Covering Note

This report contains sensitive information relating to location of Aboriginal Cultural Heritage sites. To protect this sensitive information Council has removed the information.

Figure 2-1 of this report has been removed to protect culturally sensitive information that has been presented in the original report.

If you have any questions about how Council manages sensitive information, please contact Council on 1300 293 111.

St Georges Basin-Sussex Inlet, Swan Lake, Berrara Creek Coastal Management Program

Stage 2 Synthesis Report

Shoalhaven City Council

20/10/2023

311015-00158

Advisian
Worley Group

advisian.com

Copyright and non-disclosure

Company details

Advisian Pty Ltd
ABN 50 098 008 818

Level 17, 141 Walker Street
North Sydney NSW 2060
Australia

T: +61 2 9495 0500
F: +61 2 9810 5777

PROJECT 311015-00158 - CS-REP-006: St Georges Basin-Sussex Inlet, Swan Lake, Berrara Creek Coastal Management Program - Stage 2 Synthesis Report

Rev	Description	Author	Review	Advisian approval	Revision date	Client approval	Approval date
A	Draft for Internal Review	C Adamantidis, B Morgan, M Priestley	C. Adamantidis	C. Adamantidis	13.06.23	Initial. Surname	Approval date
B	Draft	C Adamantidis, B Morgan, M Priestley	C. Adamantidis	C. Adamantidis	05.09.23		
C	Draft	C Adamantidis, B Morgan, M Priestley	C. Adamantidis	C. Adamantidis	29.09.23		
0	Final	C Adamantidis, B Morgan, M Priestley	C. Adamantidis	C. Adamantidis	20.10.23		

Table of contents

Executive summary **10**

Acronyms and abbreviations **13**

1 Introduction **16**

1.1 Structure of the CMPs 20

1.2 Study Area 21

2 Synthesis of Cultural Social and Ecological Knowledge **23**

2.1 Cultural and Social 23

2.1.1 Aboriginal Heritage 23

2.1.2 Non-Aboriginal Heritage 26

2.1.3 Social and Economic Characteristics 34

2.1.4 Social Values 36

2.1.5 Key Cultural and Social Issues 37

2.2 Ecological Environment 40

2.2.1 Overview 40

2.2.2 Matters of National Environmental Significance 40

2.2.3 Key Fish Habitat 41

2.2.4 Marine and Estuarine Vegetation 41

2.2.5 Coastal Wetlands and Littoral Rainforests 41

2.2.6 Threatened and Protected Fauna 45

2.2.7 Invasive Pests 45

2.2.8 Key Issues 46

3 Stage 2 Risk Assessments and Supporting Studies **49**

3.1 Foreshore Erosion 49

3.1.1 Overview 49

3.1.2 Key Issues 50

3.2 Estuary Entrance Management – Swan Lake and Berrara Creek 56

3.2.1 Overview 56
3.2.2 Recommendations for Swan Lake 56
3.2.3 Recommendations for Berrara Creek 58
3.3 Water Quality 60
3.3.1 Overview 60
3.3.2 Key Issues 61
3.3.3 Recommended Sampling Program 62
3.3.4 Recommended locations for Gross Pollutant Traps (GPTs) 63
3.4 Inundation and Sea Level Rise 64
3.4.1 Overview 64
3.4.2 Key Issues 70
3.5 Navigation and Safety 72
3.5.1 Overview 72
3.5.2 Key Issues 72
4 Key Issues and Risks 77
4.3 Detailed Risk Assessment 78
4.3.1 Results 80
4.3.2 Key Issues identified during Community and Stakeholder Engagement 84
5 Summary and Conclusions 85
5.1 Need for Planning Proposal 85
6 References 87

Appendices

Appendix A Demographic and Economic Background Information

A.1 Social Characteristics
A.1.1 St Georges Basin/Sussex Inlet
A.1.2 Swan Lake
A.1.3 Berrara Creek

A.2 Economic Characteristics

A.2.1 St Georges Basin/Sussex Inlet

A.2.2 Swan Lake

A.2.3 Berrara Creek

Appendix B Synthesis of Ecological Data

B.1 Matters of National Environmental Significance

B.1.1 St Georges Basin/Sussex Inlet

B.1.2 Swan Lake

B.1.3 Berrara Creek

B.2 Key Fish Habitat

B.2.1 Waterway and Fish habitat Classification

B.3 Protected Marine and Estuarine Vegetation

B.3.1 St Georges Basin/Sussex Inlet

B.3.2 Swan Lake

B.3.3 Berrara Creek

B.4 Protected Areas

B.4.1 Corramy Regional Park

B.4.2 Conjola National Park

B.4.3 Wetlands

B.4.4 Critical Habitat / Areas of Outstanding Biodiversity Value

B.5 Threatened and Protected Fauna

B.5.1 NSW *Biodiversity Conservation Act* 2016 & Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999

B.5.2 NSW *Fisheries Management Act* 1994

B.6 Aquaculture

B.7 Invasive Pests

B.7.1 Weeds

B.7.2 Marine Pests

Appendix C Gross Pollutant Trap Locations

C.1 Background

C.2 St Georges Basin

C.3 Swan Lake

Table list

Table 2-1 – Listed Non-Aboriginal Heritage Items for St Georges Basin and Sussex Inlet 27

Table 2-2 - Listed non-aboriginal heritage items for Swan Lake 32

Table 2-3 – Forecast population growth within the study area between 2021 and 2051 36

Table 2-4 – Key Cultural and Social Management Issues applying across all estuaries 39

Table 2-5 – Key Ecological Issues applying across all estuaries 47

Table 3-1 – Key Issues relating to foreshore erosion applying across all estuaries 50

Table 3-2 - Water quality issues and implications 62

Table 3-3 – Key Issues and potential estuary-wide management actions relating to Inundation and Sea Level Rise 71

Table 3-4 – Estuary-wide issues relating to navigation and safety 74

Table 4-1 – Risk Matrix applied to evaluate risk 79

Table 4-2 – Identified High or Extreme Risks applying to all estuaries (St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek) 81

Table 6-1 - 2016 Census social statistics for Sussex Inlet and St Georges Basin suburbs 93

Table 6-2 - 2016 Census social statistics for Cudmirrah and Swanhaven 95

Table 6-3 - 2016 Census social statistics for Berrara 95

Table 6-4 - 2016 Census economic statistics for Sussex Inlet and St Georges Basin suburbs 97

Table 6-5 - 2016 Census economic statistics for Cudmirrah and Swanhaven 99

Table 6-6 - 2016 Census economic statistics for Berrara 100

Table 6-7 - Threatened and protected marine species listed under the Commonwealth EPBC Act 1999 and NSW BC Act 2016 with the potential to occur within Sussex Inlet, St. Georges Basin, Swan Lake and Berrara Creek 116

Table 6-8 – Suggested locations for GPTs or other WSUD stormwater treatment, St Georges Basin .. 131

Table 6-9 – Suggested locations for GPTs or other WSUD stormwater treatment, Sussex Inlet 133

