CONCEPT PLAN APPROVAL MODIFICATON BEVIAN ROAD, ROSEDALE

INTEGRATED WATER MANAGEMENT PLAN

23rd April 2025

Civille

CONTENTS

1 INTRODUCTION

Walker Rosedale Pty Ltd (Walker) propose a modification of the 2008 Concept Plan Approval (application number 05_0199) for a residential subdivision located at Bevian Road, Rosedale, NSW.

This report addresses the Secretary's environmental assessment requirements (SEARS) for "Water and Soils" provided by the Biodiversity and Conservation Diversion (BCD). This report undertakes a review and assessment of the impacts of the development on the local receiving waters and provides recommended mitigation measures to address any associated impacts with the development.

This report should be read in conjunction with the concept plan approval modification civil engineering stormwater servicing report (Enspire 2025), the flood impact and risk assessment, the riparian and aquatic assessment report (Ecological Australia 2025), the contamination detailed site investigation (Lanterra 2025), the geotechnical report (Fortify 2025) and the biodiversity development assessment report (Ecological Australia 2025A).

1.1 SITE HISTORY

The site has been historically cleared and used for agricultural purposes, including grazing pasture, food manufacturing and a plant nursery.

A former cheese factory and buildings associated with a former nursery use were previously on site, destroyed in the 2019/2020 bushfires.

Current use of the site includes rural residential, with the area re-zoned for low density residential purposes (*R2 General Residential),* with relatively small sections of C2 Environmental Conservation

The site is currently occupied by a single residential dwelling located adjacent to the eastern boundary. The remaining site comprised of former pasture lands and grasslands, vegetated areas, grasslands, waterways including farm dams and a portion of Bevian Wetland.

Stage 1 (to the east of the site) began construction in late 2021, including internal roads and cleared lots and was recently completed with the subdivision now registered as DP1293369.

The site and surrounding area is shown in Figure 1.

1.2 PROJECT

The modification sought is from the Part 3A Concept Approval:

- From a *Community Title Subdivision* for residential development and ancillary commercial and community facilities, ecological stewardship, public roads and open space areas yielding a total of 792 residential lots (*reference number 05_0199*)
- To a *Torrens Title Subdivision* development that includes residential development and ancillary commercial facilities, public roads, public open areas and residual rural lot yielding a total of 792 residential lots inclusive of the 51 Torrens title residential lots recently

constructed and registered as part of stage 1 (DA305/18).

Stage 1 of the Concept Approval for 51 Torrens title residential lots has received local development consent (DA305/18), with the infrastructure, including roads, recently constructed and subdivision now registered as DP1293369. For the purposes of the modification, stage 1 has been excluded from further consideration.

1.3 SEARS AND DPHI REQUIREMENTS

The Department of Planning, Housing and Infrastructure (DPHI), in consultation with other agencies, have provided SEARs requirements related to the modified development proposal.

The SEARs developed by the Biodiversity Conservation Division for 'Soils and Water' require an existing condition and impact assessment of the local catchment areas and receiving waters, including Bevian Wetland / Burri Swamp, Saltwater Creek estuarine creek, and coastal ocean waters.

A table of the SEARS requirements, relevant clauses and summary addressing each requirement are included in Table 1-1.

Note that the NSW EPA also had included a number of SEARs for water quality and water management for the development. IN subsequent discussions with NSW EPA, they have noted the overlap in SEARs and stated that they will defer to BCS for any SEARS related to water management at the site. Hence the SEARs developed by the NSW EPA have not been considered further.

Additional queries were received on 6th November 2024 with regards to the Integrated Water Management Plan. A summary of the responses to this feedback is included in Table 1-2.

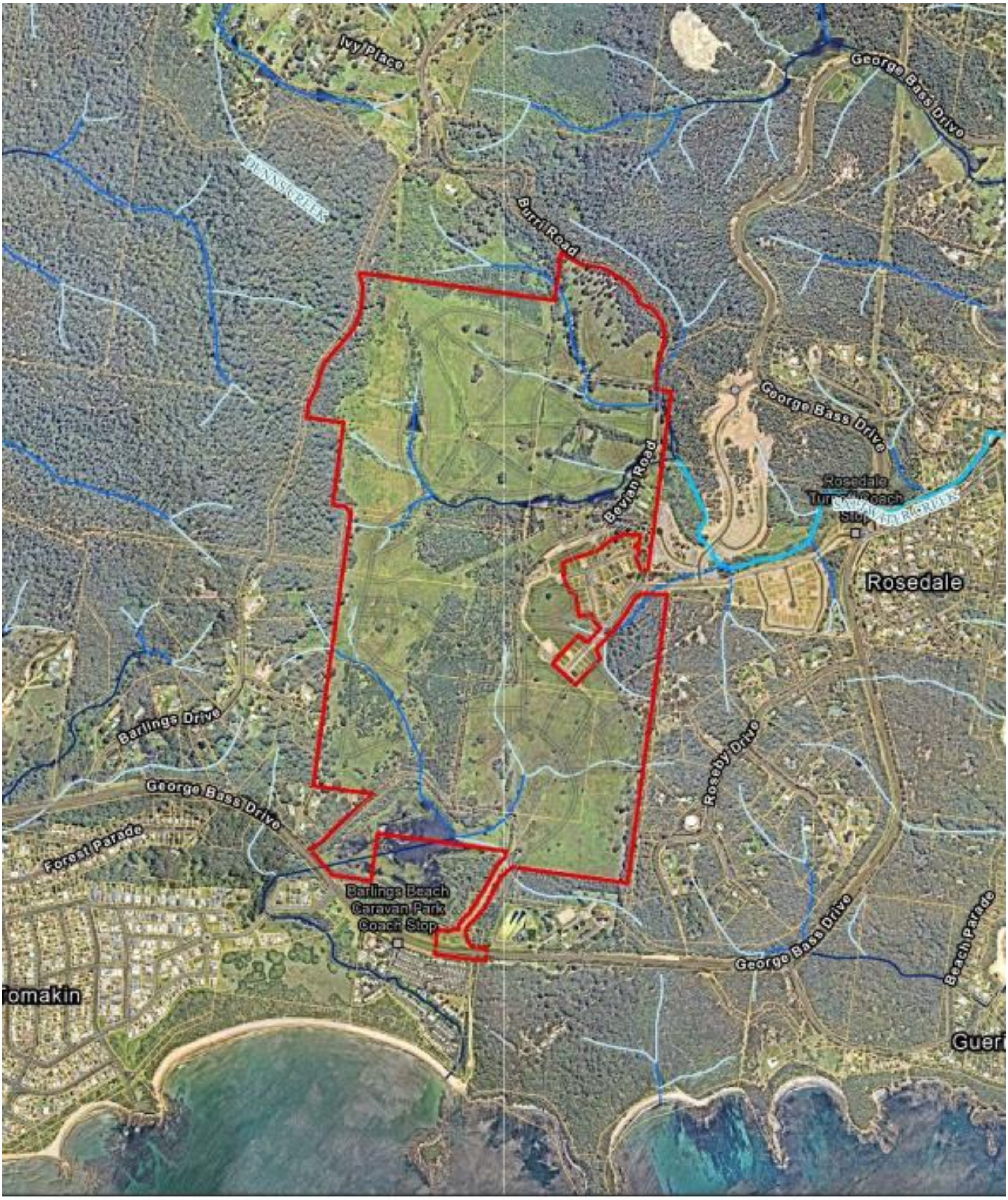


Figure 1: Site Location

Table 1-1: SEARS Requirements and Details - Biodiversity and Conservation Division – #12. Water and Soils

Item Number	Clause / details	Section addressed in this report
1	…potential impacts on coastal wetland, the revised concept plan should be designed and assessed in relation to the requirements of the State Environmental Planning Policy (Resilience and Hazards) 2021 Part 2.2, Division 1 Coastal wetlands and littoral rainforest areas, and	Section 3.2 and section 5.3
2	…consistent with the requirements of Planning Direction 4.2 Coastal Management.	Section 3.2 and section 5.3
3	The EIS must map the following features relevant to water and soils including: a. Acid sulfate soils (Class 1, 2, 3 or 4 on the Acid Sulfate Soil Planning Map) b. Rivers, streams, wetlands, estuaries (as described in s4.2 of the Biodiversity Assessment Method) c. Wetlands as described in s4.2 of the Biodiversity Assessment Method. d. Groundwater e. Groundwater dependent ecosystems f. Proposed intake and discharge locations	a. Section 3.6.4 b. Section 3.1, 3.2, 3.3 and 3.4 c. Section 3.2 d. Section 3.6.3 e. Section 3.2, 3.3 f. Section 3.4
4a	The EIS must describe background conditions for any water resource likely to be affected by the proposed modification to Concept Application 05_0199, including: a. Existing surface and groundwater	a. Section 3
4b	b. Hydrology, including volume, frequency and quality of discharges at proposed intake and discharge locations	b. Section 5.3
4c	c. Water Quality Objectives (as endorsed by the NSW Government http://www.environment.nsw.gov.au/ieo/index.htm) including groundwater as appropriate that represent the community's uses and values for the receiving waters.	Section 4
4d	d. Where locally derived indicators and guideline values are not available for the relevant Water Quality Objectives, the EIS must refer to the Australian and New Zealand Guidelines for Fresh and Marine Water Quality (ANZG, 2018).	a. Section 4

Item Number	Clause / details	Section addressed in this report
5a	The EIS must assess the impacts of the proposed modification to Concept Application 05_0199 on water quality, including: a. The nature and degree of impact on receiving waters for both surface and groundwater, demonstrating how the proposed modification to Concept Application 05_0199 protects the Water Quality Objectives where they are currently being achieved, and contributes towards achievement of the Water Quality Objectives over time where they are currently not being achieved. This should include an assessment of the mitigating effects of proposed stormwater and wastewater management during and after construction, using the Risk-based framework for considering waterway health outcomes in strategic land use planning decisions.	Section 5
5b	b. Identification of proposed monitoring of water quality or required changes to existing monitoring programs	Section 6
5c	c. How the development meets the objects of the Coastal Management Act 2016 and management objectives of relevant Coastal Management Areas defined under this Act	Section 7
5d	d. Consistency with any relevant certified Coastal Management Program (or Coastal Zone Management Plan)	Section 2.3 and 4.3
6a	The EIS must assess the impact of the proposed modification to Concept Application 05_0199 on hydrology, including: a. Water balance including quantity, quality and source	Section 5.3 and 5.4
6b	b. Effects to downstream rivers, wetlands, estuaries, marine waters (including marine protected areas) and floodplain areas	Section 5 and section 3.10
6c	c. Effects to downstream water-dependent fauna and flora including groundwater dependent ecosystems	Section 5.3 and 5.4
6d	d. Impacts to natural processes and functions within rivers, wetlands, estuaries and floodplains that affect river system and landscape health such as nutrient flow, aquatic connectivity and access to habitat for spawning and refuge (e.g. river benches)	Section 5.3 and 5.4 Also refer Ecological Australia (2025)
6e	e. Changes to environmental water availability, both regulated/licensed and unregulated/rules-based sources of such water	Section 5.3 and 5.4
6f	f. Mitigating effects of proposed stormwater and wastewater management during and after construction on hydrological attributes such as volumes, flow rates, management methods and re-use options	Section 5

Item Number	Clause / details	Section addressed in this report
6g	g. Identification of proposed monitoring of hydrological attributes	Section 6
7a	The description of existing water quality/hydrology in the EIS must be based on suitable data (meaning data collection may be required) and must include: a. Relevant water quality objectives	Section 3.2 and 3.3
7b	b. Water chemistry	Section 3.2 and 3.3
7c	c. A description of receiving water processes, circulation and mixing characteristics and hydrodynamic regimes	Section 3.2 and 3.3
7d	d. Lake or estuary flushing characteristics.	Section 3.2 and 3.3
7e	e. Sensitive ecosystems or species conservation values	Section 3.2 and 3.3
7f	f. Specific human uses and values (e.g. fishing, proximity to recreation areas)	Section 3.11
7g	g. A description of any impacts from existing industry or activities on water quality	Not applicable
7h	h. A description of the condition of the local catchment e.g. erosion, soils, vegetation cover	Section 3.4
7i	i. An outline of baseline groundwater information, including, for example, depth to water table, flow direction and gradient, groundwater quality, reliance on groundwater by surrounding users and by the environment	Section 3.6.3
7j	j. Historic river flow data	Section 3.9
8a	The assessment of the [development/ infrastructure] on water quality and hydrology in the EIS must include: a. Water circulation, current patterns, water chemistry and other appropriate characteristics such as clarity, temperature, nutrient and toxicants, and potential for erosion	Section 5.3 and 5.4
8b	b. Changes to hydrology (including drainage patterns, surface runoff yield, flow regimes, and groundwater)	Section 5.3 and 5.4
8c	c. Disturbance of acid sulphate soils and potential acid sulfate soils	Section 3.6.4
8d	d. Stream bank stability and impacts on macro invertebrates	Section 3.7
8e	e. Water quality and hydrology modelling and/or monitoring, where necessary	Section 5 and 6
9a	15. The proposed monitoring of water quality must be undertaken in accordance with the Approved Methods for the Sampling and Analysis of	Section 6

Item Number	Clause / details	Section addressed in this report
	Water Pollutant in NSW 2022 The EIS must include a water quality and aquatic ecosystem monitoring program that includes: a. Adequate data for evaluating maintenance, or progress towards achieving, the relevant Water Quality Objectives	
9b	b. measurement of pollutants identified or expected to be present	Section 3.2, 3.3 and 6
10a	a. Consistency with any existing entrance management policies or strategies for coastal lakes and lagoons	Not applicable
10b	b. The ongoing implications and impacts of sea level rise on the continued use of the land and development subject to the EIS.	Section 4.3

Table 1-2: SEARS Requirements and Details - Biodiversity and Conservation Division – #12. Water and Soils

Item Number	Detail	Section addressed in this report
2.8	Water Quality An assessment needs to be undertaken into the water quality impacts on the receiving catchment, including the wetlands to ensure that appropriate measures are installed to ensure that there is no adverse impact on the significant environmental features adjoining the land.	Refer Section 3 (pages 16 to 47) where the existing receiving waters are assessed, Section 4 (pages 48-51) where site specific receiving water objectives have been set based on the assessment of receiving waters and Section 5 (pages 51 to 63) where the proposed strategy has been demonstrated to meet the locally specific receiving water objectives
4.1b	Saltwater Creek is a class 1 waterway adjacent to the site and receiving waterway downstream of the site. As it is considered important key fish habitat, best practice development of this site should ensure the maintenance and improvement of key fish habitat by; …… - Protection or improvement of water quality through water sensitive urban design, adequate stormwater treatment and best practice erosion and sediment control measures during construction	Refer Section 3 (pages 16 to 47) where the existing receiving waters are assessed, Section 4 (pages 48-51) where site specific receiving water objectives have been set based on the assessment of receiving waters and Section 5 (pages 51 to 63) where the proposed strategy has been demonstrated to meet the locally specific receiving water objectives

Item Number	Detail	Section addressed in this report
4.1b	DPIRD Fisheries highlight that the proposal should follow the principles set out for Water Sensitive Urban Designs. DPIRD Fisheries notes that the Water Cycle Management and Civil Engineering Report demonstrated that the proposed development can be supported by stormwater control infrastructure to adequately achieve statutory performance targets. However, it is noted that rainfall data from 2001 was used for the Catchment Hydrology (s.7.3.1 of report) due to insufficient rainfall being recorded for other years. Can the absence of data please be clearly explained, as the annual rainfall of 2001 is less than 8 of the past 10 years (2014-2024)? More contemporary data should be used to inform the model used and ensure that hydrological regimes and runoff from the site will not negatively impact the downstream receiving environments, which includes Batemans Marine Park.	Please refer to section 5.6 Sensitivity to Rainfall Data
15.4	…... It is recommended that stringent neutral or beneficial pollution reduction targets be applied to protect all sensitive receiving waters including Bevian Wetland and Saltwater Creek estuary. …..	This is the approach that has been taken – refer Section 3 (pages 16 to 47) where the existing receiving waters are assessed, Section 4 (pages 48-51) where site specific receiving water objectives have been set based on the assessment of receiving waters and Section 5 (pages 51 to 63) where the proposed strategy has been demonstrated to meet the locally specific receiving water objectives
15.7	Section 1.7 of the Modification Report suggests that the proposed development is not located within the coastal zone, however this is incorrect. Part of the site contains a coastal wetland and coastal wetland proximity area, which are considered to be part of the coastal zone as defined by Section 5 of the Coastal Management Act 2016. These are both mapped under the State Environmental Planning Policy (Resilience and Hazards) 2021 (SEPP). The proposal should be assessed against the requirements of this SEPP, in particular Section 2.8 which relates to development within the proximity area for coastal wetlands to ensure the development will not significantly impact on:	Refer Section 2 which provides the Coastal Planning context, Section 3 (pages 16 to 47) where the existing receiving waters are assessed, Section 4 (pages 48-51) where site specific receiving water objectives have been set based on the assessment of receiving waters and Section 5 (pages 51 to 63) where the proposed strategy has been demonstrated to meet the

Item Number	Detail	Section addressed in this report
	the biophysical, hydrological or ecological integrity of the adjacent coastal wetland, and the quantity and quality of surface and ground water flows. All runoff from the proposed development has the potential to impact directly on either the Bevian Wetland, or alternatively the Saltwater Creek estuary.	locally specific receiving water objectives

2 PLANNING CONTEXT

The location of the site is subject to a number of state and local planning controls relating to water management at the site. The relevant planning context for the site is outlined in the following sections.

2.1 COASTAL MANAGEMENT ACT 2016

The *Coastal Management Act (CMA) 2016* aims to manage the coastal environment of NSW in a manner consistent with the principles of ecologically sustainable development for the social, cultural and economic well-being of the people.

The Act includes objectives and priorities to facilitate ecologically sustainable development in the coastal zone and promote sustainable land use decision-making.

The Coastal Management Act defines areas mapped as

- Coastal Wetlands
- Coastal vulnerability areas
- Coastal environment areas
- Coastal use areas

The development drains to a coastal wetland (Bevian Wetland) and is in close proximity to coastal use and coastal environmental mapped areas and this is discussed further in section 2.2.

The Coastal Management Act also outlines the process and requirements for Coastal Management Programs (CMPs) and gives effect to adopted and certified Coastal Management Programs. Eurobodalla Shire Council has developed an Open Coast Coastal Management Program (CMP) and this Program was adopted by Council on 13 December 2022 and certified by the NSW Minister for Local Government on 2 March 2023. This is discussed further in section 2.3.

2.2 SEPP (RESILIENCE AND HAZARDS) 2021

The *NSW State Environment Planning Policy (SEPP, Resilience and Hazards 2021)* establishes state-level planning priorities and targeted controls to help protect and manage sensitive coastal environments and achieve the objectives of the CMA.

The SEPP includes targeted development controls in coastal management areas, such as coastal wetlands and littoral rainforests, vulnerability areas, environment areas and coastal use areas.

The development site includes a portion of the coastal wetland and associated proximity area of the mapped coastal wetland Bevian Wetland / Burri Swamp as shown in Figure 2.

Development approval will require an assessment on stormwater impacts, such as stormwater (and ground water) quality and quantity. The SEPP allows developments that demonstrates:

> *Will not significantly impact on (a) the biophysical, hydrological or ecological integrity of the adjacent coastal wetland or littoral rainforest, or(b) the quantity and quality of surface and ground water flows to and from the adjacent coastal wetland or littoral rainforest.*

The development site is not located on SEPP *Coastal Use* or *Coastal Environment Areas*.

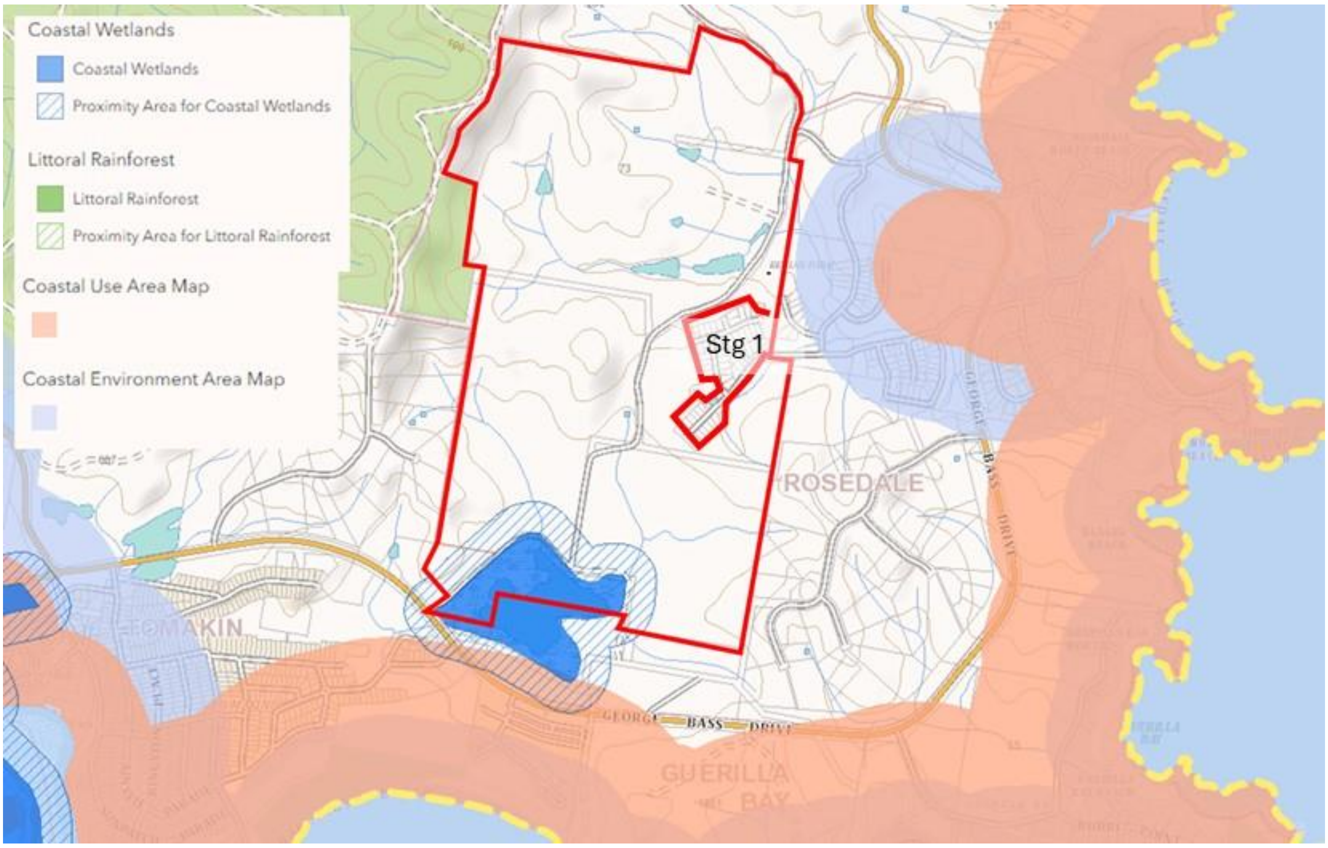


Figure 2: Coastal Areas (SEPP (Resilience and Hazards 2021))

2.3 EUROBODALLA OPEN COASTAL MANAGEMENT PROGRAM 2022

Complementing the SEPP and CMA, the *Eurobodalla Coastal Management Program* sets the long term strategy and co-ordinated management of land within the local coastal zone. It sets out further detail to manage development in a way that promotes a resilient and healthy open coast in Eurobodalla.

