telephone or online via the BVSC Project website.		opportunities to provide feedback to the Project team during detailed design and construction. Ongoing consultation would be guided by a Construction Environmental Management Plan (CEMP), which would be developed in conjunction with a construction contractor should the Project be approved.

24.7 Management of impacts

The mitigation and management measures identified to manage the sustainability of the Project are outlined in **Table 24-5**, and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

24.7.1 Performance outcomes

The performance outcomes for the Project in relation to sustainability include:

- the Project explores options for construction innovation to optimise Project constructability and reduce construction program and costs (applicable across energy, water and materials);
- sustainability objectives are implemented, and these objectives embedded into decision making for the Project;
- the Project demonstrates a high level of performance against objectives and appropriate sustainability benchmarks; and
- the Project is accountable and reports publicly on sustainability performance.

The Project would be designed, constructed and operated to achieve these performance outcomes.

24.7.2 Consideration of interaction between measures

Mitigation and management measures in other chapters that are relevant to the management sustainability include:

- **Chapter 8 Water quality, hydrology and flooding**, specifically measures SWF1, SWF2 and SWF5 to address potential impacts on water quality;
- **Chapter 11 Marine ecology** specifically measure M5 to address underwater noise and vibration impacts;
- **Chapter 14 Aboriginal heritage**, specifically measures AH1 to AH7 to address potential impacts to Aboriginal heritage;
- **Chapter 19 Property and land use**, specifically measures PL2 and PL3 to address temporary changes in land use during construction;
- **Chapter 20 Noise and vibration (airborne)**, specifically measures NV1 to NV7 to address airborne noise and vibration impacts;
- **Chapter 22 Air quality**, specifically measures AQ1 to AQ8 to address potential air quality impacts;
- **Chapter 25 Climate Change risk**, specifically measures CC1 to CC17 to address potential impacts to climate change; and **Chapter 26 Waste**, specifically measures WM1to WM8 to address waste impacts.

24.7.3 Sustainability Management Plan

Sustainability for the Project would be guided by a Sustainability Management Plan that identifies overarching principles and objectives for the Project, as well as a framework to guide the delivery of sustainability outcomes during the design, construction and operation of the Project.

The Sustainability Management Plan would consider the principles of ecologically sustainable development (ESD) and other core local, NSW and Federal Government drivers to help support policies and legislation.

24.7.4 Mitigation and management measures

Mitigation and management measures proposed to help achieve the targeted sustainability rating for the Project are outlined in **Table 24-5**.

Table 24-5 Mitigation and mitigation measures – Sustainability

Ref #	Potential impacts	Mitigation and mitigation measures	Timing
S1	IS rating is compromised and sustainability performance of the Project is not optimised	Sustainability initiatives would be incorporated into the detailed design and construction of the Project to support the achievement of the Project sustainability objectives and would be detailed in the Sustainability Management Plan	Construction
S2	IS rating is compromised and sustainability performance of the Project is not optimised	A Design rating level of 'Excellent' would be targeted under version 1.2 of the IS Rating Tool	Detailed design
S3	IS rating is compromised and sustainability performance of the Project is not optimised	Sustainability initiatives would be incorporated into the operation of the Project to support the achievement of the Project sustainability objectives and would be detailed in the Sustainability Management Plan	Operation

24.7.5 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for sustainability and is provided in **Table 24-6**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental mitigation and management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Table 24-6 Environmental risk analysis with mitigation – Sustainability

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
IS rating is compromised and sustainability performance of the Project is not optimised	Construction and operation	S1, S2, S3	Minor	Unlikely	Low

25.0 Climate change risk

A Climate Change Risk and Adaption Assessment (CCRAA) has been prepared for the Project and is provided in **Appendix P** (Climate Change Risk and Adaption Assessment). This chapter describes and presents the overall approach to climate change risk on the Project (and the broader STP site) and how specific objectives, initiatives and considerations are being incorporated into its design, construction and operation. The climate change risk assessment addresses the SEARs for the Project and aligns with the requirements outlined in version 1.2 (v.1.2) of the Infrastructure Sustainability Council of Australia's (ISCA) Infrastructure Sustainability (IS) Rating Scheme. The ISCA IS Rating Scheme is discussed further in **Section 24.3.5** of this EIS.

The SEARs provide an overarching performance outcome for the Project requiring the Project to be designed, constructed and operated to be resilient to the future impacts of climate change. **Table 25-1** shows the SEARs relevant to climate change risk and where the requirements have been addressed in this EIS.

Table 25-1 SEARs – Climate change risk

Ref	Assessment requirements	Where addressed in this EIS
16.1	The Proponent must assess the risk and vulnerability of the project to climate change in accordance with the current guidelines.	**Section 25.1** **Section 25.4**
16.2	The Proponent must quantify specific climate change risks with reference to the NSW Government's climate projections at 10 kilometres resolution (or lesser resolution if 10 kilometres projections are not available) and incorporate specific adaptation actions in the design.	**Section 25.1** **Section 25.2** **Section 25.4** **Section 25.5**
16.3	The Proponent must consider the capacity for ecosystem migration for mean sea levels of up to 0.9 metres above 1990 levels, having regard to the existing and proposed topography of the land.	**Section 25.2** **Section 25.4**

25.1 Assessment approach

25.1.1 Study area

For the purposes of this assessment, the Study Area is considered the same as the Project Area, as identified in **Figure 2-1** of **Chapter 2 Project description** of this EIS.

25.1.2 Relevant guidelines and policies

The relevant guidelines and policies for the assessment of climate change risk that have been considering during the preparation of the CCRAA include:

- draft *Technical Guide for Climate Change Adaptation for the State Road Network* (Roads and Maritime, 2015: unpublished);
- the ISCA IS Rating Tool v.1.2;
- the Bega Valley Shire Council (BVSC) *Enterprise Risk Management Framework* (BVSC, 2019), developed in accordance with Australian Standard (AS)/New Zealand Standard (NZS) 3100:2018 *Risk Management – Principles and Guidelines*;
- *AS 5334:2013 Climate change adaptation for settlements and infrastructure – A risk-based approach,* following *ISO31000:2009 Risk Management – Principles and Guidelines*;
- Australian Government's *Climate Change Impacts and Risk Management – A Guide for Business and Government* (Department of Environment and Heritage, 2006); and

- the ISCA *Climate Change Adaptation Guidelines* (Australian Green Infrastructure Council, 2011), which have been reviewed and used to guide, confirm and validate measures to mitigate and adapt to climate change risks.

25.1.3 Consultation

A CCRAA workshop was held on 4 December 2019 with a multi-disciplinary internal team with representatives from AECOM and BVSC providing design and environmental services as well as the asset owner who would have responsibility for operations and maintenance of the upgraded Sewage Treatment Plant (STP) and ocean outfall pipeline. The workshop sought to:

- validate the preliminary climate change risks informed by a desktop assessment;
- identify new climate change risks;
- allocate preliminary risk ratings; and
- review the development of adaptation actions.

25.1.4 Risk assessment methodology

The following steps were undertaken to complete the CCRAA in line with both *AS 5334:2013* and the Australia Government's *Climate Change Impacts and Risk Management – A Guide for Business and Government*:

1. identification of key climate variables (e.g. temperature, rainfall and extreme events) and the climate variability that differentiates regional climate zones;
2. development of potential climate change scenarios, based on the latest climate science, which describes how each variable may change over the design life of the Project;
3. identification of broad climate-based risks that may impact on the Project;
4. completion of a CCRAA, with risk ratings evaluated using BVSC's *Enterprise Risk Management Framework*, including likelihood and consequence criteria. Consequence ratings have been selected based on the highest rating for the risk categories. Refer to **Section 25.1.5** for the assessment criteria;
5. identification of measures to mitigate and adapt to the identified climate change risks; and
6. assessment of residual risks (vulnerability) to the Project, considering specific adaptation measures to treat high and very high risks, which in turn would also help treat medium and low risks.

25.1.5 Assessment criteria

Climate change risks identified for the Project have been assessed using BVSC's *Enterprise Risk Management Framework,* including the following likelihood and consequence tables (refer **Table 25-2, Table 25-3** and **Table 25-4**).

Table 25-2 Risk assessment matrix

Likelihood	Consequence				
	Insignificant	Minor	Moderate	Major	Catastrophic
Almost certain	Medium	High	High	Very High	Very High
Likely	Medium	Medium	High	High	Very High
Possible	Low	Medium	Medium	High	High
Unlikely	Low	Low	Medium	Medium	High
Rare	Low	Low	Low	Medium	Medium

Source: Procedure 6.03.1 of the *Enterprise Risk Management Framework* (BVSC, 2019)

Table 25-3 Likelihood criteria

Likelihood	Description	Probability of occurrence
Almost certain	Expected to occur in most circumstances	Within 1 year
Likely	Will probably occur in most circumstances	Within 2 years
Possible	Might occur at some time	Within 3-5 years
Unlikely	Could occur at some time	Within 10-20 years
Rare	May occur in exceptional circumstances	More than 20 years

Source: Procedure 6.03.1 of the *Enterprise Risk Management Framework* (BVSC, 2019)

Table 25-4 Consequence criteria

Consequence levels	Risk categories consequence descriptors				
	Environmental	Financial	Legal	Reputational	Health/Safety
Catastrophic	Irreversible long-term	>$1million	Cessation of activities	Censure/ Inquiry	Death, severe permanent disablement or adverse health effect
Major	Wide long-term	$500,000 to $1million	Successful prosecution	High media	Hospitalisation, serious injuries resulting in long term absences and adverse health effect
Moderate	Wide short-term	$100,000 to $500,000	Enforceable undertaking or fine	Moderate media	Medical treatment required and/or some lost time
Minor	Minor short-term	$20,000 to $100,000	Compliance breach resulting in corrective action	Minor media	Medical treatment required, no lost time
Insignificant	Incident not requiring intervention	< $20,000	Technical compliance breach with limited material impact	Incident that does not receive any coverage	First aid injury, no lost time

Source: Procedure 6.03.1 of the *Enterprise Risk Management Framework* (BVSC, 2019)

Source: Procedure 6.03.1 of the *Enterprise Risk Management Framework* (BVSC, 2019)

25.1.6 Data sources

The CCRAA used the following data sources for climate change projections:

- AdaptNSW and NSW and ACT Regional Climate Modelling (NARCliM) developed by the Office of Environment and Heritage (OEH, 2014; OEH 2015) which provides projections at the 10 kilometre resolution; and
- Commonwealth Scientific and Industrial Research Organisation (CSIRO) and Bureau of Meteorology (BOM) Climate Futures (CSIRO and BOM, 2015) which supplements the information available from the NARCliM projections for a number of key climate variables.

In order to assess the risk to the project posed by climate change, the current climate science and model projections have been investigated using the data sources identified above.

NARCliM

The A2 scenario from the *Special Report on Emissions Scenarios* (SRES) (Intergovernmental Panel on Climate Change (IPCC), 2007) represents a high emissions pathway driven by economic growth and is projected to result in warming by approximately 3.4 degrees Celsius (ºC) by the year 2100. The SRES A2 scenario was selected for the use in the NARCliM climate projections as a review of the global emissions trajectory suggests that emissions are tracking along the higher end of the A2 scenario (OEH, 2014 and OEH, 2015).

Climate futures

Projections are presented for emission scenarios or possible pathways, referred to as Representative Concentration Pathways (RCPs), each of which reflects a different concentration of global greenhouse gas (GHG) emissions. While RCPs exist for low emissions (RCP 2.5) and medium emissions (RCP 4.5), the RCP reported here is for high emissions (RCP 8.5). The RCP 8.5 pathway, which arises from limited effort to reduce emissions and represents a failure to prevent warming by 2100, is similar to the highest SRES scenario and is used in this report. The RCP 8.5 pathway is also closest to the current emissions trajectory.

25.1.7 Time scales

STP infrastructure has a varied expected design life depending on the particular component and programmed schedule for renewal. For the purposes of this assessment, the following design lives have been applied to the various STP components:

- electrical, pump and communications components – 20 years;
- buildings and concrete infrastructure (e.g. foundations) – 50 years; and
- outfall pipeline and other drainage infrastructure – 100 years.

The time periods selected for assessment are 2030 and 2090, based on these design lives, construction of the Project being undertaken in the coming years (around 2020 to 2022) and the latest available climate data. The year 2030 was considered appropriate for short-term impacts on construction of the Project (assuming construction would be finished in the early-2020s and operation would commence subsequent to this). Climate change projections for 2090 are considered relevant to longer term operation and maintenance of the Project, given the expected design life of critical parts of the infrastructure such as the ocean outfall pipeline.

25.2 Existing environment

In 2016, for the first time, global temperatures were confirmed to have risen by one degree Celsius (ºC) since pre-industrial levels. *The State of the Climate 2014* confirms the long term warming trend over Australia's land and oceans, showing that Australia's climate has warmed by 0.9ºC since 1910 (Ekström et al., 2015). The Intergovernmental Panel on Climate Change *Fifth Assessment Report* (IPCC, 2013) states with high confidence that Australia is already experiencing impacts from recent climate change, including a greater frequency and severity of extreme weather events. Other observed trends include an increase in record hot days, a decrease in record cold days and increases in global GHG concentrations.

Climate differs from region to region due to changes in influencing factors such as geographical location, latitude, physical characteristics, variable patterns of atmosphere, ocean circulation and in some cases, human interaction (IPCC, 2007). Consequently, climate change and the associated impacts can be expected to vary from region to region.

For the risk assessment, climate variables were selected based on the following factors related to the broader context and nature of the Project:

- the location of the Project in an area projected to experience a rise in sea levels;
- the location of the Project in an area subject to increased erosional and morphological impacts due to changing oceanic currents and extreme storm events; and

- the location of the Project in an area projected for an increase in extreme rainfall with subsequent flooding of surrounding areas.

25.2.1 Observed local climate

The region surrounding the Project area is largely wet along the coast with milder conditions found throughout the year when compared to areas further inland. In summer, average temperatures range between 18ºC and 24ºC, with winter temperatures falling to between 8ºC and 12ºC. On average, the region experiences fewer than 10 hot days (i.e. days above 35ºC) per year, and fewer than 10 cold days (i.e. days below 2ºC) per year.

Long-term observations suggest that temperatures in the area of the Project have been increasing since around 1960 (OEH, 2014) with a noticeable acceleration in temperature over the past several decades.

Rainfall across the region varies based on the presence of topographical features such as the Snowy Mountains and Great Dividing Range, as well as the influence of ocean temperatures along the coastal fringes. Annual averages for the coastal areas are around 1,000 millimetres (mm) to 1,200 mm of rainfall.

The Forest Fire Danger Index (FFDI) for the region suggests on average (based on historical averages), the Project area experiences around 1.1 severe fire weather days per year (where the FFDI is more than 50), while the average annual FFDI is around 5.2, which indicates low to moderate fire weather.

Fire danger has already been observed to be increasing throughout the 21st century, including increased fire severity and longer fire seasons due to climate change induced changes to temperature and increased frequency and duration of extreme weather events (ABC, 2017). This is reflected in the experience from the most recent bushfires in 2019/20 in south eastern NSW as documented in the BOM (March 2020) *Special Climate Statement 73—extreme heat and fire weather in December 2019 and January 2020*, which identified the following extreme weather conditions:

- 18 December 2019 was the hottest Australia-wide (area averaged) day on record, peaking at 41.88 °C;
- in December 2019 there were 11 days in which the national area-averaged maximum was 40 °C or above. Prior to December 2019 there had been only 11 such days recorded since 1910, seven of which occurred in the summer of 2018–19;
- the year 2019 was the warmest December on record Australia-wide and for all mainland States except Victoria;
- numerous high temperature records occurred at individual sites across southern and eastern Australia throughout December into early January, and at the end of January;
- dangerous fire weather conditions continued from spring 2019 into summer;
- in 2019, large areas of Australia had their highest accumulated Forest Fire Danger Index (FFDI) for December. FFDI records date back to 1950; and
- the year 2019 had the highest December accumulated FFDI for Australia as a whole, continuing the pattern seen in spring.

Climate change projections are discussed further below.

25.2.2 Climate projections

The *IPCC Fifth Assessment Report* (IPCC, 2013) states with high confidence, that Australia is already experiencing impacts from recent climate change, including a greater frequency and severity of extreme weather events. As a result, it is especially important to understand the ‘most likely’ and ‘worst case’ implications of climate change on high-value infrastructure, including the Project.

A summary of the current climate projections available for the region based on the Southern Slopes Cluster Report (CSIRO and BOM, 2015) and the South East and Tablelands Climate Change Snapshot (OEH, 2014) is provided below in **Table 25-5**.

Table 25-5 Detailed climate change projections[1]

Climate variable	Description	Baseline data[2]	NARCliM AdaptNSW (OEH)	Climate Futures CSIRO and BOM	
			2030	2030	2090
			SRES A2[3] (high emissions)	RCP 8.5[4] (high emissions)	RCP 8.5 (high emissions)
Average daily annual temperature (°C)	Coastal regions including the Southern Slopes cluster, are projected to warm at a slightly lower rate when compared to inland regions[5]. Changes in mean temperature that can affect sewage treatment infrastructure largely occur at the extremes, for instance increasing the length of a bushfire season or resulting in increased evapotranspiration rates, reducing the quantity of stored effluent in open air lagoons.	18°C and 24°C Summer 8°C and 12°C Winter	+0.7°C (+0.5 – 0.8)	+0.8°C (+0.5 – 1.1)	+3.1°C (2.5 – 4)
Average maximum temperature (°C)			+0.7°C (+0.5 – 1.0)	+0.8°C (+0.6 – 1.2)	+3.5°C (2.5 – 4.3)
Average minimum temperature (°C)			+0.6°C (+0.4 – 0.7)	+0.8°C (+0.5 – 1.1)	+2.9°C (+2.4 – 3.8)
Extreme heat days (above 35°C)	Extreme heat days are projected to increase in both duration and intensity over time, including a noticeable increase in the number of warm spell days. In addition to exacerbating impacts borne from changes in mean temperature (e.g. raising the FFDI), extreme heat days have the added effect of impacting on the STP operations through changes to aeration and digestion requirements and increasing the risk of heat exhaustion/stress for workers.	< 10 days	+2.7 days (+0.7 – 4.5)	13 days in total (12 – 15)	24 days in total (19 – 32)
Average annual rainfall (% change)	Changes in rainfall pattern have generally indicated a decline in the amount of annual rainfall over the past 60 years with some seasonal variation and smaller periods of heavily wet years and dry years. Changes to mean rainfall that could influence STP operations include disruption of expected treatment volumes/flow and higher variability in expected storage requirements due to uncertainty.	1,000 to 1,200mm	-1.8% (-9.9 – +6.0%)	-1% (-7 – +2%)	-5% (-19 – +5%)

Climate variable	Description	Baseline data[2]	NARCliM AdaptNSW (OEH)	Climate Futures CSIRO and BOM	
			2030	2030	2090
			SRES A2[3] (high emissions)	RCP 8.5[4] (high emissions)	RCP 8.5 (high emissions)
Extreme rainfall (>125 mm in 24 hours)	The frequency of heavy rainfall events and associated flooding is projected to increase in many regions of the Southern Slopes Cluster, even where projected changes to average rainfall are small or negative[5]. In a warming climate, heavy rainfall events are expected to increase in magnitude mainly due to a warmer atmosphere being able to hold more moisture (Sherwood et al., 2010). Increased intensities of rainfall can cause flash flooding across the Project area resulting in impacts such as overtopping of open-air lagoons and sludge ponds, loss of access to critical areas and inundation of intake pipes/screens resulting in disruption of treatment processes.	N/A	Extreme rainfall events to increase in intensity and severity		
Fire weather (number of days/year FFDI[6] > 50)	Climate change will have a significant impact on future fire weather and climate trends project that there will be a tendency towards increased and harsher fire conditions in the future. This is expected to be exacerbated by changing rainfall trends (reduction in average rainfall), increased drought conditions (bushfire fuel) and higher winds. Bushfire could impact on STP operations due to smoke and ash infiltrating the treatment processes, fire damaging STP infrastructure, severing access for delivery of chemicals and personnel access, as well as a risk to personnel having to work during bushfire events.	1.1 days	+0.1 days (-0.2 – +0.4 range)	1.2	2.1

Climate variable	Description	Baseline data[2]	NARCliM AdaptNSW (OEH)	Climate Futures CSIRO and BOM	
			2030	2030	2090
			SRES A2[3] (high emissions)	RCP 8.5[4] (high emissions)	RCP 8.5 (high emissions)
Drought[7]	Both the duration and frequency of time spent in drought is projected to increase in the future. The duration and frequency are directly related to reductions in annual precipitation and increases in high pressure systems which further result in dry conditions. It is noted that coastal regions fare slightly better owing to the increased incidence of rainfall in the coastal areas which limit the impacts resulting from drought. Drought is likely to impact on operation of the STP through changes to inflow resulting from water restrictions and reductions in groundwater infiltration (through lowering of the water table), as well as an increase in dust/particulate infiltration into the STP screens.	N/A	Both time spent in drought and occurrence of drought are anticipated to increase in intensity and severity.		
Solar radiation (% change)	While there is likely only to be minimal changes to solar radiation and evapotranspiration rates in the near term, there is expected to be larger changes in the long term. An increase in the amount of solar radiation and ultimately higher evapotranspiration rates could result in increased loss of water in storage tanks, increasing concentrations and ultimately requiring changes to the treatment process to account for these changes. Increasing solar radiation may also result in accelerated deterioration of components, including rubber fittings, facades and other site infrastructure.	N/A	N/A	+1.3% (+0.1 – 2.5%)	+3.1% (+0.3 – 6.8%)
Evapotranspiration (% change)		N/A	N/A	+4.3% (+2.2 – 6.1%)	+14.4% (+9.5 – 22.2%)

<table>
<tr><th rowspan="3">Climate variable</th><th rowspan="3">Description</th><th rowspan="3">Baseline data[2]</th><th>NARCliM AdaptNSW (OEH)</th><th colspan="2">Climate Futures CSIRO and BOM</th></tr>
<tr><th>2030</th><th>2030</th><th>2090</th></tr>
<tr><th>SRES A2[3] (high emissions)</th><th>RCP 8.5[4] (high emissions)</th><th>RCP 8.5 (high emissions)</th></tr>
<tr><td>Sea level rise (m)[8]</td><td>Observations of sea levels have shown an increase year on year. This trend is projected to increase into the future with a high-end estimate of 0.2 m of global sea level rise by 2030 and nearly 0.9 m of global sea level rise by 2090.
The Merimbula Lake and Back Lake Flood Study (Cardno, 2017) notes that there is capacity for ecosystem migration as a result of sea level rise, associated erosion and depositional changes and also the higher sea levels. These changes include both marine and terrestrial ecosystem migration (e.g. changes to lake, beach and dune morphology).
These changes are unlikely to impact the STP site owing to its elevation and as vegetative buffers (mangroves) provide protection from tidal inundation. Changes are likely to occur at the Merimbula Lake entrance as a result of regular tidal flow and along the western side of Merimbula Lake where the topography is lower and has greater exposure to higher tides.</td><td>N/A</td><td>N/A</td><td>0.1 m
(0.1 – 0.27)</td><td>0.6 m
(0.4 – 0.8)</td></tr>
<tr><td>Sea surface temperature (°C)[8]</td><td>Sea surface temperature is a climate variable that is directly influenced or changed as a result of climate change. Increased levels of GHG in the atmosphere causes heat to be absorbed by the ocean, triggering a rise in ocean temperatures. Changes in sea surface temperatures influence atmospheric circulation and the amount of water vapour in the air, with implications for weather and climate patterns worldwide.</td><td>N/A</td><td>N/A</td><td>+0.6
(0.3 – 0.9)</td><td>+2.3
(1.9 – 3.8)</td></tr>
<tr><td>Sea surface salinity[8]</td><td>Salinity of seawater varies due to evaporation, precipitation and ice melt over the ocean. Salinity is a factor that causes changes in the density of water and as a result would affect the circulation of ocean currents.</td><td>N/A</td><td>N/A</td><td>-0.03
(-0.1 – +0.1)</td><td>+0.1
(-0.3 – +0.4)</td></tr>
</table>

Table notes:

1 *Quantitative results presented as model median (50th percentile) value, with 10 to 90 percentile range in brackets*
2 *NARCliM changes relative to 1990 to 2009 baseline. CSIRO and BoM changes relative to 1986 to 2005 baseline*
3 *The SRES A2 is the high emissions trajectory resulting from the Intergovernmental Panel on Climate Change Fourth Assessment Report*
4 *The RCP 8.5 is the high emissions scenario resulting from the Intergovernmental Panel on Climate Change Fifth Assessment Report*
5 *The CSIRO and BOM present climate data through the Climate Futures Tool in the form of Cluster Reports, which are regional downscaled climate projects across eight regions in Australia. The Project is located in the Southern Slopes Cluster*
6 *The FFDI combines observations of temperature, humidity and wind speed. Fire weather is classified as severe when the FFDI is above 50. Data is for Nowra FFDI station – the closest to the Project area*
7 *As drought conditions are directly linked to corresponding rainfall projections, there is uncertainty regarding these projections. Rainfall is dependent on local climate drivers including topography with most models showing contrasting patterns and trajectories*
8 *Data for oceanic variables are taken from the Stony Point monitoring station referenced in the Southern Slopes Cluster Report (CSIRO and BOM, 2015) and the South East and Tablelands Climate Change Snapshot (OEH, 2014)*

25.3 Potential impacts – construction

Risks for construction resulting from a changing climate were not identified as part of the risk assessment process, as construction would be complete within the next few years (pending approval of the Project). Changes in the climate over this period would not be too dissimilar to current conditions.