Table 6-10 – Suggested locations for GPTs or other WSUD stormwater treatment, Swan Lake 135

Figure list

Figure 1-1 – Stages of a CMP 17

Figure 1-2 – Study Area for St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek CMPs..... 22
Figure 2-1 – Location of the Fishermans Rock Aboriginal site, circled in red (Source: NSW NPWS, 2021)..... 25
Figure 2-2 – View upstream of Berrara Creek towards Fishermans Rock (Source: Advisian, 2021)..... 26
Figure 2-3 – LEP listed non-aboriginal heritage items in St Georges Basin (Source: NSW Planning Portal, 2022)..... 29
Figure 2-4 - LEP listed non-aboriginal heritage items in Sussex Inlet and location of Christians Minde Settlement (Source: NSW Planning Portal, 2022)..... 30
Figure 2-5– World War II Flying Boat Base and Former Kemp's Boatshed site (Source: Advisian, 2021)..... 31
Figure 2-6 - LEP listed non-aboriginal heritage items for Swan Lake (Source: NSW Planning Portal, 2022)..... 33
Figure 2-7– Errol Bond Memorial and The Springs"—Holiday Cabins (Source: Advisian, 2021)..... 34
Figure 2-8– Location of Coastal Wetlands in St Georges Basin (NSW DPI 2021)..... 42
Figure 2-9– Location of Coastal Wetlands in Sussex Inlet (NSW DPI 2021)..... 43
Figure 2-10 - Location of Coastal Wetlands in Swan Lake and Berrara Creek (NSW DPI 2022)..... 44
Figure 3-1 – Examples of foreshore erosion issues at St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek..... 51
Figure 3-2 – Erosion Assessment Map for St Georges Basin..... 52
Figure 3-3 – Erosion Assessment Map for Sussex Inlet..... 53
Figure 3-4 – Erosion Assessment Map for Swan Lake..... 54
Figure 3-5 – Erosion Assessment Mao for Berrara Creek..... 55
Figure 3-6 – Suggested staging for progressive updates to the Swan Lake Entrance Management Policy..... 59
Figure 3-7 – IPCC (2022) sea level rise projections from Sixth Assessment Report at Jervis Bay for SSP3-7.0 and SSP5-8.5, and corresponding sea level rise for 20 year, 50 year and 100 year planning periods. Modelled sea level rise scenarios shown in blue..... 65
Figure 3-8 – Sussex Inlet Coastal Inundation Map, 1% AEP, southerly wind, 0.9 m sea level rise..... 67
Figure 3-9 – Sussex Inlet Tidal Inundation, HHWSS, 0.9 m sea level rise..... 68
Figure 3-10 – Example Estuarine Macrophyte Migration Area for Sussex Inlet, 0.9 m sea level rise..... 69
Figure 4-1 – Detailed Risk Assessment Process (from NSW Coastal Management Manual 2018)..... 78
Figure 4-2 – Risk Management Process (AS/NZS ISO 31000: Risk Management – Principles and Guidelines, as documented in the NSW Coastal Management Manual 2018)..... 79
Figure 6-1 - Commonwealth EPBC Act Protected Matters Search Area for Sussex Inlet and St Georges Basin..... 102
Figure 6-2 - Commonwealth EPBC Act Protected Matters Search Area for Swan Lake..... 103

Figure 6-3 - Commonwealth EPBC Act Protected Matters Search Area for Berrara Creek 105
Figure 6-4 - Key Fish Habitat within the study area (NSW DPI 2022) 107
Figure 6-5 - St Georges Basin and Sussex Inlet NSW DPI estuarine macrophyte mapping for 2020 108
Figure 6-6 - NSW DPI estuarine macrophyte mapping of Ruppia in Swan Lake in 2004 (NSW DPI 2004). 110
Figure 6-7 - NSW DPI estuarine macrophyte mapping for Berrara Creek in 2004 (NSW DPI 2022) 112
Figure 6-8 - Corramy Regional Park in relation to the St Georges Basin (NSW NPWS 2021a). 113
Figure 6-9 - Conjola National Park in relation to Swan Lake and Berrara Creek (NSW NPWS 2021b) .. 114
Figure 6-10 – Example trash rack at Sanctuary Point (Google Maps street view) 129
Figure 6-11 – Example Vortex-type GPT incorporating a screen (Continuous Deflective Separation, CDS® Unit, Rocla Pty Ltd) 130
Figure 6-12 – Potential and existing GPT locations at St Georges Basin 132
Figure 6-13 – Suggested GPT locations at Sussex Inlet 134
Figure 6-14 – Recommended GPT locations in Swan Lake area 136

Executive summary

Shoalhaven City Council is developing a Coastal Management Program (CMP) for Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek. A CMP is a long-term strategy for managing the coastal regions in the face of future climate risks and will provide the framework and strategy that will be used to manage these estuaries.

The study area for the CMPs includes the Sussex Inlet and St Georges Basin, Swan Lake and Berrara Creek estuaries and the land bounded by the coastal management areas within part of the coastal zone as defined in the New South Wales (NSW) *State Environment Planning Policy (Resilience and Hazards) 2021 (*RH SEPP) and the NSW *Coastal Management Act 2016* (CM Act).

This report provides a synthesis of the studies undertaken for Stage 2 of the CMPs. The purpose of this stage is to identify, analyse and evaluate risks, vulnerabilities and opportunities that exist and the impact of these to the environmental, social, cultural, and economic values of St. Georges Basin, Sussex Inlet, Berrara Creek, and Swan Lake. As identified in the NSW Coastal Management Manual (Part B Stage 2), studies prepared in Stage 2 provide information to support decision-making in later stages of the planning process. The additional information assists communities to better understand coastal management issues and to analyse and evaluate coastal risks and opportunities.

As part of Stage 2, a series of community and stakeholder communication and engagement activities, including online surveys, workshop sessions, social media, website updates and one-on-one stakeholder meetings were undertaken, to gain more specific insights from the community on the key issues and risks impacting on the values of the estuaries, and to obtain ideas on how best to manage them.

A series of supporting studies have been undertaken as part of the CMPs during Stage 2, to understand in detail what these issues are. The supporting studies are summarised within this report, and include:

- **Aboriginal and non-Aboriginal Heritage** – A review of background data / online mapping for the estuary has been undertaken to identify the cultural heritage attributes, including a desktop review of information contained in the Stage 1 Scoping Study (Advisian 2020) and current legislative and regulatory provisions for cultural heritage matters. Desktop review of heritage registers (Australian Heritage Database, State Heritage Inventory and LEP), Aboriginal Heritage Information Management System (AHIMS), heritage studies and mapping of sites has been carried out. In addition, a site walkover at Berrara Creek with the Jerrinja Tribal Group was carried out to gain the perspectives of the local First Nations people. The Jerrinja People have a very strong connection to the land. Local Aboriginal cultural heritage and land values are considered to be 'highly sensitive' and have 'high significance'. The Jerrinja Tribal Group and Jerrinja Local Aboriginal Land Council (LALC) are the key Aboriginal stakeholders that have governance of the area. Key requests from the Jerrinja Tribal Group are to ensure that for any works being carried out in these highly sensitive areas, an Aboriginal representative be present for all aspects and stages of works, and that stakeholders are educated about the Aboriginal significance of the area.
- **Social and economic characteristics** and a summary of social values and issues at each estuary, considering projected population growth, demographic changes, projected use of coastal land for infrastructure, housing, commercial, recreational and conservation purposes.