A portion of the proposal site to the south is situated within the *Coastal Vulnerability* area, and associated with Bevian Wetland as shown in Figure 3 and the extent of potential tidal inundation mapping is shown in Figure 4 and which does not extend into the site.

The site is not mapped as part of the CMPs Coastal Inundation Maps or the Erosion, Tidal and Cliff Instability maps and hence are not considered relevant for the site.

The development is required to be assessed against Council's *Coastal Hazard Code*, which includes assessment of beach erosion, shoreline recession, coastal inundation, and tidal inundation. The vulnerability area located towards the south of the site is primarily associated with minor coastal inundation and will require the relevant assessment of development levels and sea level rise. This is considered further in section 4.3

Hence the key relevant factor within the Coastal Management Program is the mapped area of coastal vulnerability for the site. Bevian Wetland is further addressed in this report in section 3.2 and 5.3.

Figure 3: Coastal Vulnerability Areas (Eurobodalla Coastal Management Program)

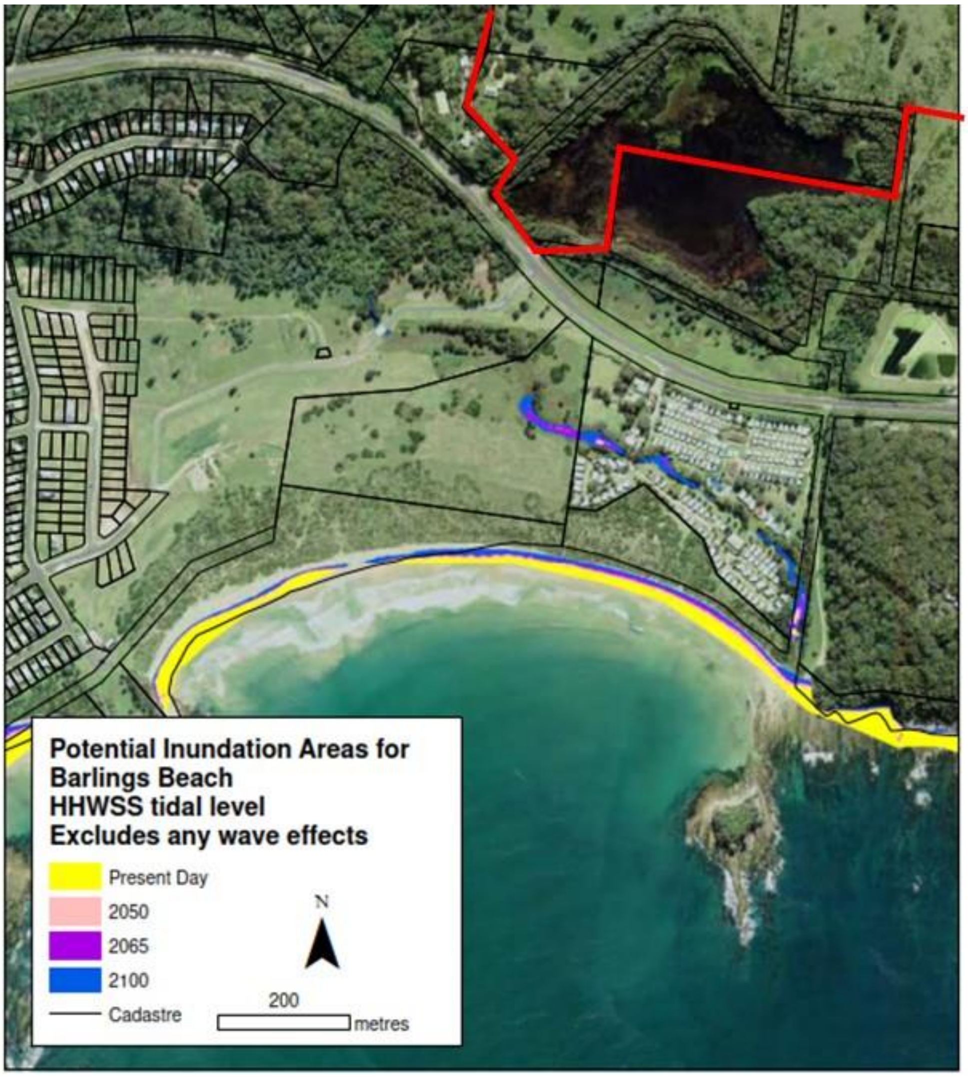


Figure 4: Potential Inundation Areas at Barlings Beach (Eurobodalla Coastal Management Program)

2.4 MARINE ESTATE MANAGEMENT ACT AND STRATEGY

The *Marine Estate Management Act 2014* provides for strategic and integrated management of the whole marine estate, including coastal waters and estuaries, consistent with the principles of ecologically sustainable development.

The site is located within the catchments of Bevian Wetland and Saltwater Creek, with the receiving waters including the immediate coastal ocean waters. These coastal waters include both general use zones, habitat protection zones and sanctuary zones within the Batemans Bay Marine Park, shown in Figure 5.

The development is subject to requirements and risk assessments outlined in the marine estate and marine park management plan, demonstrating the impact of the development on the marine estate and potential effects on plants or animals.

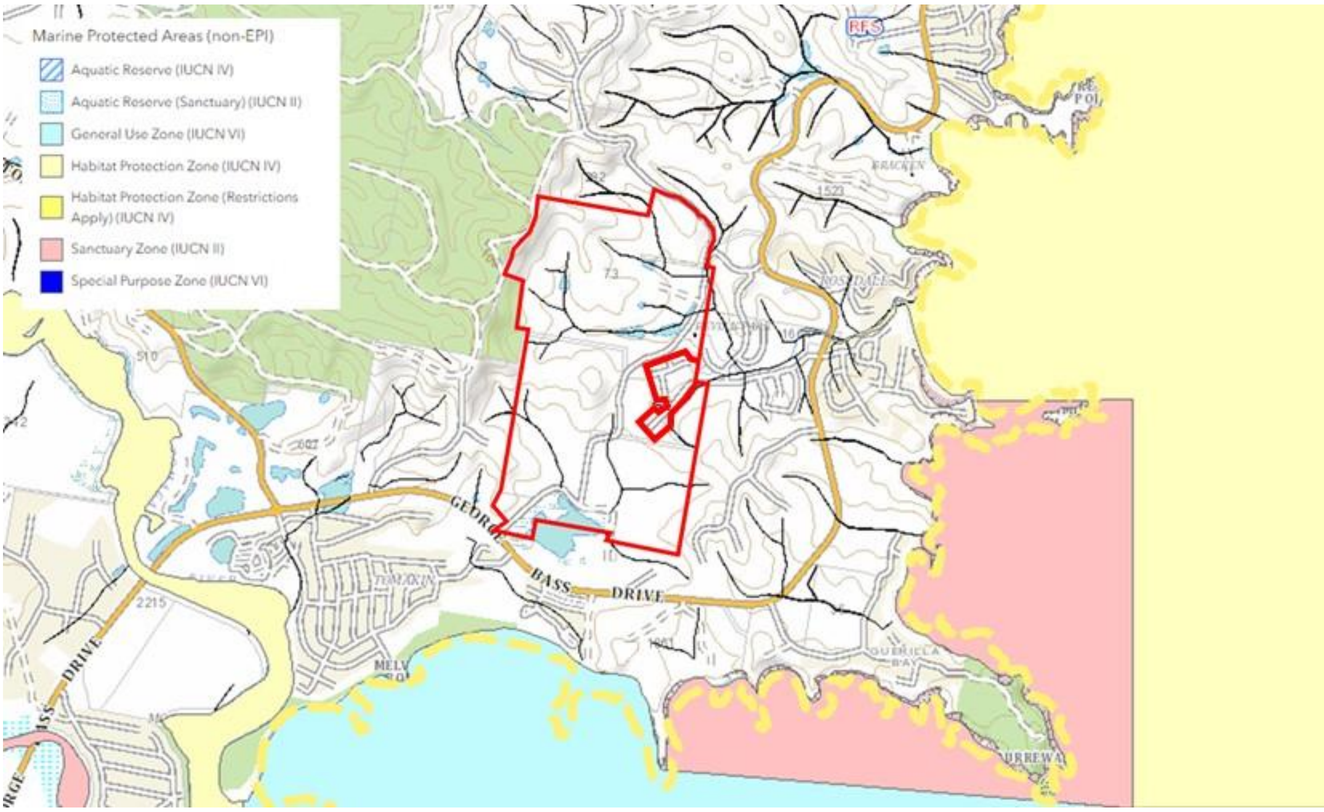


Figure 5: Batemans Bay Marine Park (NSW DPI)

2.5 KEY FISH HABITAT

Key Fish Habitats are aquatic habitats identified by the Department of Primary Industries (DPI) as important to the sustainability of fishing, fish populations and survival of threatened aquatic species. These identified habitats and policies aim to support the objectives of the Fisheries Management Act 1994.

The site is located in the catchments of Bevian Wetland and Saltwater Creek, and the immediate coastal waters downstream, all identified as Key Fish Habitats, shown in Figure 6.

The development is subject to DPI approval and permits for the design and associated works which will impact on the key fish habitats, including proposed bridges and culverts, water way re-alignments and bank / riparian corridor stabilisation works.

Figure 6: Key Fish Habitat (NSW DPI)

2.6 DEVELOPMENT CONTROL PLAN (EUROBODALLA COUNCIL)

The Eurobodalla DCP sets out direction and controls on development residential zones and subdivisions, including site and built form, biodiversity, and environment conservation measures.

The DCP also sets out guidelines on infrastructure design and performance, such as drainage and stormwater discharge, which becomes relevant to the conservation of local environment and waterways.

The DCP provides performance criteria which includes

P1.1 New development is designed in accordance with a site specific Stormwater Management Plan (SMP), approved by Council. The SMP will provide for the integrated management of stormwater in order to:

- *minimise flooding;*
- *protect and enhance environmental values of receiving waters;*
- *maximise the use of water sensitive urban design principles;*
- *maximise the use of natural waterway corridors and natural channel design principles;*
- *maximise community benefit; and*
- *minimise public safety risk.*

The DCP references Council's Infrastructure Design Code which includes the following requirements for stormwater quality

(Section 11.2) All developers must make provision for the improvement of water quality leaving the development site. Generally treatment shall comprise works at a location near the discharge point to receiving waters.

(Section 11.3) The following are general requirements for the provision of stormwater treatment:

- *Developments must comply with principles and recommendations of Water Sensitive*

Urban Design Guidelines 2009, Urban Stormwater – Best Practice Environmental Management Guidelines and Council's Stormwater Management Plans to achieve the following water quality standards:

o 80% retention of the typical urban annual load for Total Suspended Solids (TSS)

o 45% retention of the typical urban annual load for Total Phosphorus (TP)

o 45% retention of the typical urban annual load for Total Nitrogen (TN)

o 70% retention of the typical urban annual load for gross pollutants (litter).

The DCP includes the *coastal hazard code* as part of Council's *coastal management plan* (Section 2.3), requiring assessment coastal inundation and sea level rise, specific to the development site.

2.7 NSW WQO AND ANZECC GUIDELINES

The NSW Water Quality Objectives (WQO) and Australia New Zealand Guidelines for Freshwater and Marine Water (ANZG) provide a consistent framework and set of tools to assess and manage ambient water quality in natural and semi-natural water ways.

The guidelines include objectives, trigger values and guiding actions, setting benchmarks to assess and compare waterway health.

Water quality impacts due to the proposed development are to be assessed against the guidelines, and to determine the impact on site stormwater and ground water. The objectives and guideline will also inform the development of the water quality monitoring plan for the site.

2.8 DRAFT SOUTH EAST AND TABLELANDS REGIONAL PLAN 2041

The Regional Plan provides a land use planning framework for diverse landscapes and environments in the South East and Tablelands region.

Through collaborative processes with government and Aboriginal community groups, the plan promotes orderly and resilient development by aligning infrastructure decision-making with land use.

The plan identifies that sensitive estuaries and their catchments are particularly susceptible to the impacts of development and may not be suitable for intensive uses. The assessment of the development is to determine the sensitivity of the catchment and local waterways, and impacts of the site.

3 EXISITING CONDITIONS AND RECEIVING WATERS SUMMARY

3.1 RECEIVING WATERS

The development drains to different receiving waters as shown in Figure 7:

- Saltwater Creek – located towards the eastern boundary
- Bevian Wetland – located towards the southern boundary
- Pacific Ocean – Coastal waters off Barlings Beach and Rosedale Beach

The existing conditions and processes occurring in these receiving waters is summarised below.

3.2 BEVIAN WETLAND

3.2.1 GENERAL DESCRIPTION

Bevian Wetland (also known as Burri Swamp) is a SEPP mapped coastal wetland located in the south of the development and partially within the development boundary. The wetland is fringed by vegetation including swamp oak forests. Freshwater wetland vegetation is present within the wetland.

Bevian Wetland undergoes wetting drying cycles with fluctuating water levels. A review of historic satellite imagery shows reductions in size of the wetland, indicating drying out periods. A comparison with monthly rainfall averages from 2015-2023 indicate a correlation between rainfall and wetland water levels, with the wetland appearing full following higher rainfall, shown Figure 10. As such, it is expected that the wetland is primarily supplied by surface water flows.

Surface water on the site is expected to follow the topographic contours of the site, primarily from north to south in the southern portion of the site into Bevian Wetland.

Bevian Wetland drains to a small ephemeral unnamed creek which is partially located within Barlings Beach Holiday Park. The unnamed creek discharges to the ocean at the eastern end of Barlings Beach, immediately downstream of the Holiday Park. The unnamed creek is predominantly dry and does not have a permanent outlet to the ocean.

Discharge into the unnamed creek from the development site occurs only when water levels in Bevian Wetland are sufficiently high.

Bevian Wetland is currently located on private land and has limited overall access to the community with an absence of any paths or other community infrastructure around or in proximity to the wetland.

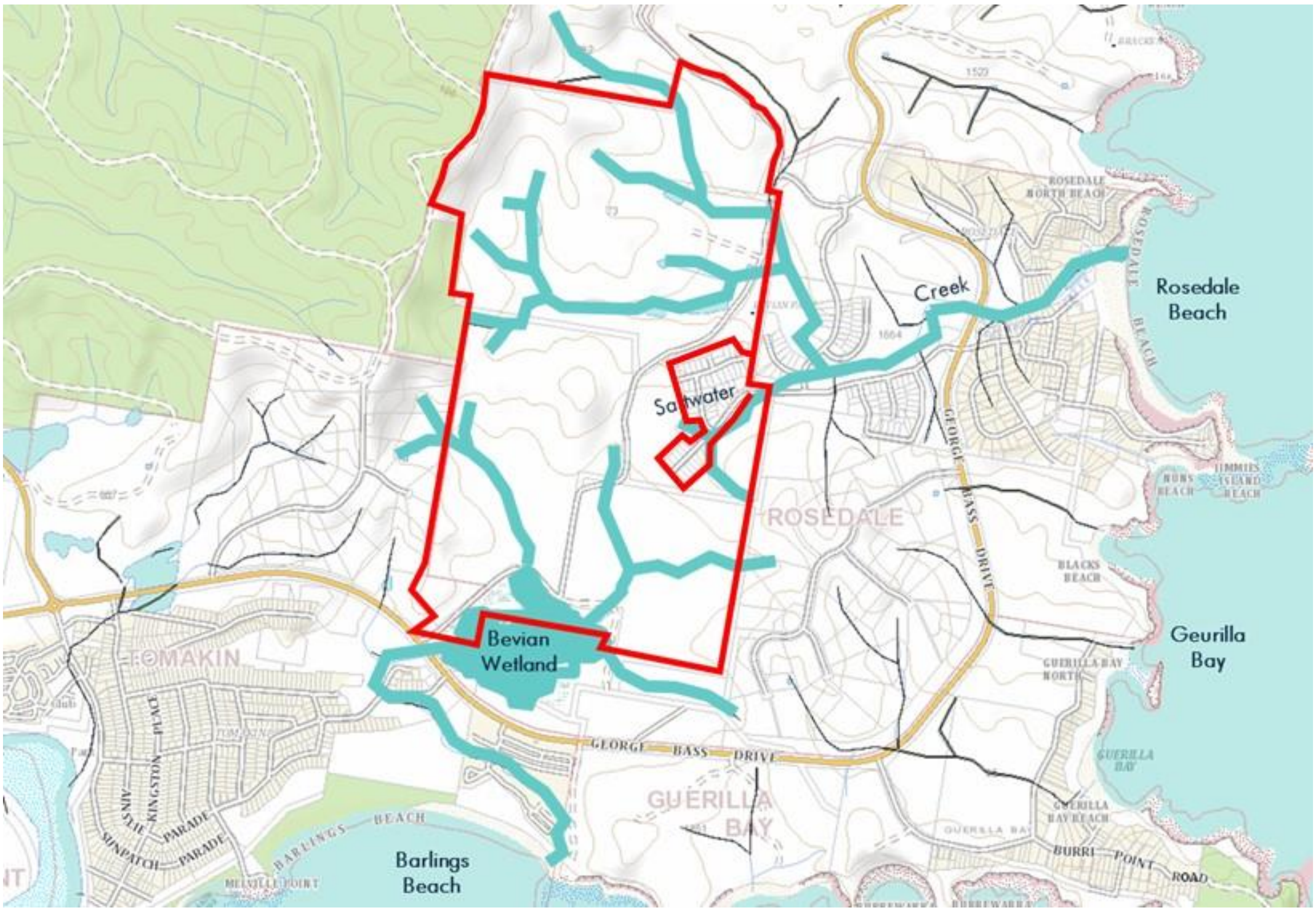


Figure 7: Receiving Waters and Waterways – NSW DPI

Figure 8: Bevian Wetland

3.2.2 BEVIAN WETLAND PROCESSES

A series of analysis, including aerial imagery, water quality, groundwater monitoring, site soil investigations and modelling of Bevian Wetland has been undertaken to

- Understand the key existing site processes on site
- Inform the water management objectives for the wetland
- inform the water management strategy at the site

The following sections outline the analysis and processes occurring within the wetland.

Wetting and drying and groundwater influence

An analysis of aerial imagery sourced from the available aerial imagery from Nearmap was undertaken. This aerial imagery was used to estimate the area of open water within the wetland and assess how this changed over time. This was used to gain an understanding of the wetting and drying hydrology of the wetland and the response of the wetland to rainfall. Where wetland water levels respond to rainfall it is more likely that they are fluvially/runoff dominated systems. Where water levels remain constant they are more likely to be groundwater dominated systems.

The open area of the water body was compared to the preceding 12 month rainfall based on rainfall data from Moruya Airport rainfall station (sourced from BOM climate data online). The aerial imagery and open water area and the corresponding rainfall from Moruya Airport is shown in Figure 10 and a summary of the data is included in Table 3-1.

Table 3-1: Rainfall and open water over of Bevian Wetland from 2018 to 2024

Date	Wetland open water area (Has)	Preceding 12 month rainfall (mm)	Preceding 6 month rainfall (mm)
Jul 2018	10.61	769	402
Sep 2019	6.29	623	257
Jan 2020	2.28	418	165
Apr 2021	10.90	1312	868
May 2022	10.70	1322	1049
Mar 2023	8.98 Has	948	650
Jan 2024	4.66 Has	680	476

The rainfall compared to open water is also plotted in Figure 9. This analysis shows that

- open water area varies significantly in response to rainfall
- the total open area at the point that the wetland overflows into the downstream wetland is approximately 10.5 to 10.9 hectares
- the lowest open water areas was 20% of the total area of the wetland corresponding to the very dry condition in 2019 (summer of 2019/2020 bushfires)
- this analysis suggest that the open water area responds relatively rapidly to precedent rainfall, for example the drying conditions of 2019 resulted in significant reduction in open water area and reduction in water level in the wetland
- that the wetland is only 'full' during high rainfall periods and that for long periods of time the wetland is unlikely to discharge to the downstream creek (e.g. from late 2018 to early 2020 it is likely that the wetland did not discharge to the downstream creek)