Given previous events experienced in and around the STP and with consideration to observed trends, risks to construction could occur by way of physical damage, reduced capacity, and potential risks to human health and safety. The increased frequency and intensity of extreme events such as extreme rainfall, bushfires and rising temperatures are already causing strain on existing infrastructure. More extreme weather events are likely to interrupt the construction process (Thom et al., 2010). Based on these past events and trends, risks to the construction process could include:

- extreme rainfall and storm events resulting in the inundation or damage to the Project area, resulting in delays to the construction schedule and associated cost implications;
- uncertainty around extreme events impacting design conditions/requirements leading to a potential over or under design of infrastructure;
- increased intensity and frequency of extreme rainfall events increasing the load on temporary water treatment devices, and erosion control devices; more frequent flooding events affecting water quality treatment levels; and
- increased intensity and frequency of extreme events (bushfire, flooding, storms) resulting in road closures or other access constraints, congestion, and increased risk of road incidents during construction. Extreme events affecting access to work sites for workers and/or equipment resulting in delays in program and lost days.

As there is a high level of uncertainty with regard to the timing and impact of extreme events, BVSC would incorporate contingency in both the schedule and budget to account for any potential delays in the program and/or construction.

25.4 Potential impacts – operation

The climate risk assessment identified a total of 43 climate change risk statements for the Project. Risks are grouped by the following climate variables:

- extreme heat – seven risks;
- bushfire events – seven risks;
- mean rainfall change/drought – four risks;
- increased CO_2 emission – four risks;
- extreme rainfall/flood/storm events – 15 risks; and
- sea level rise – six risks.

Table 25-6 presents the CCRAA for the Project; with risk ratings evaluated first using the BVSC *Enterprise Risk Management Framework* and assessment criteria as well as in consultation with Project team members during the CCRAA workshop. This combination allowed an appropriate determination of the consequence and likelihood of each risk.

Table 25-6 Climate change risks to the Project (and broader STP site) during operation

		2030			2090		
Risk ID	**Risk source**	**Likelihood**	**Consequence**	**Risk rating**	**Likelihood**	**Consequence**	**Risk rating**
An increase in mean temperature and extreme heat (days over 35 degrees Celsius) resulting in:							
Direct risks							
EH-1	Risks to health and safety of workforce working through heat stress or heat exhaustion.	Possible	Major	**High**	Likely	Major	**High**
EH-2	An increase in the frequency of electrical system outages (including pump stations, communications equipment, treatment processes (e.g. Ultraviolet (UV) disinfection), testing equipment and other critical systems) resulting from an increase in power demand/reduced efficiency of wiring.	Possible	Minor	**Medium**	Likely	Minor	**Medium**
EH-3	Additional requirements for outdoor areas of respite (e.g. shade structures).	Likely	Minor	**Medium**	Almost Certain	Minor	**High**
EH-4	Accelerated degradation of infrastructure (predominately rubber fittings/casings/valves) leading to increased operational and maintenance costs (e.g. ongoing repairs).	Unlikely	Minor	**Low**	Possible	Minor	**Medium**
EH-5	Changes to conditions (e.g. higher water temperatures) for algae, bacteria and other organisms in the system which may have an adverse impact on treatment (e.g. additional chemical dosing requirements).	Possible	Minor	**Medium**	Likely	Minor	**Medium**
EH-6	Increased evaporation in sludge tanks and other storage/processing systems resulting in changes to operational requirements (e.g. increased concentrations of dissolved solids).	Possible	Insignificant	**Low**	Likely	Insignificant	**Medium**
Indirect risks							
EH-7	Increased network power outages due to increased system demand (external sources) resulting in interruptions to operation and increased downtime of assets.	Possible	Moderate	**Medium**	Likely	Moderate	**High**

		2030			2090		
Risk ID	**Risk source**	**Likelihood**	**Consequence**	**Risk rating**	**Likelihood**	**Consequence**	**Risk rating**
An increase in the conditions for and incidence of bushfire resulting in:							
Direct risks							
BF-1	Increased particulate matter (e.g. ash) in the intake and discharge water resulting in treatment method changes and nutrient loads.	Possible	Minor	**Medium**	Possible	Minor	**Medium**
BF-2	Risk to health and safety of workforce through direct fire or indirect smoke during bushfire events (e.g. need to keep plant running/fix issue).	Possible	Major	**High**	Possible	Major	**High**
BF-3	Damage to site infrastructure resulting in closure or lost processing time.	Rare	Catastrophic	**Medium**	Possible	Major	**High**
BF-4	Loss of access to either primary (e.g. treatment) and ancillary functions (e.g. pump stations) of the Project area.	Unlikely	Moderate	**Medium**	Possible	Moderate	**Medium**
Indirect risks							
BF-5	Increased network power outages due to damage to substations resulting in interruptions to operation and increased downtime of assets.	Possible	Moderate	**Medium**	Possible	Moderate	**Medium**
BF-6	Loss of surrounding road network due to bushfire event, resulting in loss of access to the STP (e.g. loss of chemical delivery).	Possible	Minor	**Medium**	Likely	Minor	**Medium**
BF-7	Loss of personnel due to surrounding bushfires (e.g. the need to take other actions or cannot physically reach the STP).	Possible	Minor	**Medium**	Likely	Minor	**Medium**
Changes to mean rainfall patterns and increased incidence and duration of drought resulting in:							
Direct risks							
MRD-1	Erosion and movement resulting in the reduction in foundation integrity and potential structural failure of foundations and overlying structures	Rare	Catastrophic	**Medium**	Unlikely	Catastrophic	**High**
MRD-2	An increase in the amount of grit from dust and other particulates through the screens and into the STP.	Possible	Minor	**Medium**	Likely	Minor	**Medium**
MRD-3	Water restrictions reducing the amount of flows through the sewerage system (e.g. outdoor watering infiltration) increasing septicity risk (e.g. odour, septic sewerage, corrosion).	Possible	Moderate	**Medium**	Likely	Moderate	**High**

		2030			2090		
Risk ID	**Risk source**	**Likelihood**	**Consequence**	**Risk rating**	**Likelihood**	**Consequence**	**Risk rating**
MRD-4	A changing expected flow volume (either low flow or high flow periods) resulting in disruption to the treatment process.	Possible	Moderate	**Medium**	Possible	Minor	**Medium**
Increased CO2 emissions/acidity (both oceanic and atmospheric) resulting in:							
CO-1	Accelerated corrosion and deterioration of intake and discharge concrete and steel infrastructure (through increased dissolved carbon in waste stream).	Rare	Major	**Medium**	Unlikely	Major	**Medium**
CO-2	An increase to dissolved carbon amounts in intake and discharge, resulting in changes to treatment methods (e.g. aeration requirements) and nutrient loads.	Rare	Minor	**Low**	Unlikely	Minor	**Low**
CO-3	An increase to the acidity of rainfall leading to the accelerated deterioration of concrete structures (e.g. sludge lagoons, buildings).	Rare	Moderate	**Low**	Unlikely	Moderate	**Medium**
Indirect risks							
CO-4	Changing oceanic conditions (e.g. increase acidity/decreased salinity) resulting in breaches of discharge limits into Merimbula Bay.	Rare	Moderate	**Low**	Unlikely	Moderate	**Medium**
An increase in the severity and intensity of extreme rainfall, flooding and storm events resulting in:							
Direct risks							
ERF-1	Malfunctioning of electrical equipment, including pump stations, dosing equipment, aerators, communications (e.g. telemetry systems) and associated circuitry due to submersion.	Possible	Moderate	**Medium**	Likely	Moderate	**High**
ERF-2	Inundation of access roads causing potential isolation of assets.	Possible	Minor	**Medium**	Likely	Minor	**Medium**
ERF-3	Increased risk of the STP not being able to handle more frequent and higher intensity peak flow, ultimately impacting treatment during peak wet weather flow periods.	Possible	Moderate	**Medium**	Likely	Moderate	**High**
ERF-4	Inundation of the STP assets (e.g. from inadequate drainage, increased volumes of rainfall) and damage to the STP (civil structures), potentially requiring closure of the STP or backflow/unregulated discharge.	Possible	Major	**High**	Likely	Major	**High**

		2030			2090		
Risk ID	**Risk source**	**Likelihood**	**Consequence**	**Risk rating**	**Likelihood**	**Consequence**	**Risk rating**
ERF-5	Decreased safety of personnel working onsite during extreme events (e.g. workforce required onsite during a storm to address breaches or other infrastructure faults).	Likely	Major	**High**	Almost Certain	Major	**Extreme**
ERF-6	Overflow and unregulated discharge of lagoons, sludge storage areas, storm storage ponds or other plant processes, resulting in breach of Environmental Protection Licence (EPL) condition/s (e.g. Phosphate/Nitrate concentrations) for discharge and potential negative community concern.	Possible	Major	**High**	Likely	Major	**High**
ERF-7	Increased potential for landslip/erosion due to increased overland wash and/or inundation of Merimbula Lake, resulting in reduced integrity of foundations and potential structural failure.	Rare	Major	**Medium**	Unlikely	Major	**Medium**
ERF-8	Increased risk of mobilisation of fuels, oils, lubricants (chemical storage) and other contaminants (e.g. biosolids), resulting in contamination of surrounding areas.	Possible	Moderate	**Medium**	Likely	Moderate	**High**
ERF-9	An increase and/or high grit volume/screening load to the STP.	Likely	Minor	**Medium**	Almost Certain	Minor	**High**
ERF-10	Localised scour and erosion around drainage infrastructure due to increase flows.	Possible	Moderate	**Medium**	Likely	Moderate	**High**
ERF-11	Accelerated degradation of materials and reduced life of buildings and structures such as the lagoons, above ground pipework and operational buildings.	Rare	Minor	**Low**	Unlikely	Minor	**Low**
ERF-12	Accelerated erosion due to increased wave activity (storm tide) along the shoreline resulting in damage to site infrastructure.	Unlikely	Major	**Medium**	Possible	Major	**High**
Indirect risks							
ERF-13	Inundation or damage to the surrounding road network impeding access (e.g. personnel and/or deliveries) and potential isolation of assets.	Possible	Moderate	**Medium**	Likely	Moderate	**High**
ERF-14	Faults and failures in the power network resulting in interruptions to power supply including increased down time of assets (e.g. pump stations, treatment equipment).	Possible	Moderate	**Medium**	Likely	Moderate	**High**
ERF-15	Increased stormwater runoff, increasing the turbidity and sediment load in Merimbula Bay, resulting in negative community perception.	Possible	Moderate	**Medium**	Likely	Minor	**Medium**

		2030			2090		
Risk ID	**Risk source**	**Likelihood**	**Consequence**	**Risk rating**	**Likelihood**	**Consequence**	**Risk rating**
An increase in sea levels resulting in:							
Direct risks							
SLR-1	Permanent inundation of major site infrastructure (e.g. sludge lagoons, pump stations, access to site).	Rare	Catastrophic	**Medium**	Possible	Catastrophic	**High**
SLR-2	Accelerated erosion potentially uncovering the buried portion of the ocean outfall pipeline (within the surf zone).	Likely	Major	**High**	Likely	Major	**High**
SLR-3	Malfunctioning of electrical equipment, including dosing equipment, aerators, communications and associated circuitry due to submersion.	Possible	Moderate	**Medium**	Likely	Moderate	**High**
SLR-4	Deposition from changing morphology resulting in the diffuser head being covered.	Unlikely	Moderate	**Medium**	Likely	Moderate	**High**
Indirect risks							
SLR-5	Inundation or damage to the surrounding road network impeding access and potential isolation of assets.	Unlikely	Moderate	**Medium**	Likely	Moderate	**High**
SLR-6	Increased groundwater levels in the areas surrounding the STP resulting in increased pipe pressure and salinity, resulting in seepage into the mains network.	Unlikely	Minor	**Low**	Likely	Minor	**Medium**

25.5 Management of impacts

The mitigation measures identified to help avoid and minimise the identified climate change impacts of the Project are outlined in **Table 25-7**, and would be included during detailed design, in the Construction Environmental Management Plan (CEMP) for the Project, and carried through to operation by BVSC where relevant.

25.5.1 Performance outcomes

The climate change performance outcome for the Project is as follows:

- design and deliver infrastructure that is responsive and resilient to the impacts of climate change.

The Project would be designed, constructed and operated to achieve this performance outcome.

25.5.2 Consideration of interaction between measures

Mitigation measures in other chapters that are relevant to the management of potential climate change impacts include:

- **Chapter 8 Water quality, hydrology and flooding**, specifically measure SWF3 to address potential flood risks
- **Chapter 22 Air quality**, specifically measures AQ1 to AQ8 to address potential air quality impacts; and
- **Chapter 24 Sustainability**, specifically measures S1 and S2, whereby sustainability initiatives would be incorporated into the detailed design, construction and operation of the Project to support the Project sustainability objectives.

25.5.3 Mitigation measures

Table 25-7 outlines mitigation and management measures to reduce the impact of climate change risk to the Project. It is noted that in some instances, a changing climate can result in beneficial outcomes, including improved conditions for aeration and treatment (from less cold nights). For the most part however, identified measures include a combined approach that addresses the avoidance of risk, designing out risk where possible and practicable, as well as procedures for the management of risks that may be unavoidable. The Impact ID in **Table 25-7** refers to the Risk ID in **Table 25-6**.

Table 25-7 Mitigation and management measures – climate change risk

No.	Impact ID	Mitigation measures	Timing
CC1	ERF-3, ERF-4, ERF-6, ERF-9, MRD-4	Investigate the use of the large ponds within the STP site for additional wet weather storage.	Detailed design
CC2	ERF-3, ERF-4, ERF-6, MRD-4	Design the outfall pipe (both size and operational timing) to respond to increased rainfall intensities and volumes to facilitate high flow events and avoid disruptions in processing.	Detailed design
CC3	EH-1, BF-2, BF-3, ERF-5, ERF-13, SLR-5	Provide upgrades to the STP (e.g. UV disinfection) to allow for further automation and remote operation to reduce the number of personnel required onsite.	Detailed design
CC4	MRD-3	Update operational procedures to provide for a weekly flush, pigging or physical removal of marine organisms along the ocean outfall pipeline to prevent odours, septicity risk and degradation.	Operations

No.	Impact ID	Mitigation measures	Timing
CC5	MRD-1	Construct the ocean outfall pipeline out of high-density polyethylene (as opposed to concrete) to minimise the risk of accelerated degradation and structural failure.	Concept design
CC6	SLR-4	Provide for the use of remote operated vehicles and regular diver maintenance to allow for the diffuser head of the ocean outfall pipeline to remain open.	Operations
CC7	BF-3	Use underground pumps and pipeline network where feasible to prevent exposure and direct damage.	Detailed design
CC8	EH-7, BF-5, ERF-14	Design to consider connections, if possible, to multiple substations to reduce the reliance on only one substation in the event of a power outage.	Detailed design
CC9	ERF-12, SLR-2, SLR-4	Undertake additional modelling of potential changes (including future changes) to surf zone morphology and wave impacts to determine the appropriate ocean outfall pipeline depth (for the underground portion of the pipeline).	Detailed design
CC10	ERF-12, SLR-2, SLR-4	Update operational procedures to increase the frequency of erosion monitoring to protect against buried assets being uncovered.	Operations
CC11	EH-1, EH-3	Provide additional shade through the use of covered dosing sheds for incidental respite from extreme heat/solar exposure.	Construction
CC12	EH-1, BF-2, ERF-5	Undertake a review of current BVSC standard operational procedures and policies to incorporate extreme weather events (e.g. heat waves, bushfire events, etc.). This includes event notification, use of appropriate Personal Protective Equipment (PPE) and changes to operations and procedures during extreme events.	Detailed design and operation
CC13	ERF-1, ERF-8, SLR-1, SLR-3	Elevate critical equipment and systems above known flood levels.	Detailed design and construction
CC14	MRD-1	Engage experienced contractors to advise on key constructability concerns and challenges including shifting soils and foundational integrity of site infrastructure and the pipeline network.	Construction
CC15	EH-7, ERF-14	Incorporate the use of solar PV, battery storage and/or backup generators where possible onsite for critical systems to minimise the impact of power disruption.	Detailed design and construction

No.	Impact ID	Mitigation measures	Timing
CC16	MRD-3	Undertake community outreach to educate the community around potential concerns (e.g. odour, water restrictions, discolouration, etc.).	Detailed design, construction and operation
CC17	ERF-5, ERF-6, ERF-7, ERF-10	Model for potential increases in rainfall (e.g. 10%) and design site drainage to account for additional surface flows.	Detailed design

25.5.4 Environmental risk analysis

As outlined in **Section 25.1.4** and **Section 25.1.5**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of both *AS 5334:2013* and the Australia Government's *Climate Change Impacts and Risk Management – A Guide for Business and Government*: The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for climate change and is provided in **Table 24-6**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental mitigation and management measures have been recommended to manage impacts to acceptable levels. The potential impact in **Table 24-6** that would have the potential for residual risk, can be summarised as the potential that 'the Project would deliver infrastructure that is not responsive and resilient to the impacts of climate change, with particular regards to the potential for inundation by flood waters or sea level rise'.

The residual risk is the risk of the environmental impact after the proposed mitigation and management measures have been implemented.

Table 25-8 Environmental risk analysis with mitigation – Sustainability

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
That the Project would deliver infrastructure that is not responsive and resilient to the impacts of climate change, with particular regards to the potential for inundation by flood waters or sea level rise	Construction and operation	CC1, CC2, CC13, and CC17.	Moderate	Unlikely	Medium

26.0 Waste

This chapter provides an assessment of the waste-related impacts associated with the Project. **Table 26-1** sets out the requirements as provided in the Secretary's Environmental Assessment Requirements (SEARs) relevant to waste and where the requirements have been addressed in this EIS.

Table 26-1 SEARs – Waste

Ref	Assessment requirements	Where addressed in this EIS
14.1	The Proponent must assess predicted waste generated from the project during construction and operation, including: a. classification of the waste in accordance with the current guidelines;	**Section 26.3.1**
	b. estimates/details of the quantity of each classification of waste to be generated during the construction of the project, including bulk earthworks and spoil balance;	**Section 26.3.1**
	c. handling of waste including measures to facilitate segregation and prevent cross contamination;	**Section 26.5**
	d. management of waste including estimated location and volume of stockpiles;	**Section 26.3.2, Section 26.5,**
	e. waste minimisation and re-use;	**Section 26.5**
	f. lawful disposal or recycling locations for each type of waste; and	**Section 26.5**
	g. contingencies for the above, including managing unexpected waste volumes.	**Section 26.5**
14.2	The Proponent must assess potential environmental impacts from the excavation, handling, treatment and storage on-site and transport of the waste particularly with relation to sediment/leachate control, noise and dust.	**Section 26.3** and **26.4** Note that sediment/leachate control is also addressed in **Chapter 13 Landform, geology and soils**; potential noise impacts are also addressed in **Chapter 20 Noise and vibration (airbourne)**, and dust impacts are also addressed in **Chapter 22 Air quality**

26.1 Assessment approach

A qualitative desktop assessment was carried out to estimate waste types and quantities, and to identify potential impacts and the appropriate management approach. This involved:

- reviewing the regulatory framework for waste management;
- identifying potential waste generating activities during construction and operation;
- estimating the likely waste streams and volumes, including bulk earthworks and spoil balance;
- identifying the likely classification of waste streams in accordance with relevant legislation and guidelines;
- describing proposed management and handling techniques for key waste streams, including waste minimisation and re-use; and
- identifying lawful disposal or recycling locations.

The waste types and quantities estimated in this chapter are indicative and have been identified for the purpose of determining potential waste management options. Although the quantities of waste actually generated by the Project may differ from the estimates made, the identified waste management options are likely to be appropriate for the final waste quantities.

26.1.1 Legislative and policy context

Commonwealth context

The loading and dumping of waste at sea is regulated in Australia under the Commonwealth *Environment Protection (Sea Dumping) Act 1981* (the Sea Dumping Act). This Act helps to prevent marine pollution by controlling waste and other matter being discarded offshore in Commonwealth waters. Under the Sea Dumping Act, the Commonwealth aims to minimise pollution threats by:

- prohibiting ocean disposal of waste considered too harmful to be released in the marine environment; and
- regulating permitted waste disposal to ensure environmental impacts are minimised.

The Sea Dumping Act applies to all vessels, aircraft and platforms in Australian waters and to all Australian vessels and aircrafts in any part of the sea. Treated wastewater that forms part of normal operational discharges from ocean outfalls does not normally require a sea dumping permit. The Project also does not involve dredging and does not require a sea dumping permit for this reason.

The movement of controlled waste between states and territories is regulated by the *National Environment Protection (Movement of Controlled Waste between States and Territories) Measure 1998*, made under the *National Environment Protection Council Act 1994* (Commonwealth).

NSW context

The *Protection of the Environment Operations Act 1997* (POEO Act) is the primary legislation for waste management and recycling in NSW. The POEO Act establishes the procedures for environmental control, and for issuing environmental protection licences covering issues such as waste.

Schedule 5 of the POEO Act defines waste as:

a. *any substance (whether solid, liquid or gaseous) that is discharged, emitted or deposited in the environment in such volume, constituency or manner as to cause an alteration in the environment*

b. *any discarded, rejected, unwanted, surplus or abandoned substance*

c. *any otherwise discarded, rejected, unwanted, surplus or abandoned substance intended for sale or for recycling, processing, recovery or purification by a separate operation from that which produced the substance*

d. *any processed, recycled, re-used or recovered substance produced wholly or partly from waste that is applied to land, or used as fuel, but only in the circumstances prescribed by the regulations*

e. *any substance prescribed by the regulations to be waste.*

The *Protection of the Environment Operations (Waste) Regulation 2014* (POEO Waste Regulation) regulates matters such as the obligations of consignors (producers and agents), transporters, and receivers of waste, in relation to waste transport licensing and tracking requirements within NSW.

BVSC operates several waste depots/facilities, including the Merimbula Waste and Recycling Depot (approximately five kilometres from the Project area), and the Central Waste Facility (approximately 15 kilometres from the Project area at Frogs Hollow). Several waste streams from the Project would be able to be disposed of at these facilities. Specific waste disposal/management facilities would be confirmed during detailed design and construction planning based on applicable requirements under the POEO Waste Regulation, the waste type to be disposed of, classification of the waste, timing of disposal and the capacity of the waste disposal/management facility.

In NSW, waste is classified in accordance with the *Waste Classification Guidelines 2014* (NSW EPA, 2014a) (the '*Waste Classification Guidelines*'). Waste classification helps those involved in the generation, treatment and disposal of waste, ensure the environmental and human health risks associated with their waste is appropriately managed in accordance with the POEO Act and its associated regulations. Part 1 of the *Waste Classification Guidelines* provides advice and directions on classifying waste so that appropriate management of all waste types is achieved. Many waste types are pre-classified under the POEO Act and do not require testing. However, if a waste is not pre-classified, it may need to be tested to determine its classification.

Waste material generated from the Project would be classified in accordance with these guidelines. The following waste classifications are relevant to the Project:

- special waste;
- liquid waste; and
- pre-classified waste, including:
  - general solid waste (putrescible)
  - general solid waste (non-putrescible)
  - restricted solid waste
  - hazardous waste.

Part 4 of the *Waste Classification Guidelines* deals with the management and disposal of acid sulfate soils, which would be relevant to the Project if acid sulfate soils are encountered. **Chapter 13 Landform, geology and soils** provides an assessment of acid sulfate soils risk for the Project and identifies that there is the potential to disturb acid sulfate soils for the construction of the outfall pipeline between the STP and Merimbula Beach. However disturbance would be limited due to the trenchless construction methodology being used for this component for the Project.

The *Waste Avoidance and Resource Recovery Act 2001* (WARR Act) aims to ensure that waste management options are considered against the following waste management hierarchy:

1. avoidance of unnecessary resource consumption;
2. resource recovery (including re-use, reprocessing, recycling and energy recovery); and
3. disposal.

To support the waste management hierarchy, the *NSW Waste Avoidance and Resource Recovery Strategy 2014 -21* (NSW EPA, 2014b) provides a framework and targets for waste management and recycling in NSW. Targets established under this strategy include:

- avoiding and reducing the amount of waste generated per person in NSW;
- increasing recycling rates to 70 per cent for municipal solid waste, 70 per cent for commercial and industrial waste, and 80 per cent for construction and demolition waste;
- increasing waste diverted from landfill to 75 per cent; and
- managing problem wastes better, and establishing 86 drop-off facilities and services across NSW.