- **Field Based assessments of erosion and foreshore issues** affecting estuary health have been undertaken. The shoreline was inspected in detail and features that indicate the coastal processes occurring at the various sites within the study area have been noted by the Study Team. The aim of this study was to understand areas that may be prone to bank erosion, inundation, and poor water quality, as well as to provide a high-level visual inspection of foreshore assets, and ground-truthing of existing estuarine vegetation mapping**.**
- **A study of the ecological values of the estuaries,** including Matters of National Environmental Significance, Marine Protected Areas and Environmentally Sensitive Lands, threatened and protected fauna and invasive pests that affect the study area, as well as estuary entrance management issues applicable to Swan Lake and Berrara Creek.
- **A review of the existing Swan Lake Estuary Entrance Management Policy,** including framework for management of the estuary entrances at Swan Lake and Berrara Creek, as well as potential management actions to improve the existing management of these estuary entrances.
- **Water Quality and Environmental Health Study** - The Scoping Study (Advisian 2020) identified perceived poor water quality throughout the estuaries as an issue and threat by the community, resulting from industrial, agricultural, or urban runoff affecting the estuaries ecology and estuarine vegetation. Current controls include licensing of industrial discharges, urban stormwater treatment, provision of riparian zones and fencing of estuarine foreshores, and public education programs. The Water Quality and Environmental Health Study has involved assessment of existing water quality data for Sussex Inlet and St Georges Basin, Swan Lake and Berrara Creek, determining the current estuary health condition, assessing water quality suitability for recreational activity, and assessing the adequacy of Council's existing monitoring and reporting program.
- **Identification of opportunities for urban runoff treatment** – Poor water quality due to urban runoff was identified as a key risk in the Stage 1 Scoping Study for St Georges Basin and Sussex Inlet (Advisian 2020). Key locations where urban runoff may be causing water quality problems as well as locations where opportunities exist to provide urban runoff treatments have been identified as part of the Stage 2 studies for the CMP.
- **Tidal and Coastal Inundation Study** – A hydrodynamic modelling study has been carried out to help Council understand the key risks to infrastructure and the coastal environment area from tidal and coastal inundation due to existing coastal processes as well as future changes to the estuary dynamics caused by sea level rise and climate change.
- **A Boating Study of the estuary -** this assessed whether there is sufficient capacity for vessels and whether there is a need to improve existing facilities or reduce the impact of boating on the environment. The Boating Study has been informed by observations and analysis by Advisian's coastal scientists and engineers, as well as a targeted community and stakeholder engagement program directly relating to boating and navigation issues within the St Georges Basin and Sussex Inlet areas.

These studies have been summarised within this Stage 2 Synthesis report.

The first pass Risk Assessment carried out as part of the Stage 1 Scoping Study has been updated with a detailed Risk Assessment undertaken based on the outcomes of the studies (Advisian 2023e). This identifies key risks and opportunities for managing these risks within the estuaries under current

conditions and at 20, 50 and 100 year timeframes, considering the potential impacts of climate change and sea level rise. The opportunities identified through the Risk Assessment will be used as the basis for developing management actions to address the key issues. The detailed methodology and outcomes can be found in the separate Stage 2 Study Reports that accompany the CMP (Advisian 2023, 2023a, b, c, d, e and f).

The key management issues identified through the CMP process relate to the following six themes:

1. Cultural and social issues
2. Foreshore Erosion
3. Ecological Environment
4. Water Quality
5. Inundation and Sea Level Rise
6. Navigation and Safety.

From the Risk Assessment and the outcome of the individual studies, a suite of potential management actions has been developed under each of the six themes examined during the CMP, which will be presented to the community for their feedback during Stage 3 of the CMP process. The potential management actions have been developed to address these issues at a location-specific scale, as well as on a regional or estuary-wide scale.

Acronyms and abbreviations

Acronym/abbreviation	Definition
4WD	Four-wheel drive
ABS	Australian Bureau of Statistics
AEP	Annual Exceedance Probability
AHIMS	Aboriginal Heritage Information Management System
AHIP	Aboriginal Heritage Impact Permit
AOBV	Areas of Outstanding Biodiversity Value
ARI	Average Recurrence Interval
ARU	Australian Railways Union
BC Act	NSW *Biodiversity Conservation Act* 2016
BIA	Biologically Important Areas
CBD	Central Business District
CEA	Coastal Environment Area
CDS	Continuous Deflective Separation
CFU	Colony-forming unit
CMP	Coastal Management Program
CUA	Coastal Use Area
CVA	Coastal Vulnerability Area
CWLRA	Coastal Wetland and Littoral Rainforest Area
CZEAS	Coastal Zone Emergency Action Subplan
CZMP	Coastal Zone Management Plan
DA	Development Application
DCP	Development Control Plan
DECCW	Department of Environment, Climate Change and Water (now known as Department of Planning & Environment)
DO	Dissolved Oxygen
DP&E	Department of Planning & Environment. Includes sub-groups within DPE&E e.g. DPE-Planning, DPE- Crown Lands
DPE EHG	Department of Planning & Environment Environment and Heritage Group

Acronym/abbreviation	Definition
DPI	Department of Primary Industries
DPIE	Department of Planning, Infrastructure & Environment (now Department of Planning & Environment)
DST	Decision Support Tool, used in assessing potential management actions for areas impacted by bank erosion.
EC	Electrical Conductivity
EPA	NSW Environmental Protection Agency
EPBC Act	Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999
EPL	Environmental Protection License
EQL	Estimated Quantification Limit
FM Act	NSW *Fisheries Management Act* 1994
GPT	Gross Pollutant Trap
ha	Hectares
ICOMOS	International Council on Monuments and Sites
IPCC	Intergovernmental Panel on Climate Change
KFH	Key Fish Habitat
LALC	Local Aboriginal Land Council
LEP	Local Environment Plan
LGA	Local Government Area
LORs	Limits of Reporting
MER	Monitoring, Evaluation and Reporting Strategy
MNES	Matters of National Environmental Significance
NHMRC	National Health and Medical Research Council
NorBE	Neutral or Beneficial Effect
NPW Act	NSW *National Parks and Wildlife Act* 1974
NPWS	National Parks and Wildlife Service
NSW	New South Wales
NTU	Nephelometric Turbidity Units
OEH	Office of Environment and Heritage (now Department of Planning & Environment)

Acronym/abbreviation	Definition
PIRMP	Pollution Incident Response Management Plan
ppt	Parts per thousand
RH SEPP	*State Environmental Planning Policy (Resilience and Hazards) 2021*
SEPP	State Environmental Planning Policy
NSW SES	NSW State Emergency Service
SLR	Sea Level Rise
SNAG	Safe Navigation Action Group
STP	Sewage Treatment Plant
TDS	Total Dissolved Solids
TfNSW	Transport for NSW
TN	Total Nitrogen
TP	Total Phosphorus
TSS	Total Suspended Sediments
WSUD	Water Sensitive Urban Design

1 Introduction

Shoalhaven City Council (Council) is developing a Coastal Management Program (CMP) for Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek. A CMP is a long-term strategy for managing the coastal regions in the face of future climate risks and will provide the framework and strategy that will be used to manage these coastlines and estuaries.