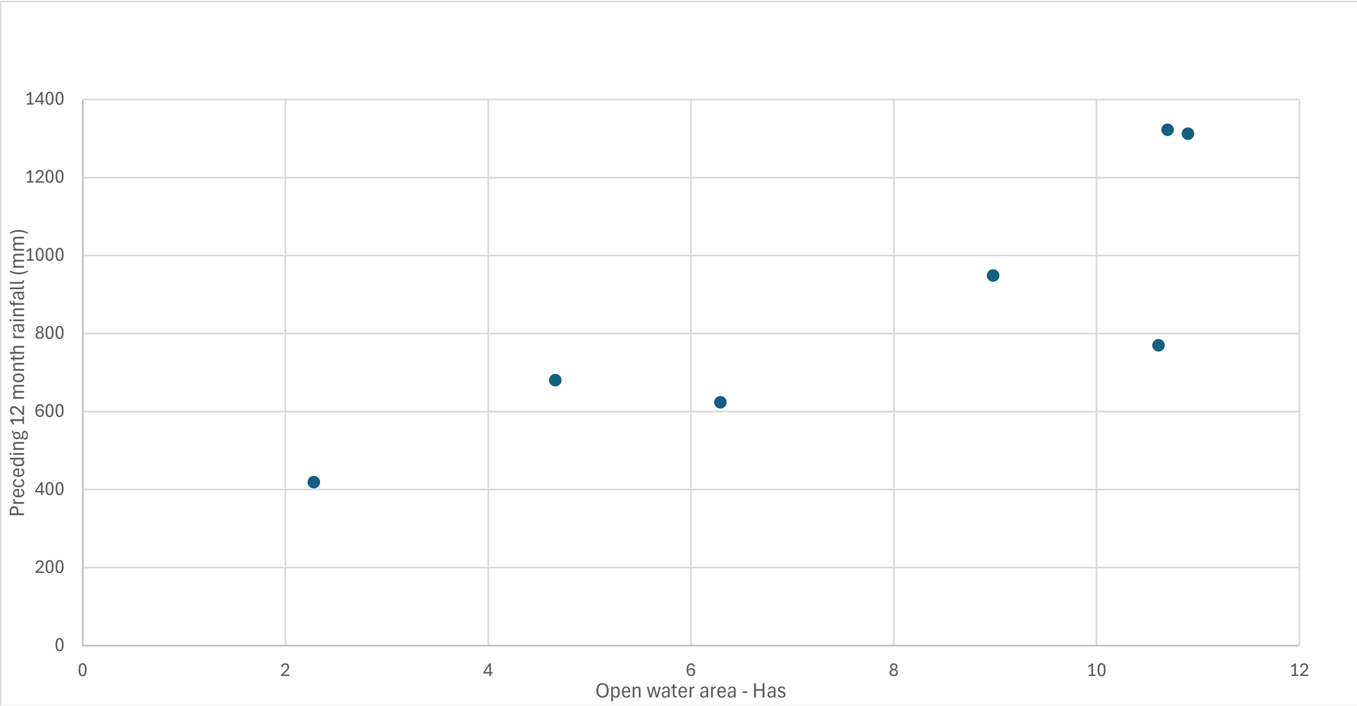
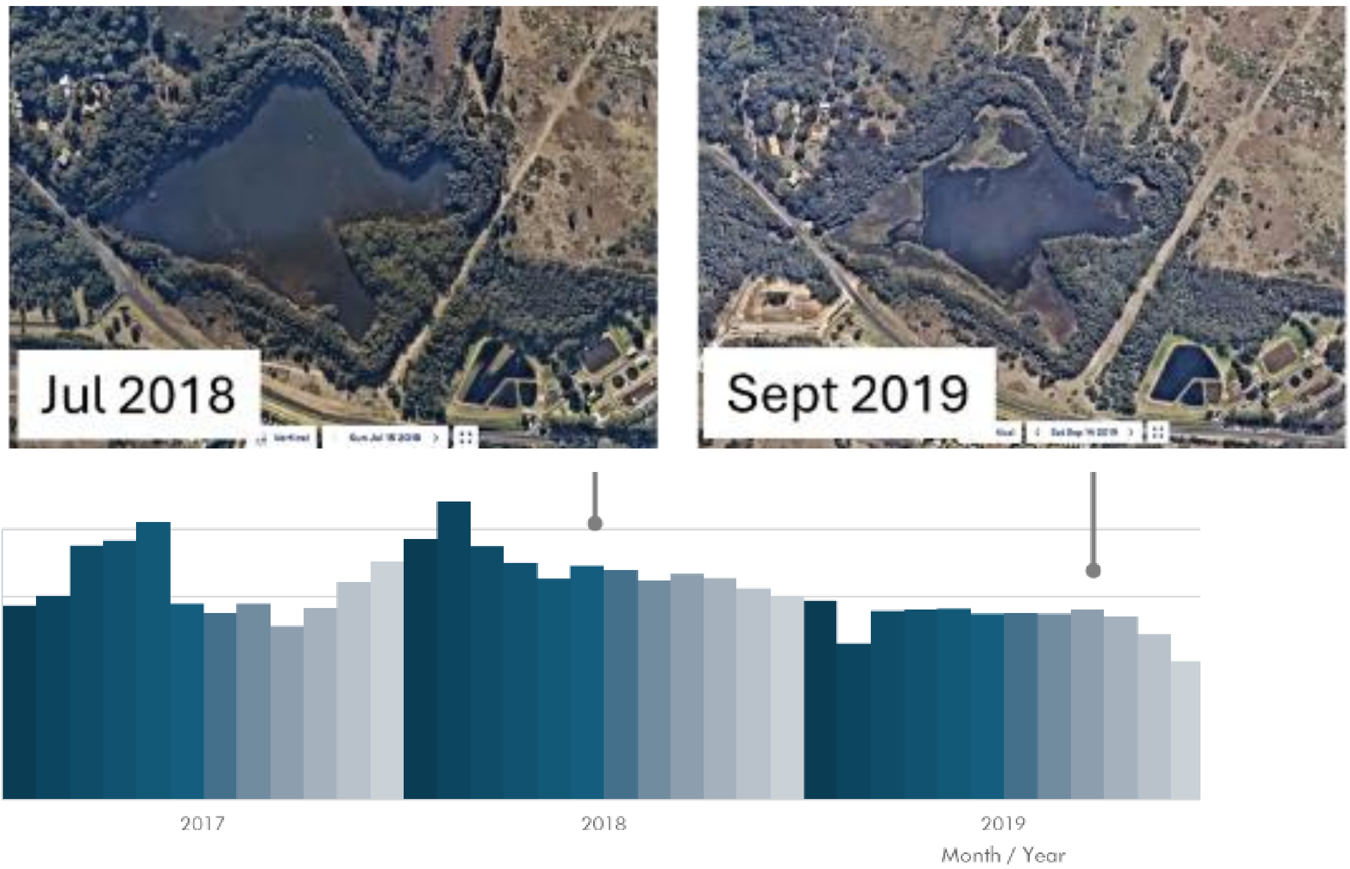
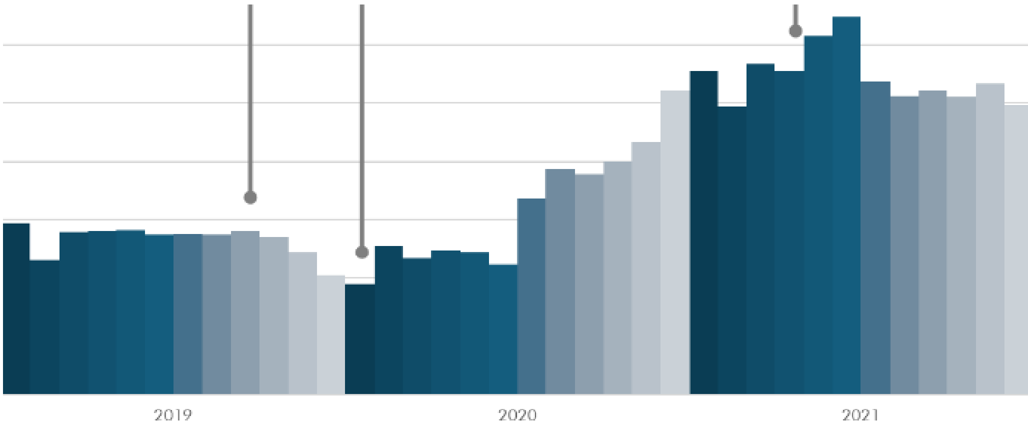


Figure 9: 12 month preceding Rainfall plotted against open water area

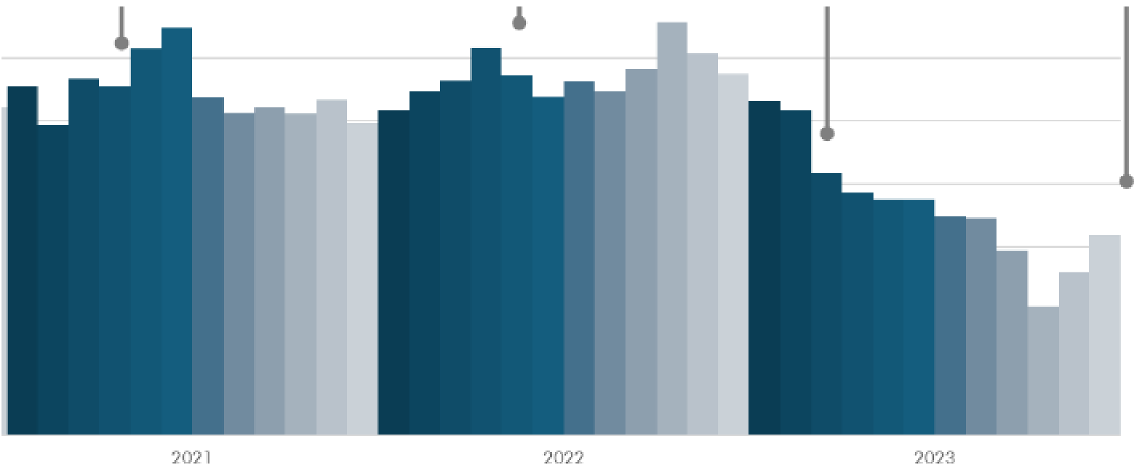
Figure 10: Rainfall and Wetland Level Comparison 2018 to 2024 (figures below)

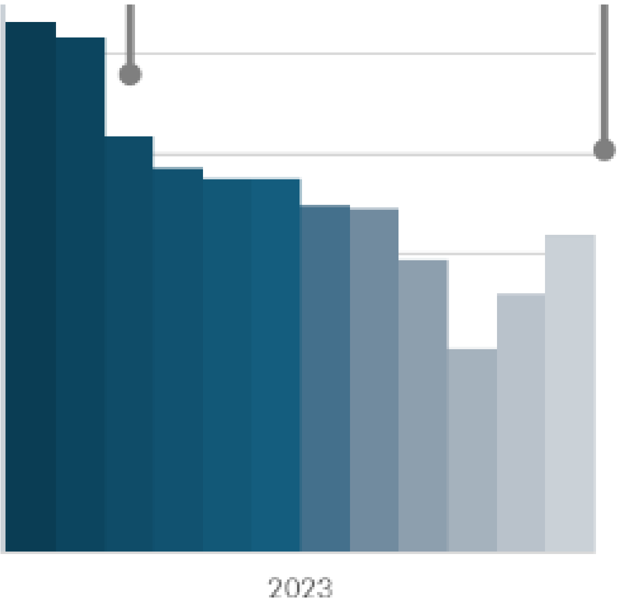



Jan 2020

April 2021

2019
2020
2021

May 2022

Mar 2023

2021
2022
2023



Water quality sampling of surface water and groundwater wells was undertaken in Bevian wetland on a weekly basis over a 4 week in March and April 2024. Sampling sites are shown in Figure 11. 8 sampling were undertaken at each location – 2 on each sampling date at low tide and high tide. Samples were taken at low and high tide to assess if there were any changes in water quality in the receiving waters due to the tide. Where changes occurred this would indicate that there was groundwater interaction between the wetland and groundwater. Sampling at groundwater wells was also used to assess the salinity and differences in water quality between the wetland and groundwater.

The results are summarised in Figure 13 and showed that on all sampling events

- the groundwater in GW7 and GW8 was high in salinity (>10,000 mg/L) indicating that the groundwater was well connected to ocean and 'groundwater intrusion' from the coast
- the wetland at sites B, C and D was freshwater to very slightly brackish (450 mg/L to 950 mg/L)
- There was little variation in salinity levels between the three wetland monitoring sites which are in different spatial locations across the wetland

This clear difference in water quality also provides good evidence that the wetland is not strongly connected to groundwater.

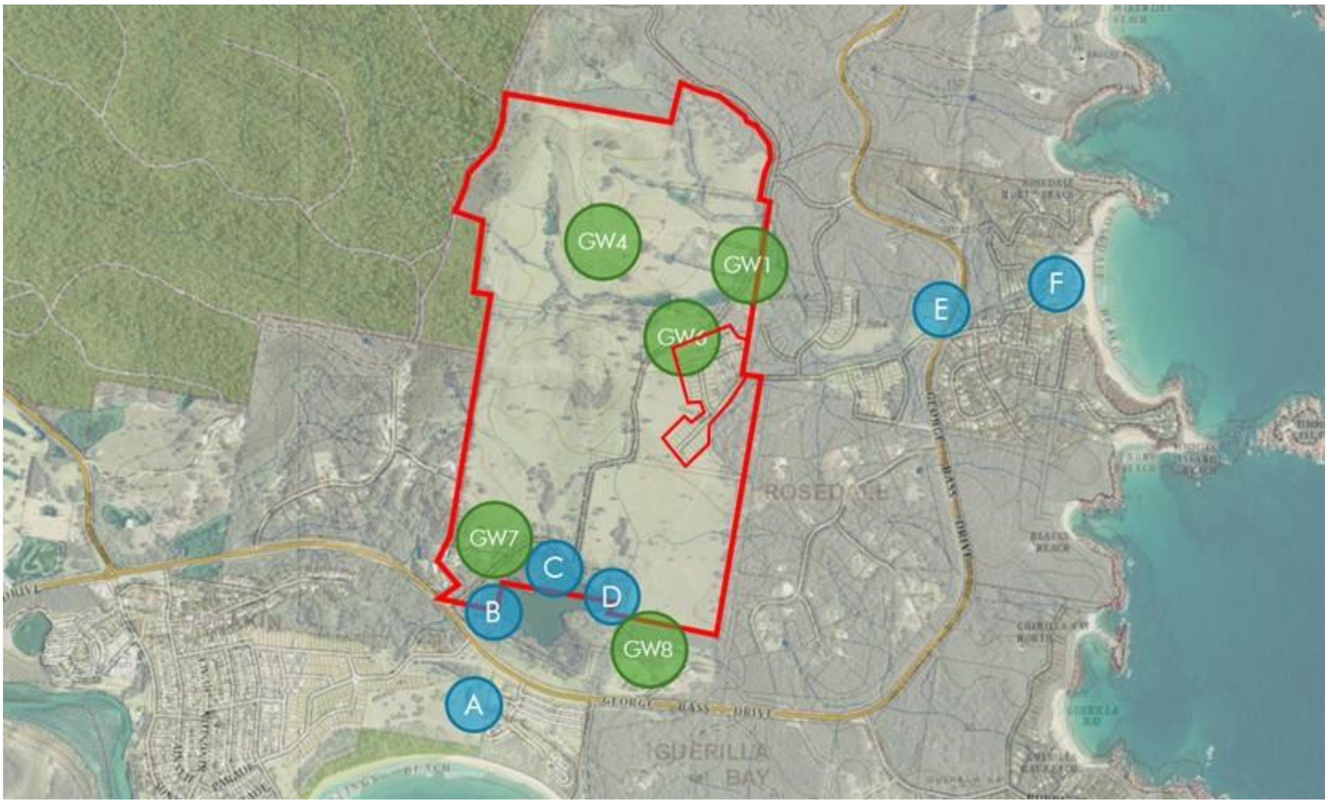


Figure 11: Surface water sampling sites (blue) and groundwater borehole sampling locations (green)

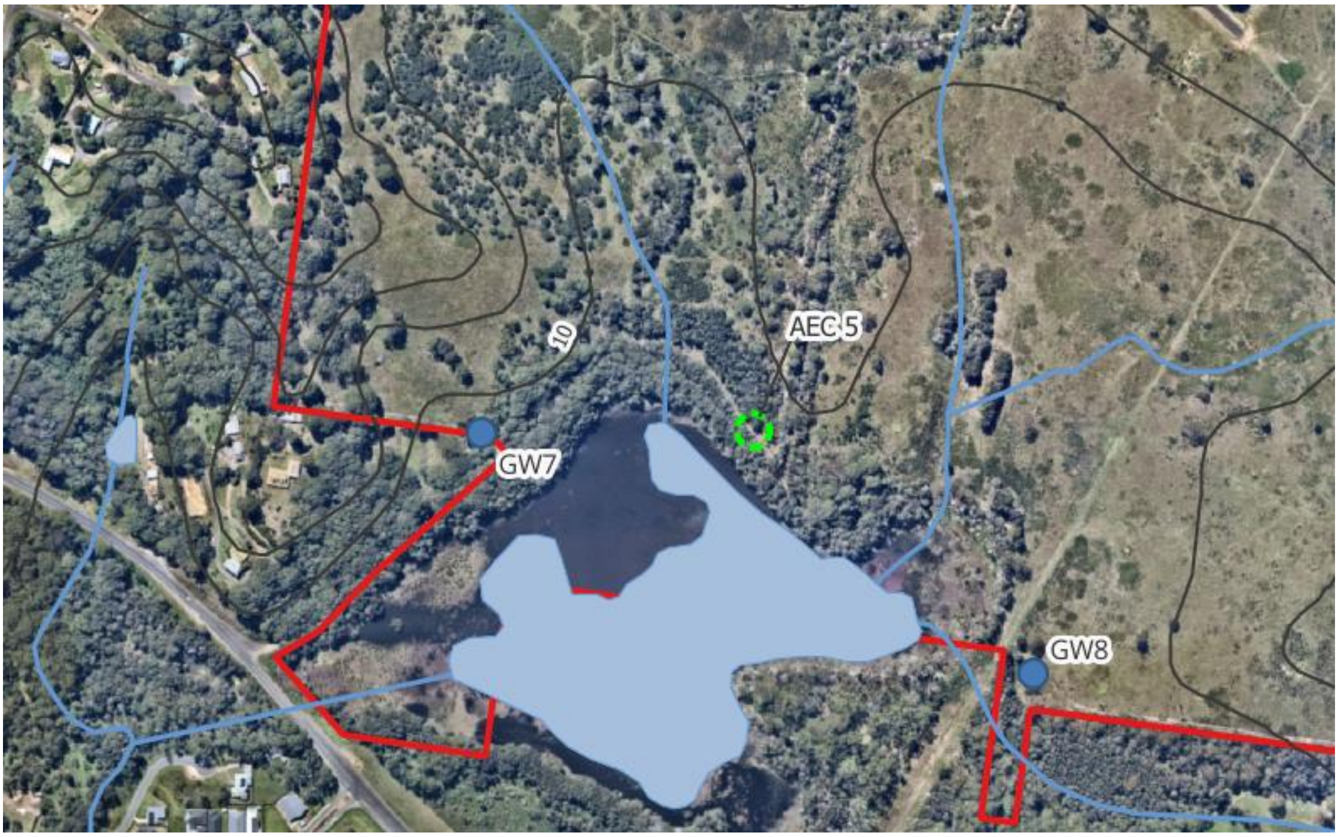


Figure 12: Groundwater sampling locations adjacent to Bevian Wetland

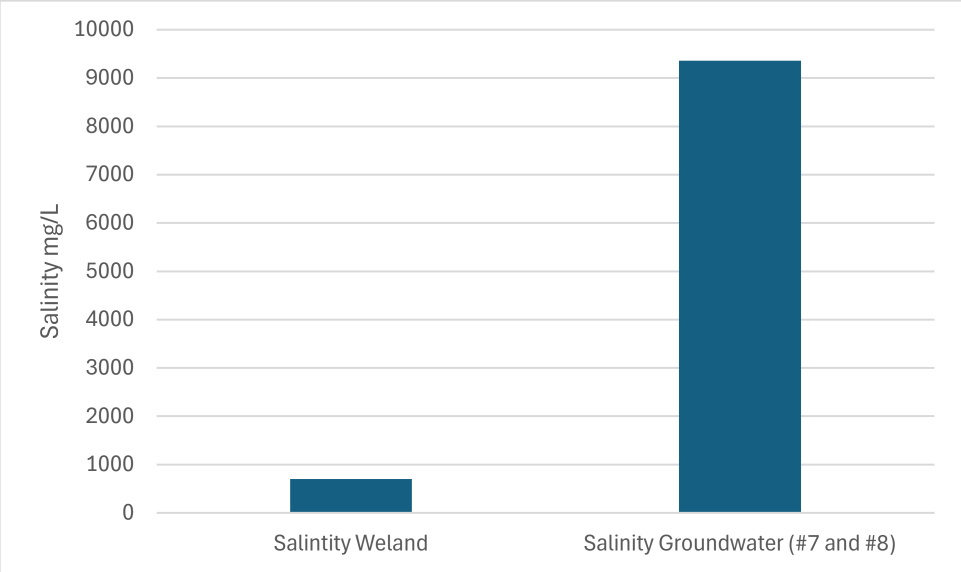


Figure 13: Average salinity across the sampling events in Bevian wetlands (B, C and D) compared to adjacent groundwater bores

Nutrients and sources of nutrients in Bevian Wetland

Analysis of the nutrient water quality in the wetland was also undertaken. The results are summarised in Figure 14:

- The total nitrogen was very high at average levels of approximately 12 mg/L
- The nitrates and ammonia concentrations and the overwhelming majority of the nitrogen was TKN indicating that the overwhelming amount of nitrogen in the water is organic nitrogen
- The average total phosphorous concentration in Bevian Wetland was 1.9 mg/L

The ANZECC (2000) guidelines trigger values for South East Australia slightly disturbed ecosystems are:

- Lowland river: TN 0.5 mg/L and TP 0.05 mg/L
- Estuaries: TN 0.3 mg/L and TP 0.03 mg/L
- Wetlands – not provided

Hence the levels in Bevian Wetland are two orders of magnitude (100 times) higher than the ANZECC trigger values for slightly disturbed ecosystems. The nutrient values in the wetland are also double the typical average concentrations of stormwater concentrations in urban runoff, (for example refer to Australian Runoff Quality Institute, Institute of Engineers, 2006)

The high levels of organic nitrogen are highly likely to be caused from a combination of

- decaying vegetation within the wetland
- the low turnover of the wetland with most nutrient flowing into the wetland from the catchment remaining in the wetland

The wetting and drying nature of the wetland creates a boom bust cycle for wetland vegetation. This occurs as follows:

- in a drying circle the wetland dries out and submerged, floating and macrophyte vegetation increases significantly at times covering the whole wetland area.

- During a wetting cycle the open water increases, sometimes covering the entire wetland open water, and the overwhelming majority of vegetation dies off and is likely to remain in the wetland as decaying organic material.

The decaying wetland vegetation material releases nutrients back into the wetland The very low hydraulic turnover and long residence times in the wetland mean that the majority of nutrient are retained in the wetland for long periods of time. This results in very high nutrient levels

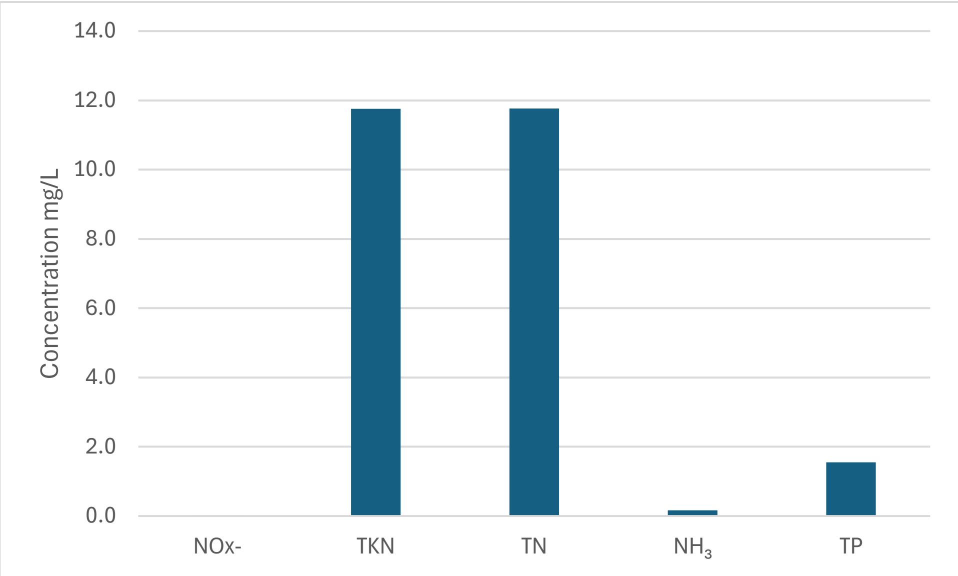


Figure 14: Average nutrient concentrations in Bevian Wetland over the sampling period

Further details of the water quality sampling data is provided in Appendix A.

Wetland hydrology

A MUSIC model was setup to assess the hydrology of the wetland from the existing catchment and the current inflows to the wetland. The model was set up with soil parameters to match the sandy/silty/gravelly clays of the existing site. The model was run and a flow frequency curve was generated to estimate the current flows into the wetland. The results are shown in Figure 15.