The NSW Environment Protection Authority has also made several Resource Recovery Orders and Resource Recovery Exemptions under the POEO Waste Regulation which contain specific conditions for waste disposal.

26.2 Existing environment

In addition to the treated wastewater produced by the operation of the Merimbula STP, current activities at the STP that generate waste are listed in **Table 26-4**, together with the associated waste streams produced and waste classifications. This waste currently generated at the STP is managed in accordance with existing waste management procedures.

Table 26-2 Types of waste currently generated at STP

Activity	Waste streams produced	Classification of waste stream
Wash down of plant and equipment and staff amenities (such as toilets)	Sediment-laden and/or potentially contaminated wastewater, sewage and grey water	Liquid waste
Maintenance of STP components, operational vehicles and equipment	Adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses, solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials, and spent spill kit absorbent materials used to clean up accidental spills during maintenance	Hazardous or restricted waste (non-putrescible)
	Drained oil filters (mechanically crushed), rags and oil-absorbent materials that do not contain free liquids	General solid waste (putrescible)
	Tyres	Special waste
	Used light bulbs/LED tubes and used light fixtures	Hazardous waste
Activities at on-site offices	Putrescibles	General solid waste (putrescible)
	Paper, cardboard, plastics, glass and printer cartridges	General solid waste (non-putrescible)
Sewage processing	Grit or screenings from the STP (that has been dewatered so that it does not contain free liquids)	General solid waste (putrescible)
	Waste from chemical processing (sludge from polyaluminium chloride dosing for phosphorous removal)	General solid waste (non-putrescible) providing that this waste can be categorised as 'unrestricted use', or 'restricted use' 1, 2 or 3, in accordance with the guidelines *Use and Disposal of Biosolids Products* (NSW EPA, 2000). Note that biosolids are applied beneficially to agricultural land according to these guidelines.
STP ponds (mechanically dewatered periodically approximately every six to eight months)	Biosolids (pond sediment/sludge)	General solid waste (non-putrescible) (providing that this waste can be categorised as 'unrestricted use', or 'restricted use' 1, 2 or 3, in accordance with the guidelines Use and Disposal of Biosolids Products (NSW EPA, 2000). Note that biosolids are applied beneficially to agricultural land according to these guidelines.

26.3 Potential impacts – construction

Potential impacts associated with construction waste likely to be generated by the Project include:

- inadequate classification and collection of waste could result in unnecessary waste disposal to landfill, which may reduce local or regional landfill capacity;
- inadequate transport and disposal of liquid and solid wastes could lead to potential environmental pollution and indirect impacts on public health;
- incorrect or inadequate storage, handling and disposal of putrescible waste from work sites or site offices could attract vermin or pest species, and also lead to nuisance effects on surrounding properties such as odour or visual amenity impacts; and
- incorrect classification, handling and/or disposal of contaminated waste (e.g. soil contaminated from spills, acid sulfate soils, or asbestos containing materials), could lead to potential environmental pollution and/or public health risk.

In addition to the above, inappropriate waste storage (both in trucks and at stockpile sites) and waste handling and management, could result in downstream sedimentation, or leachate runoff, noise impacts and dust impacts. Each of these potential impacts have been assessed in detail in **Chapter 13 Landform, geology and soils**; **Chapter 20 Noise and vibration (airbourne)**; and **Chapter 22 Air quality,** respectively. A summary of the outcomes of these assessments is provided in **Table 26-3.**

Table 26-3 Summary of relevant assessments and associated management measures

Impact	Summary	Management measures proposed
Downstream sedimentation and leachate runoff	**Section 8.3** and **Section 9.3** of this EIS assesses the potential for the Project to result in downstream sedimentation and leachate runoff impacts. Waste stockpiles have the potential to release pollutants into the surrounding environment. Typically, the potential pollutants generated would be variable and subject to the soil profile (e.g. erosion potential), phase of construction works/activities being undertaken, extent of disturbance and weather/climatic influences (e.g. rainfall). The key potential water quality pollutants of concern from construction waste would be sediment (e.g. resulting in turbidity, suspended solids), fuel/oil, grease and leaching of other chemicals used in construction (including directional drilling fluid/muds and acid sulphate soils). With appropriate measures in place, release of potential waste pollutants during construction of the Project is expected to be either avoided, or otherwise short term and limited in extent, and managed to result in negligible or minor impacts. In addition , the products selected for mixing the drilling fluid slurry would be inert (such as bentonite clay) or biodegradable (such as biopolymers or xanthan gum), many of which are certified for use in aquifers containing potable quality groundwater.	The following management measures would be applicable: • SWF2, specifically regarding measures to reduce impacts on water quality in the receiving environment; and • SWF3, specifically regarding the requirement for stockpiles and storage areas to be located outside the 1% AEP flood extent. In addition to the above, the construction of the Project would employ the following standard design features and mitigation and management measures: • incorporating features into the final design that avoid disturbance of the aquifer and groundwater wherever practicable; • avoiding the use of potentially harmful substances where practicable, including the use of ecologically harmless drilling fluid compositions; • placing barriers between any potential source(s) of

Impact	Summary	Management measures proposed
	Any impacts are also expected to be negligible relative to the mobilisation and discharge of pollutants throughout the wider catchment area following a significant weather event, in combination with tidal flushing in the surrounding marine and estuarine environments. The potential construction impacts anticipated on receiving water quality is considered to be negligible to minor overall.	contamination and the water table; • handling potentially contaminating substances such as fuels, hydraulic oils and caustic (drilling mud additive) in accordance with relevant regulations; and • developing and implementing an adequate spill response plan that complies with relevant regulations.
Noise	**Section 20.3** of this EIS assesses the potential for the Project to result in noise impacts. This assessment includes consideration of the potential for an increase in heavy vehicle movements (including those transporting waste) to result in noise impacts. The numbers of construction vehicle movements have been estimated to be up to 20 light and 10 heavy vehicles per day during peak construction periods for delivery of materials, loading of spoil and waste and concreting activities. The existing traffic flows on roads with residential receivers nearby the Project is substantially greater than the proposed construction traffic numbers. Therefore, additional traffic associated with the Project, including those transporting waste, would have a minor impact on existing road traffic noise in the area with traffic noise levels during construction expected to increase by less than 2 dB.	• NV3, specifically that vehicle movements will be routed away from sensitive receivers and scheduled during less sensitive times where feasible and reasonable; • NV4, specifically that the speed of vehicles will be limited, and the use of engine compression brakes limited; and • NV5, specifically that on-site storage capacity will be maximised to reduce the need for truck movements during sensitive times.
Dust	**Section 22.3.2** of this EIS assesses the potential for the Project to result in dust impacts. The magnitude of any unmitigated dust emissions from construction is rated as small for track out (vehicle movements generating dust on unsealed roads) and medium for earthworks (including stockpiling).There are no demolition works proposed as part of the Project. The potential unmitigated dust soiling and human health risks are low to negligible, whereas the potential unmitigated ecological risks are negligible to medium. Therefore, the unmitigated risk rating for construction of	• AQ1, specifically as it relates to the monitoring of dust impacts • AQ2, AQ3, AQ4, AQ5, AQ6, AQ7, specifically as they relate to the minimising of dust generation and dust escape including stockpile management and truck load management.

Impact	Summary	Management measures proposed
	the Project ranges from negligible to medium.	

These potential waste management impacts would be managed through the implementation of the waste management measures identified in **Section 26.5**.

26.3.1 Waste generation

The main construction activities anticipated to generate waste are listed in **Table 26-4** together with the materials that may be produced and likely waste classifications.

The types and quantities of construction waste generated by the Project would vary throughout construction. The quantities and classifications of all waste streams would be confirmed following finalisation of the detailed design for the Project.

Table 26-4 Indicative types of waste generated during construction

Activity	Waste streams that may be produced	Likely classification of waste stream
Excavation and general earthworks including site establishment and construction for the upgrade of the STP	Spoil comprising virgin excavated natural material (VENM) (uncontaminated soil and crushed rock), including aggregate, fines and road material	General solid waste (non-putrescible).
	Contaminated material (e.g. contaminated spoil or fill, acid sulfate soil)	Hazardous waste, restricted solid waste or special waste
Decommissioning of the existing STP effluent storage pond (location shown on refer Figure 2-3 in Chapter 2 Project Description)	Spoil	General solid waste (non-putrescible)
	Biosolids	General solid waste (non-putrescible) (providing that this waste can be categorised as ‘unrestricted use’, or ‘restricted use’ 1, 2 or 3, in accordance with the guidelines *Use and Disposal of Biosolids Products* (NSW EPA, 2000)
Construction of STP infrastructure, including buildings, dosing facilities, filtration units, and new pumping stations, demolition of existing trickling filters	Concrete waste, timber, scrap metal, steel, electrical and pipe fittings/cut-offs, plasterboard, cable and packaging material	General solid waste (non-putrescible)
	Cement wash out	Liquid waste
	Contaminated materials (e.g. oil/lubricant waste) Adhesives, lubricants, waste fuels and oils, solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials	Hazardous waste, restricted solid waste or special waste
	Material from existing trickling filters, including rock/cobbles	General solid waste (non-putrescible, or putrescible) - subject to any treated sewage contamination present

Activity	Waste streams that may be produced	Likely classification of waste stream
Construction of the ocean outfall (including trenchless drilling method for section one of the pipeline, and pipeline stringing and butt welding)	Spoil from directional drilling (contaminated with drilling fluid/mud), if not recycled for further use in the drilling process. The potential drilling fluids used would be determined by the drilling contractor, but may include a combination of: • high-yield Wyoming Bentonite; • fluid loss control/polyanionic cellulose; • clay control; • drilling detergent; • bore/mud lubricant; • liquid polymer; • soda ash; • xanthan biopolymer; • swelling lost circulation material polymer; and • lost circulation material – hole sealing aid.	Hazardous waste, restricted solid waste or special waste (depending on type of fluids/muds used in drilling process)
	Contaminated materials	Hazardous waste, restricted solid waste or special waste
	Acid sulfate soils	Acid sulfate soils
	Waste plastic from butt welding	General solid waste (non-putrescible) or restricted solid waste depending on composition
Dust suppression, wash down of plant and equipment, and staff amenities at construction sites and on barge/marine vessels (such as toilets)	Sediment-laden and/or potentially contaminated wastewater, sewage and grey water	Liquid waste
Maintenance of construction plant, vehicles and equipment, (including marine vessels/barges)	Adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses, solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials, and spent spill kit absorbent materials used to clean up accidental spills during maintenance	Hazardous or restricted waste (non-putrescible)
	Drained oil filters (mechanically crushed), rags and oil-absorbent materials that do not contain free liquids	General solid waste (putrescible)
	Tyres	Special waste
Construction worker activities at on-site offices and on barge/marine vessels	Putrescibles	General solid waste (putrescible)
	Paper, cardboard, plastics, glass and printer cartridges	General solid waste (non-putrescible)

Activity	Waste streams that may be produced	Likely classification of waste stream
Clearing of vegetation	Green waste	General solid waste (non-putrescible)

With respect to waste generation, the estimated spoil volumes that may be generated by the Project are shown in **Table 26-5**.

Table 26-5 Estimated bulk earthworks and spoil volumes

Component	Spoil volume (approximate)
Drilling spoil	700 cubic metres
Excavation required for new STP infrastructure (including pipelines, pumping stations, storage tanks and other components)	Pipe laying within the STP 1,850 cubic metres Pits and structures 500 cubic metres General earthworks (retaining wall, access roads) 400 cubic metres
Spoil re-used	Approximately 400 cubic metres of spoil would be re-used for backfilling
Imported fill	Nil
Total	3050 cubic metres

The BVSC development guidelines do not provide waste generation rates for construction activities. In the absence of readily available construction waste generation rates from BVSC, similar rates that have been proposed and adopted for recent STP developments and upgrades throughout New South Wales have informed this estimation of construction waste for the Project. These rates and the subsequent estimation of construction waste from the Project is provided in **Table 26-6**.

Table 26-6 Estimated construction waste volumes

Material	Volume (approximate)
Vegetation (removed and mulched)	42000 cubic metres
Drilling spoil	700 cubic metres
Excavation spoil	2750 cubic metres
Excess construction materials (such as concrete brick, timber and steel offcuts)	680 cubic metres
General solid waste (putrescible such as food scraps, worker rubbish etc)	24 cubic metres
General solid waste (non-putrescible such as packaging of construction materials)	130 cubic metres

26.3.2 Waste management

The waste types outlined in **Table 26-4** above are listed in **Table 26-7** below alongside the likely waste management approaches. All waste generated would be regularly removed from site as required, to avoid potential issues associated with odour, decreased visual amenity and creating environments that attract animals/pest species (e.g. rats and mice).

Waste generated on marine vessels (e.g. barge) would be contained onboard for management and disposal on land by licensed contractors, except where the vessel is licensed to dispose of in marine waters otherwise (e.g. bilge water). Any pipeline pig/s would be retrieved at the end of the pipe, as required. It is noted that pigs made out of freshwater ice blocks may be used. In these instances, no retrieval would be required.

Note that the following NSW EPA Resource Recovery Orders may be applicable:

- excavated natural material order 2014 (NSW Environment Protection Authority, 2014);
- recovered aggregate order / recovered fines order / reclaimed asphalt pavement order / excavated public road material order;
- biosolids;
- effluent;
- slag;
- treated drilling mud;
- plasterboard order;
- cement fibreboard order;
- recovered tyres order;
- compost order; and
- mulch order.

Opportunities to re-use these wastes under these Resource Recovery Orders would be confirmed during detailed design.

Table 26-7 Construction waste management

Waste type	Management
Spoil	Spoil comprising virgin excavated natural material (uncontaminated soil and crushed rock) would be managed in accordance with the waste management hierarchy (described in **Section 26.1.1**). Excavated spoil would be classified in accordance with the *Waste Classification Guidelines* prior to leaving site. As a worst case, all spoil generated would be disposed off-site at licensed waste facilities (e.g. landfill). However, where possible, spoil would be re-used on-site as part of the Project (e.g. as backfill of excavations within the STP site), or re-used on other project site/s (where identified) or at a soil manufacturing/re-recycling facility, including in accordance with NSW EPA Resource Recovery Order/s that may apply (where feasible). The suitability of spoil to be re-used on-site (or on alternate project site/s or at a re-purposing facility) would be confirmed during detailed design (e.g. through further soil/contamination investigations within the STP site and identification of other viable sites). Note that spoil may be stockpiled on-site if it is not contaminated prior to re-use or disposal. Stockpile locations would be within the construction laydown areas shown in **Figure 2-7** of **Chapter 2 Project description.** Total stockpile volume would be limited to the volume of spoil produced from excavation required for new STP infrastructure (including pipelines, pumping stations, storage tanks and other components). This would represent the maximum volume of spoil to be stockpiled on site, as spoil from directional drilling would be contaminated with drilling fluid and would not be stockpiled on site. Each stockpile would also be limited to a height of approximately 2 m and a batter ratio of 1:3 (height:width). Spoil would be transported from site by trucks to the nearest appropriately licenced waste facility, primarily along designated haulage routes. Material that is classified as VENM, if not re-used on site, would be transported to the Central Waste Facility in Frogs Hollow, NSW where it may be beneficially re-used as a cover material.
Contaminated material	Any contaminated spoil (e.g. from in-situ contamination) would be managed in accordance with the relevant legislation and guidelines, including the WARR Act and Waste Classification Guidelines. In-situ testing of soils within the STP site would be undertaken to determine the appropriate waste classification of spoil from within the STP site. The drilling contractor would dispose of contaminated drilling spoil as per the waste classification of the fluids/muds used. This spoil would be captured in an above ground tank and may be recycled for further use in the drilling process or disposed off-site. Contaminated materials would be appropriately contained and disposed of at a suitably licenced off-site location or managed in situ where there is no unacceptable risk to human health or ecological values.

Waste type	Management
Biosolids	In the unlikely instance that biosolids from the pond clean out are encountered, these would be classified in accordance with the Waste Classification Guidelines. Where feasible, materials would be re-used under a NSW EPA Resource Recovery Order, or otherwise disposed of by a licensed contractor to an appropriately licensed facility. Providing that this waste can be categorised as 'unrestricted use', or 'restricted use' 1, 2 or 3, in accordance with the guidelines *Use and Disposal of Biosolids Products* (NSW EPA, 2000), the waste can be classified as General solid waste (non-putrescible). Inert solids from the pond can be blended with biosolids and applied to agricultural land, in accordance with the guidelines (if required to empty the pond completely). Depending on the use of the pond after construction, the solids may be left to dry out, and the area would be filled to allow for alternative uses of this land. If required, biosolids can alternatively be taken to an authorised landfill.
Construction waste (concrete, timber, scrap metal, steel, plasterboard, electrical and pipe fittings/cut-offs, plasterboard, cable and packaging material) including Hazardous waste Restricted waste or General solid waste (non-putrescible)	Construction waste would be managed in accordance with the waste management hierarchy (described in **Section 26.1.1**). Where feasible, materials would be re-used under a NSW EPA Resource Recovery Order. Otherwise construction waste would be segregated and sorted at a Materials Processing Facility or Materials Recycling Facility. Electrical waste would be stored for collection by an authorised contractor for recycling off-site, where feasible, or taken off-site for disposal at an appropriately licenced facility. All construction waste would be classified in accordance with the Waste Classification Guidelines and where it cannot be re-used, directed to a waste management facility that is lawfully permitted to accept that type of waste.
Acid sulfate soils	Any acid sulfate soils encountered during construction of the Project would be managed in accordance with the Acid Sulfate Soils Manual (Acid Sulfate Soils Management Advisory Committee, 1998). Management of acid sulfate soils is addressed in **Chapter 13 Landform, Geology and Soils**. In the event that indicators of contamination or acid sulfate soils are encountered during construction (such as odours, visually contaminated materials etc.), work in the immediate area would cease, and the finds would be managed in accordance with the unexpected contamination finds procedure.

Waste type	Management
Drilling fluids/slurry	The trenchless drilling method would involve a mud recycling system on-site to minimise the need for drilling fluids. The disposal of drilling fluids/slurry would be managed in accordance with the waste management hierarchy (described in **Section 26.1.1**). Drilling fluids would be captured in an above ground tank and recycled as part of the drill rig set up where possible. Opportunities to re-use drilling fluids, using a recycling unit to separate the solids from the liquid, would be investigated further during detailed design and construction planning. Where feasible, this waste would be re-used under the NSW EPA Resource Recovery Order for treated drilling fluid. Following separation of solids from the liquid, solids would be managed as outlined in **Section 26.5**. Slurry that cannot be re-used would be either placed in an existing dewatering pond at the STP for disposal, or would be transported and disposed of at an appropriately licensed facility. The escape of drilling fluids can occur where pressure within the drilled borehole is sufficient to cause drilling fluid to escape from the bore hole through fractures or faults in rock or through the pores in sand and gravels. This risk would be considered further in the detailed design phase and construction contractor's drilling plan, where possible, with regard to pressure, angle and depth proposed and substrate conditions. Spill management and bunding mitigation and management measures would also be included in the CEMP. A construction EPL may be required to manage drilling activities in the marine environment.
Butt welding waste	Where feasible, off cuts of plastic would be recycled. Where this is not possible, plastic waste (derived from the pipeline) would be disposed of at a facility licensed to receive the waste.
Liquid waste	Wastewater, sewage, and grey water would be disposed to sewer (where lawfully permitted), or otherwise transported to an appropriately licenced liquid waste treatment facility. Note that only sewage is able to be accepted into the STP for processing. No liquid trade waste of any kind can be accepted as a result of the construction activities. Cement wash out would be removed from site by a licensed contractor and disposed of at a licensed facility.
Adhesives, lubricants, waste fuels and oils, engine coolant, batteries, hoses, tyres, solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials, and spent spill kit absorbent materials used to clean up accidental spills during maintenance	Waste from construction vehicle and plant maintenance activities would be collected and stored in designated waste storage areas for collection by an authorised contractor for off-site disposal. Where feasible, containers holding oil, grease, and lubricants would be washed prior to disposal, or stored separately for disposal as hazardous waste. Waste oil and oil filters would be stored in recycling bins and collected by an authorised contractor, and recycled off-site, where feasible. Tyres would be re-used under the Recovered Tyres Resource Recovery Order where feasible or otherwise collected by an authorised contractor for recycling or disposal off-site at an appropriately licensed facility.
Office waste including kitchen waste, paper, cardboard, plastics, glass	Recyclable materials such as paper, cardboard, plastics, glass, ferrous, and non-ferrous containers would be stored at recycling bins for collection by an authorised contractor and recycled off-site. Where recycling is not feasible, waste would be collected and stored in designated waste storage areas for collection by an authorised contractor for off-site disposal at a licenced waste facility.

Waste type	Management
Green waste	Green waste would be collected by an authorised contractor and recycled off-site. BVSC's Merimbula Waste and Recycling Depot can receive green waste. Noxious weeds would be disposed of in accordance with the Biosecurity Act 2015 and relevant guidelines.
General solid waste (putrescible)	General waste would be collected on-site in designated waste collection bins. No recyclable or contaminated materials would be placed in these bins. A waste contractor would pick up the bins and take them off-site as required to a licensed landfill for disposal.

26.4 Potential impacts – operation

The Project is not expected to generate a significant increase in the existing waste types outlined in **Table 26-2**. New operational activities anticipated to generate waste streams are outlined in **Table 26-8** together with the materials that may be produced and likely waste classifications. The types and quantities of operational waste generated by the Project would vary throughout the life of the Project and would largely be managed under existing waste management procedures.

Potential impacts associated with operational waste likely to be generated by the Project include:

- inadequate classification and collection of waste could result in unnecessary waste disposal to landfill, which may reduce local or regional landfill capacity;
- inappropriate waste storage (both in trucks and at stockpile sites), and waste handling and management could result in dust and noise impacts, downstream sedimentation or leachate runoff;
- inadequate transport and disposal of liquid and solid wastes could lead to potential environmental pollution and indirect impacts on public health;
- incorrect or inadequate storage, handling and disposal of putrescible waste from work sites or site offices could attract vermin or pest species, and also lead to nuisance effects on surrounding properties such as odour or visual amenity impacts; and
- incorrect classification, handling and/or disposal of contaminated waste (e.g. soil contaminated from spills, acid sulfate soils, or asbestos containing materials), could lead to potential environmental pollution and/or increased public health risks.

These potential waste management impacts would be managed through the implementation of the waste management measures identified in **Section 26.5**.

Table 26-8 Indicative types of additional waste generated during operation

New activity	Waste streams that may be produced	Likely classification of waste stream
Maintenance of UV disinfection units at the STP, including replacing lamps, ballast and other parts as required	UV lamps, ballast	Hazardous waste
	Other mechanical and electrical parts	General solid waste (non-putrescible)
Handling and management of additional waste from additional treatment processes at the STP, including a 20% increase in overall solids to be handled (partially as a result of backwash water return (aluminium/hydrated aluminium precipitate) from tertiary filtration units, if required).	Waste sludge (aluminium/hydrated aluminium precipitate)	Hazardous waste

New activity	Waste streams that may be produced	Likely classification of waste stream
Maintenance of new plant and equipment, including flushing pipes, mechanical and electrical maintenance of pumps and pumping stations (including replacing filters, grease, oil and other fluids)	Adhesives, lubricants, waste fuels and oils, solvents, paints, adhesives, cleaning fluids, greases, acids and alkali materials	Hazardous or restricted waste (non-putrescible).
Maintenance activities for the ocean outfall pipeline, including: • underwater visual inspections by divers and/or remote operated vehicles periodically and as required (e.g. annually) • physical and corrosion repairs by divers (e.g. physically removing corrosion/strengthening or replacing any components subject to corrosion such as fasteners, joints, fittings or anchors) • concrete repairs (to concrete mattresses over the pipe and other concrete features) Note that cleaning accumulated sediment/grease and/or other impediments by periodically flushing (increasing flow through the pipeline) and/or pigging would be carried out using clean water suitable for release from the outfall pipeline, and pigs would be captured and retained where possible (noting potential for use of pigs made of ice).	Wastes generated by crew on board vessels (e.g. kitchen waste, sewage)	General solid waste (putrescible), liquid waste
	Steel/wire offcuts	General solid waste (non-putrescible)
	Waste plastic from welding repairs	Construction waste
	Concrete	

26.4.1 Operational waste management

Operational waste generated at the STP and ocean outfall would be managed in accordance with existing waste management procedures.

Potential waste management approaches are listed in **Table 26-9** for the new waste types identified in **Table 26-8**. Similar to construction waste management (refer to **Section 26.3.2**), all waste generated would be regularly removed from site as required, to avoid potential odour issues, decreased visual amenity and the attraction of animals/pest species.

Waste generated on marine vessels (e.g. barge) would also be managed consistent with construction waste management.

Note that the following NSW EPA Resource Recovery Orders may be applicable to operational wastes generated:

- biosolids;
- effluent; and
- mulch.

Opportunities to re-use these wastes under these Resource Recovery Orders would be reviewed during detailed design and periodically throughout the operational life of the Project.