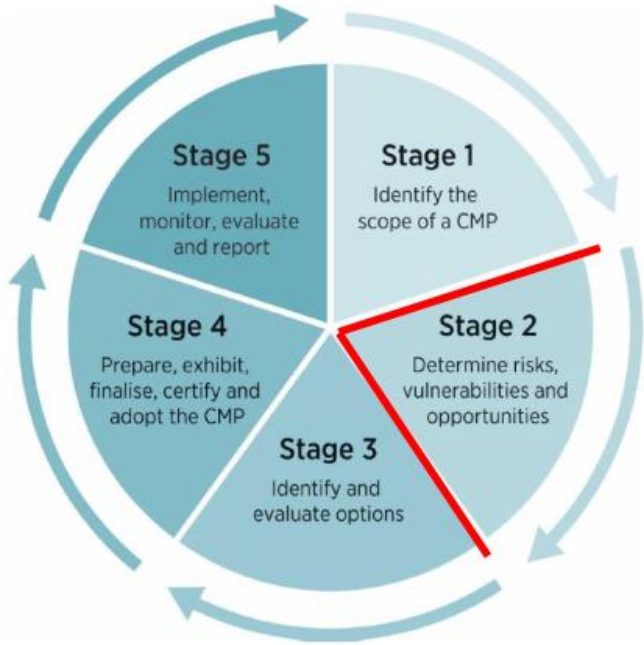
A CMP considers historic events, current conditions, and future trends including population growth, environmental conditions, and climate change. CMPs identify coastal management issues and the actions required to address these issues in a strategic and integrated way. A CMPalso details how and when those actions will be implemented, the cost, and funding mechanisms.

Engagement and input from community and stakeholders, is an essential part of the development of a CMP.

NSW has developed a new coastal management framework through the *Coastal Management Act* 2016 (CM Act), *State Environment Planning Policy (Resilience and Hazards) 2021* and the Coastal Management Manual 2018.

The NSW Coastal Management Manual 2018 sets out the framework in detail and defines the requirements for a Coastal Management Program (CMP). The purpose of a CMP is to set the long-term strategy for the coordinated management of the coastal zone with a focus on achieving the objects of the CM Act.

The Coastal Management Manual recommends that councils follow a five-stage risk management process for the preparation and implementation of a CMP, as illustrated in Figure 1-1.



(Current Stage)

Figure 1-1 – Stages of a CMP

Stage 1 of the CMP, a Scoping Study (Advisian 2020), for all the estuaries and open coast of the Shoalhaven has been completed. This can be found on Council's website at https://getinvolved.shoalhaven.nsw.gov.au/CMP/widgets/303869/documents

Stage 2 (this report) - The purpose of this stage is to understand the issues, risks, vulnerabilities and opportunities that affect the environmental, social, cultural, and economic values of St. Georges Basin, Sussex Inlet, Berrara Creek, and Swan Lake. As part of Stage 2, a series of community and stakeholder communication and engagement activities, including online surveys, workshop sessions, social media and website updates and one-on-one stakeholder meetings were undertaken, to gain more specific insights from the community on the key risks and vulnerabilities impacting on the values of the estuaries and to obtain ideas on how best to manage them.

A series of supporting studies have been undertaken as part of the CMP during Stage 2, to understand in detail what these issues are. The following Stage 2 CMP study reports have been produced for this project, and are referenced herein:

- Advisian (2023) Stage 2 CMP Foreshore Erosion Assessment Report.
- Advisian (2023a) St Georges Basin-Sussex Inlet Water Quality and Estuary Health Study
- Advisian (2023b) Berrara Creek Water Quality and Estuary Health Study
- Advisian (2023c) Swan Lake Water Quality and Estuary Health Study
- Advisian (2023d) Stage 2 CMP Tidal and Coastal Inundation Report

- Advisian (2023e) Stage 2 CMP Risk Assessment
- Advisian (2023f) Stage 2 CMP Boating Study

The supporting studies are summarised within this report, with additional supporting information provided. This information includes:

- **Aboriginal and non-Aboriginal Heritage** – A review of background data / online mapping for the estuary has been undertaken to identify the cultural heritage attributes, including a desktop review of information contained in the Stage 1 Scoping Study and current legislative and regulatory provisions for cultural heritage matters. Desktop review of heritage registers (Australian Heritage Database, State Heritage Inventory and Local Environment Plan (LEP)), Aboriginal Heritage Information Management System (AHIMS), heritage studies and mapping of sites has been carried out. In addition, a site walkover at Berrara Creek with the Jerrinja Tribal Group was carried out to gain the perspectives of the local First Nations people. The Jerrinja People have a very strong connection to the land, local Aboriginal cultural heritage and land values are considered to be 'highly sensitive' and have 'high significance'. The Jerrinja Tribal Group and Jerrinja LALC are the key Aboriginal stakeholders that have governance of the area. Key requests from the Jerrinja Tribal Group are to ensure that for any works being carried out in these highly sensitive areas, an Aboriginal representative be present for all aspects and stages of works being carried out and that stakeholders are educated about the Aboriginal significance of the area. **Key risks addressed: Cultural and Social risks within the Coastal Environment Area.**

- **Social and economic characteristics** and a summary of social values and issues at each estuary considering projected population growth, demographic changes, projected use of coastal land for infrastructure, housing, commercial, recreational and conservation purposes.