The MUSIC model estimated that the

- total mean annual runoff volume into the wetland is approximately 196 ML/yr
- that flows into the wetland are effectively dry for approximately 75% of the time matching the field observations on site of ephemeral shallow creeks flowing into Bevian wetland

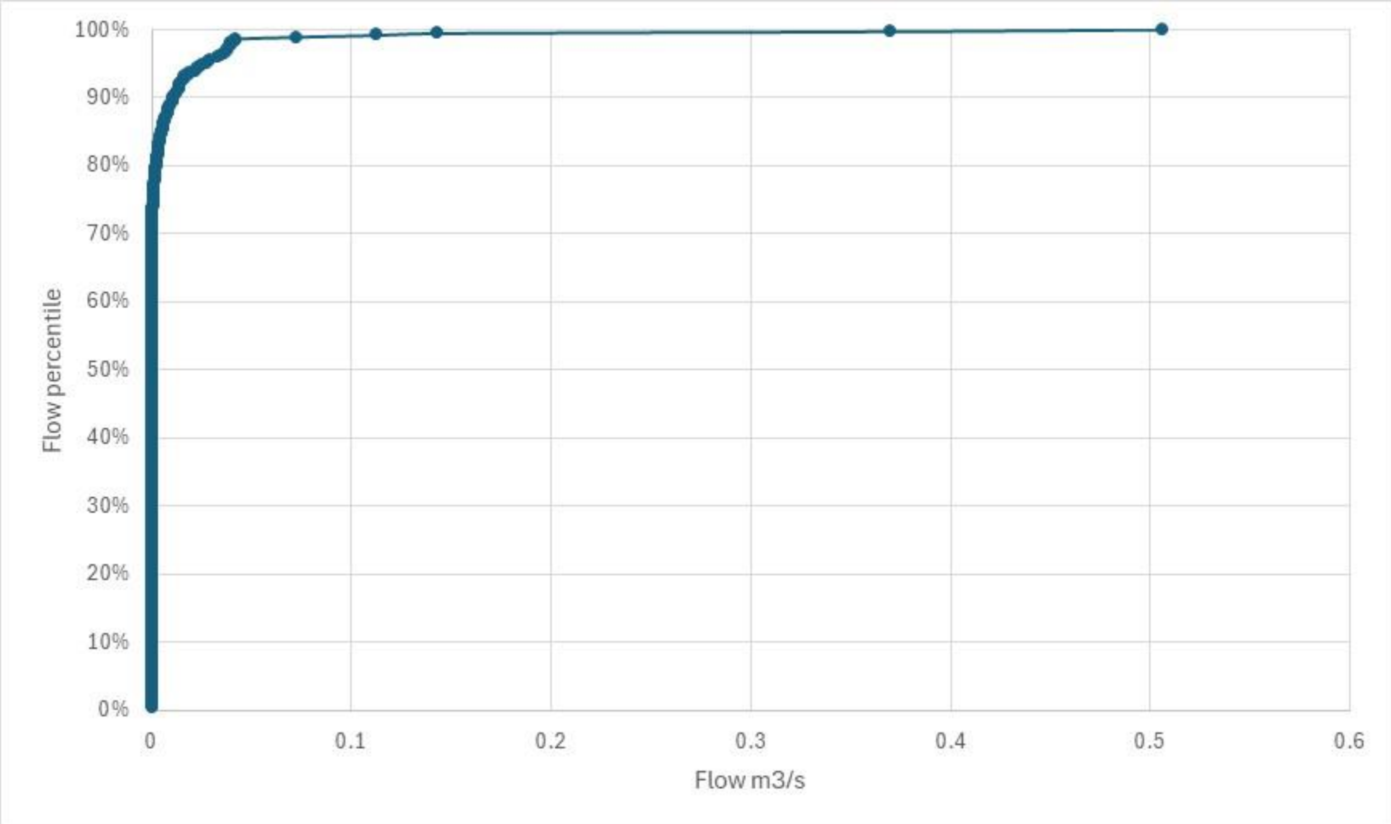


Figure 15: Flows into Bevian Wetland – flow percentile

Bevian wetland ecological communities

Ecological Australia (2025A) have undertaken vegetation mapping and validation. The results of the vegetation mapping is shown in Figure 16. This mapping included

- good condition Southern Estuarine Swamp Paperbark Creekflat Scrub (PCT 4056) fringing Bevian wetland
- open water within Bevian Wetland

PCT 4056 is a high swampy open forest of slightly saline, near-permanently waterlogged margins of estuaries and coastal lagoons. The canopy consisted of *Casuarina glauca* with scattered Eucalyptus tereticornis. A mid-dense to closed canopy of small trees is almost always dominated by *Melaleuca ericifolia*. A dense to mid-dense shrub stratum includes smaller individuals of canopy species. The ground layer tends to have low species richness and is very frequently dominated by *Machaerina juncea*, commonly with scattered *Phragmites australis*.

This community tends to occur in complex mosaics with many other types along gradients of salinity and soil moisture.

Previous ecological studies found Persicaria elatior (Tall Knotweed) south of Bevian Wetland, growing in a recently flooded drainage line. Follow up surveys undertaken in January 2025 did not find any individuals on the site (Ecological Australia 2025A). The species is associated with wetlands, ephemeral wet areas or within 50m of waterbodies.

Ecological Australia reported that Masked Owls were recorded close to Bevian Wetland in 1986 with a deceased individual located on George Bass Drive and Sooty Owls have been observed in the surrounding forest in the east as recently as 2021. They also reported that there are no breeding trees within the site, however the scattered trees within provide vantage points to scan the surrounding open grasslands for food.

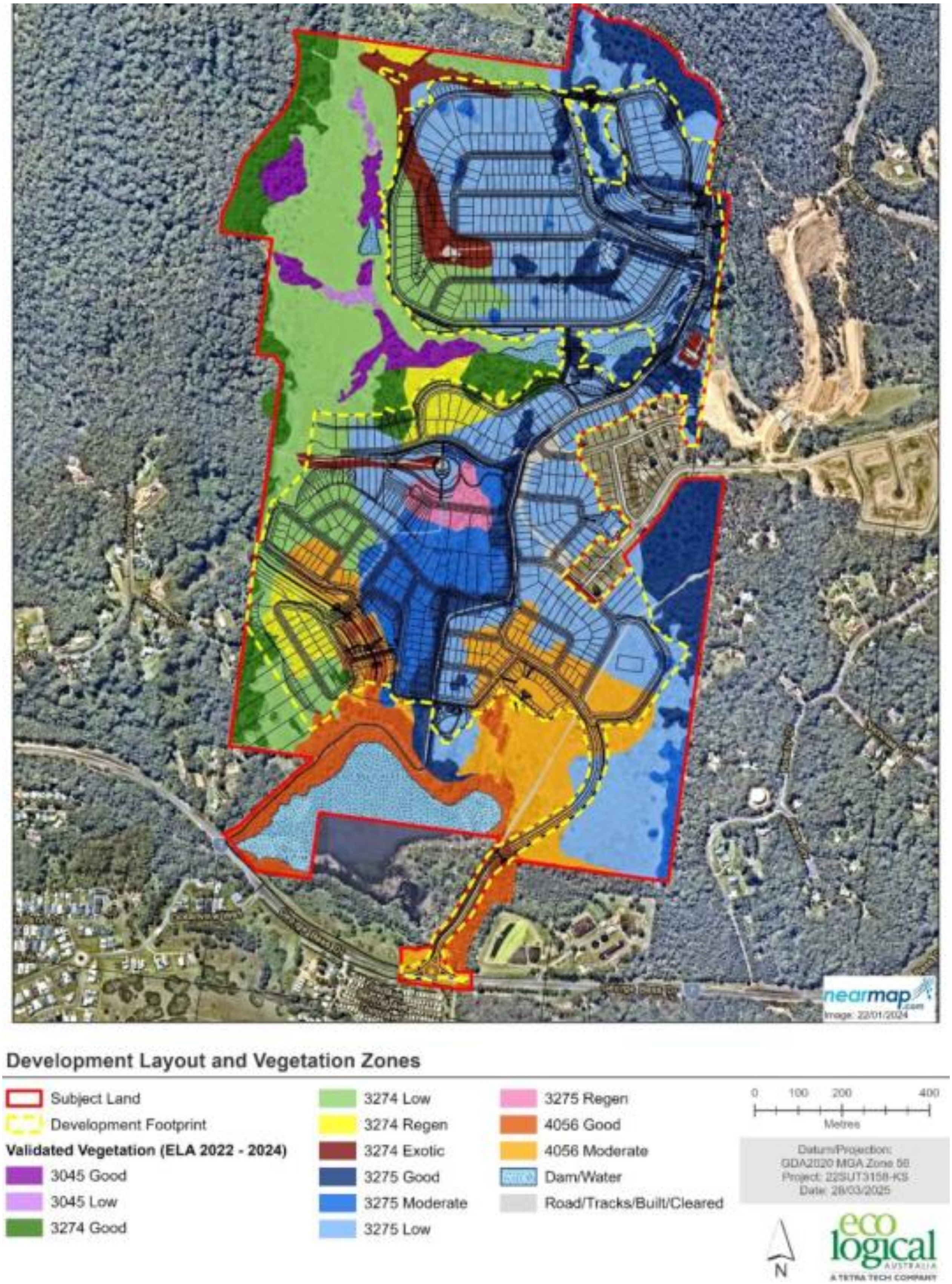


Figure 16: Bevian Wetland – Plant Community Types (Ecological Australia 2025A)

Previous ecological assessment undertaken by *Conacher Travers (2008)* assessed the vegetation communities associated with Bevian Wetland. The main wetland was identified as freshwater wetland vegetation fringed by swamp oak floodplain forest.

The freshwater wetland community include

- typical freshwater wetland vegetation species including Centella asiatica (Swamp Pennywort), Eleocharis sphacelata, Ottelia ovalifolia (Swamp Lily) Persicaria decipiens, Persicaria lapathifolia, Philydrum lanuginosum (Woolly Frogmouth), Typha spp.
- freshwater species that have some tolerance to slightly brackish water Juncus usitatus (Common Rush), Paspalum distichum, Schoenoplectus validus

The swamp oak floodplain forest was found to be dominated by Casuarina glauca with a low number of Eucalyptus botryoides (Bangalow). The community was found to have a sparse shrublayer.

The flora assessment is consistent with the water quality monitoring data which found that the wetland was freshwater/slightly brackish water. The vegetation communities that are established within the wetland are predominantly freshwater species which have minimal tolerance to elevated levels of salinity. There is also an absence of vegetation communities which typically are found in more brackish coastal wetlands (e.g. *Phragmites, Bolboschoenus spp*).

Assessment of the wetland by *Conacher Travers (2007)* found clay deposits within the wetland.

Bevian wetland summary

The analysis and assessment of Bevian wetland and the wetland processes found that it is subject to

- significant wetting and drying cycles
- vegetation within the wetland responds significantly to wetting and drying (from almost 100% to vegetation cover during drying cycles to 0% vegetation cover in wetting cycles)
- The wetland is freshwater/slightly brackish
- The wetland is considered independent of the groundwater and is perched above the groundwater through a relatively impermeable clay layer
- The wetland overflows only after significant rainfall events and during drying cycles does not overflow for years at a time
- The wetland is effectively a 'sink' with all nutrients entering the wetland remaining in the wetland
- Combined with high biomass from vegetation decay during wetting cycles Bevian Wetland has very poor water quality, 100 times higher than the ANZECC guidelines for slightly disturbed ecosystem and double the typical concentrations of urban stormwater runoff

Bevian wetland is therefore considered likely to be sensitive to:

- Changes in hydrology, particularly those that prolong or increase wetting cycles reducing drying cycles and whole of wetland landscape vegetation responses
- Significant increases in loads into the wetland which will likely remain in the wetland (the wetland is a 'sink')
- physical changes (e.g. core drilling) within the wetland which may disturb the natural clay

liner and increase connectivity to the groundwater

3.3 SALTWATER CREEK ICOLL

3.3.1 GENERAL DESCRIPTION

Saltwater creek is identified as an intermittently closed open lake and lagoon (ICOLL), featuring a coastal barrier at the mouth of the creek, located at the northern end of Rosedale Beach (east of the site). The barrier is periodically open allowing an exchange of water between the ocean and the creek. Saltwater Creek is a brackish water ICOLL.ICOLLS are a common occurrence along the coast in NSW, and there are approximately 70 ICOLLS along the NSW coast (DPI, 2024). The Saltwater Creek ICOLL is shown in Figure 17 and Figure 18 in a closed and open condition. There was significant rainfall in early 2021 and the ICOLL was opened to the ocean in relation to flows from the catchment 'forcing' open the closed entrance lagoon.

Figure 17: Saltwater Creek ICOLL - closed to the ocean (2019)

Figure 18: Saltwater Creek ICOLL - open to the ocean (April, 2021)

The ICOLL catchment is relatively small in size (less than 0.5 hectare) and wave activity pushes sand into the mouth of the Saltwater Creek estuary. The ICOLL is a relatively long and linear system with a high length to width ratio.

The ICOLL is flanked by private residential properties on its north and south and has limited public access apart from access to the 'mouth' of the ICOLL along Rosedale Beach.

The upper catchment of Saltwater Creek is located on gently undulating to steep land and features a small network of ephemeral tributaries. Saltwater Creek near George Bass Drive is shown in Figure 19.

During large rainfall events the water in the ICOLL rises and can spill over the entrance sand berm and drain out to the ocean. The force of the 'backed up' water within the creek then quickly scours an entrance channel through the beach and opens the ICOLL to the ocean. When ICOLLs are open they become tidal with seawater moving into and out of the estuary with the daily tidal cycle.

In times of reduced rainfall the ICOLL entrances closes more frequently and stays closed for long periods of time. Based on review of the Saltwater Creek ICOLL, the ICOLL appears to open relatively regularly with aerial data showing that it was open in:

- March 2023 (partially open to tidal exchange)
- May 2022 (partially open to tidal exchange)
- April 2021 (fully open)
- July 2018 (fully open)

The ICOLL appeared to be closed during all of 2019 and parts of 2020. Historical records show that about 70% of the ICOLLs in NSW are closed for the majority of the time (DPI, 2024).

Based on data from OEH the estimated depth of the ICOLL is approximately 100mm deep and hence is relatively shallow. The current catchment is approximately 20% developed consisting of residential landuses.

Figure 19: Saltwater Creek

3.3.2 SALTWATER CREEK ICOLL PROCESSES

The following sections outline the analysis and processes occurring within the ICOLL.

Historical water quality monitoring

Monitoring of the Saltwater Creek ICOLL is undertaken approximately every 3 years by OEH (2024). The last water quality testing was undertaken in 2020-21 with sampling over summer every month at 2 sites in the lagoon.

The testing found that water quality was 'fair' as shown in Figure 20. This was similar to the condition assessment undertaken in 2014-15 with algae, water clarity and overall grade ranked as fair.

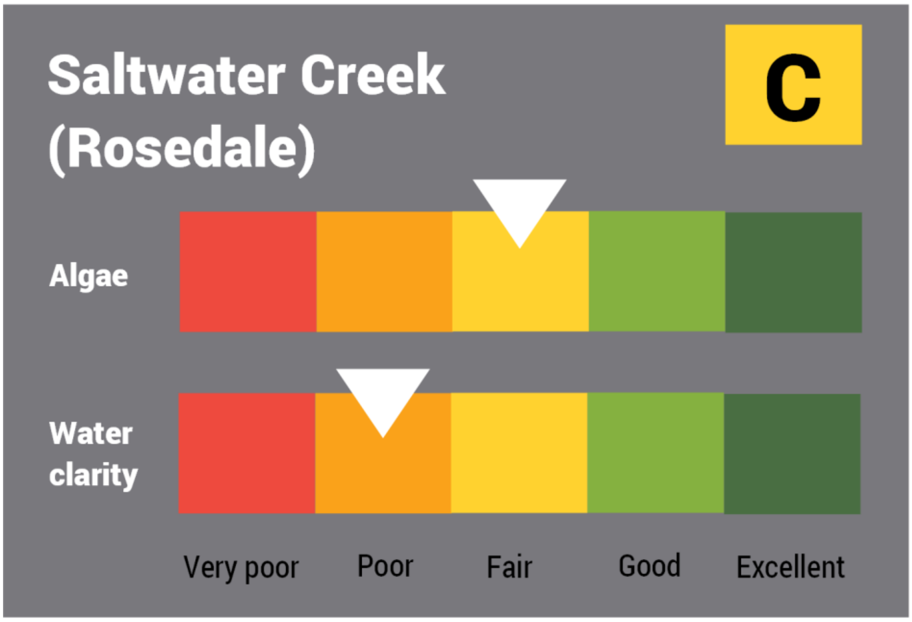


Figure 20: Saltwater Creek report card ,Top: 2020-21, (NSW Government OEH, 2024)

Water quality in Saltwater Creek ICOLL

Testing was undertaken at Saltwater Creek at George Bass Drive and at the mouth of the ICOLL. The water quality results showed that there was a significant difference in salinity between the upstream and downstream sampling locations in Saltwater Creek as shown in Figure 21. The values show that the system is slightly brackish at the upstream monitoring location and brackish at the mouth of the ICOLL indicating that there is more mixing with saline groundwater in the most downstream reaches and that there is groundwater mixing in the ICOLL particularly in the most downstream reach of the ICOLL with a gradient of groundwater mixing to the upstream end of the ICOLL.

Nutrients in the estuary were found to be

- very low in phosphorous in both the upstream and downstream monitoring locations
- below the ANZECC guideline trigger value for TP for estuaries
- concentrations of nitrogen in the ICOLL typical of disturbed urban water bodies in both the upstream and downstream monitoring locations indicating relatively high levels of TN
- significantly above the ANZECC guideline trigger value for TN for estuaries
- very low levels of TSS below the detection the lab threshold of 5 mg/L indicating good clarity of water in the ICOLL

The monitoring results indicate that the system is a low P system and is likely to be limited by P. Additional inputs of P into the ICOLL have the potential to cause increased eutrophication of the

ICOLL with potential for increased algae in the ICOLL (currently rated as fair). Additional inputs of P will potentially result in more algal growth in the ICOLL.

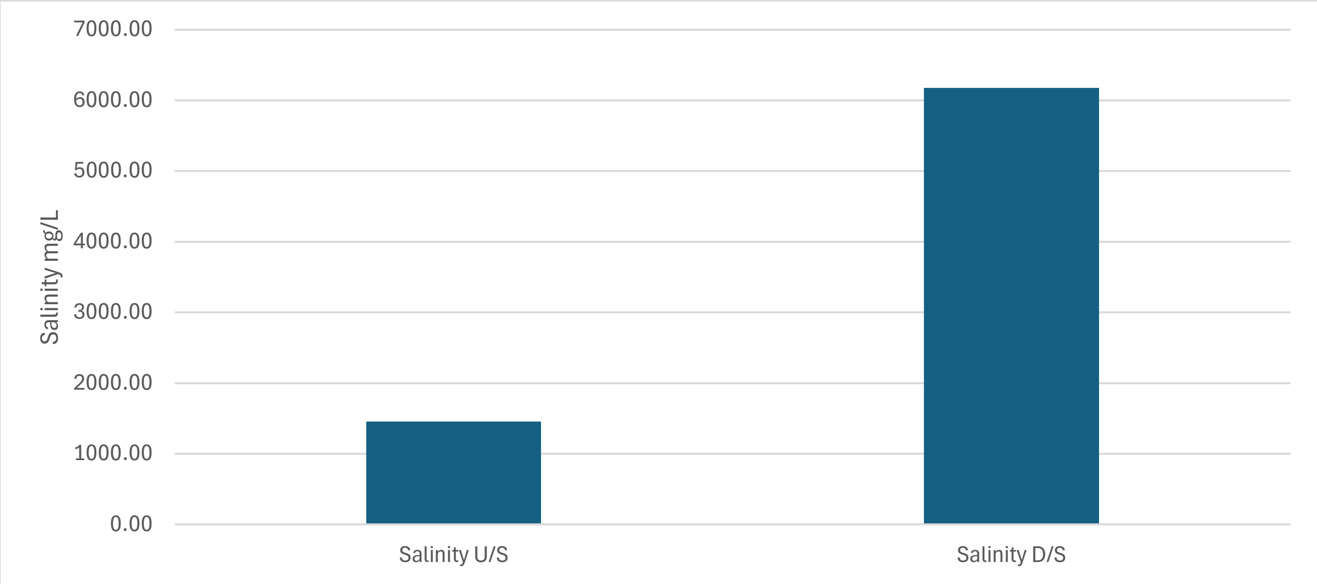


Figure 21: Saltwater Creek salinity levels

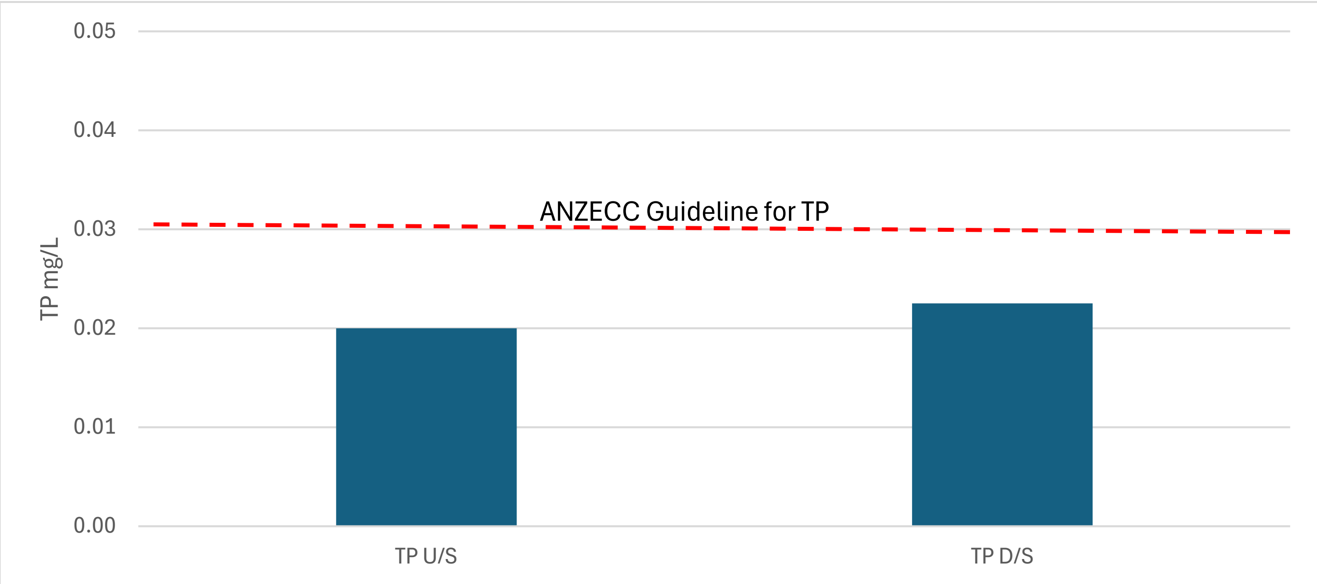


Figure 22: Saltwater Creek TP levels and ANZECC trigger criteria

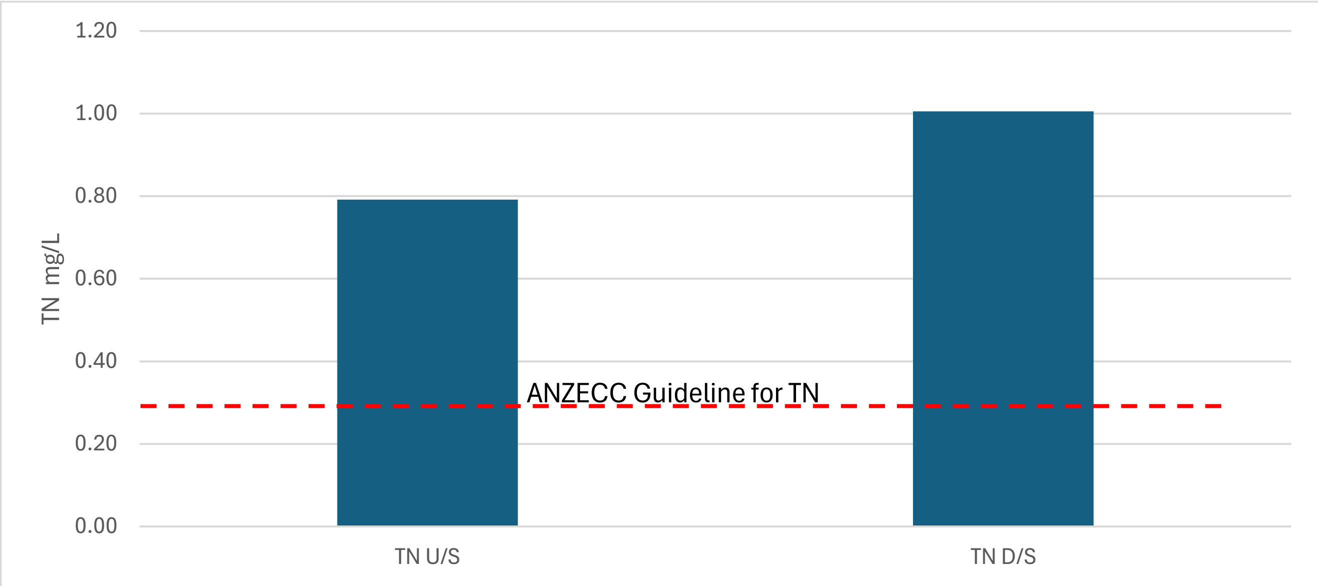


Figure 23: Saltwater Creek TN levels and ANZECC trigger criteria

Groundwater along Saltwater Creek within the development

The water quality in the ICOLL has been compared to the groundwater in the most eastern groundwater monitoring well along Saltwater Creek. The groundwater quality at the boundary of the site is considered poor with

- very high levels of TP with average values of 2.7 mg/L over the four sampling events, 10 times the typical concentrations of stormwater runoff
- very high levels of TN with average values of 12.6 mg/L over the four sampling events, approximately 5 times the typical concentrations of stormwater runoff
- Nitrogen was dominated by organic nitrogen
- slightly brackish groundwater with salinity of 980 mg/L

Hence in contrast to the low concentrations of P in the ICOLL the groundwater at the site showed elevated levels of nutrients. There is likely to be some mixing of this within the ICOLL downstream and may be contributing to the higher levels of nitrogen in the ICOLL. The dominant form of nitrogen in the ICOLL was also organic nitrogen with low levels of nitrates and ammonia in the ICOLL.