Table 26-9 Operational waste management for new waste types produced as a result of the Project

New waste type to be generated by the Project	Management
UV lamps and ballast	UV lamps and ballast would be collected in specifically labelled bins and removed from site by a licensed contractor. UV lamps and ballast under 1.2 m in length would be taken to the BVSC Community Recycling Centre in Merimbula for disposal as electronic waste (e-waste). Lamps would be protected from breakage and would be delivered to a waste facility for disposal. The specialised maintenance contractor for other UV installations in the BVSC would remove the lamps and ballast for disposal as part of the maintenance service.
Waste sludge (aluminium/hydrated aluminium precipitate)	Waste sludge would be classified in accordance with the Waste Classification Guidelines. Where feasible, material would be re-used under a NSW EPA Resource Recovery Order, or otherwise disposed of by a licensed contractor to an appropriately licensed facility.
Wastes generated by crew on board vessels (e.g. kitchen waste, sewage)	Waste generated on marine vessels would be contained onboard for management and disposal on land via licensed contractors, except where the vessel is licensed to dispose of in marine waters (e.g. bilge water).
Corroded pipe material and steel/wire offcuts	Waste would be managed in accordance with the waste management hierarchy (described in **Section 26.1.1**). Where feasible, materials would be re-used under a NSW EPA Resource Recovery Order. Waste would be classified in accordance with the Waste Classification Guidelines and where it cannot be re-used, it would be directed to a waste management facility that is lawfully permitted to accept that type of waste (e.g. Merimbula Waste and Recycling Depot). Waste would be segregated and sorted at a Materials Processing Facility or Materials Recycling Facility where possible.
Concrete and cement waste	Concrete waste would be accepted at BVSC's Central Waste Facility, Frogs Hollow. Cement wash out would be removed from site by a licensed contractor and disposed of at a licensed facility.

26.5 Management of impacts

The mitigation measures identified to help avoid and minimise the identified waste impacts are outlined in **Table 26-10**, and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC as part of the Project's Operation and Maintenance manual, where relevant .

26.5.1 Performance outcomes

The waste management performance outcomes for the Project are as follows:

- the waste management hierarchy is implemented across all construction sites;
- waste from construction and operation of the Project is classified in accordance with the Waste Classification Guidelines (NSW EPA, 2014a); and
- waste types once classified are reviewed against appropriate guidelines to manage waste appropriately.

The Project would be designed, constructed and operated to achieve these performance outcomes.

26.5.2 Consideration of the interaction between measures

Mitigation measures in other chapters that are relevant to the management of potential waste impacts include:

- **Chapter 8 Surface water, hydrology and flooding,** specifically measures SWF1, SWF2 and SWF5, which address potential water quality impacts of construction wastewater and treated wastewater discharge during operation
- **Chapter 13 Landform, geology and soils**, specifically measures S1 to S5, which address the management of contamination risks including acid sulfate soils and potential erosion and sedimentation impacts during spoil handling and management
- **Chapter 16 Hazard and risk**, specifically measures HR1 to HR9 which addresses the safe handling and storage of hazardous materials and special waste
- **Chapter 18 Traffic and transport**, specifically mitigation measures T4 and T7 which address potential traffic and transport impacts from spoil haulage
- **Chapter 22 Air quality**, specifically measures AQ1 to AQ5, and AQ7 which addresses dust impacts from spoil handling, transport and spoil stockpiles
- **Chapter 24 Sustainability**, specifically measure S1 which would involve the preparation of a Sustainability Management Plan for the Project. Draft sustainability objectives that are identified for inclusion in the Sustainability Management Plan (refer to **Section 24.4**) includes objectives regarding reducing materials consumption and maximising re-use of resources.

26.5.3 Mitigation measures

Project-specific waste management and mitigation measures are detailed in **Table 26-10**.
Note that management of acid sulfate soils and contamination is addressed in **Chapter 13 Landform, Geology and Soils**.

Table 26-10 Mitigation and management measures – Waste management

Ref #	Potential impacts	Mitigation and management measures	Timing
WM1	Generation of general waste	Waste would be managed in accordance with the waste hierarchy established in the WARR Act. This would include: • meeting targets established under the *NSW Waste Avoidance and Resource Recovery Strategy 2014 -21* (NSW EPA, 2014b) where practicable; • classification of waste during construction in accordance with the *Waste Classification Guidelines* (NSW EPA, 2014a); • segregation of waste at construction laydown areas and substations (within appropriate bins) for ease of recycling/re-use; • procurement of materials on an as needed basis to avoid waste due to over-ordering; and • investigating opportunities to re-use materials where feasible. All waste to be disposed off-site would be directed to a waste management facility that is lawfully permitted to accept that type of waste. Monitoring of all wastes would be carried out during construction and operation. Records of waste tracking and disposal would be maintained. Waste classified as general solid waste non putrescible and general solid waste putrescible would be accepted at BVSC's Central Waste Facility, Frogs Hollow.	All Project phases
WM2	Generation of construction waste	A Waste Management Sub-Plan would be prepared as part of the Construction Environmental Management Plan (CEMP). The Sub-Plan would: • identify requirements consistent with the waste and resource management hierarchy; • demonstrate that the waste hierarchy has been applied; • ensure resource efficiency is delivered through the design and construction practices; • provide consistent clear direction on waste and resource handling, storage, stockpiling, use and re-use management measures; • outline procedures for stockpiling of wastes (refer to mitigation measure WM3); • set out processes for disposal, including on-site transfer, management and the necessary associated approvals/permits. All waste generated would be regularly	Detailed design and construction

Ref #	Potential impacts	Mitigation and management measures	Timing
		removed from site as required by licensed contractors, in order to avoid potential issues associated with odour, visual amenity and attracting animals/pest species; • outline waste management practices which include measures requiring segregation of waste at source within the Project area and designating waste management areas for storage of waste within the Project area; • include material tracking measures to track waste and recyclables generated from the Project and removed from the Project area. Material tracking records would include types, volumes and management measures for waste and resources arising from/used for the Project; • outline an unexpected finds protocol to manage the potential for unexpected finds during construction of the Project (i.e. asbestos or other hazardous materials); • include a process for auditing, monitoring and reporting; and be managed, reviewed or audited by an appropriately qualified professional.	
WM3	Spoil generation and stockpiling	The Waste Management Sub-Plan would include requirements for spoil management. The plan would identify: • spoil generation activities and locations; • spoil management hierarchy; • on-site management, including stockpile sites; • spoil re-use options; • spoil disposal locations; • spoil transport modes and routes; and • waste tracking requirements. Stockpiled wastes would be: • appropriately segregated to avoid mixing and contamination; • appropriately labelled; • appropriately stored to minimise risk of erosion • contained in stockpiles less than three metres in height with an appropriate height to length batter ratio (e.g. 1:3); and located as far away as practical from sensitive receivers, ecological areas and watercourses.	Detailed design and construction

Ref #	Potential impacts	Mitigation and management measures	Timing
WM4	No waste minimisation	Consistent with materials and water-related sustainability objectives which would be included in the Sustainability Management Plan for the Project, the following waste minimisation strategies would be implemented when sourcing construction materials during detailed design: • if an option less favourable than the first option is selected and implemented, then justification for not selecting options higher on the waste hierarchy would be provided; • use of recycled materials (i.e. recycled content for asphalt and concrete including the use of fly ash) wherever feasible; • use of wastewater or recycled water to reduce potable water demand for construction activities; and • use of modular, precast/prefabricated structures, where feasible.	Detailed design and construction
WM5	No waste re-use	Where a NSW EPA Resource Recovery Order exists for a specific waste material, the opportunity to re-use the waste under that order should be considered prior to disposal. Current orders (and exemptions) are found on the NSW EPA website: https://www.epa.nsw.gov.au/your-environment/recycling-and-re-use/resource-recovery-framework/current-orders-and-exemption The current orders should be periodically reviewed during construction and operation for applicability.	Detailed design, construction and operation
WM6	Pollution from marine vessel wastes	Marine vessel/s (e.g. barge) used in construction and operation of the Project would have adequate waste management procedures in place that address applicable legislative requirements	Detailed design, construction and operation
WM7	Generation of operation waste	The existing Operational Waste Management Plan for the STP would be updated to include management measures developed for the new waste streams that would result from the Project (identified in **Table 26-9**).	Operation
WM8	Unexpected waste	Contingency measures would be implemented to manage unexpected waste volumes and materials generated during project construction. Where feasible, suitable hardstand or lined areas would be identified to allow for contingency management of unexpected waste materials.	Detailed design and construction

Provided recommended mitigation measures are implemented, residual environmental impacts as a result of waste and resource use from construction of the Project are unlikely, except for any contributions of waste from the Project to off-site landfill or other waste management facilities.

Operation of the Project would also contribute minor ongoing waste streams, which would be managed in accordance with the waste hierarchy (prevention, re-use, recycle, other use (e. g. energy recovery) or disposed of off-site at licensed waste facilities, including landfill in some cases, in line with existing management procedures, where the waste hierarchy cannot be achieved.

26.5.4 Environmental risk analysis

As outlined in **Section 7.3**, a risk assessment was undertaken using BVSC's *Enterprise Risk Management Framework* and in accordance with the principles of the Australian and New Zealand standard *AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines*. The risk assessment involved the identification of the consequence and likelihood of impacts to determine the risk of a given action or impact. An environmental risk analysis was undertaken for waste and is provided in **Table 26-11**.

A level of assessment was undertaken commensurate with the potential degree of impact the Project may have on that issue. This included an assessment of whether the identified impacts could be avoided or minimised. Where impacts could not be avoided, environmental management measures have been recommended to manage impacts to acceptable levels.

The residual risk is the risk of the environmental impact after the proposed mitigation measures have been implemented.

Table 26-11 Environmental risk analysis with mitigation– Waste management

Summary of impact	Construction/ operation	Management and mitigation reference	Consequence	Likelihood	Residual risk
Generation of general waste	Construction and operation	WM1	Minor	Unlikely	Low
Generation of construction waste	Construction	WM2	Minor	Likely	Low
Spoil generation and stockpiling	Construction	WM3	Minor	Possible	Low
No waste minimisation	Construction	WM4	Minor	Likely	Low
No waste re-use	Construction and operation	WM5	Minor	Possible	Low
Pollution from marine vessel wastes	Construction and operation	WM6	Minor	Unlikely	Low
Generation of operation waste	Operation	WM7	Minor	Possible	Low
Unexpected waste	Construction	WM8	Minor	Possible	Low

27.0 Cumulative impacts

Impacts from a project, when considered in isolation, may be considered minor, however, when multiple developments/activities result in impacts to the same receivers, the impacts may be more substantial. These are what are referred to as cumulative impacts. Potential cumulative impacts could include:

- increased construction traffic travelling on the local and regional road network;
- increase in construction noise and vibration, including road traffic noise;
- reduced visual amenity during construction
- increased boat/vessel traffic during construction; and
- increase in dust emissions during construction.

Cumulative impacts can be determined by an assessment of developments that are proposed, have been approved (but not yet under construction) and/or those that would be constructed or operating at the same time as the planning, construction or operation of the Project.

This chapter provides an assessment of the potential cumulative impacts of the Project which has been undertaken in accordance with the SEARs. **Table 27-1** sets out the requirements as provided in the SEARs relevant to cumulative impacts and where the requirements have been addressed in this EIS.

Table 27-1 SEARs – Cumulative impacts

Ref.	Assessment requirements	Where addressed in this EIS
2.1(n)	An assessment of the cumulative impacts of the project taking into account other projects that have been approved but where construction has not commenced, projects that have commenced construction, and projects that have recently been completed.	This chapter – **Chapter 27 Cumulative Impacts**

27.1 Assessment approach

This cumulative impact assessment has been informed by the environmental assessment undertaken for the Project, as presented in this EIS. It has considered the potential impacts of the Project, the management measures that would be implemented to avoid or reduce potential impacts, and the resulting degree of residual impacts. Where a residual impact is considered to be minor or negligible, this would be highly unlikely to result in cumulative impacts, and as such, is not considered further with regards to cumulative impacts.

It is anticipated that the Project would be undertaken over an approximate period of up to 24 months commencing in early 2022, once all necessary approvals are obtained.

Relevant registers and websites were searched for approved (i.e. determined), proposed (i.e. currently on exhibition/ SEARs issued) or future (i.e. committed with funding) developments that could interact with the Project.

The following tasks were undertaken to assess the potential for cumulative impacts:

- identifying existing (approved, under construction or completed) and proposed projects in the vicinity of the Project, based on information available in the public domain. Searches included:
  - a review of the NSW Department of Planning, Industry and Environment (DPIE) Major Projects website;
  - a review of other state and commonwealth government agency websites (such as Transport for NSW, Health Infrastructure NSW, and Commonwealth Department of Infrastructure, Transport, Regional Development and Communications);
  - a search of Bega Valley Shire Council (BVSC) development register;

  - a search of local utility providers current/committed projects online register; and
  - a search and review of media releases relating to major projects;
- screening identified projects for their potential to interact with the Project. If an identified development failed to meet the screening criteria, it was excluded from further consideration in the cumulative impact assessment;
- where an adverse impact is considered likely, mitigation and/or management measures would be implemented to avoid or reduce this impact. This assessment assumes that specific mitigation and management measures proposed for the Project (as summarised in **Chapter 28 Project synthesis**) would be applied
- identifying and assessing the significance of potential cumulative impacts by:
  - considering Project-specific impacts for the key Projects with the potential for cumulative impacts when combined with the construction and/or operation of the Project; and
  - undertaking an issue-specific cumulative assessment for the key environmental issues listed in the SEARs, considering major Projects being undertaken close to the Project Area for the Project.

27.1.1 Screening criteria

The screening of projects considered the following:

- the project location – projects in close proximity to the Project where there is potential for impacts to spatially overlap. This included potential for shared use of roads for construction access, for example;
- the project timeframe and planning approval –projects likely to be constructed concurrently with the Project are most likely to result in cumulative impacts and have been considered accordingly. This includes projects that have received planning approval or are currently under construction. Projects at a conceptual or pre-approval stage were generally not able to be considered due to an absence of project and/or environmental impact details or development timeframes; and
- the project size – projects considered are typically larger scale projects identified on the DPIE Major Projects website and council development application registers.

Furthermore, identified developments must have had publicly available information with an adequate level of detail available at the time of preparing the project EIS to be included in the qualitative cumulative impact assessment outlined below.

If an identified development failed to meet all of the above screening criteria, it was excluded from further consideration in the cumulative impact assessment.

A list of identified projects with the potential to contribute to cumulative impacts is provided in **Table 27-2**. A rationale for why the project was included or excluded in the assessment, based on the above criteria, is also provided in **Table 27-2**.

Table 27-2 Screening of identified developments within the vicinity of the Project

Proponent	Development name	Description and timing	Approximate distance to the Project area	Included or excluded from the assessment
BVSC	Merimbula Airport Runway Extension	Development for the runway extension - construction of a 120 metre (m) long runway extension at each end of the existing runway pavement (northern and southern ends of the existing runway). Stage 2 would involve a further 80 m extension of the runway pavement at both ends of the upgraded Stage 1 runway. This project is currently under assessment by Southern Regional Planning Panel and the timing of the project is yet to be announced.	1 km north of the Project area	Excluded; would not be constructed at the same time as the Project
BVSC	Merimbula Airport General Aviation Precinct	Located on the northern and western sides of Merimbula Aircraft Maintenance, to the north of the Merimbula Airport Passenger Terminal. This project involves the provision of taxiways, roadways, services and building platforms for the commercial and general aviation precinct. Once complete business and light aircraft owners would be able to lease land for use to park aircraft, and construct hangars and buildings for aviation-based businesses. Construction is scheduled to commence in the first half of 2021 and be completed in the first half of 2022.	1 km north of the Project area	Excluded: Would not be constructed at the same time as construction of the Project.
BVSC	Lake Street Shared Path - Merimbula	Construction of a shared-use path adjacent to Lake Street, Merimbula from Rotary Park to Merimbula Wharf via Bar Beach. Construction for the project is proposed from August 2020 to May 2021.	4 km northeast of the Project area	Excluded; not spatially relevant and construction of this project would not coincide with construction of the Project.

Proponent	Development name	Description and timing	Approximate distance to the Project area	Included or excluded from the assessment
BVSC – Pambula Sport Complex	Recreation facility (indoor) erection of squash courts	Construction of a recreation facility (indoor) and the erection of squash courts. The development was approved early 2020.	Approximately 1.6 km south of the Project area	Excluded; this development is anticipated to be completed prior to the end of 2021 and as such, would not be constructed at the same time as the Project
BVSC	Upgrades to the Pambula Surf Club precinct	Upgrades to the Pambula Surf Club precinct with accessibility as the main objective. Works to include car park upgrades and paths to provide safe access to the beach.	Approximately 2.5 km southeast of the Project area	Excluded; this development is anticipated to be completed prior to the end of 2021 and as such, would not be constructed at the same time as the Project
Twyford Hall Committee	Theatre Twyford	Construction of an entertainment establishment including a theatre with 200 seat capacity. Construction commenced in March 2020 with an estimated completion in the second quarter of 2021.	Approximately 3.5 km north of the Project area	Excluded; would not be constructed at the same time as the Project
NSW Department of Industry – Lands & Forestry	Eden Breakwater Wharf Extension (Eden Cruise Wharf)	Allow vessels up to 100 m in length to load/unload, refuel, maintenance and servicing, and passenger embarking/disembarking at the Eden Cruise Facility between 7am and 10pm and overnight berthing 24/7. Project is approved and construction completed.	Approximately 14 km south of the Project area	Excluded; this project is completed.

Proponent	Development name	Description and timing	Approximate distance to the Project area	Included or excluded from the assessment
Transport for NSW	Eden Welcome Centre	The Eden Welcome Centre located on the fisherman's co-op site in Eden, within close proximity of the recently completed cruise wharf, will have two floors with an approximate size of 1000 square metres. The ground floor will be for visitors, market stallholders and amenities and the first floor for office space	Approximately 14 km south of the Project area	Excluded; this project is expected to be completed by early 2021, and as such is unlikely to result in cumulative impacts.
Transport for NSW	Eden Harbourside Activation Project	At present, no decision has been made on the longer-term plans for the Eden Harbourside Activation Project. Existing plans and activities have included: • Crown Lands took possession of the site and secured vacant possession to address immediate tenant and public safety concerns • Hoarding has been erected around the building to enhance security and safety • Licence granted to the Eden Visitor Information Centre to permit vendors including food vans and mobile caterers to operate from Snug Cove through to the end of April 2021.	Approximately 14 km south of the Project area	Excluded; this project is currently within the planning stage and no detail is available regarding long term construction plans .
BVSC	Barclay Street Sportsground Revitalisation	Upgrades to the Barclay Street sportsground at Eden, including: • Construction of a new purpose-built sports pavilion for use by the sporting groups and the wider community in Eden • Design and installation of floodlighting at the Barclay Street AFL/Cricket oval to improve lighting for training purposes (50 lux) Work commenced on this project January 27 2020	Approximately 13 km south of the Project area	Excluded; this project is expected to be completed by early 2021 and as such is unlikely to result in cumulative impacts.

27.2 Potential cumulative impacts

Following the screening presented in **Table 27-2**, no developments were considered for inclusion in the cumulative impact assessment. Therefore, no further assessment of cumulative impacts has been undertaken for the Project.

Potential amenity impacts throughout the duration of construction (for example, as a result of traffic and noise and vibration generated by the Project) are assessed in the respective chapters of this EIS.

The noise and vibration assessment identified that there would be no construction noise exceedance for the majority of construction scenarios with the exception of Stage 1B - Site establishment – day, where the construction noise levels at Pambula Beach Caravan Park at 56 dB(A) exceed the criteria by 6dB(A) as a consequence of heavy vehicle movements into the beach work site. The duration of Stage 1B works would be about 2 weeks and is therefore not considered to result in construction fatigue for sensitive receivers, or the need for respite periods.

27.3 Management of impacts

The mitigation measures identified to help avoid and minimise the identified cumulative impacts of the Project are outlined in **Table 27-3**, and would be included in the Construction Environmental Management Plan (CEMP) for the Project and carried through to operation by BVSC where relevant.

27.3.1 Performance outcomes

The cumulative impacts performance outcome for the Project is as follows:

- the Project is scheduled to avoid cumulative impacts from overlapping construction phases if required.
- The Project would be designed, constructed and operated to achieve this performance outcome.

27.3.2 Consideration of interaction between measures

As discussed previously, in all instances where an adverse impact has been considered likely, mitigation and/or management measures would be implemented to avoid or reduce this impact. This cumulative impact assessment assumes that specific mitigation and management measures proposed for the Project would be applied. As such, all mitigation and management measures summarised in **Chapter 28 Project synthesis** are also applicable to this chapter.

27.3.3 Mitigation measures

The management and mitigation measures outlined in **Table 27-3** are intended to assist in further reducing the potential for cumulative impacts resulting from the Project.

Significant cumulative impacts with other developments in the vicinity of the Project are not expected. Notwithstanding, opportunities to further minimise construction impacts from the project beyond those considered in this EIS would be undertaken during detailed design and construction planning, including consultation with affected landowners and key stakeholders.

Table 27-3 Mitigation measures – Cumulative impacts

No.	Impact	Mitigation measures	Timing
CU1	General	BVSC will explore Project refinements and opportunities (including construction scheduling) to further minimise potential impacts on the environment and communities.	Detailed design
CU2	General	BVSC will review the environmental impacts of the Project before the start of construction and periodically during construction to identify further opportunities to reduce potential for cumulative impacts. Any relevant changes will be captured in the Construction Environmental Management Plan (CEMP).	Detailed design and construction

No.	Impact	Mitigation measures	Timing
CU3	General	Consultation in regard to construction planning will be undertaken with relevant stakeholders, particularly with proponents for any other developments within proximity to the Project which haven’t been identified at the time of writing this EIS.	Detailed design and construction

28.0 Synthesis of the Environmental Impact Statement

28.1 Introduction

This chapter provides a synthesis of the findings of this Environmental Impact Statement (EIS).

Table 28-1 sets out the requirements as provided in the Secretary's Environmental Assessment Requirements (SEARs) relevant to a synthesis of the EIS and where these requirements have been addressed in this chapter.

Table 28-1 SEARs – Synthesis of the EIS

Ref	Assessment requirements	Where addressed
2.1	p) a chapter that synthesises the environmental impact assessment and provides:	
	a succinct but full description of the project for which approval is sought;	**Section 28.2**
	a description of any uncertainties that still exist around design, construction methodologies and/or operational methodologies and how these will be resolved in the next stages of the project;	**Section 28.3**
	a compilation of the impacts of the project that have not been avoided;	**Section 28.4**
	a compilation of the proposed measures associated with each impact to avoid or minimise (through design refinements or ongoing management during construction and operation) or offset these impacts;	**Section 28.5**
	a compilation of the outcome(s) the proponent will achieve;	**Section 28.6**
	the reasons justifying carrying out the project as proposed, having regard to the biophysical, economic and social considerations, including ecologically sustainable development and cumulative impacts;	**Section 28.7**

28.2 Description of the Project for which approval is sought

The Project would involve:

- upgrade of the STP to improve the quality of treated wastewater (including for beneficial re-use);
- decommissioning the beach-face outfall;
- stopping use of the in-dune exfiltration ponds;
- supporting future increases in beneficial re-use of treated wastewater;
- installation of a secondary disposal mechanism - an ocean outfall pipeline about 3.5 km in length to convey treated wastewater away from sensitive areas to a submerged diffuser;
- installation of upgraded pumps; and
- continuation of the beneficial re-use irrigation scheme at the PMGC grounds and nearby Oaklands agricultural area.

Following completion of the Project, the strategy for managing treated wastewater from the STP would involve a combination of:

- beneficial re-use (preferred disposal option): use of treated wastewater to irrigate the adjacent PMGC grounds and nearby 'Oaklands' agricultural area; and

- disposal: discharge of excess treated wastewater to the environment, via the new ocean outfall pipeline.

A summary of the proposed Project elements is provided in **Table 28-2**.

Table 28-2 SEARs – Project elements

<table>
<tr><th>Project Element</th><th>Summary</th></tr>
<tr><td>STP upgrade</td><td>The STP upgrade would involve additional treatment processes incorporated into the existing STP site, including dual-point PAC dosing, UV disinfection, chlorine dosing and tertiary filtration (if required).
The new treatment processes would be incorporated into the following STP phases (described in Chapter 2 Project description):
<u>Phase two: secondary treatment</u>
Addition of:
• Two stage PAC dosing for phosphorous removal.
<u>Phase three: disinfection</u>
A change to the existing disinfection (chlorine dosing) treatment, involving:
• addition of ultraviolet (UV) treatment.
• chlorine dosing, using liquified 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).
• 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 effluent back into the STP treatment train
• 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 access roads).
• relocation and upgrade of utilities to accommodate the additional features proposed.</td></tr>
<tr><td>Effluent storage pond</td><td>The existing 17 ML effluent storage pond within the STP site would be decommissioned, including dewatering and sediment/sludge removal.</td></tr>
</table>

Project Element	Summary
Ocean outfall pipeline and effluent diffuser, and associated pump station	*Phase four: Disposal and beneficial re-use* 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 onshore component of the pipeline would be about 0.8 km. Geotechnical logs indicate the terrestrial component of the outfall pipeline would be laid between -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 50m to 80 m in length. The pipeline would likely have an outer diameter of up to 450 mm (366 mm internal diameter) and consist of pipeline lengths welded together. 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. 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. The pipeline would contain valves along its length for mitigating against air entrapment.
Beach face outfall	The existing 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 (buried underground).