- **Field Based assessments of erosion and foreshore issues** affecting estuary health have been undertaken. The shoreline was inspected in detail and features that indicate the coastal processes occurring at the various sites within the study area have been noted by the Study Team. The aim of this study was to understand areas that may be prone to bank erosion, inundation, and poor water quality, as well as to provide a high-level visual inspection of foreshore assets, and ground-truthing of existing estuarine vegetation mapping. **Key risks addressed: Foreshore Erosion within the Coastal Environment Area and Coastal Vulnerability Area.**

- **A study of the ecological values of the estuaries,** including Matters of National Environmental Significance, Marine Protected Areas and Environmentally Sensitive Lands, threatened and protected fauna and invasive pests that affect the study area. **Key risks addressed: Environmental health, and risks to the ecological environment within the Coastal Environment Area and Coastal Wetlands and Littoral Rainforest area.**

- **A review of the existing Swan Lake Estuary Entrance Management Policy,** including framework for management of the estuary entrances at Swan Lake and Berrara Creek, as well as potential management actions to improve the existing management of these estuary entrances. **Key risks addressed: Environmental health, and risks to the ecological environment and infrastructure within the Coastal Environment Area, Coastal Wetlands and Littoral Rainforest area, Coastal Vulnerability Area and Coastal Use Area.**

- **Water Quality and Environmental Health Study** - The Scoping Study identified perceived poor water quality throughout the estuaries as an issue and threat by the community, resulting from industrial, agricultural, or urban runoff affecting the estuaries ecology and estuarine vegetation. Current controls include licensing of industrial discharges, urban stormwater treatment, provision of riparian zones and fencing of estuarine foreshores, and public education programs. The Water Quality and Environmental Health Study has involved assessment of existing water quality data for Sussex Inlet and St Georges Basin, Swan Lake and Berrara Creek, determining the current estuary health condition, assessing water quality suitability for recreational activity, and assessing the adequacy of Council's existing monitoring and reporting program. **Key risks addressed: Water Quality, Environmental health, and risks to the ecological environment within the Coastal Environment Area and Coastal Use Area.**

- **Identification of opportunities for urban runoff treatment** – Poor water quality due to urban runoff was identified as a key risk in the Stage 1 Scoping Study for St Georges Basin and Sussex Inlet. Key locations where urban runoff may be causing water quality problems as well as locations where opportunities exist to provide urban runoff treatments have been identified as part of the Stage 2 studies for the CMP. **Key risks addressed: Water Quality within the Coastal Environment Area.**

- **Tidal and Coastal Inundation Study** – A hydrodynamic modelling study has been carried out to help us understand the key risks to infrastructure and the coastal environment area from tidal inundation due to existing coastal processes as well as future changes to the estuary dynamics caused by sea level rise and climate change. **Key risks addressed: Tidal Inundation and Sea Level Rise within the Coastal Wetlands and Littoral Rainforest, Coastal Environment, Coastal Vulnerability, Coastal Use Areas.**

- **A Boating Study of the estuary -** this assessed whether there is sufficient capacity for vessels and whether there is a need to improve existing facilities or reduce the impact of boating on the environment. The Boating Study has been informed by observations and analysis by Advisian's coastal scientists and engineers, as well as a targeted community and stakeholder engagement program directly relating to boating and navigation issues within the St Georges Basin and Sussex Inlet areas. **Key risks addressed: Navigation and Safety within the Coastal Use Area.**

These studies have been summarised within this Stage 2 Synthesis report. The first pass risk assessment carried out as part of the Stage 1 scoping study has been updated with a detailed **Risk Assessment** undertaken based on the outcomes of the studies (Advisian 2023e). This identifies key risks and opportunities for managing these risks within the estuaries under current conditions and at 20, 50 and 100 year timeframes, considering the potential impacts of climate change and sea level rise. The opportunities identified through the Risk Assessment will be used as the basis for developing management actions to address the key issues.

Stage 3 will involve the identification and evaluation of management actions to address the risks and opportunities relating to the future management of the estuaries. The management actions will be assessed and prioritised with input from local stakeholders.

Stage 4 involves the preparation of the CMP report and the exhibition of the draft CMP.

Stage 5 involves the implementation of the final CMP.

This Stage 2 Synthesis Report provides a synthesis of existing available information to inform the CMP for the St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek estuaries.

The St Georges Basin/Sussex Inlet estuary was identified in the CMP Scoping Study (Advisian 2020) as a high priority for development of a CMP for the following reasons:

- An existing Estuary Management Plan is in place for St. Georges Basin, although that requires review to ensure that the key risks identified from the CMP Scoping Study (Advisian 2020) have been captured and have appropriate management actions assigned to them.
- Through the community and stakeholder consultation process in the CMP Scoping Study (Advisian 2020), a large number of high priority risks and issues have been identified which are cause for community concern.

Swan Lake and Berrara Creek were also identified in the CMP Scoping Study as requiring a CMP to be developed, due to the passage of time since these estuaries were last considered as part of the Swan Lake and Berrara Creek Natural Resources Management Strategy in 2002.

The key management issues identified through the CMP process and summarised within this report relate to the following six themes:

1. Cultural and social issues
2. Foreshore Erosion
3. Ecological Environment
4. Water Quality
5. Inundation and Sea Level Rise
6. Navigation and Safety.

1.1 Structure of the CMPs

It should be noted that St. Georges Basin and Sussex Inlet are part of the one system and need to be considered as a single system for scientific and management purposes. Although both have some unique environmental, social and economic considerations, what people do in one part of the system will affect the other parts. The community engagement process identified a community desire for a separate stand-alone CMP for Sussex Inlet and St Georges Basin, due in part to these communities being geographically separated and subject to a unique set of issues at each location. However, as both localities are part of the same estuary system, they will be combined Into a single CMP document during Stage 4 of the CMP process.

Swan Lake and Berrara Creek would be the subject of separate CMP documents that will be produced in Stage 4 of the process. However, the key issues and risks for these estuaries have been included within this Stage 2 Synthesis Report so that the community are able to read about their specific localities of interest.

1.2 Study Area

The study area for the CMPs includes the Sussex Inlet and St Georges Basin, Swan Lake and Berrara Creek estuaries and the land bounded by the Coastal Management Areas within the coastal zone as defined in the *State Environment Planning Policy (Resilience and Hazards) 2021* (RH SEPP) and the NSW *Coastal Management Act* 2016 (CM Act).

The study area covering the CMPs for St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek is shown in Figure 1-2.

The CM Act sets out mandatory requirements for the preparation of a CMP. Under S13 (b) of the CM Act, the CMP must "consider and promote the objects of (the) Act" and "give effect to the management objectives for the coastal management areas covered by the program". The RH SEPP commenced on 1 March 2022. It supports implementation of the management objectives set out in the NSW CM Act. The hierarchy of coastal management areas as referred to in the CM Act and RH SEPP (Resilience and Hazards) are identified below, from highest to lowest priority:

- **coastal wetland and littoral rainforest area** (CWLRA) - areas which display the characteristics of coastal wetlands or littoral rainforests. Development controls for the mapped CWLRA aim to continue existing protection for these important ecological communities. Note that there are no mapped littoral rainforest areas within the CMP study areas. Areas within a 100 m buffer zone bordering coastal wetlands are mapped within the RH SEPP as Coastal Wetland Proximity Areas.
- **coastal vulnerability area** (CVA) - areas subject to coastal hazards such as coastal erosion and tidal inundation. Development controls for the CVA are concerned with managing risk to human life, infrastructure, and public and private property that may be impacted by coastal hazards and ensuring that legacy issues are not created for future generations to deal with. Note that the CVA for the estuaries within the study area is yet to be determined.
- **coastal environment area** (CEA) - areas that are characterised by natural coastal features such as beaches, rock platforms, coastal lakes and lagoons and undeveloped headlands. Marine and estuarine waters are also included. Development controls for the CEA aim to protect and improve natural coastal features, coastal waters and environmental values for places such as beaches, dunes, surf zone and undeveloped headlands.
- **coastal use area** (CUA) - land adjacent to coastal waters, estuaries and coastal lakes and lagoons where impacts of development on the use and enjoyment of the beaches, foreshores, dunes, estuaries, coastal lakes and lagoons, and the ocean, need to be considered. Development controls for CUA are concerned with ensuring appropriate urban development for coastal areas, considering urban design issues such as the bulk, scale and size of proposed development, water sensitive urban design, and preventing adverse impacts on scenic qualities, visual amenity and Aboriginal cultural heritage.