Summary of Saltwater Creek ICOLL processes

The analysis and assessment of Bevian wetland and the wetland processes found that it is subject to

- some mixing with groundwater, with increases in mixing towards the mouth of the ICOLL
- minimal vegetation within the ICOLL
- The ICOLL is slightly brackish
- The ICOLL opens to the ocean after significant rainfall events and has occurred approximately once every one to two years based on review of available aerial data and during these times the ICOLL is subject to tidal mixing on a daily basis
- When the ICOLL is closed it is effectively a 'sink' with all nutrients entering the ICOLL remaining in the ICOLL and these are likely to be flushed out to the ocean when the entrance opens and then after tidal mixing with seawater

- The ICOLL has very low TP and moderate levels of TN indicating that the system is P sensitive and has the potential to increase eutrophication and algal biomass with increased TP inputs into the system

Saltwater Creek and its ICOLL is therefore considered likely to be sensitive to:

- Significant increases in loads into the wetland which will likely remain in the ICOLL when the entrance is closed (the ICOLL is a 'sink' for long periods)
- Inputs of P into the system potentially increasing growth of algae

3.4 CATCHMENT AREAS

The catchment areas within the development draining to each receiving water are shown in Figure 24 and discussed in the following sections.

3.4.1 SALTWATER CREEK

The Saltwater Creek catchment consists of various headwater gullies, and relatively small ephemeral waterways, primarily draining in an easterly direction. A number of farm dams have been constructed along the existing tributaries and creek.

The total catchment area of Saltwater Creek (including areas towards the east) is approximately 276 hectares. The northern portion of the development site is located on approximately 133 hectares of the catchment, making up 48% of the total catchment area.

The land contained within the catchment of Saltwater Creek is highly disturbed. Approximately half the catchment area has been cleared for grazing and rural residential development, with 20% developed for urban use at Rosedale. Approximately 30% of the catchment remains forested.

3.4.2 BEVIAN WETLAND

Three broad gullies drain in a primarily southerly direction to the wetland. The total catchment area of the wetland is approximately 154 hectares. Approximately 77 hectares of the southern portion of the development drains to the wetland, or approximately 50% of its total catchment area.

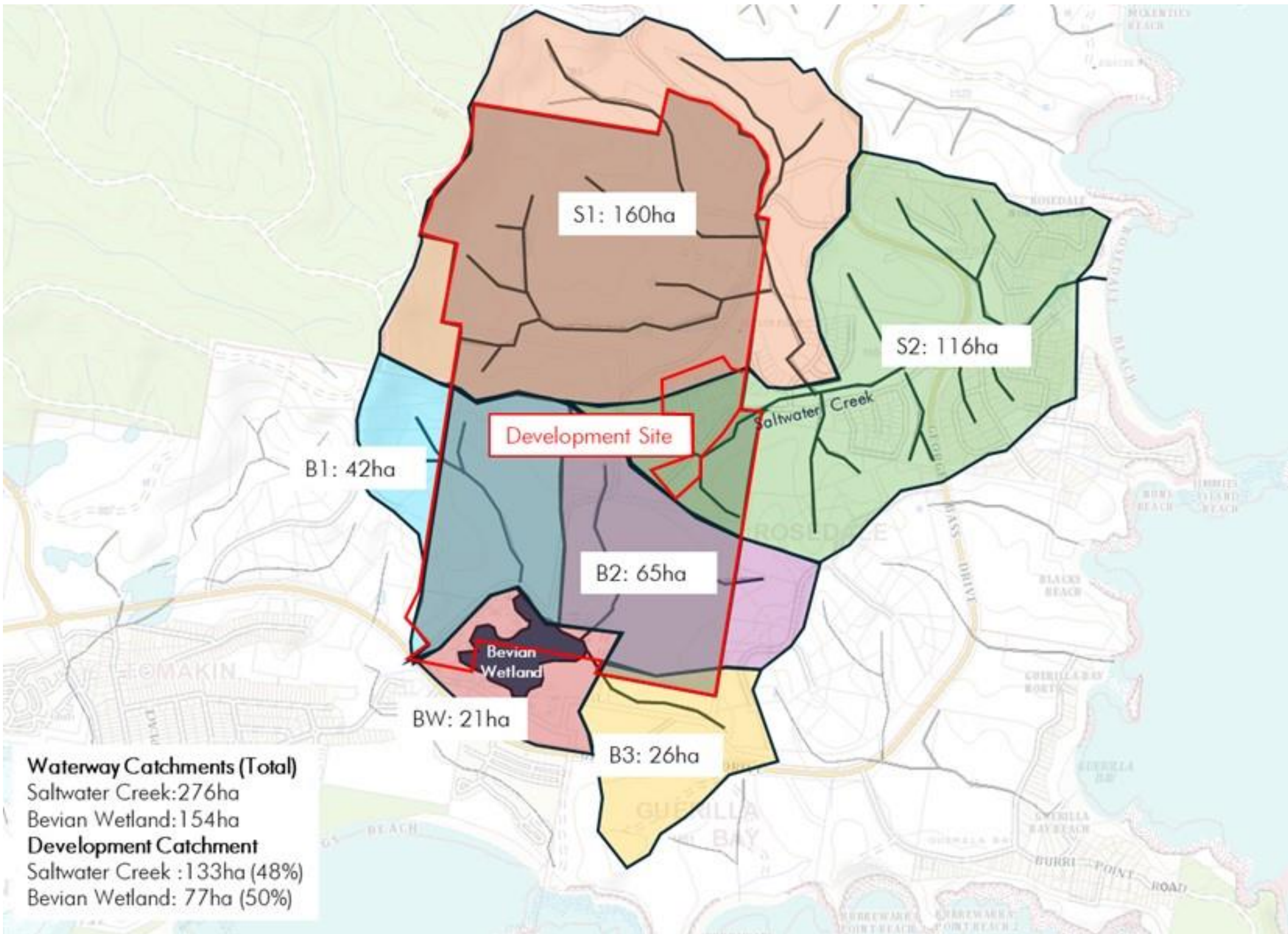


Figure 24: Local Catchment Areas - Saltwater Creek and Bevian Wetland

3.5 EXISTING LAND USE

The development site is situated on mostly open, undulating cleared land, historically cleared to establish grazing pastures with some remaining pockets of woodland and coastal forest.

General surface topography falls west to east with a gentle slope from north to south. A ridge across the site from west to east divides the two catchment areas.

Initial stages of the overall development area have been constructed, located towards the east between the development site and George Bass Drive. This includes a small road network, cleared land for new residential lots and existing residential buildings.

Figure 25: Existing Site – View from centre ridgeline looking south towards Barlings Beach

Figure 26: Existing Site – New roads in eastern portion of site (Development Stage 1)

3.6 SOILS AND GEOTECHNICAL OVERVIEW

3.6.1 SUB SURFACE PROFILE

Geotechnical investigations undertaken by *Fortify Geotech* included an investigation of sub-surface conditions by 24 augured and cored boreholes across the site.

The subsurface profile as found in bore holes included various clay layers over a weathered bedrock consisting of chert or siltstone. Bed rock depth varied across the site, ranging from 0.4m to 3.5m below the existing surface.

A summary of the subsurface profile is provided in Table 3-2.

Table 3-2: Subsurface Profile - Summary

Geological Profile	Typical Depth Interval	Description
TOPSOIL	0m to 0.10m/0.20m	**Silty CLAY:** low plasticity, dark brown, trace of root fibres, moist equal to plastic limit, soft.
ALLUVIAL SOIL	0.10m/0.20m to 0.4m/0.8m	**Sandy CLAY:** low plasticity, brown, red brown, red mottled, fine to coarse sand, moist equal to plastic limit, firm to stiff. (Only in BH8, BH9 and BH17)
	0.10m/0.20m to 0.4m/1.5m	**Gravelly CLAY/ Gravelly sandy CLAY:** low plasticity, brown, red brown, red mottled, fine to coarse, angular to sub-angular gravel, fine
	0.2m/1.5m to 0.4m/2.0m	**Silty CLAY/Sandy silty CLAY**: low plasticity clay, pale
RESIDUAL SOIL	0.5m/2.5m to 0.8m/3.5m	**Silty clayey SAND/Clayey SAND/ Clayey gravelly SAND**: fine to coarse sand, red brown, pale grey, low plasticity clay, fine to coarse,
WEATHERED BEDROCK	Below 0.4m/3.5m	**CHERT**: Extremely (XW) to Moderately (MW) weathered, fine-grained, thin bedded, some fine-grained sandstone and mudstone interlayers, white, blue grey, pale grey, dry to moist, low to medium strength. **SILTSTONE**: Highly (HW) to Moderately (MW) weathered, fine grained, blue grey, grey, thin bedded, low to medium strength rock.

3.6.2 INFILTRATION CAPACITY

In-situ infiltration capacity has been undertaken (Patterson Britton, 2007). As the soil conditions have not been modified since the 2007 infiltration testing it is considered that the infiltration testing is likely to provide a reliable estimate of infiltration capacity at the site.

Figure 27: In-situ infiltration testing (Patterson Britton, 2007)

The infiltration testing showed that the silty/sandy/gravelly clay soils had an average infiltration rate of approximately 55 mm/hr across the site with some variability (from 2mm/hr to 200mm/hr). Given the variability of the site, if the two largest rates of infiltration were not included in the average infiltration rate, the infiltration would reduce to 25 mm/hr (refer Table 3-3).

As the soils were found to be consistently silty/sandy/gravelly clays across the site in testing undertaken in both 2007 and 2024 it is considered that the infiltration is likely to be relatively consistent across the site with some local variability.

Given the capacity of the soils to infiltrate water at the site, it is recommended that infiltration be adopted as part of the strategy. Infiltration in particular is beneficial to reduce the impacts of the development on hydrology.

It is recommended that a conservative infiltration rate of 30 mm/hr or less be adopted for modelling of infiltration at the site.

Table 3-3: Infiltration rates (Patterson Britton 2007)

Test location	Test type	Result mm/hr
1	Double ring infiltrometer	17
2	Double ring infiltrometer	51
3	Double ring infiltrometer	58
4	Double ring infiltrometer	92
5	Double ring infiltrometer	2
6	Double ring infiltrometer	200
7	Falling head	17
8	Falling head	8
All site	**AVERAGE**	**55 mm/hr**
Excluding sites 4 and 6 (two highest rates)	**AVERAGE EXCL 4 and 6**	**25 mm/hr**

3.6.3 GROUND WATER OVERVIEW

Fortify Geotech (2024) undertook 24 boreholes across the site shown in Figure 28. Their investigations found did not encounter free groundwater at the site. Many of the boreholes encountered shallow bed rock (e.g Boreholes 12 to 18 all encountered bedrock at less than 2m depth)

Fortify (2024) estimated that depth of groundwater is expected at ~5m below the existing ground surface in the lower-lying parts of the site and at ~10m below the existing ground surface in the upper slopes of the site.

Shallow groundwater on the site is expected to be largely confined to the Alluvial deposits in the southern portion of the site and in gully bases.

Lanterra Consulting (2024) installed eight new groundwater monitoring and sampling wells, shown in Figure 29. At the time of sampling, standing groundwater levels ranged between 0.5m below ground level (bgl) at GW8 (east of the wetland), to 26.5m bgl at GW4 (central northern part of the site), equating to 4.8m AHD at GW8 and 25.65m AHD at GW.

The inferred groundwater flow direction is expected to be in a south-east direction towards the ocean. Groundwater was found to be fresh to brackish and mild acidic.

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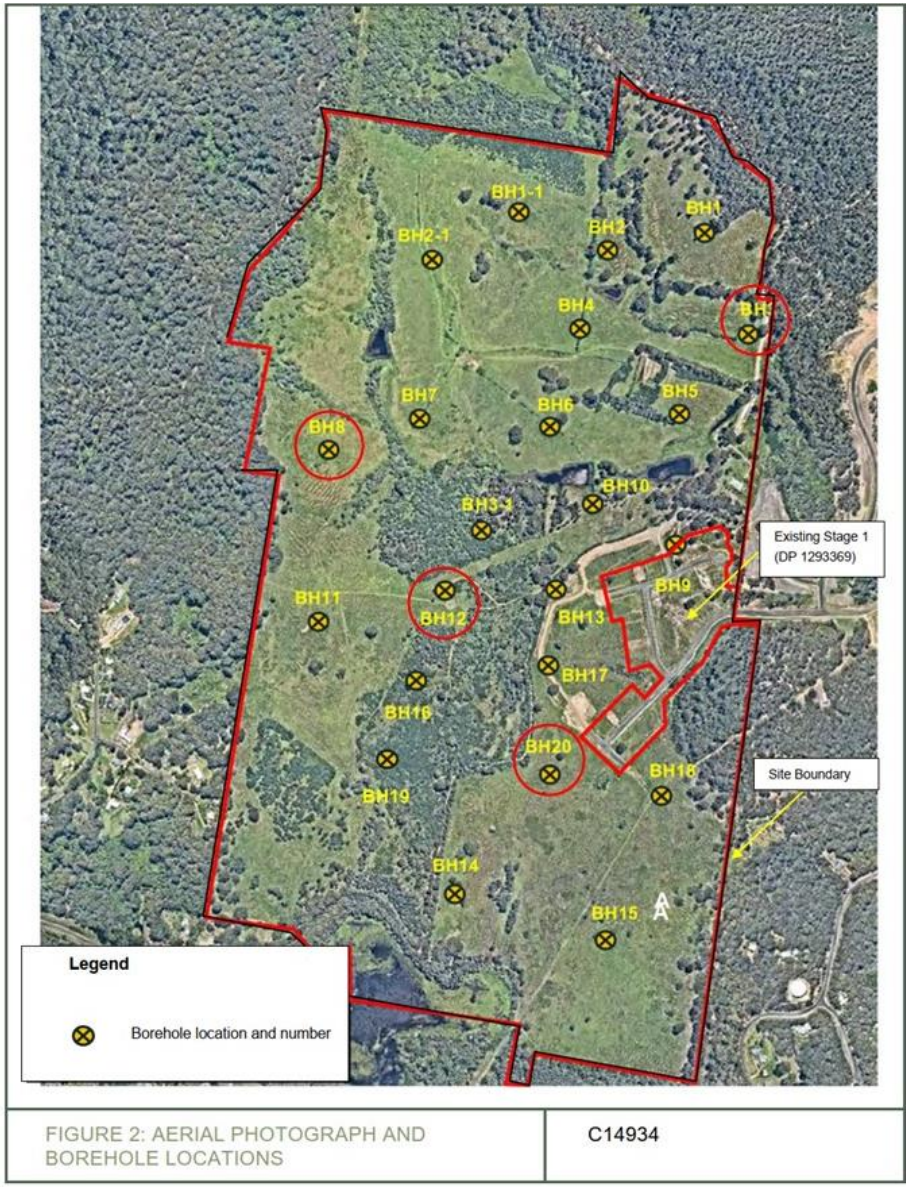

Figure 28: Location of boreholes (Fortify, 2024)

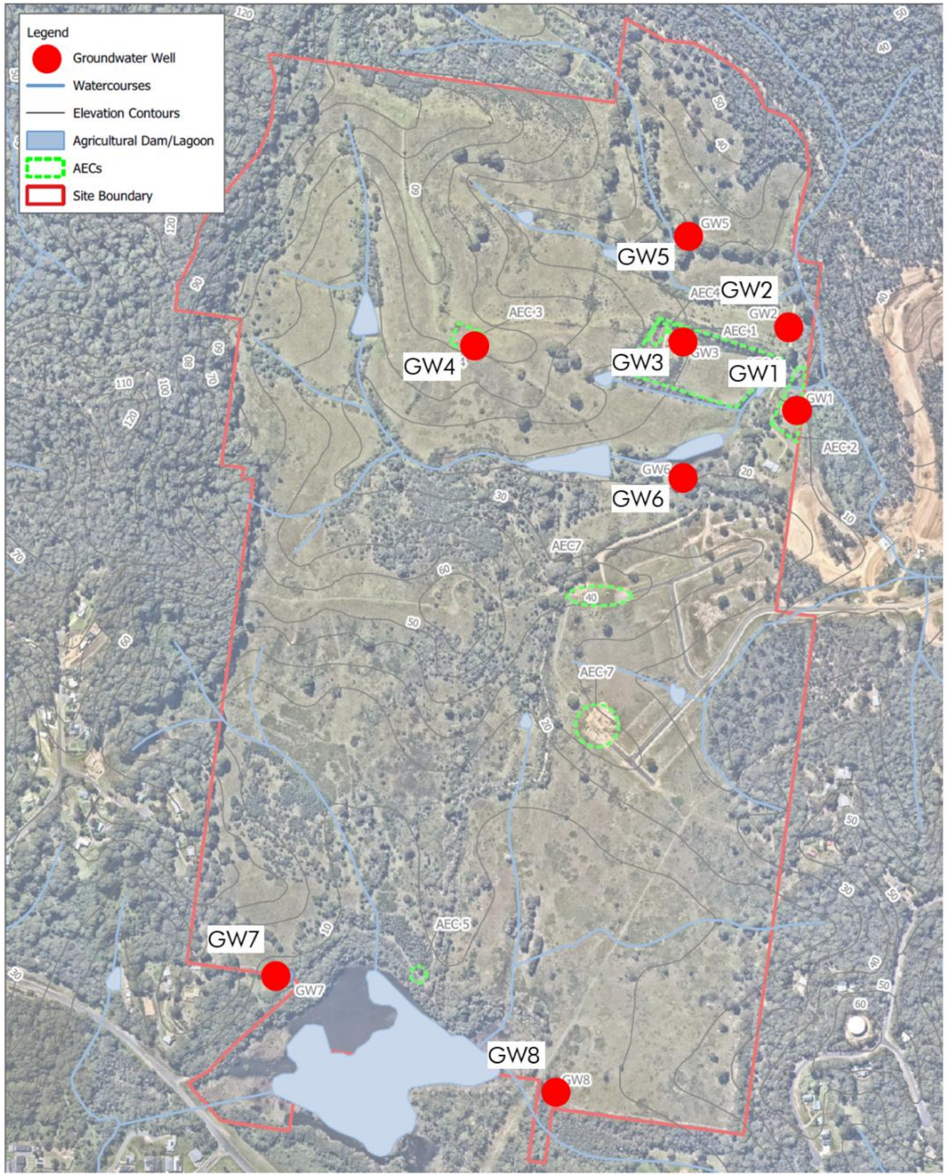

Figure 29: Groundwater Sampling Wells (Lanterra Consulting 2024)

3.6.4 ACID SULPHATE SOILS (ASS)

Refer to Civille (2025) Acid Sulphate Soils Summary report.

3.6.5 SITE SOIL INVESTIGATIONS

For investigations into site soil refer to *Lanterra Consulting (2024)*.

3.7 WATERWAY ASSESSMENT AND KEY FISH HABITAT ASSESSMENT

Ecological Australia (2025) have undertaken a *Riparian and Aquatic Assessment* for the site.

Field work was undertaken in June 2023 to ground-truth/adjust the desktop top of bank mapping. For watercourses that were proposed for removal or realignment, a rapid assessment of aquatic and riparian condition was used to describe the value of those watercourse. Reaches 1B, 1K, 1L and 1O were defined as not a river. A summary of the mapping and proposed riparian is shown in Figure 30 and the order of the waterways and a condition summary is included in Table 3-4.

The riparian assessment found that most of the waterways were in poor to moderate conditions with varying degrees of channel alteration through online dams, realignment, informal culverts and similar. The waterways were lacking riparian corridor and riparian vegetation.

Ecological Australia (2025) undertook an assessment of key fish habitat and identified that the site and adjacent areas contain:

- a section of 3rd order stream and a coastal wetland, which DPI Fisheries (Fairfull 2013) defines as key fish habitat.
- Bevian coastal wetlands which is classed as Type 1 – highly sensitive key fish habitat.
- South of Bevian wetland, downstream of the caravan park at Barlings Beach, there is a small patch of Posidonia seagrass (Type 1 key fish habitat) protected by a rocky headland

Table 3-4: Waterway summary (Ecological Australia, 2025)

Reach	Stream order	Condition	Image of current condition
1C	1st	Poor condition	
1D	1st	Moderate condition	

2A	2nd	Moderate to good condition	
2B	2nd	Poor condition	
2D	2nd	Poor condition	
2E	2nd	Poor to moderate condition	
3B	3rd	Poor to moderate condition	

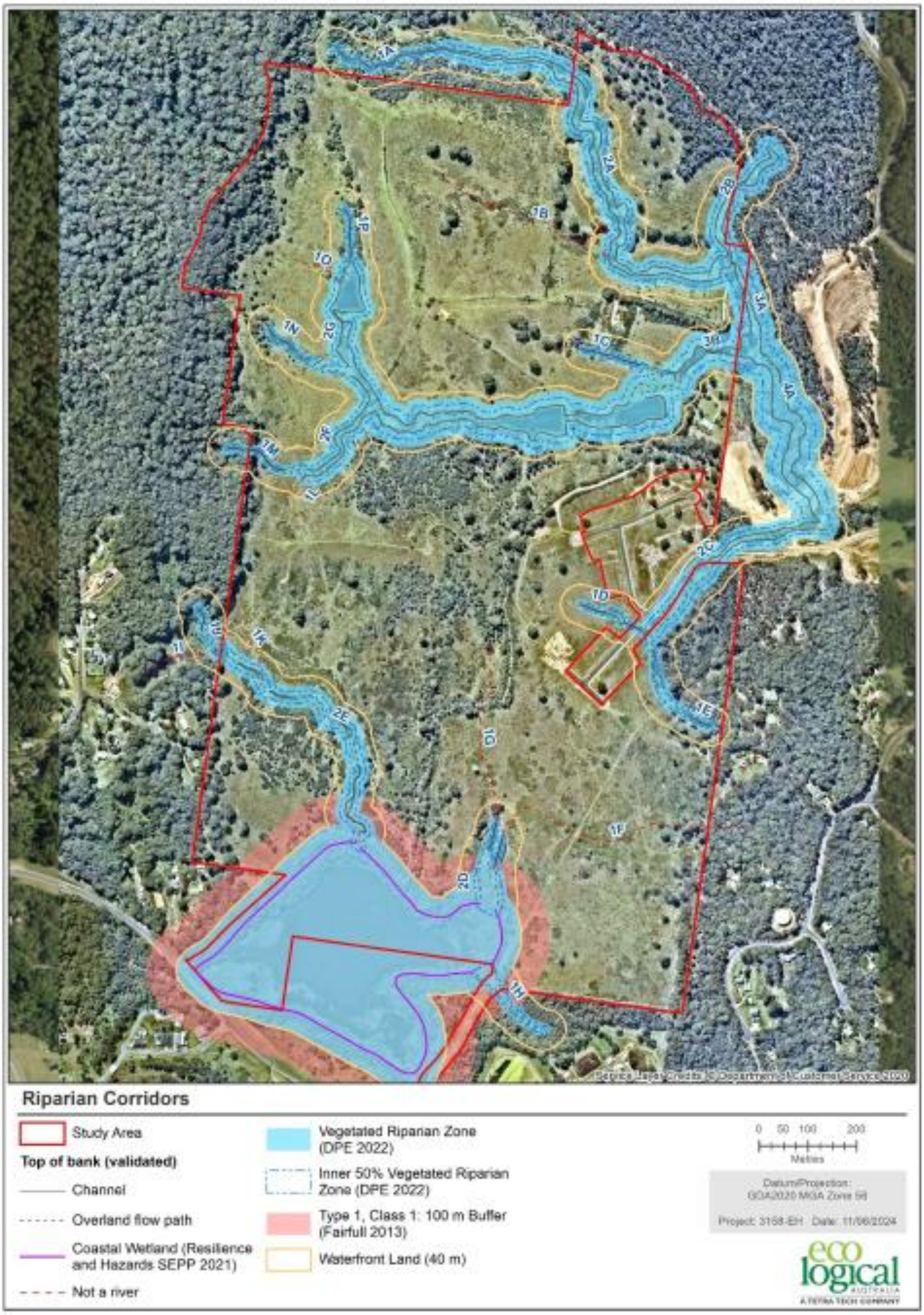

Figure 30: Waterway assessment (Ecological Australia, 2025)

3.8 EXISTING SEWAGE NETWORK

The development is proposed to be a sewered development and to connect into the Tomakin STP for treatment prior to disposal.