28.2.1 Construction of the Project

Construction of the Project is anticipated to be undertaken over a period of 24 months. The construction footprint for the Project includes all areas that would be used for the construction of the Project, inclusive of temporary compound and laydown areas, construction parking areas and access tracks. The construction footprint is shown in **Figure 2.7** and **Figure 2.8**.

Construction of the STP upgrade would include the following:

- establishment of site construction areas, including compound areas, laydown areas, parking areas and access tracks;
- installation of erosion and sediment controls, and establishment of other no-go areas (e.g. flagging vegetation to be retained);
- mobilisation of machinery and delivery of materials, equipment, and process units to site;
- identification, relocation and upgrade of utilities;
- bulk earthworks and importing of fill and decommissioning of effluent storage pond; including dewatering, mechanical removal of sludge/sediment into truck/s or alternatively left to dry out, and further excavation;
- construction and installation of new STP infrastructure. This would involve laying foundations/concrete slabs, installation of process units, placement and joining of pumping station equipment, erection of buildings and pumping station buildings;

- installation of pipes, switches, valves and connections throughout plant; and
- installation of electrical and control infrastructure.

Construction of the ocean outfall pipeline would include the following:

- establishment of site construction areas, including compound areas (including parking areas), laydown areas and access tracks;
- transport of pipeline lengths and construction materials to site and laydown;
- pipeline stringing and welding;
- establishment of drill rig pad and entry point, drill rig and recycling unit/tank to collect drilling fluids (where soil cuttings are separated from the fluid for removal offsite to a licensed facility), and re-use of the fluid for drilling (where appropriate). Excess fluid at the conclusion of drilling would also be removed offsite. The final location/s of the drill rig would be confirmed by the drilling contractor during detailed design and in the finalisation of the drilling plan. There are three possible locations for the drill rig to be set up, including a drill pad site at the STP site; in the temporary laydown area on Merimbula Beach, or located offshore on a barge (and drilling westward). The hole may be drilled in one length or require two lengths to be drilled and therefore require two drill rig locations. These scenarios have been addressed in the environmental assessments carried out as part of this EIS where necessary;
- installation of underground section (Section one) via trenchless method (e.g. horizontal direction drilling or direct drive tunnelling), following by pipeline insertion via pulling or pushing;
- installation of a transition riser, beyond the surf zone, if required. The riser would be installed using micro-piling and would consist of a precast concrete structure approximately 5 m by 3 m and would be installed in sections via an excavation created by simple airlifts. Alternatively, the riser may consist of a section of pipe specifically fabricated to match the ends of the underground pipeline (Section one) and the start of the section above the sea floor (Section two);
- installation of the above ground section (Section two) via direct placement on sea floor in 600 m to 800 m lengths. This would also involve progressive covering, protection and stabilisation works for the pipeline (e.g. potentially using concrete or rock mattresses) held together with ropes/ slings/ cables;
- installation of a temporary barrier such as silt curtains to minimise mobilisation of sediment and pollutants into adjacent areas;
- installation of fittings including access points and intermediate air valves. Access points may be required at the upstream end (e.g. at outfall pumping station) and the downstream end (e.g. at the diffuser) of the outfall pipeline for maintenance. Air valves would be required if a transition riser is incorporated; and
- installation of a multi-port diffuser (approximately 80 metres in length) and risers (up to three) at the downstream end of the pipeline, including rock or concrete protection.

28.2.2 Commissioning

Commissioning activities for the STP upgrade would include:

- testing of all new components and structures of the new treatment trains (including hydraulic testing, electrical testing and functional testing); and
- influent and treated wastewater quality testing.

Commissioning of the ocean outfall pipeline would include:

- pipeline flushing and pigging;
- hydrostatic testing (pre- and post- installation);
- testing of other structural components; and
- removal of waste generated during commissioning.

28.2.3 Project operation and maintenance activities

The upgraded STP would be operated with the additional treatment processes which would improve the quality of the treated wastewater. Levels of total phosphorus, total suspended solids, biological oxygen demand, virus, bacteria and other pathogens would be managed to be within discharge limits. Treated wastewater would be tested for quality prior to discharge via the ocean outfall pipeline or via beneficial re-use offsite (to existing land application areas at the Oaklands agricultural area or the adjacent PMGC grounds). In future BVSC may seek to beneficially re-use treated wastewater at other sites. This would be subject to separate approval process/es and agreement/s with relevant landholders in future.

New maintenance activities at the STP site would include:

- calibrating new dosing equipment, mechanical and electrical repairs of new STP elements as required;
- maintenance of UV disinfection units (including chemical cleaning, replacing lamps, ballast and other parts as required, periodic calibration of the units, and adjustment of alarm levels);
- handling and management of additional waste (as a result of additional treatment processes), including waste sludge (aluminium/hydrated aluminium precipitate), solids capture from filters;
- storage and handling of chemicals including:
  - chlorine (approximately 1,840 kg stored in tank/s on site, replaced approximately every 28 days);
  - PAC (47m^3 stored in tank/s on site, replaced approximately every 14 days); and
  - maintenance of new plant and equipment, including flushing pipes, inspecting connections, mechanical and electrical maintenance of pumps and pumping stations (including replacing filters, grease, oil and other fluids.

Maintenance activities for the ocean outfall pipeline would include:

- monitoring, inspections, cleaning and repairs as required, including:
  - measurement and recording pipeline flow and hydraulic head;
  - underwater visual inspections by divers and/or remote operated vehicles (ROV) periodically and as required (e.g. annually);
  - cleaning accumulated sediment/grease and/or other impediments by periodically flushing (increasing flow through the pipeline) and/or pigging, and/or physically removing marine organisms growing/accumulating around the diffuser (e.g. barnacles);
  - corrosion repairs by divers (e.g. physically removing corrosion/strengthening or replacing any components subject to corrosion such as fasteners, joints, fittings or anchors);
- disposal of maintenance waste material including sediment/grease/impediments and contaminants, structural repair waste (e.g. cement waste, steel/wire offcuts).

The exfiltration ponds site would also continue to be maintained by Council (e.g. for safety reasons), even though treated wastewater would cease to be pumped to these ponds under the Project. Council would determine the best use of this site in future, and any works proposed may be subject to a separate approvals process.

Maintenance of the STP upgrades and pipeline would continue until the STP is decommissioned or further upgraded in the future.

28.3 Project uncertainties and approach to design refinements

This EIS is based on a concept design for the Project. It is noted that during subsequent design stages, and subsequent to a design and construction contractor(s) being engaged, details of the Project may change or be refined (e.g. specific locations of some elements or infrastructure within the existing STP site; materials to be used in plant construction and technology). The technology provider would be required to meet performance specifications so that the STP upgrade and ocean outfall pipeline are designed, constructed and operated using proven technology and incorporating environmental and safety measures. Procurement for the Project would be subject to sustainability considerations (refer **Chapter 24 Sustainability**). Design changes that would have a material impact on the assessments within this EIS would require re-assessment.

To achieve a level of flexibility without compromising the level of impact assessment, the general approach adopted in this EIS has been to assess a 'realistic worst case' impact for particular Project elements and construction methodologies where there is reasonable potential for design refinements to occur.

A summary of the Project uncertainties that have the potential to impact on the environment, and how these would be resolved is provided in **Table 28-3**.

Table 28-3 Project uncertainties

Category of impact	Uncertainty	How the uncertainty would be resolved
Terrestrial ecology	Extent of tree clearing for upgrading of the vehicle access at the entry to the STP off Arthur Kaine Drive. It is likely that fewer tree/s than those assessed in this EIS will need to be removed.	The extent of tree clearing at the STP site will be determined during detailed design and construction planning. As there is likely to be a decreased impact associated with a reduction in vegetation to be removed, no additional assessment would be required.
Water quality, marine ecology	The requirement for tertiary filtration and the type of tertiary filtration that may be installed is to be determined. Tertiary filtration involves a large upfront cost, increased pumping, chemical and energy use, and operator and maintenance time and spend. The benefits to the receiving environment may be low and not offset the additional cost, chemical and carbon requirements.	This uncertainty would be resolved in a subsequent design stage with consideration to projected performance against water quality objectives for the Project design as well as consideration of whether tertiary filtration provides a material benefit or additional security should it be included.
N/A	Use of the site of the 17 ML effluent storage pond that would be decommissioned. Following decommissioning the effluent storage pond, the site may be re-purposed as wet weather detention storage, a smaller storage pond, or backfilled completely.	This uncertainty would be resolved in the detailed design to determine the optimum volume of wet weather or re-use storage / flow balancing required. This may involve a combination of smaller storage ponds; additional space for sludge management, plant/materials storage, area for energy generation (e.g. solar panels) or other similar uses. The decision would be determined by long term operational needs and/or costs.

Category of impact	Uncertainty	How the uncertainty would be resolved
N/A	Location of new elements within the STP site: the exact location of new STP elements proposed (e.g. upgraded chlorine storage shed) are to be confirmed. Final locations would be within areas of the existing STP site that are cleared of vegetation.	This would be confirmed during detailed design, in consultation with the design and construction contractor(s), based on engineering and constructability requirements. Final locations would be within areas of the existing STP site that are currently cleared of vegetation, or where the EIS has accounted for clearing within the STP site (refer **Chapter 12 Terrestrial Ecology**).
Directional drilling method		
N/A	The pipeline construction method between the STP and a location beyond the surf zone is to be confirmed, and may consist of horizontal directional drilling (HDD) or direct drive tunnelling (DDT).	This would be determined by the construction contractor chosen (in coordination with BVSC), and may be considered in terms of methods available to the contractor, engineering/terrain constraints, constructability constraints and/or cost.
Property and land use / Social and economic / Noise and vibration (airborne) / Waste management.	Need for an intermediate pipeline drilling location: an intermediate pipeline drilling location may be required on Merimbula Beach (east of the STP) due to the length of trenchless pipeline construction required. The intermediate drilling location would include establishing a construction compound of around 40 m by 20 m and operation of a drill rig.	The intermediate drilling location (if required) would include establishing a construction compound of around 40 m by 20 m and operation of a drill rig; as well as an excavation where the separate sections of pipe would join. The requirement for an intermediate drilling location would depend on the final directional drilling plan (method, locations used, direction to drill from, etc.), which would be determined by the construction contractor in coordination with BVSC.
Property and land use / Social and economic / Noise and vibration (airbourne)	Pipe laydown and stringing location: pipe stringing for the trenchless installation of the underground portion of the outfall pipeline would require temporary use of an area/s to lay down and string the lengths of pipe to be installed. Potential areas to lay out and string the pipe are included in the Project area and include within the STP site, on a portion of the adjacent PMGC grounds and/or within an area on Merimbula Beach.	The location of these 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. Relevant landowners would be consulted with regard to the location and use of laydown areas.
Marine ecology / Marine processes (e.g. risk of sediment plume)	Transition riser: a permanent riser structure may be required to connect the underground pipeline with the above-ground offshore pipeline section laid on the seabed. If required, the riser would be located within the	The requirement for a transition riser would be determined by the construction contractor during detailed design and construction planning.

Category of impact	Uncertainty	How the uncertainty would be resolved
	"transition zone". A permanent riser structure may be required if the underground portion of the pipeline is at considerable depth below the seafloor, or if recovery of directional drilling equipment is required.	
Traffic and transport	Clearing of the vegetation on the roundabout at the Princes Highway/Toallo Street intersection may be required to accommodate the passage of oversized construction vehicles (such as the drill rig truck).	Any vegetation removal at the roundabout would be carried out in consultation with the relevant stakeholders. Following the completion of construction, any disturbed areas at the roundabout would be restored to a pre-construction condition, or better.

Additional design changes and refinements, such as changes in construction laydown areas or minor changes to Project features, may be made to:

- reduce the construction timeframe;
- further avoid areas of environmental or heritage sensitivity;
- reduce impacts on the community and other stakeholders.

For future design refinements, a screening assessment would be undertaken to consider whether the refinement would:

- result in any of the conditions of approval not being met;
- be consistent with the objectives and operation of the Project as described in this EIS;
- result in a significant change to the approved Project description; and
- result in potential environmental or social impacts of a greater scale or impact on previously unaffected receivers than that considered in this EIS.

If any refinements, post approval, are not consistent with the approval issued by the NSW Minister for Planning and Public Spaces, and constitute a modification, an approval would be sought from the Minister for any such modifications in accordance with the requirements of Part 5 Division 5.2 of the *Environmental Planning and Assessment Act 1979* (EP&A Act).

28.4 Compilation of potential residual impacts

Chapter 8 to **Chapter 27** provide an assessment of the potential impacts of the Project during construction and operation. These impacts would be addressed through implementation of mitigation and management measures described throughout the EIS and consolidated in **Section 28.5.3**. These measures relate to performance outcomes which have also been developed for the Project (refer to **Section 28.6**). Residual impacts are those identified for either construction or operation that would remain post-implementation of these measures. The potential residual impacts of Project development and the associated residual risk post mitigation are shown in **Table 28-4**.The benefits of the Project (positive impacts) are summarised in **Section 28.7.1**.

The potential residual impacts would continue to be considered through the development of the design and construction planning. The Construction Environmental Management Plan (CEMP) and sub-plans for the Project would be developed to take into account further management, mitigation and monitoring requirements brought about by changes in the design. Implementation of the mitigation and management measures proposed would lessen the degree of some residual impacts, however other impacts would represent a permanent change. Achievement of the performance outcomes would also assist in managing the residual impacts identified. The environmental management approach for the Project is described in **Section 28.5.1**.

Table 28-4 Summary of potential residual impacts

Issue	Potential residual impacts	Residual risk
Water quality, hydrology and flooding	Impacts on water quality in the receiving environment during construction and operation	Medium
	Impacts on water bodies in the receiving environment during construction	Medium
	Flood-related impacts during construction	Low
Groundwater	Excessive loss of circulating fluids during drilling, and groundwater quality adversely affected by drilling operations	Low
	Construction impacts to groundwater, particularly during the construction of the ocean outfall pipeline (drilling operations)	Medium
	Poor water management leading to adverse impacts on the environment	Low
	Impacts to groundwater quality, groundwater levels or groundwater flows	Low
	Adverse impacts on the local hydrogeological regime due to pipeline leakage	Low
Marine and coastal processes	Interruption of sand transport by pipeline	Low
	Scour leading to excessive bridging in the above-ground section of the ocean outfall pipeline	Low
	Damaged pipeline (anchor drag of pipeline movement) resulting in leak and impact outside of the mixing zone	Low
	Interaction of coastal hazards with construction of the Project	Low
Marine ecology	Translocation or introduction of Invasive Marine Pests	Low
	Underwater noise disturbance	Low
	Accidental Spills	Low
	Marine mammals’ risk of vessel strike	Low
	Changes in water quality associated with treated wastewater discharge	Low
	Settlement of particulate matter associated with treated wastewater discharge	Low
Terrestrial ecology	General terrestrial ecology	Low
	Potential displacement of fauna	Low
	Potential interruption of critical life cycle events such as breeding or nursing	Low
	Potential for adverse hydrological impacts	Low
	Impacts to hollow bearing trees	Low
	Impacts as a result of soil disturbance including risk of sedimentation and water quality impacts	Low
	Noise and light impacts	Low
	Impacts to significant environmental features such as wetlands	Low

Issue	Potential residual impacts	Residual risk
	Potential spread of weeds and pathogens	Medium
	Inadvertent adverse impacts to biodiversity values within Project area	Low
	Impacts to vegetation during operation	Low
Landform, geology and soils	Contamination impacts during ground disturbance activities	Low
	Exposure to contaminated material	Low
	Erosion and sedimentation	Low
	Release of acid sulfate soils	Low
	Accidental spills (including accidental release of drilling fluids)	Medium
	Accidental spills	Low
Aboriginal heritage	Potential accidental site disturbance during construction	Low
	Impacts to previously identified skeletal remains south of exfiltration ponds	Low
	Impacts to previously unrecorded Aboriginal archaeological sites	Low
	Encountering human remains	Low
	Potential ineffective or inappropriate consultation with the Aboriginal community (Consultation protocols)	Low
	Potential accidental site disturbance and / or potential ineffective or inappropriate consultation with the Aboriginal community (Aboriginal cultural heritage awareness training)	Low
	Insufficient reporting under the ACHMP	Low
Non-Aboriginal heritage	Unexpected discovery of a relic or potential relic during construction works	Low
Hazard and risk	Potential hazards (and subsequent impacts such as injury, financial risks etc) associated with plant and machinery	Low
	Potential hazards associated with the installation and operation of plant and machinery	Low
	Potential impacts to humans and the environment as a result of incorrect handling chlorine gas including: • corrosion; • mechanical damage; • personnel exposure to toxic gas; and • environmental emission	Low
	Potential impacts to humans and the environment as a result of operational failures	Low
	Potential impacts to humans and the environment as a result of human error	Low
Human health	Human health impacts from irrigated treated wastewater	Low
	Human health impacts at the STP site from proposed upgrades	Low
	Road and pedestrian network changes	Low

Issue	Potential residual impacts	Residual risk
Traffic and transport	Temporary diversion and lane closures of pedestrian and cycle routes	Low
	Increased risk of collision for pedestrians and cyclists	Low
	Diversions for vehicles and space restrictions	Low
	Parking arrangements	Low
	Traffic congestion	Low
	Construction vehicle route	Medium
Property and land use	Use of Crown Land	Low
	Temporary change in land use for construction access on beach	Low
	Temporary land use change for portion of PMGC grounds	Low
Noise and vibration (airborne)	General noise and vibration management	Low
	Construction noise emissions causing nuisance at nearest sensitive receivers (particularly during Stage 5)	Medium
	Construction related traffic noise emissions (particularly during Stage 1B)	Medium
	Vibration minimum working distances	Low
Noise and vibration (underwater)	General underwater noise	Low
Air quality	Dust emissions causing nuisance to neighbours	Low
	Odour impacts during construction	Low
	Adverse impacts to sensitive receptors from vehicle emissions	Low
Social and economic	Access and connectivity: Impacts associated with construction traffic and the beach access and laydown area	Medium
	Property and land use: Impacts to property and land use associated with construction areas required	Medium
	Community values: Impacts to Environmental values	Low
	Local character, identify and amenity	Medium
	Economy: Impacts to the local economy	Low-positive
	Business and industry: Impacts to nearby businesses	Low
Sustainability	IS rating is compromised and sustainability performance of the Project is not optimised	Low
Climate change	That the Project would deliver infrastructure that is not responsive and resilient to the impacts of climate change, with particular regards to the potential for inundation by flood waters or sea level rise	Medium
Waste management	Generation of general waste	Low
	Generation of construction waste	Low
	Spoil generation and stockpiling	Low
	No waste minimisation	Low
	No waste re-use	Low

Issue	Potential residual impacts	Residual risk
	Pollution from marine vessel wastes	Low
	Generation of operation waste	Low
	Unexpected waste	Low

28.5 Environmental management and mitigation

28.5.1 Approach to environmental management during construction

The approach to environmental management during construction for the Project involves the implementation of the CEMP.

The CEMP would contain the mitigation and management measures identified which are focused on delivery of a range of performance outcomes for the Project (refer to **Section 28.6**). These are designed to drive a high level of environmental management during construction.

The CEMP would also identify the environmental, stakeholder, and community management systems and processes that would be applied during construction. It would also contain protocols for approvals, environmental monitoring, inspections, auditing, reporting and review.

28.5.2 Approach to environmental management during operation

The Project would be operated and maintained in accordance with the mitigation and management measures that are specified for operation, as well as existing BVSC operating procedures and protocols. Existing operating procedures and protocols would be updated where necessary to account for the upgrades from the Project.

28.5.3 Compilation of environmental mitigation and management measures

Table 28-5 provides a compilation of the measures proposed to mitigate and manage the potential environmental impacts of the Project, as identified in the environmental assessment chapters of the EIS (i.e. **Chapter 8** to **Chapter 27**).

These measures may be revised in subsequent stages of the Project based on design changes or submissions raised in response to the EIS. If the Project is approved, the Project would be undertaken in accordance with the conditions of approval and the final list of mitigation and management measures.

Table 28-5 Compilation of Project specific mitigation and management measures

Ref#	Potential impacts	Mitigation and management measure	Timing
Water quality, hydrology and flooding			
SWF1	Impacts on water quality in the receiving environment	Monthly water quality monitoring will be undertaken within Merimbula Bay for at least 12 months prior to the commencement of construction. The data would be used as a baseline to monitor impacts on water quality during construction and operation. Monitoring would also be undertaken to coincide with discharge of treated wastewater from the ocean outfall.	Prior to construction
SWF2	Impacts on water quality in the receiving environment	The Project CEMP will include procedures to minimise potential impacts to surface water and hydrology, including procedures for: • dewatering excavations during construction (if required, e.g. post-rainfall), so that water is tested and if necessary treated, prior to release in accordance with approval conditions.	Prior to construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		Storage and use of fuel, oil and hydraulic fluids that have the potential of release into the receiving environment.	
SWF3	Flood-related impacts	Temporary construction compounds, stockpiles and storage areas are to be located outside the 1% AEP flood extent. Any construction access requirements to and from the STP site during potential flood conditions should be confirmed to be from the south along Arthur Kaine, in order to avoid potential flood waters across the road north of the STP site.	Construction
SWF4	Impacts on water quality in the receiving environment	An operational water quality monitoring program focusing on Merimbula Bay, Merimbula Lake and Pambula River will be conducted as a key performance indicator of environmental compliance. The monitoring program will have the objective of assessing marine water quality at sites inside and outside the treated wastewater mixing zone against MWQO trigger values to ensure sensitive receptors and environmental values are protected. Monitoring would comprise monthly monitoring over a minimum 24-month period, from the commencement of operation, to build up a data set that can be compared to the data set from 2014 to 2017. Monitoring following the 24-month period will occur with consideration to the frequency of discharge of the treated wastewater from the ocean outfall pipeline (i.e. will be aimed to coincide with discharge).	Operation

Ref#	Potential impacts	Mitigation and management measure	Timing
Groundwater			
GW1	Excessive loss of circulating fluids during drilling affecting water quality	Potentially adverse impacts to groundwater levels will be minimised by the detailed design of the drill-path and implementation of a drilling fluid management plan which will consider the appropriate design, management and control of the physical and chemical characteristics of the drilling fluid. This plan will be incorporated in the groundwater management plan (discussed in more detail below). The make-up of the drilling fluid will be determined by an appropriately qualified drilling fluid engineer, based on local groundwater and soil geochemistry so that it forms a suitable wall cake thus minimising fluid loss and exchange with local groundwater. Inert or non-contaminating but effective additives for drilling fluids will be used. Any drilling fluid additives used e.g. bentonite clay, xanthan gum and/or biopolymer compounds will be certified for use in potable aquifers (certified to *American National standards Institute (ANSI)/NSF International (NSF) STD 60 Certified well Drilling Aids and well Sealants*). The drilling fluid additives will be closely monitored by the drilling fluid engineer and driller so that it remains chemically stable and volumetrically balanced with the progression of the hole and, if necessary, modified to maintain stability and minimise interaction with the groundwater. The appropriately experienced and qualified drilling fluid engineer will supervise the drilling operations and control the types, rates and volumes of additives should the fluid chemistry be unexpectedly altered by the formation. Drilling will be undertaken by a directional borehole driller who is appropriately trained and experienced with the selected drilling and casing installation technique.	Construction

Ref#	Potential impacts	Mitigation and management measure	Timing
GW2	Construction impacts to groundwater.	A groundwater monitoring program will be developed and implemented for construction. The groundwater monitoring programme will include appropriate investigations and baseline monitoring during the detailed design phase so that the drilling programme can incorporate contingency measures to minimise impacts to groundwater levels and flow conditions. It will include but not be limited to infill test drilling to determine the physical characteristics (grain size analysis, permeability, organic content) of the materials and quality of groundwater in the aquifer through which the pipeline would pass. Ground water monitoring during construction will consider methods for checking: • that the water table is not significantly mounded indicating drilling fluids are being released to the aquifer; and • that the drilling fluids are not affecting the quality of groundwater in a manner that could lead to a deterioration in the ecological value. To achieve this, groundwater monitoring should be undertaken at existing and new monitoring bores as specified in **Appendix D** (Groundwater Technical report) (refer to Table 4-1 and Figure 14).	Pre- Construction and Construction
GW3	Impacts to groundwater quality	The groundwater monitoring program will include groundwater quality trigger levels which if exceeded will initiate response actions as follows: confirmation, investigation, risk assessment and, if required, a construction method review and/or remediation. • The trigger levels should be defined based on the results of baseline monitoring and be selected to identify potentially abnormal changes to groundwater levels and quality.	Construction
GW4	Impacts to groundwater quality, groundwater levels or groundwater flows during operation	The groundwater monitoring program will monitor groundwater levels and groundwater quality in the superficial sand and clayey sand formations at the commencement of the operations phase. The monitoring should be a continuation of the construction groundwater monitoring program. The monitoring program should be developed in consultation with the NSW Environment Protection Authority, NSW Department of Planning Industry and Environment-Water and BVSC. The program should identify groundwater monitoring locations, performance criteria in relation to groundwater levels and groundwater quality and potential remedial actions that will	Operation