Each of the above areas has outcome-oriented management objectives so that councils can apply appropriate management tools and development controls.

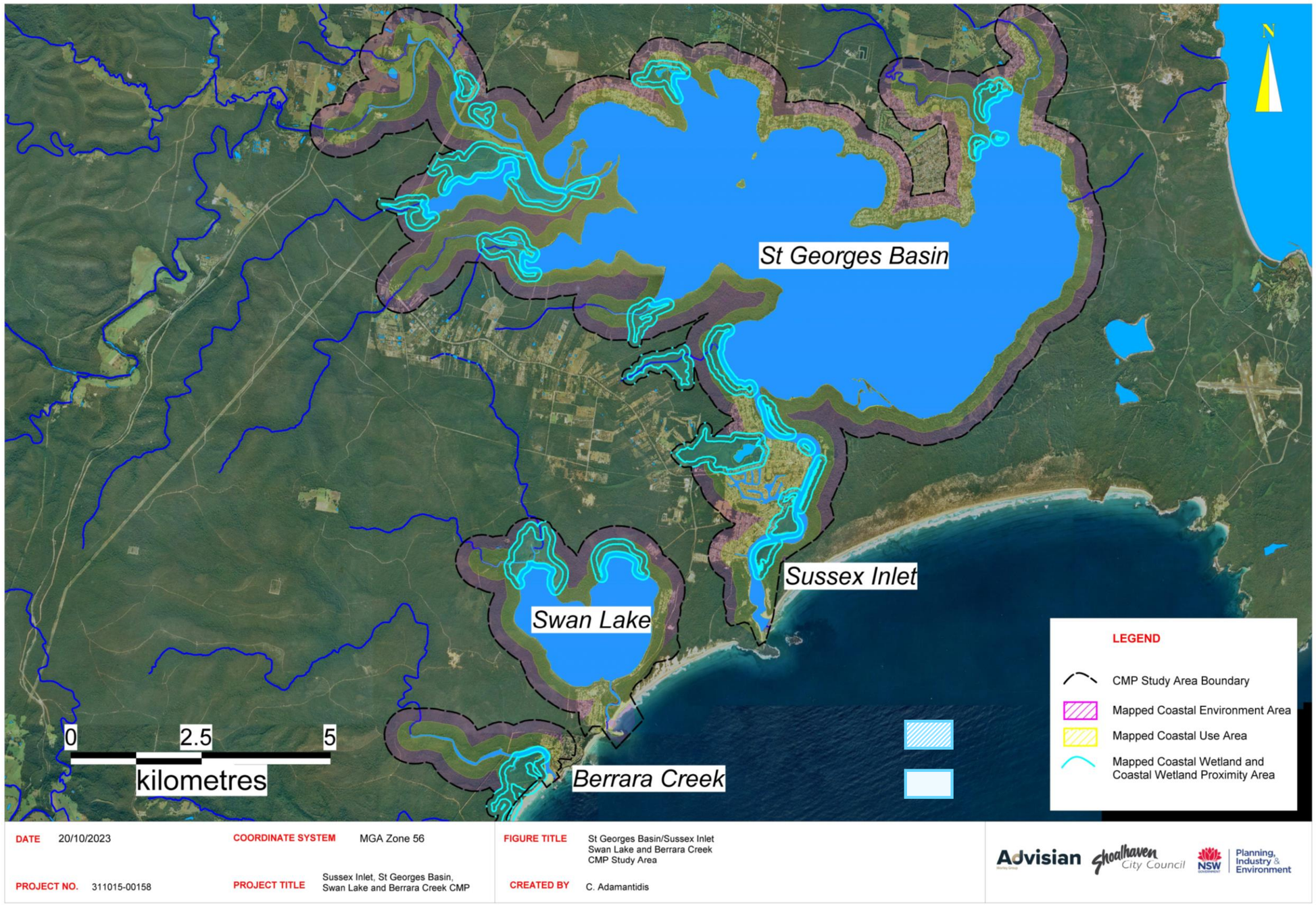


Figure 1-2 – Study Area for St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek CMPs

2 Synthesis of Cultural Social and Ecological Knowledge

This section of the report presents a synthesis of current knowledge on estuary processes and health. It includes discussion on the key risks associated with cultural and social aspects of the St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek estuaries, as well as a synthesis of relevant environmental and ecological background information, issues, risks and opportunities for the estuaries.

2.1 Cultural and Social

This Chapter summarises the Cultural and Social context of the Study area, including the key issues identified through the CMP process for each estuary.

2.1.1 Aboriginal Heritage

The NSW *National Parks and Wildlife Act 1974* (NPW Act) is the primary statute for management of Aboriginal cultural heritage in NSW. Items of Aboriginal heritage (Aboriginal objects) or Aboriginal places (declared under section 84) are protected and regulated under the NPW Act. Aboriginal heritage is also protected under the provisions of Clause 5.10 of the *Shoalhaven Local Environmental Plan 2014* (the LEP).

Aboriginal objects are protected under Section 86 of the NPW Act. It is an offence to harm or desecrate an Aboriginal object, either knowingly (Section 86(1)) or unknowingly Section 86(2)). There are offences and penalties relating to the harm to, or desecration of, an Aboriginal object or declared Aboriginal place. Harm includes to destroy, deface, damage or move. Where direct impact is proposed, an Aboriginal Heritage Impact Permit (AHIP) is required from Heritage NSW.

Aboriginal people have continuously utilised the resources of the South Coast region for at least 20,000 years (NPWS, 2009). The Jerrinja People are the traditional owners of the Shoalhaven region. They fish and meet socially as a tribe and also undertake spiritual hunting and fishing ceremonies (P. Rowe, personal communication, 30 March 2022). Owing to the productive nature of the land and its proximity to the sea (which provides important food sources), there are many sites with significant Aboriginal heritage value across the Shoalhaven LGA. Along the coast this includes middens, burial sites, artefacts, rock shelters and ceremonial areas.

2.1.1.1 Discussions with Jerrinja People

A site inspection was carried out by Advisian in collaboration with the Local Aboriginal stakeholders, representing the Jerrinja Tribal Group, on 15 March 2022. A summary of the discussions and general sentiments shared by the Aboriginal stakeholders are presented below:

- The Jerrinja People, represented by the Jerrinja Tribal Group and the Jerrinja LALC, are the traditional owners of the Shoalhaven region.
- The local Aboriginal community have a very strong connection to the land.