The Tomakin sewerage treatment plant (STP) is located immediately south of the development site.

The Tomakin STP and associated network services the immediate townships of Rosedale, Guerrilla Bay and Tomakin, in addition to other nearby townships of Mossy Point Broulee and Mogo. Malua Bay is to be diverted to the Tomakin network in future.

The STP is a continuous extended aeration plant, including primary treatment (screening and grit removal), secondary treatment (activated sludge and clarification processes) and tertiary treatment (maturation ponds, UV disinfection and/or chlorination for reuse streams).

Treated sewerage water is discharged to the ocean at Long Nose Point.

Tomakin STP is proposed to be upgraded by Eurobodalla Council as part of their future planning for urban development in Rosedale and other suburbs serviced by the STP.

For further details on the existing and future sewer refer to Enspire (2025) civil report and design drawings.

3.9 HISTORICAL RIVER FLOW DATA

There is no available historical river flow data for the unnamed creek or Saltwater Creek. Typically 1st and 2nd order waterways with small catchments are not monitored for river flow.

3.10 DOWNSTREAM OPEN WATERS MARINE ESTATE

The development discharges to high energy wave environments downstream of the site when the Saltwater Creek ICOLL is open after high rainfall events.

The development also will discharge to Barlings Beach if the ICOLL within the Holiday Park is open. Based on review of historical aerial imagery the opening of this ICOLL has not occurred in the most recent large rainfall events since 2020, events which the Saltwater Creek ICOLL was open to the ocean. Bevian Wetland upstream of the ICOLL is a large open water body which acts as a significant buffer to flows and only occasionally overflows to the downstream ICOLL. Hence it is anticipated that discharge to Barlings Beach from the development will occur only on rare occasions.

Water is discharge to the ocean from the Tomakin STP at Longnose Point via a submarine outfall. Eurobodalla Shire Council estimates that the discharge from the STP is estimated at approximately:

- 300 ML/yr of flows
- Approximately 1000 kg/yr of nitrogen
- Approximately 2400 kg/yr of phosphorous

These nutrient loads are more than an order of magnitude higher than the estimated pollutant loads from the development runoff from stormwater (as outlined in section 5.3).

Overall the impact from the development to the marine estate from stormwater runoff is considered negligible as

- The development will discharge to Rosedale Beach only when the Saltwater Creek ICOLL is open which happens during large storm events once every 1 to 2 years on average
- The development will discharge into a high energy environment which will result in significant mixing and dispersal of any pollutants
- The pollutant loads are an order of magnitude less than the STP discharges

3.11 HUMAN USES

Human uses of the receiving water including the ICOLLS and marine estate include a range of uses such as:

- Aquatic recreation including primary contact
- Recreational fishing and related uses
- Visual amenity and similar values uses for the local community and visitors

There are no aquaculture or similar commercial uses of the receiving waters.

4 DEVELOPMENT DESIGN CRITERIA

4.1 WATER QUALITY OBJECTIVES AND ANZECC GUIDELINES

A comparison of the water quality concentrations with ANZECC water quality trigger guidelines for slightly disturbed ecosystems (estuaries) and typical concentrations from urban stormwater runoff and receiving waters at the site is shown in Figure 31 and **Figure 32**.

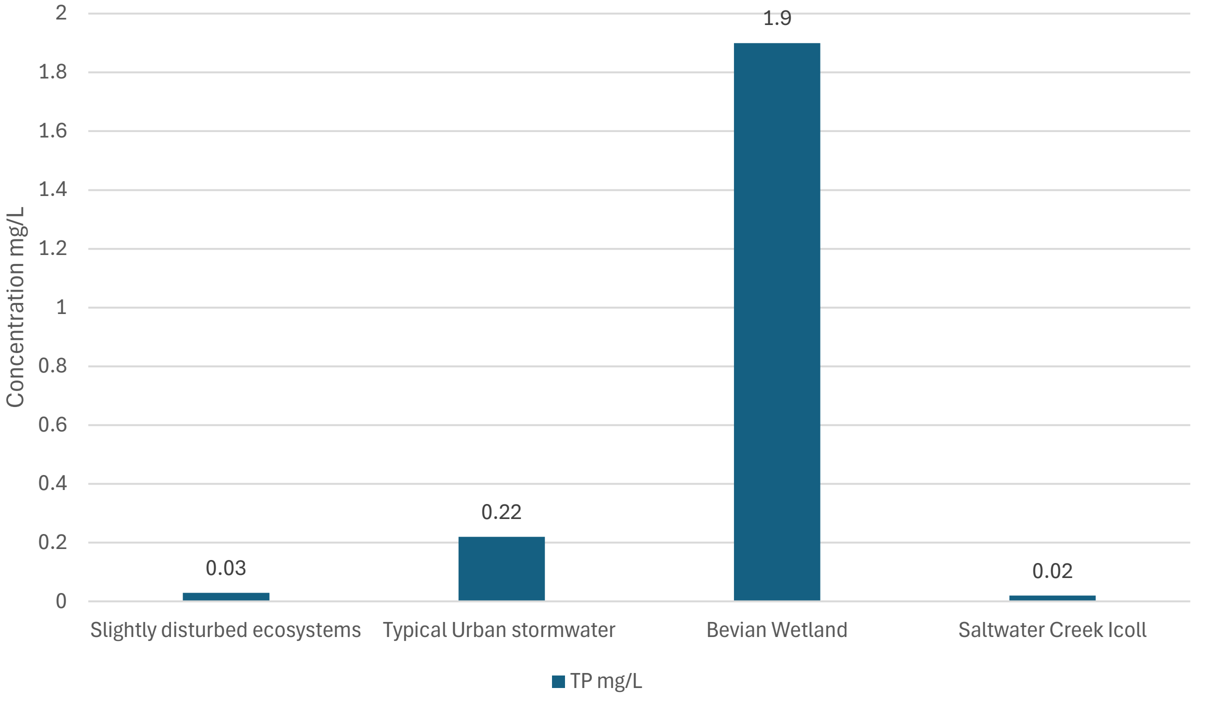

Figure 31: Phosphorous concentrations in receiving water and ANZECC guidelines

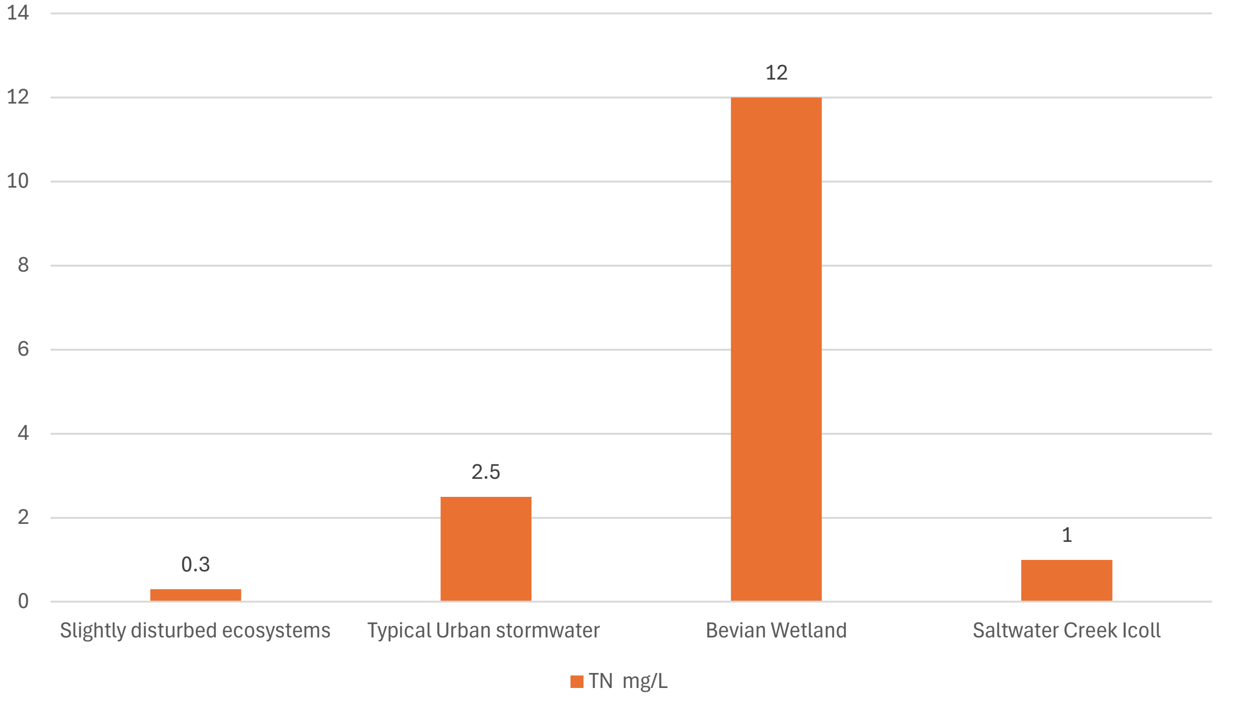

Figure 32: Nitrogen concentrations in receiving water and ANZECC guidelines

The water quality concentrations within Bevian Wetland are currently very high relative to natural and even typical stormwater runoff concentration. The existing water quality concentrations are an order of magnitude higher than the trigger values for water quality concentrations for slightly disturbed estuary systems. Also as shown in Figure 32 above the water quality concentrations for untreated stormwater are also **lower than** the concentrations in the Bevian wetland.

As Bevian wetland is a lentic system and as outlined in Australian Runoff Quality, for lentic systems, load based targets are considered the most appropriate targets. Bevian Wetland in particular is not considered to be insensitive to water quality concentrations, given the current high values of water quality within the Wetland.

Saltwater Creek ICOLL is similarly a predominantly lentic system as the majority of the time the system is closed to the ocean. When the system is open to the ocean after large rainfall events, the water quality will be dominated by tidal exchange. As the majority of the time the system is closed to the ocean and during this time it is a lentic system, load based targets are considered appropriate.

Saltwater Creek ICOLL is likely to be sensitive to changes in phosphorous and hence higher load targets are recommended for phosphorous.

The recommended targets for two different catchments are outlined in the following table with adoption of Eurobodalla's Shire Council's DCP and Infrastructure Design Standard stormwater water quality targets for Bevian Wetland and adoption of a precautionary approach of no increase in loads from pre-development to post development in the Saltwater Creek and Saltwater Creek ICOLL catchment. This is considered conservative as when the system is open to the ocean there is likely to be significant exchange of nutrients between the ICOLL and the ocean.

	TSS – Load reduction	TP – Load reduction	TN Load reduction
Bevian Wetland	80% reduction of the typical urban annual load for Total Suspended Solids (TSS)	45% reduction of the typical urban annual load for Total Suspended Solids (TSS)	45% reduction of the typical urban annual load for Total Suspended Solids (TSS)
Saltwater Creek Icoll	Post development loads equal to pre-development loads	Post development loads equal to pre-development loads	Post development loads equal to pre-development loads

4.2 WETLAND AND ICOLL HYDROLOGY

Bevian wetland is sensitive to changes in hydrology. As the wetland is disconnected from the groundwater significant changes to the runoff into the wetland has the potential to impact on the wetland. Significant increases in flow into the wetland has potential to impact on the wetting-drying hydrology of the wetland and to increase the water levels in the wetland with the potential to reduce the times available for wetland vegetation dependent on dry spells in the wetland to germinate and establish.

As the system is a lentic system, the wetland is sensitive to changes in the mean annual runoff volume (MARV) into the wetland. Due to the size of the wetland it is relatively insensitive to any one event as any one event will have a relatively small impact on the wetland as the volume of the wetland is very large relative to the catchment runoff. Hence the key parameter is to ensure that

- No increase in the post development mean annual runoff volume (MARV) compared to the pre-development MARV
- No increase in the post development **80**% ile flow into the wetland (to preserve the

wetland drying hydrology) compared to the pre development 80% ile flow into the wetland

There is potential for increased flows into Saltwater Creek ICOLL to impact on the hydrology of the ICOLL. In particular significant increases in flows have the potential to change the salinity of the ICOLL with increased surface flows resulting in a reduction in salinity. However, as the system is connected to the groundwater with both recharge from the ICOLL into groundwater occurring during wetter periods and seepage into the ICOLL during dry periods. Hence it is likely that the ICOLL is less sensitive to changes in runoff.

- No more than 5% increase in the post development mean annual runoff volume (MARV) compared to the pre-development MARV

4.3 SEA LEVEL RISE

4.3.1 EUROBODALLA COASTAL HAZARD CODE

As the site is located adjacent to the Coastal Vulnerability area of Barlings Beach and Bevian Wetland, the adopted criteria for sea level rise is based on requirements set out in the *Eurobodalla Coastal Hazard Code*. The relevant general requirements includes:

Schedule 6 - Planning levels for coastal inundation

- *All properties will need to account for coastal inundation in the 100 Year ARI design event plus a freeboard and an allowance for sea level rise, when determining planning levels.*
- *The following freeboard will apply: 500mm residential use, 300mm other types of use.*

Schedule 10 vii - Land Subdivision

- *b. Subdivision of land will not be permitted where the building platforms of residential allotments will be created below the 100 Year ARI Coastal Inundation Level (including sea level rise for appropriate planning period).*

Sea level rise values adopted by Council:

- 23cm sea level rise by the year 2050
- 72cm sea level rise by the year 2100

4.3.2 ADOPTED DESIGN VALUES

The adopted coastal planning levels for assessment are summarised in

Table 4-1 Adopted Coastal Planning Levels

Coastal Vulnerability Area	2100 100 Year ARI Coastal Inundation Level (m AHD)	2100 100 Year ARI Maximum Wave Run-up Level (m AHD)*	Sea Level rise (2100) (m)	Freeboard (m)	Coastal Planning Level (m, AHD)
Barlings Beach	2.83	5.7	0.72	0.5	**4.05**

** Wave action not relevant to site location*

The existing levels of the development site are above 4mAHD and outside the mapped coastal vulnerability zone, with the exception for the portion of the site immediately adjacent to Bevian Wetland. The lower dwelling level is approximately 9m AHD. Hence the developed portion of the site is not impacted by inundation (including future sea level rise).

5 DEVELOPMENT SUMMARY AND STRATEGY

5.1 PROPOSED DEVELOPMENT

An overview of the development is shown in Figure 33. This figure shows the

- residential development and associated ancillary community and commercial development
- the proposed waterways and waterway riparian corridors
- Bevian wetland area and wetland buffer zone
- Proposed stormwater management areas including WSUD and detention basins

The proposed development includes 792 residential lots including the completed Stage 1 area (DP1293369). For the purposes of the modification, stage 1 is excluded from this assessment.

The post development catchments have been determined by Enspire based on the proposed development layout, proposed design surface levels, road layout and overall topography.

The post development catchments are shown in Figure 34 with

- catchments A and B and E11 draining to Bevian Wetland
- catchments C, D, E, F and G draining to Saltwater Creek

The total areas draining to the receiving water from the development pre and post development are shown in Table 2. This shows that there is a minor increase in the Bevian Wetland catchment and a minor decrease in the Saltwater Creek catchment post development.

Table 2: Catchments – Pre-development and post-development

Receiving Water	Pre-development Has	Post development
Saltwater Creek	125.88	123.44
Bevian Wetland	87.25	89.88

The development will increase the amount of impervious area in the catchment. Currently there is minimal impervious area in the catchment. Post development there is an increase in the amount of impervious area in the catchment.

The total impervious areas for the proposed residential developed areas (including roads) varies slightly between catchments depending on the amount of larger lots within the catchment and is calculated to vary between 50 to 55% impervious area.

Riparian corridors and revegetated areas are assumed to have minimal impervious areas and hence the total impervious area post development is estimated to be less than 40% for the entire development area.

The introduction of impervious areas and development in the catchment has the potential to:

- increase the annual runoff volumes of runoff from the development
- increase the discharge of peak flows from the development
- reduce the water quality discharging from the development and discharge of pollutants

to downstream waterways

A strategy has been developed to address the impacts of development and to meet the design criteria outlined in section 4. This strategy is outlined in the following sections.

Figure 33: Overview of proposed development (developable land summary)

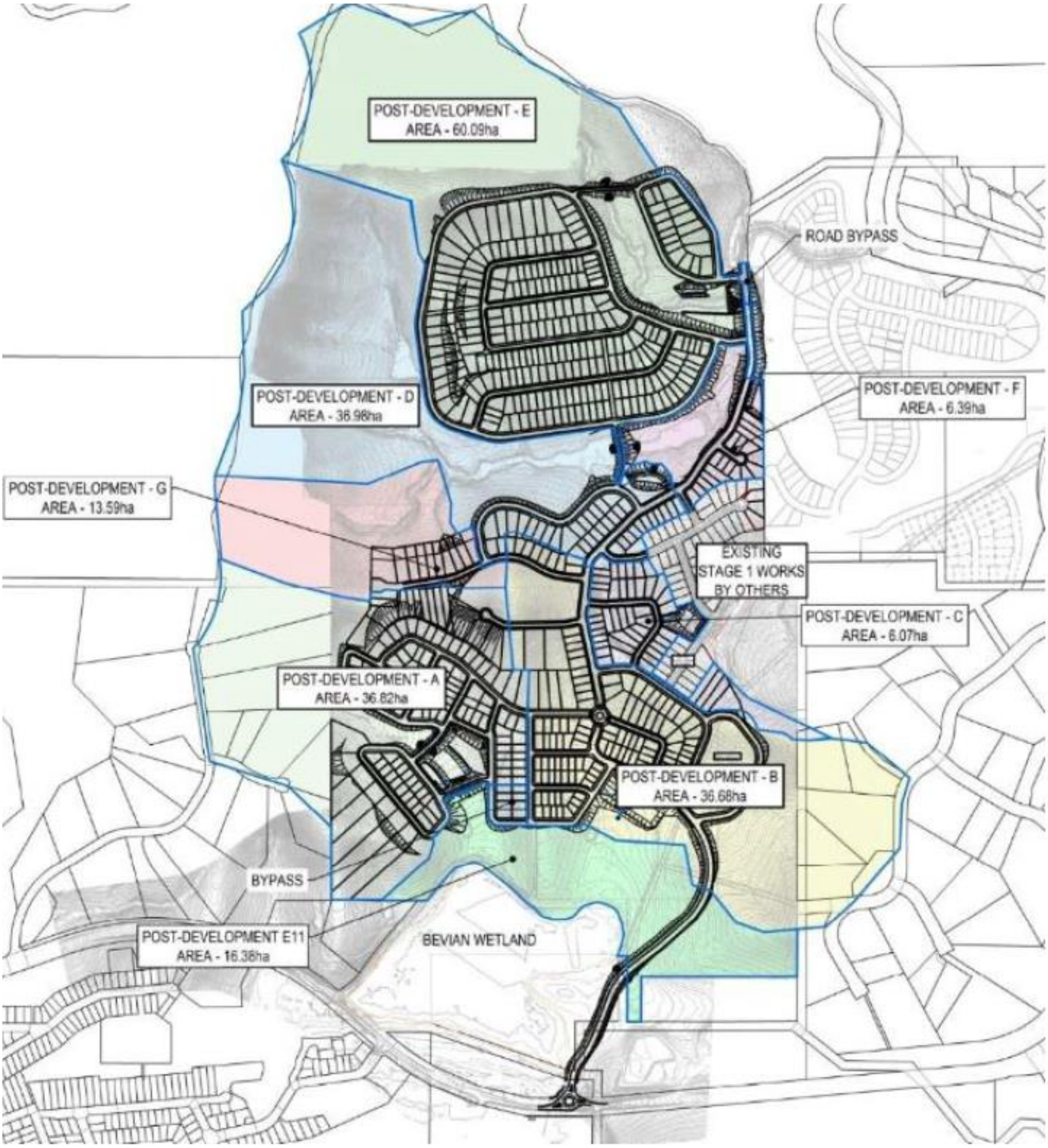

Figure 34: Post development catchments (Enspire 2025)

5.2 INTEGRATED WATER MANAGEMENT STRATEGY

To address the impacts an integrated water management strategy has been developed to manage the potential impacts of the development on the receiving water. The water management strategy is conceptually shown in Figure 35 and the elements and the role in the strategy is summarised in Table 3. The location of the proposed basins within the development is shown in Figure 33 and in further detail in Enspire's accompanying civil engineering drawing set.

For further detail on the water management strategy including details on proposed configuration of the elements, sizing and modelling of the individual components refer to Enspire's Civil engineering report (2025).