Ref#	Potential impacts	Mitigation and management measure	Timing
		manage or mitigate any non-compliances with performance criteria. The monitoring program should include manual and automatic (using dataloggers) groundwater level monitoring and groundwater quality monitoring from selected monitoring wells intersecting groundwater in the superficial aquifer. • The monitoring frequency should be six-monthly for three years or as stated in the conditions of Project approval.	
GW5	Adverse impacts on the local hydrogeological regime due to pipeline leakage	Any operational constraints and compliance criteria should be developed in accordance with ANZG 2018 and with consideration to the relevant NSW Water Quality Objectives. The operational water quality objectives are likely to be set by the local land services of the receiving waters in consultation with the NSW EPA.	Operation
Marine and coastal processes			
MC1	Interruption of sand transport by pipeline	Although not expected to be a significant issue, subsequent design stages of the ocean outfall pipeline would review the findings presented in **Appendix E** (Water Quality Technical report) regarding interruption of marine sediment/sand transport by the ocean outfall pipeline.	Design
MC2	Scour leading to excessive bridging in the above-ground section of the ocean outfall pipeline	Scour with flow below the ocean outfall pipeline can cause bridging of the pipeline. The pipeline design will consider the possibility of sag with up to 1 m height in differential settlement in supports (Fredsøe et al. 1988).	Design
MC3	Damaged pipeline (anchor drag of pipeline movement) resulting in leak and impact outside of the mixing zone	The pipeline design will take into account possible anchor or net drag as well as large wave forces (which could result in a leak and impact outside of the mixing zone). If deemed an issue, coverage by armour rock/mattress could be considered.	Design
MC4	Interaction of coastal hazards with construction of the Project	The CEMP will include specific provisions and a work plan for use of Merimbula Beach (laydown and intermediate drilling site, if required as part of the Project). This would include (but not be limited to): • planning works around tide times, and avoiding high tides and king tides (including mobilisation to site, site access, and other activities); • frequent review of weather forecasts, and planning to avoid adverse weather, including storms, high wind or swell events;	Detailed design and construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		• planning the laydown area so that materials are stored at the back (western extent) of the beach, but avoiding the sand dunes; • establishing and using the beach access in accordance with requirements of the NSW National Parks and Wildlife Service; • minimising the number of plant, equipment and materials on the beach at any one time; • no storage of fuel, chemicals or oil at the beach laydown; • implementing speed limits and only using the established beach access, as well as daily visual observations of the condition of the access; • minimising construction timeframes as far as practicable; • having evacuation plans in place to rapidly demobilise from site if required (e.g. if a weather forecast changes).	
MC5	Interaction of coastal hazards with construction of the Project	Offshore construction works would be planned to avoid adverse weather events, including storms, strong wind and swell events. Frequent review of weather forecasts and contingency planning for the construction timeframes and works required would be undertaken.	Detailed design and construction
Marine ecology			
ME1	Introduction or translocation of marine pests (It is expected that construction vessels would adopt standard environmental management practices and controls that meet the broad objectives of the *National Marine Pest Plan 2018-2023* to mitigate the risk)	All contractors must undertake a vessel risk assessment prior to mobilising the vessel to site. This will include an inspection of all vessels and equipment considered uncertain or at high risk for introduction of invasive marine pest (IMP). Any vessel or equipment mobilising to site from outside of Australia will automatically be considered high risk and an IMP inspection will be required	Construction
ME2		Construction vessel antifouling must be maintained to avoid the attachment and potential translocation of IMPs from Twofold Bay	Construction
ME3		No sediments from Twofold Bay are to be disturbed or carried by construction vessels en-route to Merimbula Bay	Construction
ME4		Ballast water management procedures are to be adopted by all construction vessels and barges in accordance with the *Australian Ballast Water Management Requirements* (DAWE, 2020)	Construction

Ref#	Potential impacts	Mitigation and management measure	Timing
ME5	Underwater noise disturbance	A CNVMP will be prepared as part of the Construction Environmental Management Plan (CEMP), and will include measures for minimising underwater noise emissions. The CNVMP should include general feasible and reasonable work practices as identified in 'Section 6 Work practices' of the *Interim Construction Noise Guideline* (ICNG) (Department of Environment and Climate Change (DECC), 2009). The CNVMP will include the following measures as a minimum: • undertake works during standard construction hours where practicable; • works undertaken during June to November during the whale migration period (southern right and humpback whale southern migrations) will be avoided where possible, or otherwise minimised. If work is required within this period adopt a safety shut-down zone of 170 m and a watch zone of 2.3 km where work activity would either be temporarily halted or varied in event that a LF cetacean occurs within these zones; • works undertaken outside of June to November, will implement a watch zone of 500 m where marine mammals (dolphins and seals) will be observed and recorded. No shut down zone is required; • vessels are to have a trained marine mammal observer onboard during all underwater noise generation activities, to record observations of when a cetacean or pinniped enters the 2.3 km watch zone. All marine fauna sightings are to be recorded; • prior to commencing noise disturbance activities, the watch zone is to be clear of marine mammals for a period of at least 10 minutes; all injured marine mammals should be immediately reported to ORRCA (02 94153333) and National Parks and Wildlife Service Merimbula office (02 64955000); and • implement vessel speed limits to reduce vessel noise.	Construction
ME6	Accidental spills and mobilisation of marine sediments	Routine control measures to protect water quality during the construction phase are to be outlined in a CEMP. The CEMP will outline the following minimum control measures to mitigate the risk of accidental spill of hazardous substances from construction vessels and equipment and the mobilisation of sediment as a result of construction activities: • all contractor vessels to demonstrate a spill response plan that includes procedures,	Construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		roles and responsibilities. The plan should include contact details of authorities that are to be notified in the event of a spill including NSW EPA; • a spill response plan to be included as part of general site works induction; • all contractor vessels are to carry spill response kits; • secure and safe storage of all fuels, oils and fluids for construction equipment; and; where required, construction will use specialised equipment such as sediment curtains or similar to reduce the likelihood of turbid plumes.	
ME7	Marine mammals, risk of vessel strike	The Project CEMP will also include provisions for mitigating risk of vessel strike to whales when mobilising to site. Control measures to be adopted to reduce risk of vessel or anchor cable strike include: • construction phase works to be undertaken where practicable outside of peak whale migration periods (June and November) • vessels to adopt safe travel speeds no greater than 10 knots when mobilising to site • vessels maintain a 300 m exclusion zone with all whales en-route to and from construction site • slower speeds adopted in the event a whale is observed within 100 m of the vessel • Vessels are to have a trained marine fauna observer onboard to record observations of marine fauna when transiting in the vessels.	Construction
ME8	Changes in water quality associated with treated wastewater discharge	• Upgrades to STP process such as PAC dosing, UV treatment and tertiary filtration if required will be implemented. • A long-term strategy to upgrade reticulated water system to reduce copper and zinc concentrations in treated wastewater streams will be considered. • Operational water quality monitoring will be carried out.	Operation
ME9	Settlement of particulate matter associated with treated wastewater discharge	• Operational monitoring will include infauna and sediment from sites within and outside of the mixing zone to assess any potential impacts from the treated wastewater discharge.	Operation

Ref#	Potential impacts	Mitigation and management measure	Timing
Terrestrial ecology			
B1	General terrestrial ecology	A flora and fauna management plan will be prepared as part of the CEMP and include the following: • undertaking the underground trenchless drilling and other construction activities such that there are no adverse impacts on surface or subsurface hydrology; • undertaking pre-construction targeted surveys at the Pambula Beach construction access proposed, to ensure the affected areas are not being used by threatened shorebirds; • avoiding foredune and other vegetated parts of the beach for beach access; • rehabilitating the minor impacts on PCT 772 associated with construction access to Pambula Beach post construction; • designing construction access to the STP to avoid the hollow bearing and Yellow-bellied Glider feed trees that occur near the STP and to minimise or avoid the need to remove trees and native vegetation as far as is possible; • using flagging tape to delineate the boundary of the wetland in the central parts of the study area (Zone 4 and Zone 5) to protect it from any adverse impacts during construction (refer to **Chapter 12 Terrestrial ecology** for extent); • minimising the disturbance and clearance of native vegetation as far as is possible; • identifying exclusion zones to protect against accidental vegetation damage; • undertaking vegetation clearing in a manner which avoids impacts on adjoining retained vegetation; • managing weeds and pathogens (e.g. provide vehicle wheel wash upon entry and exit to site; vehicle inspections for weed, seed and plant material and records taken; regular visual inspections); • restoring disturbed areas to pre-disturbance condition; and • carrying out preclearing fauna surveys (handling of fauna will be carried out by appropriately licenced or experienced person and in accordance with relevant guidelines).	Prior to and during construction
B2	Potential displacement of fauna	• the limits of the vegetation to be removed or modified for the Project will be clearly marked so workers undertaking any proposed clearing do not remove vegetation that should be retained;	Prior to and during construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		• pre-construction targeted surveys should be undertaken at the Pambula Beach construction access proposed, to ensure the affected areas are not being used by threatened shorebirds; • beach access will avoid the foredune and other vegetated parts of the beach • Truck movements will be speed limited to reduce the risk of vehicle strike or otherwise adverse impacts on fauna; and • pre-construction targeted surveys should be undertaken prior to the decommissioning of the STP effluent pond to ensure the pond is not being used by threatened amphibians and particularly the Green and Golden Bell Frog.	
B3	Potential interruption of critical life cycle events such as breeding or nursing	Pre-construction targeted surveys should be undertaken at the proposed Pambula Beach construction access to ensure the affected areas are not being used by threatened shorebirds.	Prior to and during construction
B4	Potential for adverse hydrological impacts	Underground trenchless drilling and other construction activities should be undertaken such that there are no adverse impacts on surface or subsurface hydrology.	Prior to and during construction
B5	Impacts to hollow bearing trees	Pre-clearing and clearing protocols should be incorporated into any clearing plan that may affect hollow-bearing trees.	Prior to construction
B6	Impacts as a result of soil disturbance including risk of sedimentation and water quality impacts	• clearing protocols should identify vegetation to be retained, prevent inadvertent damage and reduce soil disturbance; for example, removal of native vegetation by chainsaw, rather than heavy machinery, in situations where partial clearing is proposed; and • sediment and water control measures should be installed as necessary such as fencing and hay bales	Construction and post construction
B7	Noise and light impacts	Work within the land-based footprint of the Project would be restricted to daylight hours except during the pipeline pulling.	Construction
B8	Impacts to significant environmental features such as wetlands	Flagging tape will be used to delineate the boundary of the wetland in the central parts of the study area to protect it from any adverse impacts.	Construction
B9	Potential spread of weeds and pathogens	Appropriate hygiene protocols should be incorporated into the Project to avoid the spread of weeds such as African Lovegrass. Known weed or invasive species should not be planted for landscaping purposes.	During and post construction

Ref#	Potential impacts	Mitigation and management measure	Timing
B10	Inadvertent adverse impacts to biodiversity values within Project area	Workers should be inducted as to the biodiversity values of the Project area and mitigation and management measures to protect these values	Construction
B11	Impacts to vegetation during operation	• retained vegetation should be managed sympathetically with its conservation status according to state and national legislation; • any clearing, exotic plantings, or tree removal beyond what is proposed should be avoided; and • vegetation in the eastern parts of the Project area will be restored.	Post construction and operation
Landform, geology and soils			
S1	Unexpected find of contamination	The CEMP will include a procedure for managing unexpected finds of contamination (e.g. during excavation works). Works will cease, worker health will be prioritised, and contaminated material will be contained, classified and disposed of according to the *Waste Classification Guidelines* (NSW EPA, 2014). Plans for ongoing work in the area will also be revised accordingly.	Construction
S2	Erosion and sediment control, and stockpile management	A Soil Erosion and Sedimentation Management Sub-Plan will be developed to manage potential soil and water issues relevant to the construction of the Project. This sub-plan will be part of the CEMP. The sub-plan will include detailed erosion and sediment control plans for each work site and will outline which erosion and sediment control measures will be implemented at each location or for specific works. These control measures will be developed with the management approaches outlined in *Managing Urban Stormwater: Soils and Construction Volume 1* (Landcom, 2004), and *Volume 2* (DECC, 2008) (as applicable) (the Blue Book).	Construction
S3	Erosion and sedimentation (subsidence)	The ocean outfall pipeline alignment will be monitored for subsidence, and mitigation and management measures will be implemented if required (e.g. ground reinforcement measures, filling).	Construction and operation

Ref#	Potential impacts	Mitigation and management measure	Timing
S4	Accidental spills	Spill mitigation and management measures will be included in the CEMP and there will be Standard Operating Procedures during operation, including: • machinery and equipment will be maintained in accordance with manufacturers requirements to minimise the risk of leaks or broken hoses, etc. Equipment will be not be used if there are any signs of fuel, oil or hydraulic leaks; • spill kits will be kept on-site at all times and in vehicles where appropriate. Any accidental spills will be contained, collected/excavated and disposed of at an appropriately licensed waste facility, and appropriate records kept; • specific provisions will be included in the CEMP for emergency measures in the event of frac out; and • spills will be subject to incident reporting under the CEMP, including notification under the *Protection of the Environment Operations Act 1997* where necessary.	All stages
S5	Acid sulfate soils	Any potential or actual acid sulfate soils will be managed in accordance with the *NSW Acid Sulfate Soils Manual* (Stone et al, 1998).	Construction
Aboriginal heritage			
AH1	Potential accidental site disturbance during construction	Newly identified surface sites Merimbula STP SM1, Merimbula STP SM2 and Merimbula STP IA1, as well as previously recorded burial site 62-6-0173 and scarred tree 62-6-0475, should be protected throughout the life of the Project via permanent stock-proof fencing and appropriate associated signage. All relevant workers should be made aware of the nature and location of these sites as well as BVSC's legal obligations with respect to them. Protected sites should be identified on all relevant site plans and designated as 'no-go' zones. Should BVSC and/or its contractors require use of the vehicle tracks upon which Merimbula STP SM1, Merimbula STP SM2 and Merimbula STP IA1 are located, alternative access arrangements should be investigated and detailed in the ACHMP. In view of its demonstrated archaeological and cultural sensitivity, should installation of Section 1 of the ocean outfall pipeline result in any surface impacts to the Merimbula Barrier sand mass, BVSC should consult with RAPs	Prior to and during construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		regarding the appropriate management of these impacts.	
AH2	Impacts to previously identified skeletal remains south of exfiltration ponds	While no potential or definite human skeletal remains were identified on the track in question (disused east-west trending vehicle track to the south of the STP's existing dunal exfiltration ponds) during the archaeological survey undertaken for the EIS, this track will be identified in the Project's CEMP and all relevant site plans as an environmental 'no-go zone'. Fencing with appropriate signage will be installed at the eastern and western ends of the track to ensure that it is not used by any Project-related machinery.	Prior to and during construction
AH3	Impacts to previously unrecorded Aboriginal archaeological sites	Provisions regarding appropriate management action(s) for any previously unrecorded Aboriginal archaeological sites identified within the study area throughout the life of the Project will be incorporated into the ACHMP. Management action(s) will vary according to the type of evidence identified, its significance (both scientific and cultural) and the nature of potential impacts. Vegetation clearance proposed for the Pambula Beach construction access track to be undertaken manually under the supervision of a minimum of one RAP representative.	During construction
AH4	Encountering human remains	In the event that potential human skeletal remains are identified within the study area at any point during the life of the Project, the following standard procedure, to be detailed in the ACHMP, will be followed: • all work in the vicinity of the remains will cease immediately; • the location will be cordoned off - work can continue outside of this area as long as there is no risk of interference to the remains or the assessment of the remains; • where it is instantly obvious from the remains that they are human, the Project Manager (or a delegate) will inform the NSW Police by telephone (prior to seeking specialist advice); • where uncertainty over the origin of the remains exists, a physical or forensic anthropologist will be commissioned to inspect the exposed remains in situ and ascertain the origin, ancestry (Aboriginal or non-Aboriginal) and antiquity (pre-contact, historic or modern) and: - if the remains are identified as modern and human, notify NSW Police;	During construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		- if the remains are identified as pre-contact or historic Aboriginal, notify Department of Premier and Cabinet using its Environment Line (131 555); and - if the remains are identified as historic (non-Aboriginal), notify the NSW Heritage Division. An Aboriginal community representative must be present where it is reasonably suspected burials or human remains may be encountered. If human remains are unexpectedly encountered and they are thought to be Aboriginal, the Aboriginal community must be notified immediately. Recording of Aboriginal ancestral remains must be undertaken by, or be conducted under the direct supervision of, a specialist physical anthropologist or other suitably qualified person. Archaeological reporting of Aboriginal ancestral remains must be undertaken by, or reviewed by, a specialist physical anthropologist or other suitably qualified person, with the intent of using respectful and appropriate language and treating the ancestral remains as the remains of Aboriginal people rather than as scientific specimens.	
AH5	Consultation protocols	Provisions regarding appropriate consultation protocols with RAPs will be incorporated into the ACHMP. Contact details and preferred contact methods for each RAP, as well as other relevant stakeholders.	Prior to and during construction
AH6	Aboriginal cultural heritage awareness training	An Aboriginal cultural heritage awareness training package will be developed for the Project. This package will be developed in consultation with RAPs and completed prior to the commencement of any ground disturbance works within the study area. A register of all persons having completed the training package will be maintained throughout the life of the Project. Aboriginal cultural awareness training will be mandatory for all workers whose roles may reasonably bring them into contact with Aboriginal sites and/or involve consultation with local Aboriginal community members. BVSC should ensure that the Project's standard environmental site induction includes an Aboriginal heritage component. At a minimum, this should outline current protocols and responsibilities with respect to the management of Aboriginal cultural heritage within the study area, provide an overview of the diagnostic	Prior to and during construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		features of potential Aboriginal site types and procedures for reporting the identification of Aboriginal archaeological sites.	
AH7	Reporting under the ACHMP	Any Aboriginal heritage management or mitigation works carried out will be documented to a standard comparable to that required by the *Code of Practice for Archaeological Investigation of Aboriginal Objects 2010*. Printed and/or digital copies of any associated reports will be made available to RAPs upon request. The ACHMP for the Project will be subject to periodic review to ensure that all management policies are being adhered to and are working effectively. Periodic reviews will also provide an opportunity to make modifications to existing policies and to add, where appropriate, new policies.	Prior to and during construction
Non-Aboriginal heritage			
HH1	Unexpected discovery of a relic or potential relic during construction works	In the event that any potential archaeological 'relics' are discovered during construction works associated with this Project, all work in the area shall cease and the Project Archaeologist notified of the discovery. Once the archaeologist has gathered suitable information regarding the unexpected find, an appropriate course of action can be determined. This may include, but would not be limited to: • no further works required; or • stop construction works in the area and notification to Heritage NSW, NSW Environment, Energy and Science, regarding the discovery of the relic and an outline of additional work and/or permitting requirements.	Construction
Hazard and risk			
HR1	Impacts associated with corrosion; mechanical damage; personnel exposure to toxic gas; and environmental emission	Safety in design -Locate chemical storage tanks and chemical containers (packages) at separation distances with specific reference to the applicable Australian Standards i.e. AS1940*The storage and handling of flammable and combustible liquids;* *AS4452 The storage and handling of toxic substances;* *AS4326 The storage and handling of oxidising agents; and* *AS3780 The storage and handling of corrosive substances.*	Detailed design phase
HR2	Potential hazards (and subsequent impacts such as injury, financial risks etc)	Safety in design - Conduct a Hazard and Operability (HAZOP) study for the processes and plant items within the Project area to identify potential hazards and operational problems in terms of plant design and human error.	Detailed design phase

Ref#	Potential impacts	Mitigation and management measure	Timing
	associated with plant and machinery		
HR3	Potential hazards associated with the installation and operation of plant and machinery	Safety Instrumented Systems - Identify and implement Safety Instrumented Systems in line with AS IEC 61511.1, *Functional safety – Safety instrumented systems for the process industry sector.*	Detailed design phase
HR4	Potential impacts to humans and the environment as a result of incorrect handling chlorine gas including: • corrosion; • mechanical damage; • personnel exposure to toxic gas; and • environmental emission	Workers training and competency - Ensure workers have appropriate training and the necessary competencies for handling chlorine gas.	Pre-Operation phase
HR5		Safety Management Plan - Update the Site Safety Management Plan for the introduction of chlorine gas.	Pre-Operation phase
HR6		Emergency Response Plan - Update the Site Emergency Response Plan for the introduction of chlorine gas.	Pre-Operation phase
HR7	Potential impacts to humans and the environment as a result of operational failures	Workers training and competency - Undertake audits on operational activities, and address and communicate any findings to the relevant workers.	Operation phase
HR8		Perform appropriate preventive maintenance programs.	Operation phase
HR9	Potential impacts to humans and the environment as a result of human error	Ensure all workers have appropriate training and necessary competencies.	Operation phase
Human health			
HH1	Human health impacts from irrigated wastewater	Irrigation routine management: • maintain buffer distances between irrigation areas and water courses of 40 m – 50 m; and • observe and track current and imminent weather conditions (wind) for pre-warning of cessation or commencement of irrigation.	Operation
HH2	Human health impacts from irrigated wastewater	Irrigation incident response: • cease irrigation if surface runoff is observed; • cease irrigation during strong winds that result in spray drift outside irrigation areas; and • if a human infection or public health incident occurs and a link with recycled water	Operation

Ref#	Potential impacts	Mitigation and management measure	Timing
		irrigation is suspected, assist with investigations and provide all required information to NSW Health and other relevant organisations.	
HH3	Human health impacts at the STP site from proposed upgrades	Operations routine management: • schedule operation and maintenance of STP system components in accordance with a relevant STP Site Operations and Maintenance Plan, Job Safety and Environmental Analysis forms and Standard Operating Procedures; • implement routine mitigation and management measures in accordance with relevant STP Aspect/Impact and Hazard/Risk Register; • undertake routine STP operational monitoring and inspections; and • properly maintain generators and backup equipment on-site.	Operation
HH4	Human health impacts at the STP site from proposed upgrades	Operations incident response: • implement incident mitigation and management measures in accordance with the relevant STP Aspect/Impact and Hazard/Risk Register, Standard Operating Procedures and Emergency Response Plan; • where/if incident response to STP process failure is not documented, key response measures to include: - seek to eliminate and mitigate against further environmental harm; - investigate cause of STP process failure; - seek advice from STP Process Engineers about restoring process control; - notify and discuss with BVSC Operations Superintendent, Water and Sewerage Services; - restart/restore STP process control; - reseed bioreactor tanks from another STP (if necessary, e.g., due to biomass depletion/kill); - advise EPA of STP process failure and seek advice; - notify public if recycled water disposal is likely to pose an elevated public health risk, or STP odours are likely to be objectionable and persistent; and • undertake regular monitoring in the aeration tanks and recycled water storage.	Operation
Traffic and transport			
T1	Road and pedestrian	Ongoing consultation will be carried out with BVSC, Transport for NSW, emergency services,	Construction