- The local Aboriginal cultural heritage and land values are considered to be 'highly sensitive' and have 'high significance'.
- A key request from the Jerrinja Tribal Group is to ensure that there be an Aboriginal representative present for all aspects and stages of works being carried out.
- A number of midden material and former camp sites were observed at the Berrara Creek site.
- 'Extremely high' cultural significance presides over the subject area.
- Overall, all the areas are quite different in terms of geography, uses and Aboriginal cultural and heritage values.

2.1.1.2 St Georges Basin/Sussex Inlet

The Jervis Bay Territory is listed on the Commonwealth Heritage List in "*recognition of natural values and of Aboriginal sites of significance which demonstrate the historic and ongoing Aboriginal occupation of the park and changes in cultural practices over time*" (Director of National Parks, 2015, p. 57). Aboriginal cultural heritage within Booderee National Park which borders the eastern foreshore of St Georges Basin and Sussex Inlet includes shell middens and camp hearths plus oral history and cultural associations with the landscape (Director of National Parks, 2015). Section 6 of the Booderee National Park Management Plan 2015-2025 describes the performance indicators and policies for looking after culture and country including cultural heritage.

A review of the Aboriginal Heritage Information Management System (AHIMS) in February 2022 identified over 100 Aboriginal sites recorded in and around Sussex Inlet and St Georges Basin. It is expected that the majority of the sites are located within the mapped Coastal Environment Area (CEA) and mapped Coastal Use Area (CUA) under the RH SEPP. There are no declared Aboriginal places.

Section 8.1 of the St Georges Basin Revised Estuary Management Plan (Shoalhaven City Council, 2013) describes the richness of Aboriginal cultural heritage around the St Georges Basin area with open camp sites and various stone artefacts being examples of the extensive physical and spiritual connections to the country. The Conjola National Park Plan of Management (NPWS, 2009) also provides a number of strategies regarding management of protection of Aboriginal sites and values through consultation with and involvement by Aboriginal community organisations and representations.

2.1.1.3 Swan Lake

A review of the Aboriginal Heritage Information Management System (AHIMS) in February 2022 identified at least thirteen Aboriginal sites recorded in and around Swan Lake. The sites are located within the mapped Coastal Environment Area (CEA) and mapped Coastal Use Area (CUA) under the RH SEPP. There are no declared Aboriginal places.

As an example, the Cudmirrah Berrara Swanhaven Progress Association Inc. (undated) describe the discovery of an Aboriginal burial site in 2006 along the edge of Swan Lake in Errol Bond Reserve Cudmirrah. They also noted that when water levels are low in Swan Lake, some grinding stones and the remains of a series of fish traps are also visible. The Conjola National Park Plan of Management provides a number of strategies regarding management of protection of Aboriginal sites and values through consultation with and involvement by Aboriginal community organisations and representations.

2.1.1.4 Berrara Creek

A review of the Aboriginal Heritage Information Management System (AHIMS) in February 2022 identified twelve Aboriginal sites recorded in and around Berrara Creek. The sites are located within the mapped Coastal Environment Area (CEA) and some are also located within the mapped Coastal Use Area (CUA) under the RH SEPP. There are no declared Aboriginal places.

A significant Aboriginal site along the northern foreshore of Berrara Creek is the Fishermans Rock complex (Figure 2-1 and Figure 2-2), where there is a midden containing fragments of mussels and mud oysters plus axe-grinding grooves in the sandstone (NPWS, 2022). The Conjola National Park Plan of Management notes that this site is vulnerable to erosion, souveniring of artefacts, vandalism and lighting of fires (NPWS, 2009). The Plan of Management also provides a number of strategies regarding management of protection of Aboriginal sites and values through consultation with and involvement by Aboriginal community organisations and representations.

This figure has been removed to protect culturally sensitive information that has been presented in the original report.

If you have any questions about how Council manages sensitive information, please contact Council on 1300 293 111.

Figure 2-1 – Location of the Fishermans Rock Aboriginal site, circled in red (Source: NSW NPWS, 2021)

Figure 2-2 – View upstream of Berrara Creek towards Fishermans Rock (Source: Advisian, 2021)

2.1.2 Non-Aboriginal Heritage

The NSW *Heritage Act 1977* contains provisions for listing sites or places on the State Heritage Register (SHR), applying interim heritage orders and the protection of relics. Non-Aboriginal heritage is also protected under the provisions of Clause 5.10 of the LEP.

2.1.2.1 St Georges Basin/Sussex Inlet

Searches of the Australian Heritage Database, NSW State Heritage Inventory and the LEP in November 2021 identified the following listed heritage items at or in the vicinity of St Georges Basin and Sussex Inlet (Table 2-1 and Figure 2-3 to Figure 2-5). The majority of heritage items are located within mapped CEA and CUA under the RH SEPP.

Table 2-1 – Listed Non-Aboriginal Heritage Items for St Georges Basin and Sussex Inlet

Item name	Address	Listing(s)	Significance	Distance to Foreshore	RH SEPP Coastal Management Area		Subject to coastal hazards
					CEA	CUA	
Colonial road—remnants (former Wool Road)	D3164 and D3200 Princes Highway and The Wool Road, Jerrawangala	LEP (Item No. 218)	Local	Variable – closest is 150m	Yes (part)	Yes (part)	Yes, coastal and tidal inundation (part)
Former Boarding House and St Georges Basin Post Office	23 Deane Street, St Georges Basin	LEP (Item No. 453)	Local	0m	Yes	Yes	Yes, coastal and tidal inundation, foreshore erosion
World War II Flying Boat Base	2 Island Point Road, St Georges Basin	LEP (Item No. 454)	Local	0m	Yes	Yes	Yes, coastal and tidal inundation, foreshore erosion
"Jessie Blacket"—Sandstone Memorial Drinking Trough	41 Tasman Road, St Georges Basin	LEP (Item No. 455)	Local	310m	Yes	No	No
Federation Fisherman's Cottage and garden	146 The Wool Road, St Georges Basin	LEP (Item No. 456)	Local	180m	Yes	Yes	No
"Greentree's"—Holiday Cabins	158 Jacobs Drive, Sussex Inlet	LEP (Item No. 457)	Local	475m	Yes	Yes	Yes, tidal and coastal inundation
Post-war fibre cement Community Hall/Sussex Inlet Picture Theatre	173 Jacobs Drive, Sussex Inlet	LEP (Item No. 458)	Local	345m	Yes	Yes	Yes, tidal and coastal inundation
Gothic Carpenter style relocated Church (former Termeil Wesleyan Church)	175 Jacobs Drive, Sussex Inlet	LEP (Item No. 459)	Local	320m	Yes	Yes	Yes, tidal and coastal inundation