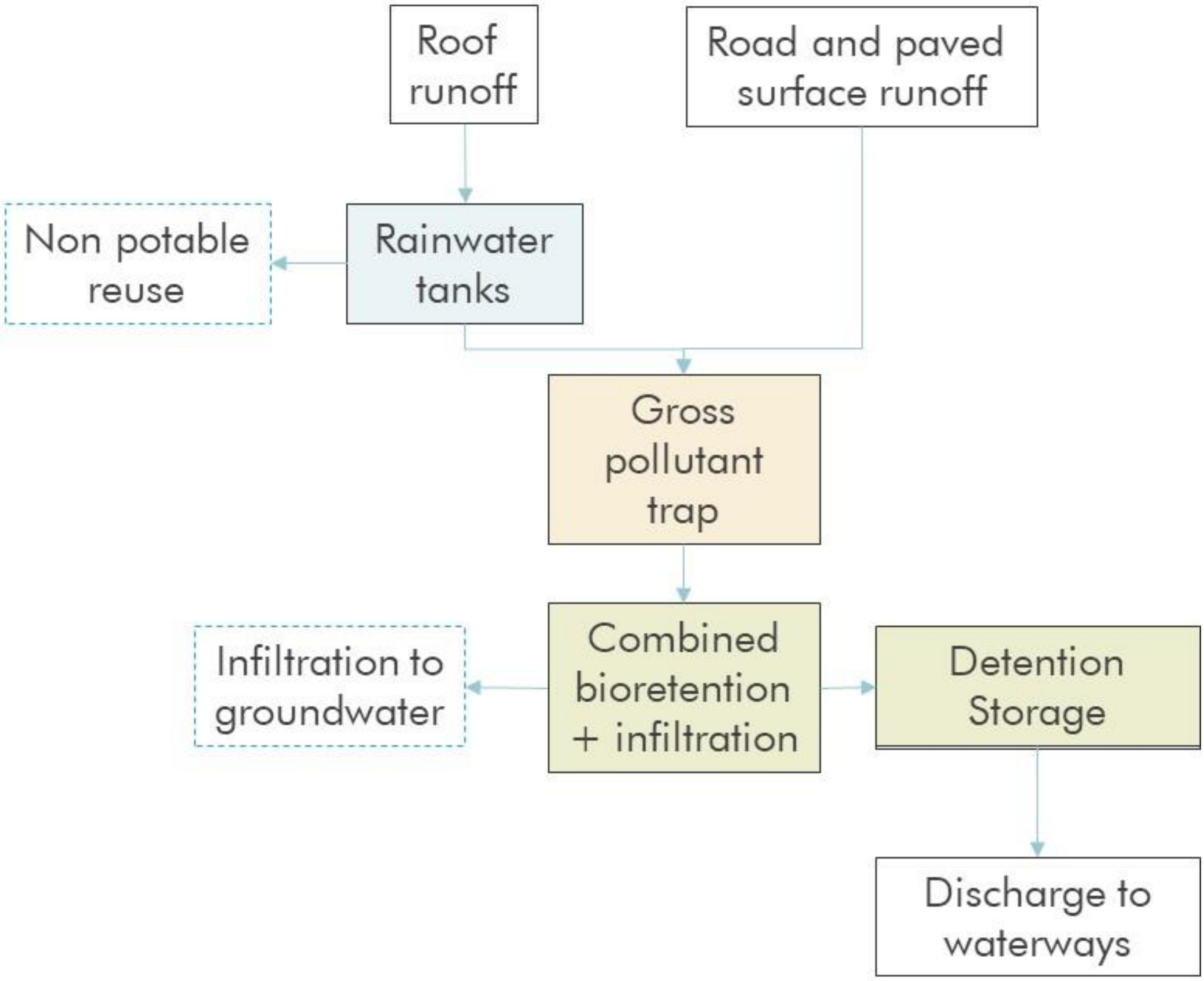

Figure 35: Water management strategy

Table 3: Water management strategy

Element in strategy	Description	Role in strategy
Rainwater tanks	Collection of roofwater and reuse for non-potable reuse on lot	Reduce runoff and contribute to pre-development hydrology
Gross pollutant trap	Coarse screen and sump to collect litter, leaf litter and coarse sediment	Improve the water quality discharging from site and provide a key maintenance point to manage 'bulky' pollutants
Bioretention and infiltration systems	Bioretention systems with a vegetated soil filter and unlined base to enable infiltration into the in-situ soils	Treat runoff from the development to a high quality prior to discharge and the unlined base allows infiltration to occur to reduce the stormwater runoff from the development and to enable recharge of groundwater
Detention storage	Additional 'air space' above the raingarden with a controlled pipe outlet to allow large stormwater events to pond temporarily	Reduce the peak flows from large storm events to reduce the potential for erosion and scour of the waterway

5.3 EVALUATION OF WATER MANAGEMENT STRATEGY- BEVIAN WETLAND

The following sections provide a summary of the outcomes of the water management strategy and an assessment of the strategy against the objectives that were established in section 4 of this report for Bevian Wetland.

5.3.1 WATER QUALITY IMPACTS

Water quality from the development is managed primarily through biofiltration basins with secondary water quality benefits provided by rainwater tanks and infiltration.

The water quality of the post development scenario has been assessed in MUSIC and compared to the pre-development scenario and objectives.

The results for Bevian wetland are shown in Figure 36, Figure 37 and Table 4. The results show that the strategy is able to mitigate the impacts of water quality from the development and is able to:

- Reduce the post development mean annual pollutant loads below the pre-development loads for TSS, TP and TN
- Meet the water quality load objectives for reducing loads post development without any attenuation

Hence the proposed strategy is able to meet the water quality objectives developed to ensure that water quality from the development will be managed so as to minimise any impacts on the Bevian Wetland.

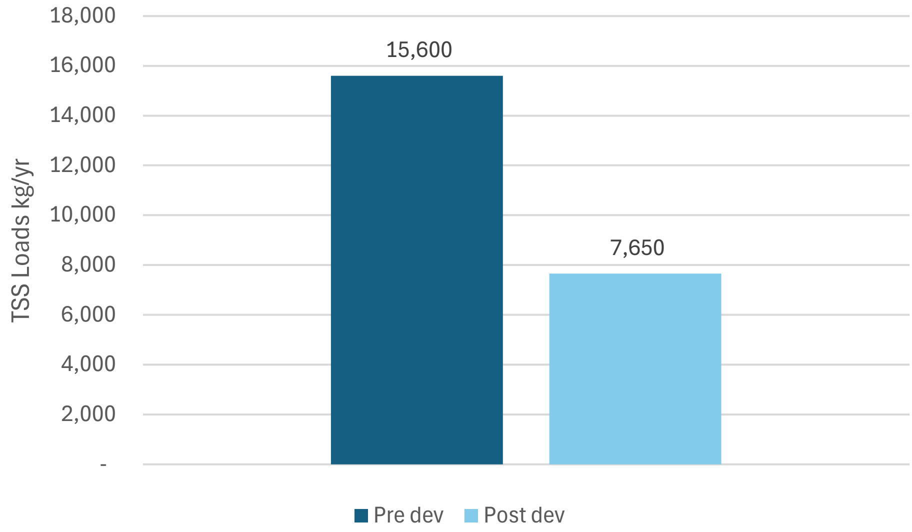

Figure 36: Bevian wetland TSS Loads – Pre and Post Development

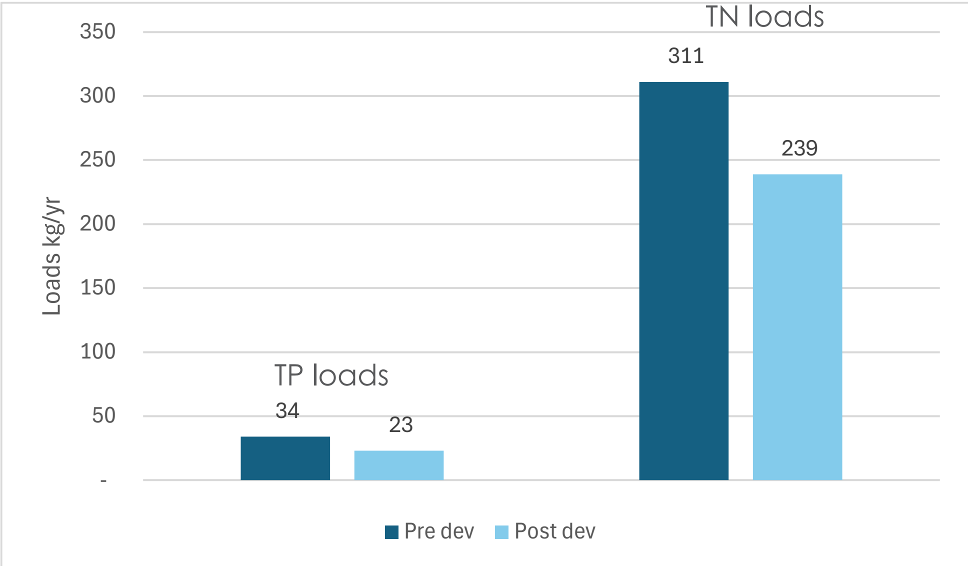

Figure 37: Bevian wetland nutrient Loads – Pre and Post Development

Table 4: Bevian wetland pollutant loads– pre and post development

Parameter	Pre-Dev	Post-dev no attenuation - kg/yr	Post-development – with proposed strategy - kg/yr	Pollutant load reduction %	Objective %
TSS	15,600	44,480	7,650	83	Min. 80
TP	34	89.5	23	74	Min. 45
TN	311	634	239	62	Min. 45

5.3.2 FLOW HYDROLOGY IMPACTS

Flow hydrology for the development is managed post development through rainwater tanks and infiltration into the existing soils.

The flow hydrology of the post development scenario has been assessed in MUSIC and compared to the pre development scenario and objectives.

The results for Bevian wetland are shown in Figure 38, Figure 39 and Table 5. The results show that the strategy is able to mitigate the impacts of runoff from the development and is able to meet the objectives developed in section 4:

- Match the pre-development mean annual runoff volumes flow with the post - development mean annual flow runoffs (refer Figure 39)
- Preserve the wetting-drying hydrology of Bevian wetland by matching the pr-development and post development 10%ile, 50%ile and 80% ile flows (refer

Hence the proposed strategy is able to meet the objectives developed and will ensure that flows from the development will be managed so as to minimise any impacts on the flow hydrology of Bevian Wetland.

Table 5: Bevian wetland flow hydrology – pre and post development flows

Flow percentile	Pre development m^3/s	Post development m^3/s
20% ile	0	0
50% ile	0	0
80% ile	0.003	0.003

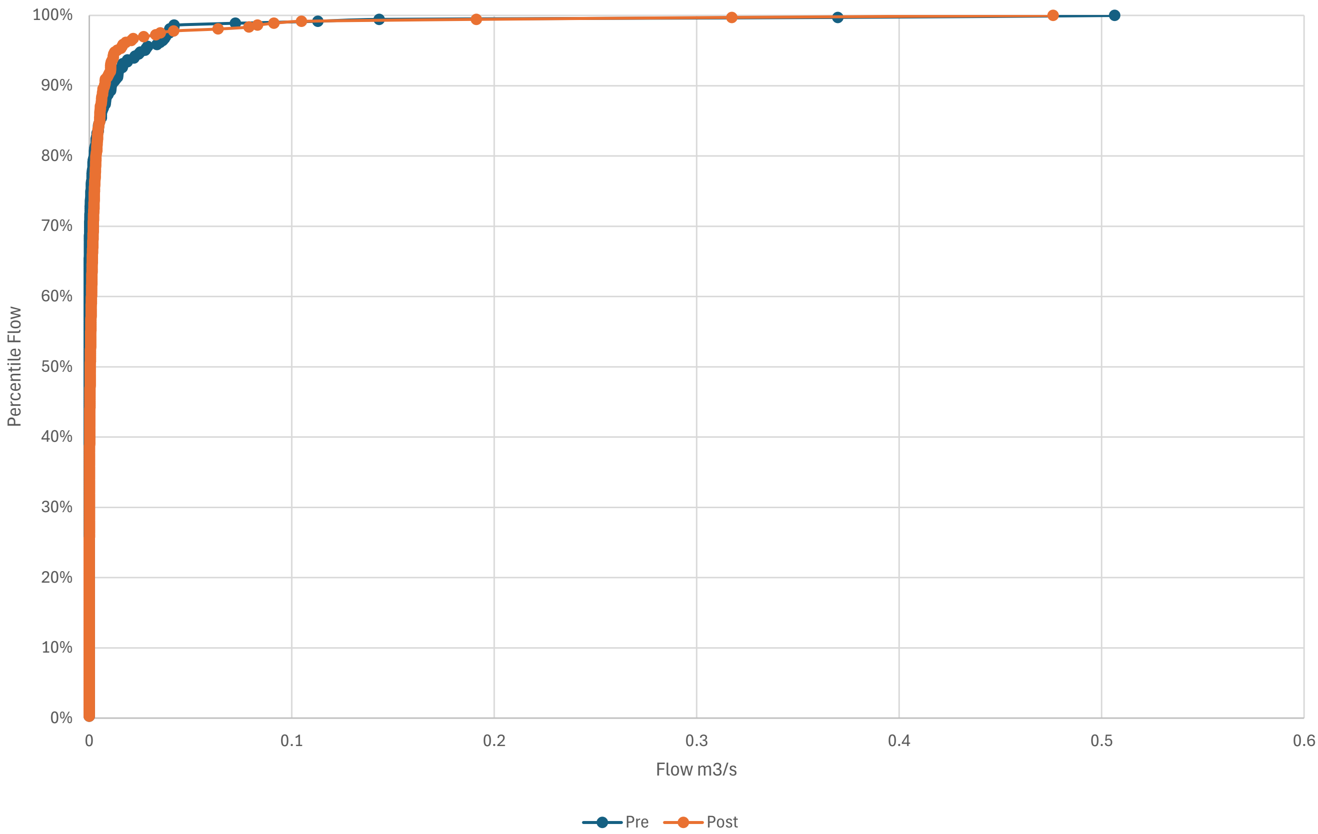

Figure 38: Bevian Wetland flow hydrology– pre and post development flows

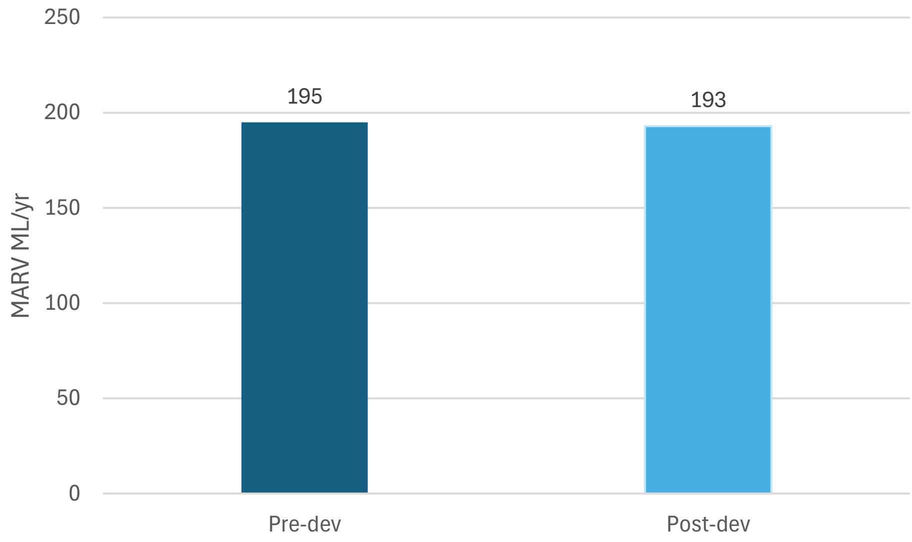

Figure 39: Bevian Wetland mean annual runoff – pre and post development flows

5.3.3 BEVIAN WETLAND ASSESSMENT SUMMARY

The proposed strategy is able to:

- Match the pre-development flow hydrology and runoff volumes
- Improve the water quality draining to Bevian wetland

Hence overall the development is anticipated to have an overall positive impact on to the receiving water of Bevian wetland.

5.4 EVALUATION OF WATER STRATEGY- SALTWATER CREEK

The following sections provide a summary of the outcomes of the water management strategy and an assessment of the strategy against the objectives that were established in section 4 of this report for Saltwater Creek and associated receiving water.

5.4.1 WATER QUALITY IMPACTS

Water quality for the Saltwater Creek catchment is managed primarily through biofiltration basins with secondary water quality benefits provided by rainwater tanks and infiltration.

The water quality of the post development scenario has been assessed in MUSIC and compared to the pre-development scenario and objectives.

The results for Saltwater Creek are shown in Table 6, Figure 40 and Figure 41. The results show that the strategy is able to mitigate the impacts of water quality from the development and is able to:

- Reduce the post development mean annual pollutant loads below the pre-development loads for TSS, TP and TN
- Meet the water quality load objectives for reducing loads post development without any attenuation

Hence the proposed strategy is able to meet the water quality objectives developed to ensure that water quality from the development will be managed so as to minimise any impacts on the Bevian Wetland.

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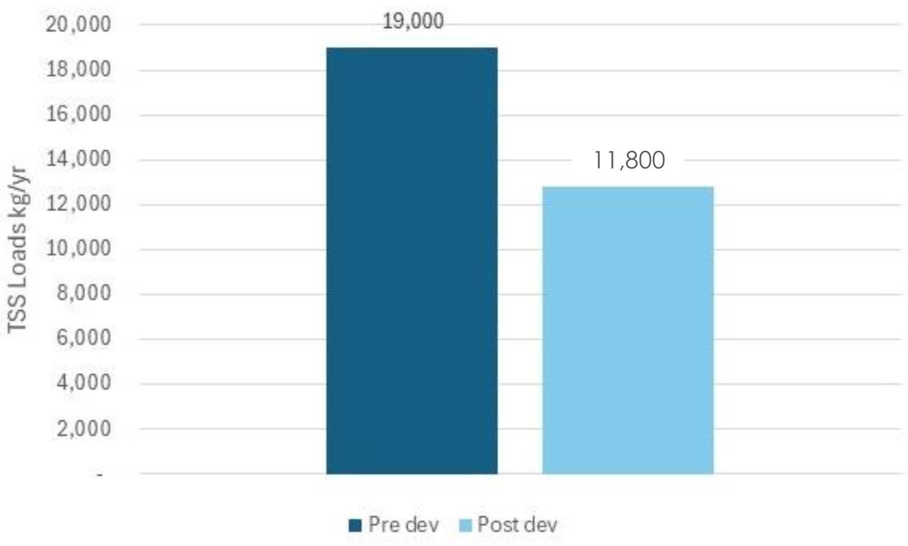

Figure 40: Saltwater Creek TSS loads – Pre and Post Development

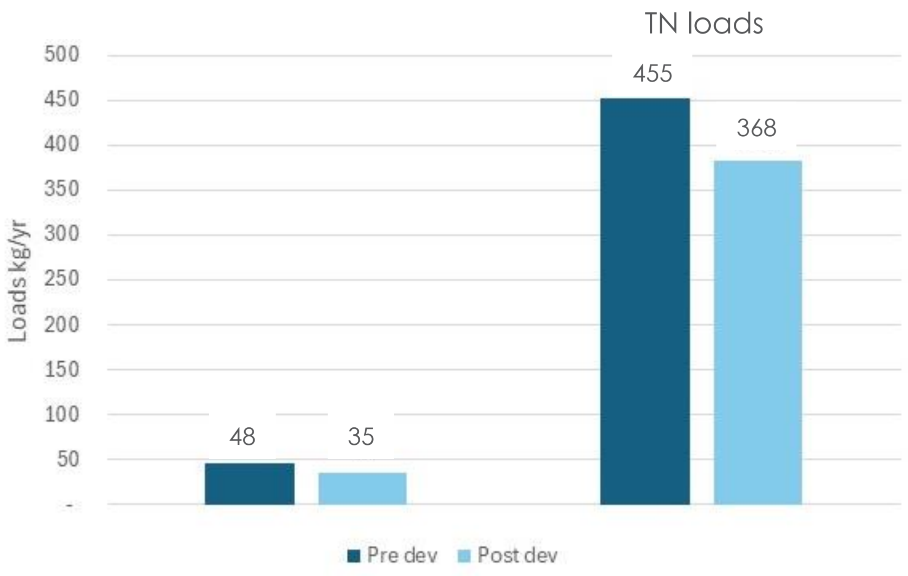

Figure 41: Saltwater Creek nutrient loads – Pre and Post Development

Table 6: Saltwater Creek pollutant loads– pre and post development

Parameter	Pre-dev kg/yr	Post-dev no attenuation - kg/yr	Post-development – with proposed strategy - kg/yr	Pollutant load reduction %	Objective %
TSS	19,000	42,800	2,770	93.5	Min. 80
TP	45	83.8	10.6	87.3	Min. 45
TN	382	557	127	77.2	Min. 45

5.4.2 FLOW HYDROLOGY IMPACTS

Flow hydrology for the development is managed post development through rainwater tanks and infiltration into the existing soils.

The flow hydrology of the post development scenario has been assessed in MUSIC and compared to the pre development scenario and objectives.

The results for Saltwater Creek are shown in Table 7, Figure 42 and Figure 43. The results show that the strategy is able to mitigate the impacts of runoff from the development and is able to meet the objectives developed in section 4:

- Match the pre-development mean annual runoff volumes flow with the post - development mean annual flow runoffs (less than 5% increase)

The results also show that the flow percentiles are similar pre and post development. There are minor increases post development, however Saltwater Creek, unlike Bevian Wetland is not sensitive to wetting and drying hydrology. The ICOLL is a permanent water, partially groundwater fed and hence slight increases in flows will have negligible impacts to the hydrology of the ICOLL. As post-development runoff does not increase from the pre-development runoff there is no change to the overall composition of flows into the ICOLL.

Hence the proposed strategy is able to meet the objectives developed and will ensure that flows from the development will be managed so as to minimise any impacts on the hydrology of Saltwater Creek and its ICOLL.

Table 7: Saltwater Creek flow hydrology – pre and post development flows

Flow percentile	Pre development m^3/s	Post development m^3/s
20% ile	0	0
50% ile	0	0.001
80% ile	0.003	0.007

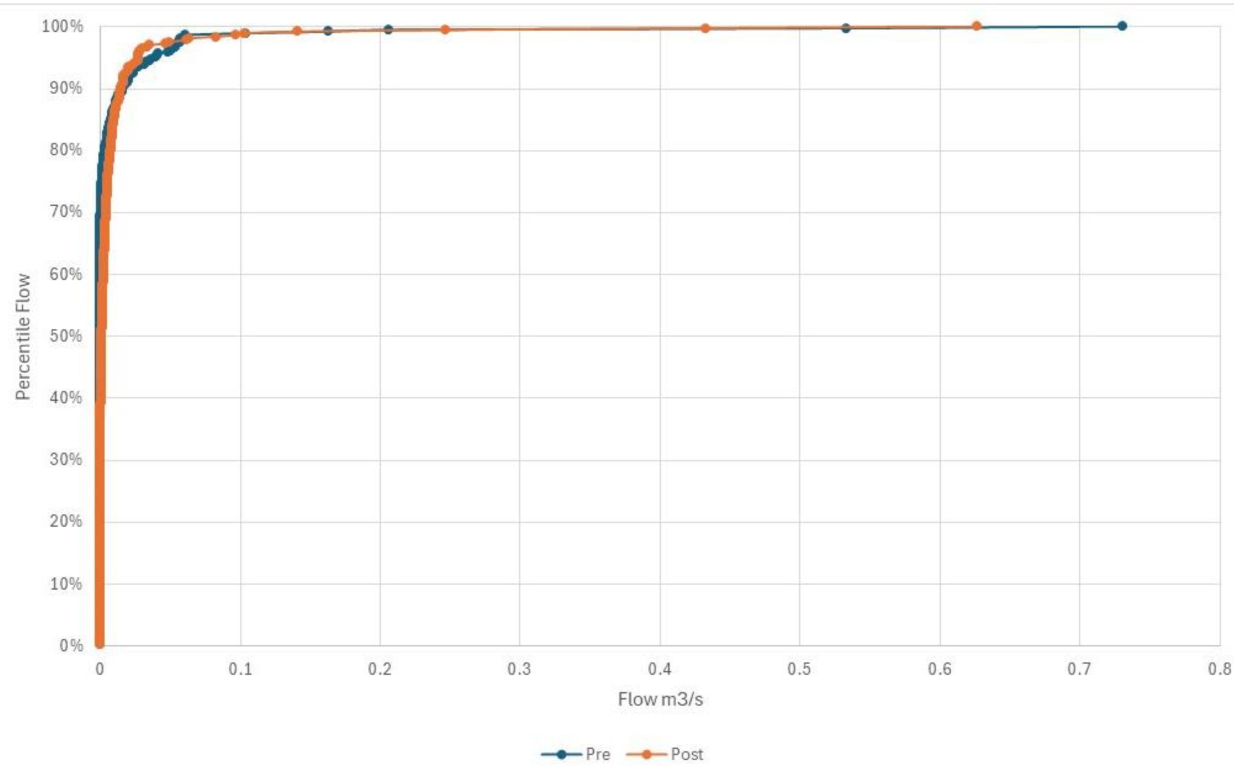

Figure 42: Saltwater Creek flow hydrology– pre and post development flows

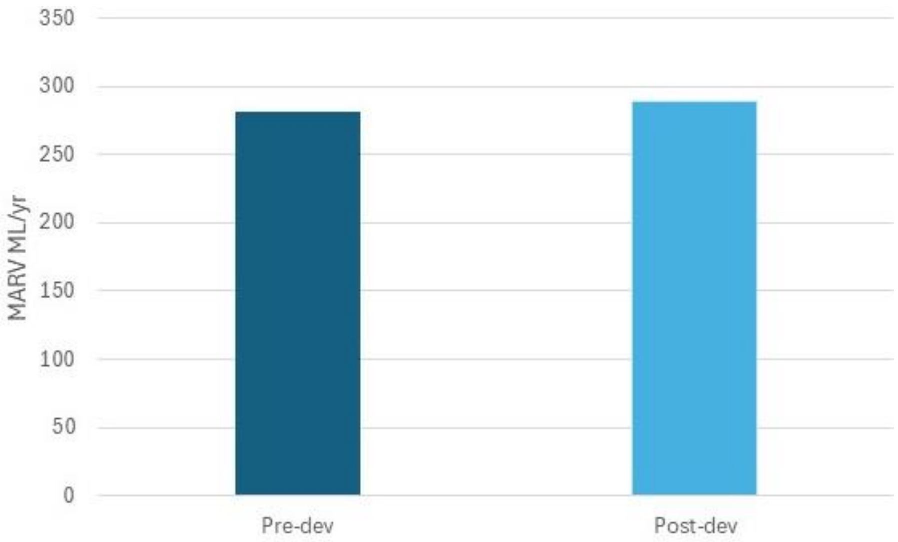

Figure 43: Saltwater Creek mean annual runoff volume – pre and post development flows

5.5 WATERWAY CROSSINGS

A summary of the waterway crossings which includes box culvert crossings are shown in Figure 44. There is an existing pipe culvert outlet to Bevian Wetland which is not proposed to be altered. There are also a number of pipe outlets from the development into the waterways shown in the figure. In accordance with the Guidelines for Controlled Activities on Waterfront Land and the riparian corridor matrix box culverts are acceptable on (refer Ecological Australia section 2.5)

- Any crossings are allowed in 1st and 2nd order streams
- Culvert crossings are acceptable on 3rd order streams

Hence the proposed waterway crossings are consistent with and meet the requirements of the Guidelines for Controlled Activities on Waterfront Land. Refer to Enspire (2025) design drawings for more details on the box culverts.