Ref#	Potential impacts	Mitigation and management measure	Timing
	network changes or disruptions	bus operators and other relevant authorities to minimise transport impacts during construction.	
T2	Road and pedestrian network changes or disruptions	Community consultation will be carried out and notifications would be issued in advance for any proposed road and pedestrian network changes or disruptions through appropriate channels and forms of communication.	Construction
T3	Temporary diversion and lane closures of pedestrian and cycle routes	Access to pedestrian routes and cycle paths will be maintained. Where this is not possible, alternative routes will be provided. Appropriate signage will also be provided to guide pedestrians and cyclists past the Project area and on the surrounding network where required.	Construction
T4	Increased risk of collision for pedestrians and cyclists	Vehicle access to and from the Project area will be managed to minimise safety risk to pedestrians, cyclists and motorists. All trucks will enter and exit construction sites within the Project area in a forward direction, where possible. At Pambula Beach, appropriate delineation, and/or traffic control measures will be used to direct and guide pedestrians, cyclists and motorists past the entrance to the Project area during oversized load delivery and high usage times. Further arrangements for construction vehicle access at Pambula Beach will be identified in the CTMP during subsequent design stages.	Construction
T5	Diversions for vehicles and space restrictions	Access to existing properties and buildings will be maintained, at all times, in consultation with property owners.	Construction
T6	Parking arrangements	The Project area will be managed to minimise construction worker parking on surrounding streets. Workers will be encouraged to carpool. Parking facilities will be provided.	Construction
T7	Traffic congestion	Construction traffic will be managed to minimise traffic impacts during the peak periods through scheduling construction vehicle movements outside the peak hours.	Construction
T8	Construction vehicle route	The proposed access from Princes Highway onto Toallo Street via the roundabout at this location will be tested for access suitability for the construction vehicles expected (including an adequate turning path) and to determine whether infrastructure upgrades are required. Alternative routes will be investigated in the event that upgrade works are required at the roundabout. These alternative haulage routes will be identified and confirmed in consultation with relevant authorities prior to the commencement of construction works.	Construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		Testing will be carried out as part of the CTMP once plant and equipment and vehicles required to transport them are determined by the contractor.	
T9	Beach Access Route	Public access to the beach as well as the car park (off Coraki Drive) will be maintained.	Construction
Property and land use			
PL1	Use of Crown Land	A permit under *the Crown Land Management Act 2016* will be required prior to construction of the Project to allow occupation of Crown Land during both construction and operation.	Detailed design (i.e. construction and operation)
PL2	Temporary change in land use from construction access on beach	Agreements will be negotiated with relevant landowners for the temporary use of property during construction. Land will be returned to its original condition following construction or otherwise reinstated in consultation with the landowner, and in accordance with any licence conditions.	Detailed design and construction
PL3	Temporary land use change for portion of PMGC grounds	BVSC will work directly with the PMGC to minimise impact on the activities and operation of the PMGC grounds and will limit use of the property to one fairway during construction where practical.	Detailed design and construction
Noise and vibration (airborne)			
NV1	General noise and vibration management	A CNVMP will be prepared as part of the CEMP and would include general feasible and reasonable work practices as identified in ‘Section 6 Work practices’ of the ICNG (Department of Environment and Climate Change (DECC), 2009).	Construction
NV2	Construction noise emissions at nearby sensitive receptors (particularly during Stage 5)	During construction Stage 5, if Option C is undertaken, a temporary noise barrier should be located around the drill rig to shield residential properties to the south-east on Arthur Kaine Drive.	Construction
NV3	Construction related traffic noise emissions (particularly during Stage 1B)	Vehicle movements will be routed away from sensitive receivers and scheduled during less sensitive times where feasible and reasonable.	Construction
NV4		The speed of vehicles will be limited, and the use of engine compression brakes limited.	Construction
NV5		On-site storage capacity will be maximised to reduce the need for truck movements during sensitive times.	Construction
NV6	Vibration minimum working distances	If vibration intensive equipment is to be used within the minimum working distances for cosmetic damage, it is recommended that attended vibration measurements are undertaken when work commences, to	Construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		determine “site specific minimum working distances”.	
NV7		Vibration intensive work should not proceed within the site specific safe working distances, unless a permanent vibration monitoring system is installed approximately 1 m from the building footprint, to warn operators (e.g. via flashing light, audible alarm, SMS) when vibration levels are approaching the peak particle velocity objective.	Construction
Air quality			
AQ1	Air quality impacts	Daily construction activities should be planned to consider the expected weather conditions for each workday. Regular dust observations of active excavation, earthmoving works or stockpiling areas will be undertaken to determine whether dust is moving off-site and whether any areas need additional mitigation measures(such as watering). Compile records of observations to enable the demonstration that dust is being managed in an ongoing manner. Records should include (as a minimum) the following: • observation date and time; • area being inspected; • level of dust being generated; • meteorological conditions when observation occurred; and • mitigation/management measures undertaken.	Construction
AQ2	Dust impacts	Minimise exposed surfaces, such as stockpiles and cleared areas, including partial covering of stockpiles with materials such as dust mesh where practicable.	Construction
AQ3	Dust impacts	Water exposed soil surfaces using water trucks or sprinklers during demolition and construction.	Construction
AQ4	Dust impacts	Establish defined site entry and exit points to minimise tracking of soil on surrounding roads. Use wheel washes or shaker grids where the risk of off-site track out of soil is identified.	Construction
AQ5	Dust impacts	Cover heavy vehicles entering and leaving the Project area to prevent material escaping during transport.	Construction
AQ6	Dust impacts and vehicle and equipment emissions	Keep vehicles and construction equipment operating on-site well maintained and turned off when not operating (minimise idling on the site).	Construction
AQ7	Dust impacts	Minimise the handling of spoil when excavating and loading vehicles.	Construction
AQ8	Odour impacts	Prior to commencement of construction works for the Project, deliver information flyers to the surrounding community; noting there may be some potential temporary odour impacts arising	Construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		from the Project (e.g. when excavating spoil/sludge from site from the decommissioning of the existing effluent storage pond). Provide contact information directing the community to the operator-run complaints management system.	
Social and economic			
SE1	Lack of community involvement	Continue consultation with the community throughout the assessment, approval and construction phases (and post construction) of the Project in accordance with the *Community and Stakeholder Engagement Plan* (CSEP) (AECOM, 2017). Use a variety of engagement tools and methods to provide the community with: • accurate and accessible information regarding the processes and activities associated with the Project; • appropriate avenues for the community to provide comment or raise concerns; and • responsiveness to issues and concerns raised.	Construction and Operation
SE2	Lack of community involvement	In conjunction with mitigation measure SE1, a socio-economic impact monitoring framework will apply throughout the construction phase of the Project (and three months post construction) to: • monitor the communities experience and perception of impacts; • monitor the effectiveness of the identified mitigation and management measures outlined in the various EIS chapters prepared for the Project; and • monitor complaints and public enquiries.	Construction and Operation
SE3	Impact to areas used for construction laydown and access, including impacts to nearby businesses	The construction laydown area on Merimbula Beach and associated access will be planned to minimise impacts on beach users. Public access to Pambula beach will be maintained at all times. Establishment and use of the laydown area and access track will consider public safety and maintaining safe access around the site. Signage will be erected at the access to, and along the length of, Pambula Beach with the purpose of informing the public of the location of construction activities.	Construction
SE4	Impacts to visual amenity	All construction sites will be maintained to minimise visual amenity impacts, including keeping sites tidy, litter-free, and with well-maintained fences/bunting, signage, erosion and sediment controls, and entrances and access tracks. Hoarding may also be used (where appropriate).	Construction

Ref#	Potential impacts	Mitigation and management measure	Timing
SE5	Population and demographics and impacts related to economy	BVSC will investigate opportunities to source construction workers, equipment and materials from the local community.	Construction
Sustainability			
S1	IS rating is compromised and sustainability performance of the Project is not optimised	Sustainability initiatives will be incorporated into the detailed design and construction of the Project to support the achievement of the Project sustainability objectives and will be detailed in the Sustainability Management Plan.	Construction
S2	IS rating is compromised and sustainability performance of the Project is not optimised	A Design rating level of 'Excellent' will be targeted under version 1.2 of the IS Rating Tool.	Detailed design
S3	IS rating is compromised and sustainability performance of the Project is not optimised	Sustainability initiatives will be incorporated into the operation of the Project to support the achievement of the Project sustainability objectives and would be detailed in the Sustainability Management.t Plan	Operation
Climate change			
CC1	Impact ID[13] ERF-3, ERF-4, ERF-6, ERF-9, MRD-4	Investigate the use of the large ponds within the STP site for additional wet weather storage.	Detailed design
CC2	Impact ID: ERF-3, ERF-4, ERF-6, MRD-4	Design the outfall pipe (both size and operational timing) to respond to increased rainfall intensities and volumes to facilitate high flow events and avoid disruptions in processing.	Detailed design
CC3	Impact ID: EH-1, BF-2, BF-3, ERF-5, ERF-13, SLR-5	Provide upgrades to the STP (e.g. UV disinfection) to allow for further automation and remote operation to reduce the number of personnel required onsite.	Detailed design
CC4	Impact ID: MRD-3	Update operational procedures to provide for a weekly flush, pigging or physical removal of marine organisms along the ocean outfall pipeline to prevent odours, septicity risk and degradation.	Operations
CC5	Impact ID: MRD-1	Construct the ocean outfall pipeline out of high-density polyethylene (as opposed to concrete) to minimise the risk of accelerated degradation and structural failure.	Concept design
CC6	Impact ID: SLR-4	Provide for the use of remote operated vehicles and regular diver maintenance to allow for the	Operations

[13] Refer to **Table 25-6** in **Chapter 25 Climate change** which presents the Climate Change Risk and Adaption Assessment for the Project. Each Impact ID correlates to a climate change risk which has been assessed for the Project.

Ref#	Potential impacts	Mitigation and management measure	Timing
		diffuser head of the ocean outfall pipeline to remain open.	
CC7	Impact ID: BF-3	Use underground pumps and pipeline network where feasible to prevent exposure and direct damage.	Detailed design
CC8	Impact ID: EH-7, BF-5, ERF-14	Design to consider connections, if possible, to multiple substations to reduce the reliance on only one substation in the event of a power outage.	Detailed design
CC9	Impact ID: ERF-12, SLR-2, SLR-4	Undertake additional modelling of potential changes (including future changes) to surf zone morphology and wave impacts to determine the appropriate ocean outfall pipeline depth (for the underground portion of the pipeline).	Detailed design
CC10	Impact ID: ERF-12, SLR-2, SLR-4	Update operational procedures to increase the frequency of erosion monitoring to protect against buried assets being uncovered.	Operations
CC11	Impact ID: EH-1, EH-3	Provide additional shade through the use of covered dosing sheds for incidental respite from extreme heat/solar exposure.	Construction
CC12	Impact ID: EH-1, BF-2, ERF-5	Undertake a review of current BVSC standard operational procedures and policies to incorporate extreme weather events (e.g. heat waves, bushfire events, etc.). This includes event notification, use of appropriate Personal Protective Equipment (PPE) and changes to operations and procedures during extreme events.	Detailed design and operation
CC13	Impact ID: ERF-1, ERF-8, SLR-1, SLR-3	Elevate critical equipment and systems above known flood levels.	Detailed design and construction
CC14	Impact ID: MRD-1	Engage experienced contractors to advise on key constructability concerns and challenges including shifting soils and foundational integrity of site infrastructure and the pipeline network.	Construction
CC15	Impact ID: EH-7, ERF-14	Incorporate the use of solar PV, battery storage and/or backup generators where possible onsite for critical systems to minimise the impact of power disruption.	Detailed design and construction
CC16	Impact ID: MRD-3	Undertake community outreach to educate the community around potential concerns (e.g. odour, water restrictions, discolouration, etc.).	Detailed design, construction and operation
CC17	Impact ID: ERF-5, ERF-6, ERF-7, ERF-10	Model for potential increases in rainfall (e.g. 10%) and design site drainage to account for additional surface flows.	Detailed design

Ref#	Potential impacts	Mitigation and management measure	Timing
Waste			
WM1	Generation of general waste	Waste will be managed in accordance with the waste hierarchy established in the WARR Act. This will include: • meeting targets established under the *NSW Waste Avoidance and Resource Recovery Strategy 2014 -21* (NSW EPA, 2014b) where practicable; • classification of waste during construction in accordance with the *Waste Classification Guidelines* (NSW EPA, 2014a); • segregation of waste at construction laydown areas and substations (within appropriate bins) for ease of recycling/re-use; • procurement of materials on an as needed basis to avoid waste due to over-ordering; and • investigating opportunities to re-use materials where feasible. All waste to be disposed off-site will be directed to a waste management facility that is lawfully permitted to accept that type of waste. Monitoring of all wastes will be carried out during construction and operation. Records of waste tracking and disposal will be maintained. Waste classified as general solid waste non putrescible and general solid waste putrescible will be accepted at BVSC's Central Waste Facility, Frogs Hollow.	All Project phases
WM2	Generation of construction waste	A Waste Management Sub-Plan will be prepared as part of the Construction Environmental Management Plan (CEMP). The Sub-Plan will: • identify requirements consistent with the waste and resource management hierarchy; • demonstrate that the waste hierarchy has been applied; • ensure resource efficiency is delivered through the design and construction practices; • provide consistent clear direction on waste and resource handling, storage, stockpiling, use and re-use management measures; • outline procedures for stockpiling of wastes (refer to mitigation measure WM3); • set out processes for disposal, including on-site transfer, management and the necessary associated approvals/permits. All waste generated will be regularly removed from site as required by licensed contractors, in order to avoid potential issues associated with odour, visual amenity and attracting animals/pest species;	Detailed design and construction

Ref#	Potential impacts	Mitigation and management measure	Timing
		• outline waste management practices which include measures requiring segregation of waste at source within the Project area and designating waste management areas for storage of waste within the Project area; • include material tracking measures to track waste and recyclables generated from the Project and removed from the Project area. Material tracking records will include types, volumes and management measures for waste and resources arising from/used for the Project; • outline an unexpected finds protocol to manage the potential for unexpected finds during construction of the Project (i.e. asbestos or other hazardous materials); • include a process for auditing, monitoring and reporting; and be managed, reviewed or audited by an appropriately qualified professional.	
WM3	Spoil generation and stockpiling	The Waste Management Sub-Plan will include requirements for spoil management. The plan will identify: • spoil generation activities and locations; • spoil management hierarchy; • on-site management, including stockpile sites; • spoil re-use options; • spoil disposal locations; • spoil transport modes and routes; and • waste tracking requirements. Stockpiled wastes will be: • appropriately segregated to avoid mixing and contamination; • appropriately labelled; • appropriately stored to minimise risk of erosion • contained in stockpiles less than three metres in height with an appropriate height to length batter ratio (e.g. 1:3); and • located as far away as practical from sensitive receivers, ecological areas and watercourses.	Detailed design and construction

Ref#	Potential impacts	Mitigation and management measure	Timing
WM4	No waste minimisation	Consistent with materials and water-related sustainability objectives which will be included in the Sustainability Management Plan for the Project, the following waste minimisation strategies will be implemented when sourcing construction materials during detailed design: • if an option less favourable than the first option is selected and implemented, then justification for not selecting options higher on the waste hierarchy would be provided; • use of recycled materials (i.e. recycled content for asphalt and concrete including the use of fly ash) wherever feasible; • use of wastewater or recycled water to reduce potable water demand for construction activities; and • use of modular, precast/prefabricated structures, where feasible.	Detailed design and construction
WM5	No waste re-use	Where a NSW EPA Resource Recovery Order exists for a specific waste material, the opportunity to re-use the waste under that order should be considered prior to disposal. Current orders (and exemptions) are found on the NSW EPA website: https://www.epa.nsw.gov.au/your-environment/recycling-and-re-use/resource-recovery-framework/current-orders-and-exemption The current orders should be periodically reviewed during construction and operation for applicability.	Detailed design, construction and operation
WM6	Pollution from marine vessel wastes	Marine vessel/s (e.g. barge) used in construction and operation of the Project will have adequate waste management procedures in place that address applicable legislative requirements.	Detailed design, construction and operation
WM7	Generation of operation waste	The existing Operational Waste Management Plan for the STP will be updated to include management measures developed for the new waste streams that would result from the Project (identified in **Chapter 26 Waste**).	Operation
WM8	Unexpected waste	Contingency measures would be implemented to manage unexpected waste volumes and materials generated during project construction. Where feasible, suitable hardstand or lined areas will be identified to allow for contingency management of unexpected waste materials.	Detailed design and construction
Cumulative impacts			
CU1	General	BVSC will explore Project refinements and opportunities (including construction scheduling) to further minimise potential impacts on the environment and communities.	Detailed design

Ref#	Potential impacts	Mitigation and management measure	Timing
CU2	General	BVSC will review the environmental impacts of the Project before the start of construction and periodically during construction to identify further opportunities to reduce potential for cumulative impacts. Any relevant changes will be captured in the CEMP.	Detailed design and construction
CU3	General	Consultation in regard to construction planning will be undertaken with relevant stakeholders, particularly with proponents for any other developments within proximity to the Project which haven't been identified at the time of writing this EIS.	Detailed design and construction

28.6 Consolidated performance outcomes

The SEARs identify a number of desired performance outcomes for the Project (refer to **Appendix A** (SEARs Compliance Table). These performance outcomes outline the broader objectives to be achieved during design, construction, and operation.

Based on the outcomes of the environmental impact assessment and having regard to the performance outcomes nominated in the SEARs, Project specific performance outcomes have also been developed. These performance outcomes would assist in managing residual impacts identified for the Project.

BVSC has committed to achieving the Project specific performance outcomes described in **Table 28-6**. Future design development would be considered against these performance outcomes.

Table 28-6 Compilation of environmental performance outcomes

Environmental aspect	Project specific environmental performance outcomes
Surface water and flooding	• potential water quality pollutants used or generated during construction are controlled to minimise impacts to the receiving environment; • construction of the Project is outside the 1% AEP flood extent and therefore not affected by flood waters in this event; • treated wastewater to be beneficially re-used during operation (for irrigation) is within authorised release limits; • treated wastewater released from the ocean outfall is within authorised discharge limits; • marine water quality outside of the ocean outfall mixing zones (25 m 99% of the time and 200 m 1% of the time) complies with applicable MWQO values; and • no impacts to hydrology of surface water during construction or operation.
Groundwater	• potential impacts to groundwater are minimised and managed during drilling; • risk of groundwater contamination due to accidental spills and leaks during the construction are managed; and • groundwater monitoring results during operation are within applicable criteria developed.

Environmental aspect	Project specific environmental performance outcomes
Marine and coastal processes	• marine sediment and morphology impacts are minimised and managed during construction; • no impacts to Merimbula Lake or Pambula River mouth entrance stability from the Project; • operational marine sediment and morphology impacts are minimised through design; and • no direct surface impacts to the mapped wetland in State Environmental Planning Policy (Coastal Protection) 2018 (Coastal Management SEPP).
Marine ecology	• the Project design considers all feasible measures to avoid and minimise impacts on marine biodiversity; and • the Project is designed, constructed and operated to avoid or minimise impacts on protected and sensitive species.
Terrestrial ecology	• flora and fauna impacts not already identified in this EIS are avoided; • flora and fauna habitat is retained/impacts avoided, or enhanced where possible; and • biodiversity offsets are carried out in accordance with BBAM and the BBCC.
Landform, geology and soils	• the environmental values of land, including soils, subsoils and landforms, are protected; • human health and ecological risks arising from the disturbance and excavation of land and disposal of soil are minimised, including erosion and sedimentation, subsidence risks and potential disturbance of acid sulfate soils; and • accidental spills and leaks of fuel, oils or other chemical substances during construction and operation are contained and any contaminated material removed.
Aboriginal heritage	• no impacts to Aboriginal sites, objects or places identified in the assessment during construction; • if an unexpected find is encountered during construction, relevant procedures are followed; and • the Aboriginal Cultural Heritage Management Plan is developed and implemented adequately.
Non-Aboriginal heritage	• no impacts to non-Aboriginal sites, objects and places during construction; and • if an unexpected find is encountered during construction, relevant procedures under an Cultural Heritage Management Plan are followed.
Hazardous materials	• no impacts to the receiving environment form the storage or handling of dangerous goods (during construction or operation).
Human health	• improvement to water quality during operation of the Project (including at Merimbula Beach, in Merimbula Bay, and at beneficial re-use sites) which would subsequently decrease human health risks.

Environmental aspect	Project specific environmental performance outcomes
Traffic and transport	• public access routes are maintained for pedestrians, cyclists and road users, including buses during construction; • public access is maintained for all road users to Pambula Beach; • access to residences and commercial properties is maintained; • construction worker parking for the Project is contained to the STP site and construction laydown areas; and • no road or cycle diversions or closures are required as a result of the Project.
Property and land use	• access to properties, businesses and community facilities during construction is maintained; and • continue consultation with individual property owners/managers to identify individual concerns and develop and document strategies to address these concerns during construction.
Noise and vibration (airborne)	• minimise adverse impacts on acoustic amenity during construction; and • community consultation/notifications in relation to construction noise are undertaken where necessary, in a timely fashion.
Noise and vibration (underwater)	• safety zones are implemented during construction to mitigate hearing injury to marine mammals.
Air quality	• visible dust is managed during construction to minimise the release beyond the Project area boundaries; • no unnecessary vehicle combustion emissions; • no soil track-out onto public roads; • no complaints from receptors in relation to dust emissions; • no odour complaints from receptors during construction works; and • temporary impacts of odour are appropriately mitigated and managed.
Social and economic	• construction impacts on businesses and industry are minimised through adequate mitigation and consultation; and • environmental and cultural values of importance to the community, tourists and commercial operators (commercial fishing) and the recreational value of the marine environment (for recreational fishing, swimming) are improved.
Sustainability	• the Project explores options for construction innovation to optimise Project constructability and reduce construction program and costs (applicable across energy, water and materials); • sustainability objectives are implemented, and these objectives embedded into decision making for the Project; • the Project demonstrates a high level of performance against objectives and appropriate sustainability benchmarks; and • the Project is accountable and reports publicly on sustainability performance.
Climate change	• design and deliver infrastructure that is responsive and resilient to the impacts of climate change.
Waste	• the waste management hierarchy is implemented across all construction sites; • waste from construction and operation of the Project is classified in accordance with the Waste Classification Guidelines (NSW EPA, 2014a); and • waste types once classified are reviewed against appropriate guidelines to manage waste appropriately.

Environmental aspect	Project specific environmental performance outcomes
Cumulative impacts	• the Project is scheduled to avoid cumulative impacts from overlapping construction phases if required.

28.7 Justification

28.7.1 Project justification and consequence of not proceeding

The ongoing use of the current Merimbula STP and beach-face outfall does not meet community or regulatory agency expectations and presents unacceptable risks to public health, the environment and the regional economy. Current operations do not consistently meet the *Water Quality Objectives for NSW Ocean Waters – South Coast* (DEC, 2005), based on the *Australian and New Zealand Guidelines for Fresh and Marine Water Quality* (ANZECC Guidelines) (ANZECC, 2000). Furthermore, data from the Merimbula STP shows that the treated wastewater quality is not wholly compliant with NSW Environment Protection Authority (EPA) licence limits.

The Project would address these issues by improving the quality of treated wastewater being disposed of from the STP, and address the issue of a beach-face outfall by introducing an ocean outfall pipeline with an offshore discharge point. The Project is expected to contribute to the strengthening of the local economy by improving the recreational aesthetic of the Merimbula Beach and Merimbula Bay environs while at the same time reducing risks to public health, the environment, and commercial industry. The Project is also important in the context of NSW Government, regional and Council policies, strategies and initiatives.

The Project would deliver the following key benefits and opportunities:

- improve the quality of treated wastewater and minimise public health and environmental risks associated with using and disposing of treated wastewater;
- give rise to the least impacts during construction (when compared to a trenched construction methodology) and operation (compared to other disposal options such as disposal at the beach-face outfall), and recognises the value the Merimbula community places on its beach and ocean front;
- provide for a sustainable wastewater management method for disposing of excess treated wastewater during wet weather periods, when treated wastewater re-use schemes cannot irrigate;
- provide a solution which is more socially, environmentally and economically sustainable in the long term (compared to the current operation);
- reduce the potential for water quality impacts on the local oyster industry; and
- reduce the potential for impact on tourism.

28.7.2 Environmental considerations

Comprehensive investigations have been carried out in the preparation of this EIS to assess the biophysical, economic and social impacts. The key potential impacts that cannot be avoided are summarised in **Section 28.4**. The Project would incorporate environmental management and design features so that unavoidable potential impacts are managed and mitigated as far as feasible and reasonable and to an acceptable level.

Biophysical, economic and social considerations have also been assessed in the context of the principles of ecologically sustainable development. The EP&A Act adopts the definition of ecologically sustainable development contained in the *Protection of the Environment Administration Act 1991.* An assessment of the biophysical, economic and social impacts of the Project in the context of the principles of ecologically sustainable development is provided in **Section 28.7.3**.

28.7.3 Principles of ecologically sustainable development

Precautionary principle

A range of environmental investigations have been undertaken during the development of the Project and the environmental assessment process, to ensure that potential impacts are understood with a high degree of certainty. The assessment of the potential impacts of the Project is considered to be consistent with the precautionary principle. The assessments undertaken are consistent with accepted scientific and assessment methodologies and have considered relevant statutory and agency requirements. The assessments have applied a conservative approach with regard to construction and operational arrangements, including the hydrodynamic modelling undertaken.

The Project has evolved to avoid impacts where possible, and to reflect the findings of the assessments undertaken. A number of mitigation measures have been proposed to mitigate identified risks and threats of environmental damage, which would be implemented during construction and operation. No mitigation measures have been postponed due to lack of full scientific certainty.

Principle of inter-generational equity

Construction of the Project has the potential for some degree of environmental and social disturbance. However, the potential for environmental and social disturbance during construction has to be balanced against the long-term benefits of the STP upgrade and new ocean outfall.

Once operational, the Project would benefit future generations. The Project would improve the quality of treated wastewater and reduce environmental and health risks associated with discharge of treated wastewater. It provides a solution which is more socially, environmentally and economically sustainable in the long term (compared to the current operation), including during wet weather periods which would increase in frequency and intensity with climate change.

The Project is targeting an ‘Excellent’ ‘Design’ rating under the Infrastructure Sustainability Council of Australia (ISCA) IS Rating Tool, which incorporates best practice benchmarks for sustainable design and construction. The ISCA IS Rating Tool has been designed to help infrastructure meet its full sustainability potential. An IS Design Rating is considered a ‘temporary’ rating, applicable for a two-year period following award. In order to maintain an IS Rating, BVSC would be required to pursue an As Built Rating, assessable during the construction period of the Project.