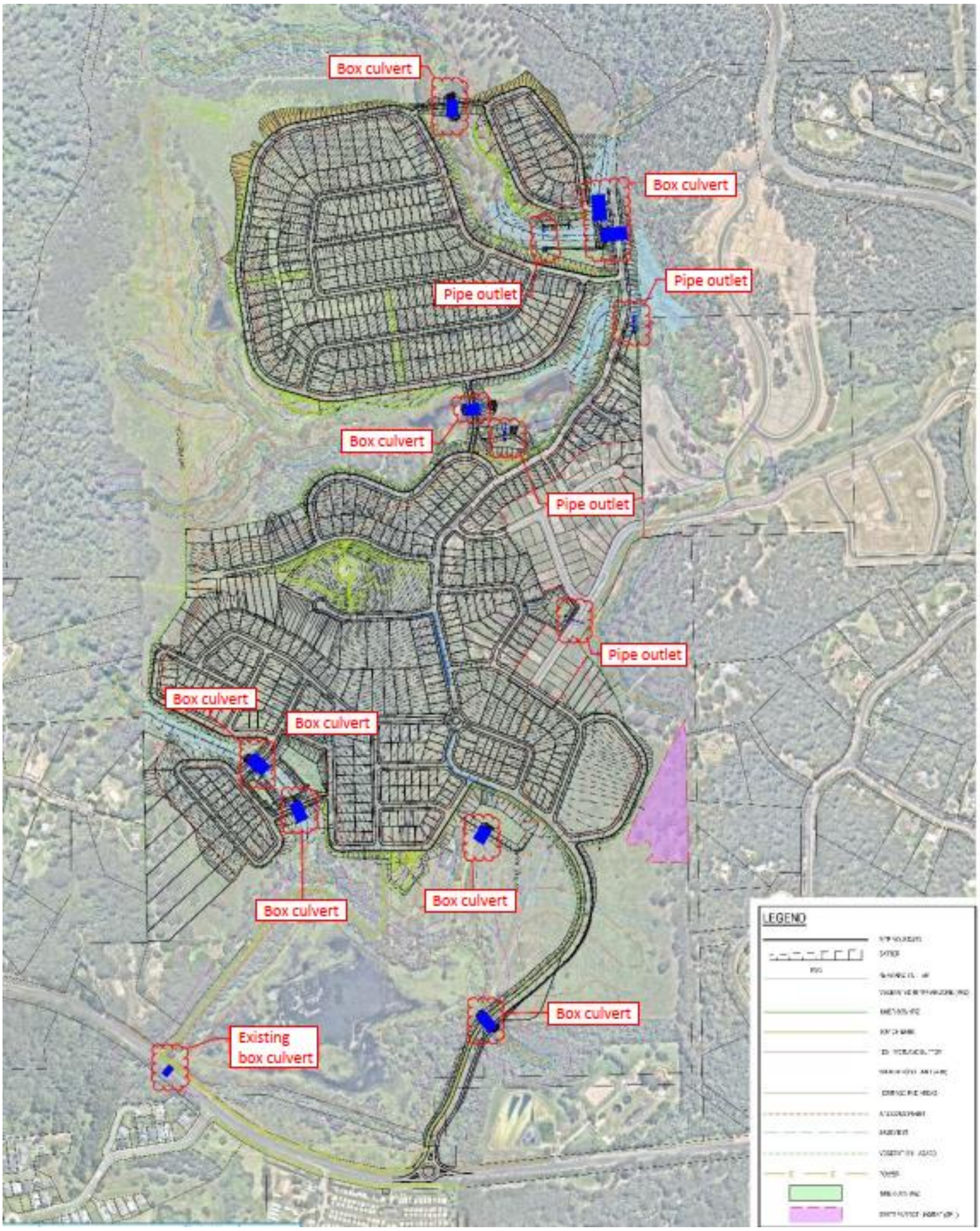

Figure 44: Waterway crossing summary (Ecological Australia, 2025)

Stream order	Vegetated Riparian Zone (VRZ)	RC offsetting for non RC uses	Cycleways and paths	Detention basins		Stormwater outlet structures and essential services	Stream realignment	Road crossings		
				Only within 50% outer VRZ	Online			Any	Culvert	Bridge
1st	10 m	•	•	•	•	•	•	•		
2nd	20 m	•	•	•	•	•		•		
3rd	30 m	•	•	•		•			•	•
4th+	40 m	•	•	•		•			•	•

Figure 45: DPE Riparian corridor matrix and waterway crossing guidelines

5.6 SENSITIVITY TO RAINFALL DATA

MUSIC modelling for water quality and flow management data requires the use of 6 min rainfall, pluviograph, data. As outlined in Enspire (2025) *Water Cycle Management and Civil Engineering Report* for the development in section 7.3.1 rainfall data was selected from station 69148 Moruya as it was the closest 6 minute rainfall station to the site. However data collected at this site is limited to 1 year of suitable available data as outlined by Enspire (2025).

A comparison of rainfall of the 2001 data to the mean long term rainfall at Moruya Station 69148 shows that the rainfall was approximately 90% of the long term mean rainfall at the station (refer Figure 46) with noticeably wetter months in July and August and noticeably drier months in April, May and June.

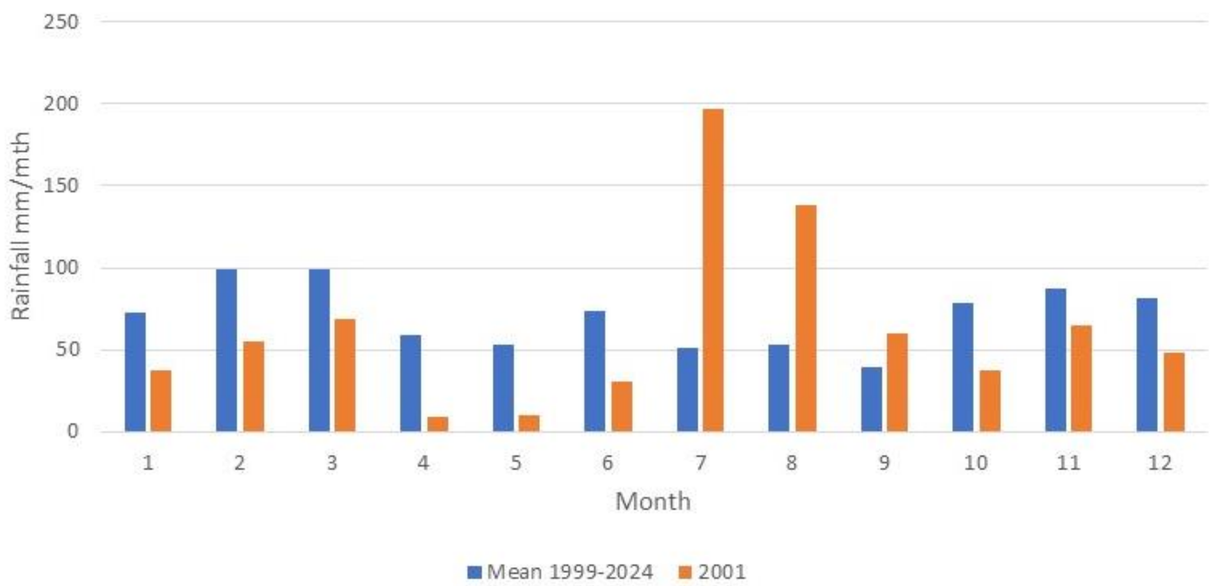

Figure 46:Rainfall in 2001 and long term average

Further analysis was also undertaken between the Moruya rainfall pattern and a pluviograph station with a similar rainfall pattern. This is commonly undertaken for MUSIC modelling as pluviograph data is limited and pluviograph station are not widely available (in contrast to daily rainfall data)

Comparison to a number of stations found that data at Moruya Head which has a long term record of rainfall from 1875 to 2024 was well represented by Pluvio station 66124 (Parramatta North) which has a similar long term rainfall data period (1965-2024). Moruya Head has a similar mean annual rainfall (954mm/yr) with Parramatta North (979mm/year) and is within 3% of the rainfall. The monthly distribution is also well matched as shown in Figure 47.

Similarly a comparison of number of raindays (greater than or equal to 1mm) shows that they both have a similar number of rain days (84 raindays at Moruya and 91 at Parramatta North) which indicates that there is a good correlation of rainfall intensity between the two stations.

Based on this analysis Parramatta North was considered a reasonable representation of pluviograph data for the site.

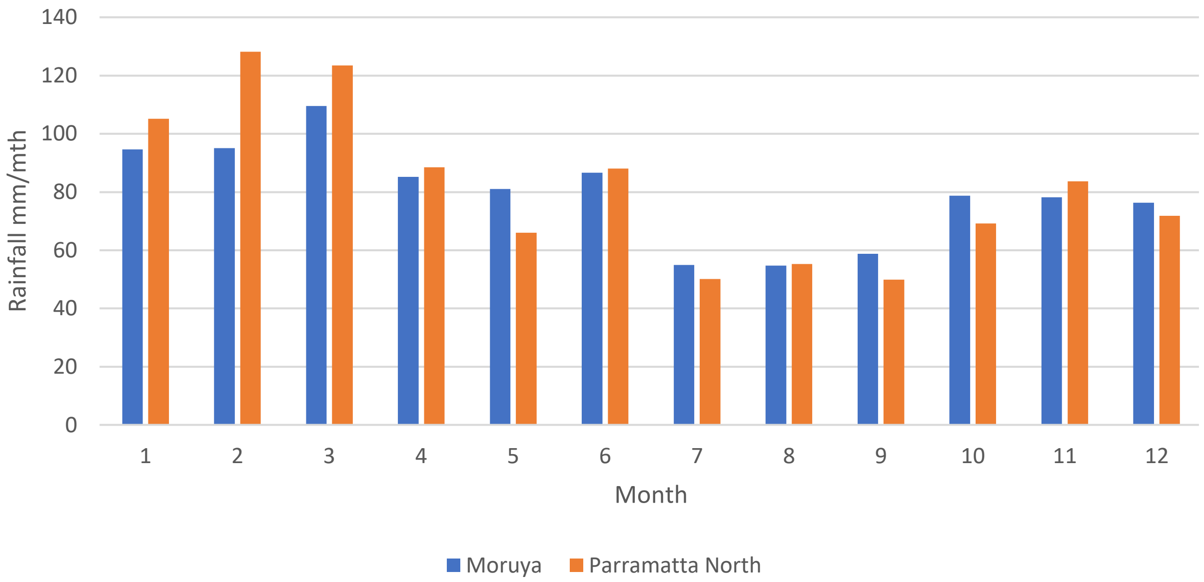

Figure 47:Long term rainfall at Moruya compared to Parramatta North pluvio station

Hence to understand the sensitivity of the current modelling to long term rainfall data a model was run with Parramatta North rainfall data over a 10 year modelling period. 10 years is considered an acceptable length of time for MUSIC modelling for 6 minute rainfall data (e.g. the adopted NSW Government MUSIC model for Wianamatta Creek Aerotropolis has 10 years of rainfall data).

The MUSIC model was run for the 10 year rainfall data (1986 to 1995) with a similar average to the long term average rainfall. The results found that the proposed treatment train was able to meet the targets of no net increase in pollutant loads when using the longer term data from a comparative long term pluvio station.

The results are shown in the table below for Bevian Wetland and show that the objectives are met with a reduction in flow and pollutant to the wetland from pre development to post development.

Table 8: Bevian wetland pollutant loads– pre and post development adopting long term pluvio data from a comparative rainfall station

Parameter	Pre-Dev	Post-dev no attenuation - kg/yr	Post-development – with proposed strategy - kg/yr	Pollutant load reduction %	2001 Moruya model
TSS	23,400	44,480	12800	82	83

TP	54	134	41.5	69	74
TN	518	912	402	56	62
Flow	305	445	300	33	33

Hence it has been found that the modelling undertaken to date does not change with longer term rainfall modelling using a representative pluvio station with long term pluvio data. Hence it is concluded that the outcomes of the proposed strategy are not sensitive to the rainfall data that has been adopted and the rainfall data that has been adopted is considered suitable.

6 MONITORING AND ASSESSMENT

6.1 MONITORING OBJECTIVES INCLUDING WQOS

A recommended monitoring and assessment program is outlined in the sections below. The program has two key objectives:

- Monitor the health of the key receiving waters to assess any impacts from the development on the receiving waters
- Monitor the performance of the mitigation measures to confirm that the mitigation measures are operating effectively

6.2 RECEIVING WATER MONITORING

To achieve the monitoring objective for the key receiving waters it is proposed to monitor the receiving waters of the two key catchments (Bevian Wetland catchment and Saltwater Creek catchment). The proposed locations for monitoring are shown in Figure 48 and include the key receiving water systems in the catchments:

- Bevian Wetland and ICOLL in Barlings Beach Holiday Park
- Saltwater Creek and the Saltwater Creek ICOLL

It is proposed to monitor monthly

- During construction
- for 12 months post completion of all works within the catchment
- including at least two wet weather samples, out of every 12 samples. A wet weather sample is defined as a sample taken during or within 24 hours of a rainfall event greater than 15mm in a single day

It is proposed to sample for the following analytes for testing in a NATA accredited lab:

- NO_{X}, TKN, NH_{3}, TN
- TP, Reactive P
- TSS
- BOD
- TDS

It is proposed to assess in-situ in the field for the following analytes:

- pH
- Conductivity
- Dissolved oxygen
- Temperature
- Turbidity
- Water levels within Bevian Wetland and Saltwater Creek ICOLL

As part of the monitoring recording of water levels is to be undertaken measuring the water levels from an identifiable datum such as the culver outlet/bridge deck level.

Figure 48: Receiving water monitoring locations

6.3 WATER QUALITY MONITORING OF MITIGATION MEASURES

To achieve the monitoring objective for the mitigation measures it is proposed to monitor the sediment basins during construction and bioretention basins post completion of works in the catchment. It is proposed to monitor each of the interim sediment basins and ultimate bioretention basins as outlined in the Enspire drawings.

It is proposed to monitor discharges from the sediment basins during construction including sampling of sediment basins during discharge from the basins for events greater than 15mm including

- TSS
- pH
- Conductivity
- Turbidity

- Temperature

For the bioretention basins it is proposed to monitor the ins-situ infiltration rates using a double ring infiltrometer at the existing in-situ soils at the time of:

- construction of the interim sediment basins
- construction of the final bioretention basins and decommissioning of the interim sediment basins

It is proposed to monitor the bioretention basins monthly for 12 wet weather events, A wet weather sample is defined as a sample taken during or within 24 hours of a rainfall event greater than 15mm in a single day. This is to occur within 24 months of the completion of the basins.

It is proposed to sample the outlet of the bioretention system for the following analytes for testing in a NATA accredited lab:

- NO_{X}, TKN, NH_{3},TN
- TP, Reactive P
- TSS

It is proposed to assess in-situ in the field at the outlet of the bioretention system for the following analytes:

- pH
- Conductivity
- Dissolved oxygen
- Temperature
- Turbidity

In addition to the water quality monitoring it is proposed to undertake on at least three occasions a verification of the hydraulic functioning of the bioretention systems including

- Confirm adequate discharge of water into the basins without bypass
- Confirm the discharge of water from the basin outlet
- Confirm that the basins have drained within 6 hours after cessation of the rain event
- Confirm that the basins are free from scour and erosion and are generally stable

After completion of the construction bioretention basins and again 12 months after completion of construction of the basins it is proposed to undertake in situ hydraulic conductivity monitoring of the basin soil media. This is to be undertaken using a double ring infiltrometer to measure the in-situ hydraulic capacity of the soil

7 SUMMARY AND RECOMMENDATIONS

7.1 SUMMARY

<u>Bevian Wetland</u>

Bevian wetland is sensitive to changes in hydrology and changes to the runoff into the wetland has the potential to impact on the wetland including impacts to the wetting-drying hydrology of the wetland and water levels in the wetland with the potential to reduce the times available for wetland vegetation dependent on dry spells in the wetland to germinate and establish.

As the system is a lentic system, the wetland is sensitive to changes in the mean annual runoff volume (MARV) into the wetland. Due to the size of the wetland it is relatively insensitive to any one event as any one event will have a relatively small impact on the wetland as the volume of the wetland is very large relative to the catchment runoff. Hence the key parameter is to ensure that

- No increase in the post development mean annual runoff volume (MARV) compared to the pre-development MARV
- No increase in the post development **80**% ile flow into the wetland (to preserve the wetland drying hydrology) compared to the pre development 80% ile flow into the wetland

The water quality concentrations within Bevian Wetland are currently very high and are an order of magnitude higher than the trigger values for water quality concentrations for slightly disturbed estuary systems.

As Bevian wetland is a lentic system and as outlined in Australian Runoff Quality, for lentic systems, load based targets are considered the most appropriate targets. Bevian Wetland in particular is not considered to be insensitive to water quality concentrations, given the current high values of water quality within the Wetland.

<u>Saltwater Creek ICOLL</u>

Saltwater Creek ICOLL is similarly a predominantly lentic system as the majority of the time the system is closed to the ocean. When the system is open to the ocean after large rainfall events, the water quality will be dominated by tidal exchange. As the majority of the time the system is closed to the ocean and during this time it is a lentic system, load based targets are considered appropriate.

Saltwater Creek ICOLL is likely to be sensitive to changes in phosphorous and hence higher load targets are recommended for phosphorous. It is recommended that adoption of a precautionary approach of no increase in total pollutant loads from post development runoff comparted to pre-development in the Saltwater Creek catchment. This is considered conservative as when the system is open to the ocean there is likely to be significant exchange of nutrients between the ICOLL and the ocean.

There is potential for increased flows into not Saltwater Creek ICOLL to impact on the hydrology of the ICOLL. In particular significant increases in flows has the potential to change the salinity of the ICOLL with increased surface flows resulting in a reduction in salinity. However, as the system is connected to the groundwater (unlike Bevian wetland) with recharge from the ICOLL into groundwater occurring during wetter periods and seepage into the ICOLL during dry periods. Hence it is likely that the ICOLL is less sensitive to changes in runoff.

Adoption of the recommended water quality and hydrology management objectives the current processes of the Saltwater ICOLL and Bevian Wetland will be able to retain the current pre-development water quality and hydrology processes in the receiving waters.

Adoption of these objectives will also serve to protect the associated values with these systems including ecological processes, habitat, groundwater and human values.

Marine Protected Estate

The objectives will also serve to protect the downstream marine estate through negligible changes to the water quality and hydrology discharging to the ocean. In particular the proposed strategy will

- Match the existing hydrology and pollutant loads to Bevian Wetland resulting in no additional discharges to the Marine Protected Estate from this catchment,
- Discharges from the Icoll downstream of Bevian Wetland is rarely open to ocean and hence direct discharges from the catchment from the Bevian Wetland are expected to occur only rarely thereby having negligible impact on the marine estate
- Negligible increase in the existing hydrology and pollutant loads to Salt Water Creek Icoll resulting in negligible additional discharges to the Marine Protected Estate from this catchment,
- Discharges to Rosedale Beach from Saltwater Creek Icoll only occur when the entrance to the Icoll is open which happens during large storm events once every 1 to 2 years on average and hence discharge from the development to the marine estate is not a regular occurrence
- When the Saltwater Creek Icoll entrance is open to ocean, the development will discharge into a high energy environment which will result in significant mixing and dispersal of nutrients and sediment into the ocean, with negligible changes to the existing discharges from the catchment
- The pollutant loads from the development (to the Icolls) are an order of magnitude less than the STP discharges directly into the marine estate.

Overall the proposed strategy of matching pre-development hydrology and water quality will result in a negligible impact to the Marine Protected Estate.

7.2 RECOMMENDATIONS

To meet the objectives developed to protect the receiving waters, a water management strategy has been developed in collaboration with Enspire. It is recommended that the following water management strategy be adopted for the development, consisting of the following components:

- Rainwater tanks for non-potable reuses to reduce runoff and conserve potable water
- Gross pollutant traps and bioretention systems to remove pollutants
- Infiltration to the base of the bioretention systems to infiltrate treated stormwater into the groundwater and reduce surface runoff
- Detention basins to reduce peak flow discharges from the development and protect

waterways from erosive high flows

MUSIC modelling has demonstrated that the above strategy is able to meet the water management objectives. Enspire (2025) outline the recommended treatment system sizes and configurations of the water management strategy.

Infiltration is an important part of the strategy. Infiltration tests across the site have determined that the existing sandy/silty/gravelly clays have a reasonable infiltration rate. As part of the monitoring strategy it is recommended that infiltration be assessed at both the time of construction of the interim sediment basins and again at the time of construction of the ultimate bioretention basins.

A monitoring strategy has also been developed to ensure that impacts to water quality and hydrology are minimised during construction and that post construction the water management strategy is operating as intended as outlined in this strategy. It is recommended that this monitoring strategy be implemented as part of the construction and post construction verification process.

8 REFERENCES

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