Conservation of biological diversity and ecological integrity

Assessments of marine ecology and terrestrial ecology have been undertaken for the Project (refer to **Chapter 11 Marine ecology** and **Chapter 12 Terrestrial ecology**).

The marine ecology assessment found that during construction, most of the potential threats to marine ecology can be effectively managed at low risk levels with the implementation of routine control measures. Exceptions include the physical disturbance and loss of soft sediment habitat (“Type 3 habitat”) and impact to the soft sediment infauna and epifauna communities during establishment of the ocean outfall pipeline, and the potential introduction of a marine pest. However, over the long-term there would be a gain in fish habitat (“Type 2 habitat”) from the introduction of the pipeline infrastructure which is recognised as being a more valuable fish habitat.

The potential impact to marine ecological values during the operational phase of the Project relate primarily to how the discharge of treated wastewater may impact the water and sediment quality of Merimbula Bay and the scale of that impact. Predicted water quality impacts would typically be confined to a 25 m near-field mixing zone most of the time (99%), extending to 200 m under worse-case conditions that may occur a minor proportion (1%) of the time.

The marine ecology assessment found that the Project is not likely to have an adverse effect on threatened or protected species listed under the *Fisheries Management Act 1994*, and the Project as a whole is also not considered a Key Threating Process (KTP) under the Act. However, in relation to the recognised KTP - *introduction of non-indigenous fish and marine vegetation to the coastal waters of New South Wales*, a potential risk exists for this KTP to occur during Project construction activities. Mitigation and management measures would be implemented to control this risk.

The Project is also not likely to have an adverse effect on threatened or protected species listed under the *Biodiversity Conservation Act 2016*, or have a significant impact on a matter of national environmental significance and a referral under the *Environment Protection and Biodiversity Conservation Act 1999* is not required.

On land, the Project would involve the clearing of approximately 0.28 hectares of highly modified native vegetation that is of negligible conservation significance. This assessment found that by implementing the Biobanking Assessment Methodology (BBAM) and the Biobanking credit calculator (BBCC), biodiversity offsets would be required.

The Project area provides a range of habitats for threatened flora and fauna. As such, the Project has been designed to avoid and minimise impacts on fauna habitats such that impacts would be limited to a small amount of foraging and sheltering habitat.

There would be a minor loss in habitat for waterbirds and amphibians in association with the proposed decommissioning of the effluent storage pond. However, this is not considered to comprise a significant adverse impact given the small area of relatively low quality habitat to be affected relative to the extent of similar and superior habitats locally. Potential temporary impacts on shorebirds associated with construction activities along Merimbula and Pambula Beach are expected to be minor and can be mitigated by appropriate measures prior to and during the construction phase of the Project.

Improved valuation and pricing of environmental resources

Economic appraisal draws on several established methodologies that provide for the valuation of externalities, including environmental externalities, and their inclusion in the appraisal process. Environmental parameters that can be valued include air pollution, greenhouse gas emissions, noise pollution and water run-off. Valuations typically adopt broad average values.

The design has been developed with an objective of minimising potential negative impacts on the surrounding environment and community. The assessment has identified mitigation measures where appropriate to manage potential impacts. If approved, construction and operation of the Project would be undertaken considering relevant legislation, the conditions of the approval, and the environmental management plans described in **Section 28.5**. These requirements would result in an economic cost to BVSC as the proponent. The implementation of mitigation and management measures would increase the capital and operating costs of the Project. This signifies that environmental resources have been given appropriate valuation.

28.8 Conclusion

The Project has been developed with the objective of minimising potential impacts on the local and regional environment and community. The design and construction methodology would continue to be developed with these objectives in mind and would continue to consider the input of stakeholders and the local community.

The Project’s environmental performance during construction would be demonstrated by implementing the CEMP (and associated sub-plans). These plans would be designed to comply with relevant legislation and conditions of approval. They would include a range of mitigation measures developed following the environmental assessment documented in this EIS. Environmental performance during operation would be demonstrated by implementing the operational measures specified. The Project would result in several positive environmental impacts.

With the implementation of the proposed mitigation and management measures, the potential environmental impacts of the Project are considered manageable. The Project would result in net positive outcomes to both the community and environment (including improvements to water quality, human health, recreation, environmental, heritage, and aesthetic values) compared to the existing beach-face outfall and dunal exfiltration ponds. Taking into account the manageability of identified impacts in addition to the identified benefits of the Project, the Project is considered justified and should proceed.

29.0 References

AECOM, 2013a. Merimbula Effluent Options Investigation

AECOM, 2013b. Desktop Ecological Assessment of the Potential Impacts on Merimbula Lake from Dunal Exfiltration of Effluent. Prepared for Bega Valley Shire Council, March 2013.

AECOM, 2019. Merimbula Ocean Outfall – Dispersion Modelling Report. Prepared for Bega Valley Shire Council, 20 December 2019.

AECOM, 2020. Geotechnical Interpretative Report. Unpublished draft report to the Bega Valley Shire Council dated 17 February 2020

AS/NZS ISO 31000:2009 Risk Management – Principles and Guidelines

ALCW, 2020. Atlas of Life in Coastal Wilderness Sightings Records, https://atlasoflife.org.au/

Atlas of Living Australia, 2017. Atlas of Living Australia, https://www.ala.org.au/

Attenbrow, V., 1976. Aboriginal Subsistence Economy on the Far South Coast of New South Wales, Australia. University of Sydney.

Australia International Council on Monuments and Sites, 1999. The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance. Burwood, Victoria. Available at: http://australia.icomos.org/wp-content/uploads/BURRA_CHARTER.pdf

Australia International Council on Monuments and Sites, 2013. The Burra Charter: The Australia ICOMOS Charter for Places of Cultural Significance. Burwood, Victoria. Available at: from http://australia.icomos.org/wp-content/uploads/The-Burra-Charter-2013-Adopted-31.10.2013.pdf.

Australian and New Zealand Environment and Conservation Council and Agriculture and Resource Management Council of Australia and New Zealand, 2000. National Water Quality Management Strategy Australian Guidelines for Fresh and Marine Water Quality

Australian Green Infrastructure Council (AGIC; now Infrastructure Sustainability Council of Australia), 2011. AGIC Guideline for Climate Change Adaptation. Revision 2.1. Available at: http://www.isca.org.au/images/pdf/cca_guideline_v2.1.pdf

Australian Museum Business Services, 2009a. Kurri-Redbank Feeder 953/95R (132kV) Upgrade: Aboriginal Heritage Assessment, Hunter Valley, NSW. Unpublished report for Energy Australia.

Australian Museum Business Services, 2009b. Kurri Kurri Aboriginal Heritage Assessment for the 33kV Kurri-Rutherford Feeder Split: Stage 1 and Stage 2 Works. Unpublished report for Energy Australia.

Bega Valley Shire Council, 2017. Bega Valley Community Strategic Plan 2040. Available at: https://www.begavalley.nsw.gov.au/cp_themes/default/page.asp?p=DOC-KQK-02-86-67.

Bega Valley Shire Council, 2019a, Enterprise Risk Management Framework, August 2019. Available at http://www.begavalleyshireratepayers.asn.au/files/2-BVSC-Policy---Procedure-5.03.1---Enterprise-Risk-Management---25.05.2016.pdf.

Bega Valley Shire Council, 2019b. Recycled Water Management System

Bega Valley Shire Council, 2020. Coastal Zone Program. Available at: https://begavalley.nsw.gov.au/cp_themes/default/page.asp?p=DOC-WND-76-61-32.

Bureau of Meteorology, 2020. Climatic data sourced from Bureau of Meteorology Station No. 69147 Merimbula Airport. Data accessed via the website: http://www.bom.gov.au/climate/data/ on 22 June 2020

Cardno, 2012, Pambula River Estuary Processes study, Prepared for Bega Valley Shire Council, Final Report - 27 April 2012.

Cardno, 2017, Flood Study Report: Merimbula Lake and Back Lake Flood Study, prepared for Bega Valley Shire Council.

Creese, R.G., Glasby, T.M., West, G. and Gallen, C. (2009). Mapping the habitats of NSW estuaries. Report to the Hunter Central Rivers Catchment Management Authority, September 2009. Available online at URL: http://www.dpi.nsw.gov.au/data/assets/pdf_file/0004/306625/AE_2009_Output--1575_Creese--et--al_Habitat--Mapping--Final--Report--113_REPORT.pdf

CSIRO and the Bureau of Meteorology, 2015. Southern Slopes Cluster Report: Projections for Australia's NRM Regions. Available at: https://www.climatechangeinaustralia.gov.au/media/ccia/2.1.6/cms_page_media/172/SOUTHERN_SLOPES_CLUSTER_REPORT_1.pdf

Department of Agriculture, Water and the Environment, 2020. Protected Matters Search Tool. Available at: http://www.environment.gov.au/epbc/protect/index.htm.

Department of Environment, 2014, Recovery Plan for the Grey Nurse Shark (Carcharias Taurus), Commonwealth Dept. of Sustainability, Environment, Water, Population and Communities, 2013.

Department of Environment and Climate Change, 2006. NSW Water Quality and River Flow Objectives, Towamba and Genoa River

Department of Environment and Climate Change, 2008. Managing Urban Stormwater: Volume 2.

Department of Environment and Conservation, 2003. Environmental Guidelines – Use of effluent by irrigation, prepared for Environmental Protection Authority.

Department of Environment and Conservation, 2004. Approved Methods for Sampling and Analysis of Water Pollutants in NSW, Sydney NSW

Department of Environment and Conservation, 2008. Approved Methods for Sampling and Analysis of Water Pollutants in NSW, Sydney NSW

Department of Environment and Conservation, 2005. Marine Water Quality Objectives for NSW Ocean Waters – South Coast.

Department of Environment and Conservation, 2006. Using the ANZECC Guidelines and Water Quality Objectives in NSW. Published by the NSW Department of Environment and Conservation. ISBN 1 74137 918 0

Department of Environment and Heritage, 2006. Climate Change Impacts and Risk Management: A Guide for Business and Government. Report prepared for the Australian Greenhouse Office, Commonwealth of Australia. Available at: http://www.climatechange.gov.au/community/~/media/publications/local-govt/risk-management.ashx

Department of Environment, Climate Change and Water, 2010a. Aboriginal Cultural Heritage Consultation Requirements for Proponents.

Department of Environment, Climate Change and Water, 2010b. Code of Practice for Archaeological Investigation of Aboriginal Objects in New South Wales.

Department of Environment, Climate Change and Water, 2010c. Seabed habitat mapping of the continental shelf of NSW. DECCW report 2010/1057, December 2010.

Department of Infrastructure, Planning and Natural Resources, 2005. Flood Development Manual, the management of flood liable land.

Department of Land and Water Conservation, 1998. NSW Groundwater Policy Framework Document

Department of Planning and Environment, 2017. South East and Tablelands Regional Plan 2036.

Department of Planning, 2007. South Coast Regional Strategy 2006-31. Available at: https://www.planning.nsw.gov.au/-/media/Files/DPE/Strategy-documents/south-coast-regional-strategy-2006-to-2031-2007-01.pdf.

Department of Planning, 2011. Applying SEPP 33, Hazardous and Offensive Industry Development Application Guidelines.

Department of Planning, 2011. Hazardous Industry Planning Advisory Paper No 4, Risk Criteria for Land Use Safety Planning.

Department of Planning, Industry and Environment, 2019. Safe and Secure Water Program – Program Guidelines.

Department of Planning, Industry and Environment, 2020. Koala Development Application Map. Available at: https://www.planning.nsw.gov.au/Policy-and-Legislation/Environment-and-Heritage/Koala-Habitat-Protection-SEPP. Accessed 20 March 2020.

Department of Primary Industries, 2012a. Aquifer Interference Policy 2012.

Department of Primary Industries, 2012b. Risk Assessment Guidelines for Groundwater Dependent Ecosystems.

Department of primary Industries, 2012c. Guidelines for Controlled Activities on Waterfront Land.

DPI, 2013. Factsheet Greynurse Shark (Carcharias Taurus), Feb 2013.

Department of Primary Industries, 2013. Policy and Guidelines for Fish Habitat Conservation and Management

Department of Primary Industries, 2015. NSW Guidance for Recycled Water Management Systems.

Department of Sustainability, Environment, Water, Population and Communities, 2013. Issues Paper for the White Shark (Carcharodon Carcharias)

Department of Water and Energy (DWE), 2007. NSW Water Extraction Monitoring Policy

Dorsal, 2018, Shark Reporting URL: https://www.dorsalwatch.com/report/

Eco Logical Australia ELA, 2020a. Merimbula STP Upgrade and Ocean Outfall Terrestrial Ecology Assessment. A report for AECOM Australia Pty Ltd.

Eco Logical Australia ELA. 2020b. Merimbula STP groundwater dependent ecosystem assessment. A report for AECOM Australia Pty Ltd.

Ekström, M. et al., 2015. Central Slopes Cluster Report, Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Cluster Reports, eds. Ekström, M. et al., CSIRO and Bureau of Meteorology, Australia.

Elgin, 2013. Ecological Assessment of the Potential Impacts on Merimbula Lake from dunal exfiltration of effluent - Supplementary Report. Prepared for Bega Valley Shire Council, 5 March 2013.

Elgin, 2014a. Merimbula Lake – Estuary Health Monitoring Report Series No.5, Report prepared for BVSC, 21 February 2014.

Elgin, 2014b. Pambula Lake – Estuary Health Monitoring Report Series No.10, Report prepared for BVSC, 5 February 2014.

enHealth, 2012a. Environmental Health Risk Assessment: Guidelines for Assessing Human Health Risks from Environmental Hazards.

enHealth, 2012b. Australian Exposure Factor Guide.

Ferguson, B. J., 1971. A Short History of Merimbula. Imlay District Historical Society.

Gorfine, H.K., Hart, A.M., and Callan, M.P.,1996. Evaluation of methods to assess abalone abundance. Final report to Fisheries Research and Development Corporation, FRDC project 93/100.

Gray, J.S. and Elliot, M.,2009. Ecology of Marine Sediments - From Science to Management, Second Edition, Oxoford University Press 2009, 225 pp.

Hart, A.M., Gorfine, H.K. and Callan, M.P.,1997. Abundance estimation of blacklip abalone (Haliotis rubra) I. An analysis of diver-survey methods used for large-scale monitoring. Fisheries Research 29 (2): 159-169.

Higgins, J., 1982. Pambula's Colonial Days: A Short History of the Period 1797-1901. Merimbula-Imlay Historical Society.

Howitt, A. W., 1904. The Native Tribes of South-East Australia. London: Macmillan.

Ian Grey Groundwater Consulting, 2006. Merimbula Reclaimed Water Management Scheme: Review of Options for Disposal of Excess Water. Ian Grey Groundwater Consulting Pty Ltd. Report BJ09/Rp011 Rev C. May 2006.

Ian Grey Groundwater Consulting, 2013. Disposal of Effluent from Merimbula Sewage Treatment Plant by Dunal Exfiltration – Investigation and Assessment of Impacts on Groundwater Levels and Water Quality of Merimbula Lake and Bay. Unpublished report by Ian Grey Consulting Pty Ltd. for the Bega Valley Shire Council

Infrastructure NSW, 2018, State Infrastructure Strategy 2018-2038: Building Momentum.

International Panel on Climate Change, 2007. Fourth Assessment Report (AR4), Working Group I: The Physical Science Basis.

International Panel on Climate Change, 2013. Fifth Assessment Report (AR5), Working Group I: The Physical Science Basis.

Landcom, 2004. Managing Urban Stormwater: Soils and Construction Volume 1

Lewis P.C & Glen R.A, 1995. Bega – Mallacoota 1:250,000 Geological Map.

Long Paddock, 2020. Patched point climatic data from Bureau of Meteorology Station No. 69147 Merimbula Airport. Data accessed via the website: http://www.longpaddock.qld.gov.au/silo on 1 November 2019

Mackie Martin Associates, 1987. Appraisal of Sand Seepage Capacity and Conceptual Design of Infiltration Systems – Merimbula STW. Mackie Martin and Associates. February 1997.

Marine and Earth Sciences, 2018. Phase 1 Merimbula Outfall Project, Geophysical Investigations, factual Report, prepared for AECOM Pty Ltd.

McDonald, R. C., & Isbell, R. F., 2009. Soil Profile. In Australian Soil and Land Survey Field Handbook (Third Edition, pp. 147–200). Collingwood: CSIRO Publishing.

National Health and Medical Research Council, 2006. Australian Guidelines for Water Recycling: Managing Health and Environmental Risks

National Transport Commission, 2018. Australian Code for the Transport of Dangerous Goods by Road and Rail (ACTDG), Edition 7.6

Naylor, S.D et al., 1998. Guidelines for the Use of Acid Sulfate Soils Risk Maps.

NSW Environment and Heritage, 2012. Coastal and floodplain management: Coastal zone management: Estuaries of NSW.

NSW Environment Protection Authority, 2000. Use and disposal of biosolids products. Available at: https://www.epa.nsw.gov.au/-/media/epa/corporate-site/resources/water/biosolidsguidelinesnsw.pdf?la=en&hash=6107DD2610489CAB387B5DD66DAA68F5FD971C57

NSW Environment Protection Authority, 2013. Methodology for Valuing the Health Impacts of Changes in Particle Emissions

NSW Environment Protection Authority, 2014a. NSW Waste Avoidance and Resource Recovery Strategy 2014 -21

NSW Environment Protection Authority, 2014b. Waste Classification Guidelines.

NSW Environment Protection Authority, 2020. Contaminated Land Record of Notices. Available at: https://www.epa.nsw.gov.au/your-environment/contaminated-land/notified-and-regulated-contaminated-land/record-of-notices

NSW Government, 2020a. Six Maps. Available at: http://maps.six.nsw.gov.au/, accessed 8, 12 and 13 May 2020

NSW Government, 2020b. Beachwatch Water Quality Program.

NSW Health, 2007. Health Impact Assessment: A practical guide.

NSW Heritage Office, & NSW Department of Urban Affairs and Planning, 1996. NSW Heritage Manual. Heritage Office & Department of Urban Affairs & Planning. http://www.heritage.nsw.gov.au/03_index.htm#M-O

NSW Heritage Office, 1996. Shipwrecks of Twofold Bay and Disaster Bay, Wreck Inspection Report.

NSW Heritage Office, 2001. Assessing Heritage Significance. http://www.heritage.nsw.gov.au/docs/assessingheritagesignificance.pdf

Office of Environment and Heritage, 2004. Draft Threatened Species Survey Guidelines. OEH, Hurstville.

Office of Environment and Heritage, 2006. Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols. NSW Natural Resources Monitoring, Evaluation and Reporting Program.

Office of Environment and Heritage, 2011. Guide to Investigating, Assessing and Reporting on Aboriginal Cultural Heritage in NSW.

Office of Environment and Heritage, 2013a. Compilation map: Biometric vegetation types and endangered ecological communities of the Shoalhaven, Eurobodalla & Bega Valley local government areas. A living map. Version 2.0. Technical Report. NSW Office of Environment & Heritage, Queanbeyan.

Office of Environment and Heritage, 2014a. New England North West Climate change snapshot. NSW Government. Available at: http://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region/New-England-North-West-Climate-Change-Downloads

Office of Environment and Heritage, 2014b. Framework for Biodiversity Assessment. State Government of NSW

Office of Environment and Heritage, 2015a. Atlas of NSW Wildlife. (online). Available: http://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx [Accessed March 2020].

Office of Environment and Heritage, 2015b. NSW Vegetation Information System (online). Available: http://www.environment.nsw.gov.au/NSWVCA20PRapp/LoginPR.aspx

Office of Environment and Heritage, 2015c. Threatened Species Profile Database (online). Available: http://www.environment.nsw.gov.au/asmslightprofileapp/account/login?ForceLogin=1

Office of Environment and Heritage, 2015d. NARCliM Interactive Map Tool. AdaptNSW. Available at: http://www.climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Interactive-map

Office of Environment and Heritage, 2016. NSW estuary health Monitoring Evaluation Reporting program

Office of Environment and Heritage, 2020. BioNet Threatened species database. Available at: https://www.environment.nsw.gov.au/atlaspublicapp/UI_Modules/ATLAS_/AtlasSearch.aspx

Otway, N.M.,1995. Assessing impacts of deepwater sewage disposal: A case study from New South Wales, Australia. Marine Pollution Bulletin, 31(4-12), pp. 347-354.

Parsons Brinckerhoff, 2004a. Investigation of the Deep Disposal Option for Reclaimed Water from Merimbula STP, Stages 1 and 2 (draft report). Parsons Brinckerhoff. July 2004.

Parsons Brinckerhoff, 2004b. Investigation of the Shallow Disposal Option for Reclaimed Water from the Merimbula STP (draft report). Unpublished report dated July 2004 referenced in IGGC report entitled: Disposal of Effluent from Merimbula Sewage Treatment Plant by Dunal Exfiltration – Investigation and Assessment of Impacts on Groundwater Levels and Water Quality of Merimbula Lake and Bay as an unpublished report by Ian Grey Consulting Pty Ltd. for the Bega Valley Shire Council

Pearson, M., & Sullivan, S., 1995. Looking After Heritage Places: The Basics of Heritage Planning for Managers, Landowners and Administrators. Carlton: Melbourne University Press.

Planning Law Solutions, 2016. Planning Report to Support an Application for State Significant Infrastructure - Merimbula Sewage Treatment Plant Upgrade and Ocean Outfall

PPK Environment & Infrastructure, 2002. Assessment of Groundwater Conditions and Dune Disposal Options for Merimbula STP. Unpublished report prepared by PPK Environment & Infrastructure for the Bega Valley Shire Council

Public Works Department, 1988. Merimbula Wastewater Augmentation, Wastewater Treatment Plant Stage 2 Geotechnical Information. Unpublished report prepared by the Public Works Department Geotechnical Centre. Report No. 88187, dated December 1988.

Puente, A. and Diaz, R.J., 2015. Response of benthos to ocean outfall discharges: does a general pattern exist? Marine Pollution Bulletin 101: 174-181.

Reef Life Survey, 2017, Reef Life Survey Data Portal, http://reeflifesurvey.imas.utas.edu.au/portal/search

Reijnen, R., R. Foppen, C. Ter Braak, C., and J. Thissen., 1995. The effects of car traffic on breeding bird populations in woodland. III. Reduction of density in relation to the proximity of main roads. Journal of Applied Ecology

Rhelm, 2020. Merimbula Lake and Back Lake Floodplain Risk Management Study, prepared for Bega Valley Shire Council.

Safe Work Australia, 2020. Hazardous Chemical Information System (HCIS). Available at: http://hcis.safeworkaustralia.gov.au/, accessed 16 June 2020.

Scanes, P.R., Philip, N.,1995. Environmental impact of deepwater discharge of sewage off Sydney, NSW, Australia. Marine Pollution Bulletin 31: 343-346.

Sherwood et al., 2010. Tropospheric water vapor, convection, and climate, Reviews of Geophysics, 48pp.

Smith, C., & Burke, H., 2007, Digging It Up Down Under: A Practical Guide to Doing Archaeology in Australia. New York: Springer.

Spooner, P. G., & Shoard, J, 2016. Using Historic Maps and Citizen Science to Investigate the Abundance and Condition of Survey Reference “Blaze” Trees. Australian Journal of Botany, 64, 377–388.

Stone et al., 1998. NSW Acid Sulfate Soils Manual.

Swinbourne, H., & Morris, O, 2012. People of the Lake - Stories of Merimbula. Merimbula-Imlay Historical Society.

Thom B et al, 2010. National Climate Change Adaptation Research Plan for Settlements and Infrastructure, National Climate Change Adaptation Research Facility, Gold Coast, 38pp. Available at: https://www.nccarf.edu.au/national-climate-change-adaptation-research-plan-settlements-and-infrastructure

Tindale, N. B., 1974. Aboriginal Tribes of Australia: Their Terrain, Environmental Controls, Distribution, Limits and Proper Names. Canberra: Australian University Press.

Tozer, M.G., Turner, C., Keith, D.A., Tindall, D., Pennay, C. Simpson, & MacKenzie, B, 2010. Native Vegetation of South East NSW: a revised classification and map for the coast and eastern tablelands, Version 1.0. Cunninghamia 11(3): 359-406.

Troedson A.L. & Hashimoto, 2013. Bega Valley Area Coastal Quaternary Geology 1:100,000 and 1:25,000 Geological Map.

Tulau, 1997. Bega-Goalen Point 1:100,000 Sheets - Geological Map.

Warwick R.M. and Clarke, K.R., 1991. A comparison of methods for analysing changes in benthic community structure. J. Mar. Biol. Assoc. U.K. 71: 225 – 244.

Zavalas R., T. Williams and Pritchard K., 2017. Merimbula offshore artificial reef – Acoustic Survey. Report to NSW Government – Department of Industry. Southern Divers in conjunction with Total Hydrographic Pty Ltd, Melbourne.