Item name	Address	Listing(s)	Significance	Distance to Foreshore	RH SEPP Coastal Management Area		Subject to coastal hazards
					CEA	CUA	
Former Kemp's Boatshed site	River Road, Sussex Inlet	LEP (Item No. 460)	Local	0m	Yes	Yes	Yes, tidal and coastal inundation, foreshore erosion
"Erowal Farm" including homestead (ruins), garden, trees and resort ruins	110 The Wool Road, Worrowing Heights	LEP (Item No. 525)	Local	110m	Yes (part)	Yes (part)	Yes, tidal and coastal inundation
Jervis Bay Territory	About 7600ha at Jervis Bay, comprising all of the Jervis Bay Territory.	Commonwealth Heritage List / Register of the National Estate (non-statutory)	Commonwealth	0m / Variable	Yes (part)	Yes (part)	Yes, foreshore erosion, tidal and coastal inundation
Christians Minde Settlement	Ellmoos Rd, Sussex Inlet, ACT, Australia	Commonwealth Heritage List / Register of the National Estate (non-statutory)	Commonwealth	0m	Yes	Yes	Yes, coastal and tidal inundation, foreshore erosion
Jervis Bay and Surrounds	Approximately 30,000ha, surrounding and including Jervis Bay	Register of the National Estate (non-statutory)	N/A	0m / Variable	Yes (part)	Yes (part)	Yes, coastal and tidal inundation, foreshore erosion
Jervis Bay and Surrounding Area	Approximately 30,000ha, surrounding and including Jervis Bay	National Heritage List (Nomination now ineligible for PPAL)	National	0m / Variable	Yes (part)	Yes (part)	Yes, coastal and tidal inundation, foreshore erosion

Figure 2-3 – LEP listed non-aboriginal heritage items in St Georges Basin (Source: NSW Planning Portal, 2022)

Figure 2-4 - LEP listed non-aboriginal heritage items in Sussex Inlet and location of Christians Minde Settlement (Source: NSW Planning Portal, 2022)

Figure 2-5– World War II Flying Boat Base and Former Kemp's Boatshed site (Source: Advisian, 2021).

The Shoalhaven Heritage Study 1995 – 1998 (Peter Freeman Pty Ltd, 2003) identified a potential heritage item of local significance at Sussex Road, Sussex Inlet, known as the Settrees's Slips Archaeological Site. This item is not listed on the LEP and no further details are provided in the Heritage Study. The archaeological site is located along the foreshore near the Marine Rescue building and is located within the mapped CEA and CUA.

The Conjola National Park Plan of Management (NPWS, 2009, p. 15) notes that "*A former Australian Railways Union (ARU) camp site is located on Farnham Headland at Sussex Inlet. This site dates back to the early 1900s. The ARU (now called the Public Transport Union) moved to its present site on the eastern side of the inlet about fifty years ago. Although there are no remains of the huts on Farnham Headland there are footings present and some interesting glass bottle retaining walls. The walls are deteriorating and present a public safety risk. There are also some exotic plants on the site. These will be assessed and either controlled or removed to prevent their spread*". NSW NPWS (2009) notes for historic heritage within the National Park including the ARU camp site that the remaining features be recorded, assess its significance and risk to public safety and take any necessary safety or conservation measures.

2.1.2.2 Swan Lake

Searches of the Australian Heritage Database, NSW State Heritage Inventory and the LEP in November 2021 identified the following listed heritage items at or in the vicinity of Swan Lake (Table 2-2, Figure 2-6 and Figure 2-7). All heritage items are located within mapped CEA and CUA under the RH SEPP.

Table 2-2 - Listed non-aboriginal heritage items for Swan Lake

Item name	Address	Listing(s)	Significance	Distance to Foreshore	RH SEPP Coastal Management Area		Subject to Coastal Hazards
					CEA	CUA	
Errol Bond Memorial	Goonawarra Drive, Cudmirrah	LEP (Item No. 183)	Local	0m	Yes	Yes	Yes, coastal and tidal inundation, foreshore erosion
"The Springs"— Holiday Cabins	1A Yarroma Avenue, Swanhaven	LEP (Item No. 461)	Local	75m	Yes	Yes	Yes, coastal inundation
Swan Lake / Cudmirrah Area	About 3,800ha	Register of the National Estate (non-statutory)	N/A	0m / Variable	Yes	Yes	Yes, coastal and tidal inundation, foreshore erosion

Figure 2-6 - LEP listed non-aboriginal heritage items for Swan Lake (Source: NSW Planning Portal, 2022)

Figure 2-7– Errol Bond Memorial and The Springs"—Holiday Cabins (Source: Advisian, 2021)

Other heritage items exist in the Cudmirrah area, but are outside the CMP study area.

The Conjola National Park Plan of Management (NPWS, 2009, p. 15) notes that "*Old Berrara Road was the original road to the coastal villages of Cudmirrah and Berrara until the present road across the Swan Lake entrance was constructed in the late 1960s. There is anecdotal evidence that the road formerly extended along the coast past the mouth of Berrara Lagoon and presumably further south, and that modifications to the shoreline still exist*". NPWS (2009) notes for historic heritage within the National Park that historic places are to be conserved in accordance with the Burra Charter of Australia International Council on Monuments and Sites (ICOMOS) and that other known historic features are to be recorded with research into their history.

2.1.2.3 Berrara Creek

Searches of the Australian Heritage Database, NSW State Heritage Inventory and the LEP in November 2021 identified no listed heritage items, heritage conservation areas or archaeological sites at or in the vicinity of Berrara Creek.

The Shoalhaven Heritage Study 1995 – 1998 (Peter Freeman Pty Ltd, 2003) identified a potential heritage item of local significance at Berrara, known as the Glanville Cemetery. This item is not listed on the LEP and no further details are provided in the Heritage Study. However, according to the Cudmirrah Berrara Swanhaven Progress Association Inc. (undated), the first European settlers in Berarra, the Glanville family, established a private cemetery in Berrara, to the rear of a residential property on the corner of Sundowner Avenue and Lakeway Avenue. The cemetery is located approximately 270 metres north of Berrara Creek and is within the mapped CEA.

2.1.3 Social and Economic Characteristics

Section 3.4 of the Stage 1 Scoping Study (Advisian 2020) included a community profile for the LGA which noted the population is primarily concentrated along the coast in major centres and numerous small centres. Sussex Inlet and the St Georges Basin District are identified as major centres. Cudmirrah, Berrara and Swanhaven are small centres located to the south of Sussex Inlet.

A review of the available Australian Bureau of Statistics (ABS) data was undertaken to understand the social characteristics of the local population for Sussex Inlet and suburbs surrounding St Georges Basin, Swan Lake and Berrara Creek. The key social statistics as derived from the 2016 Census data are presented in **Appendix A**. Total population is forecasted to grow across the LGA from 103,012 persons in 2019 to 126,255 in 2041. Sussex Inlet and St Georges Basin District are expected to provide land for new development and would cater for a proportion of the forecasted rise in population. It is also noted that the town centre experiences short-term increases in population during holiday periods which will continue in the future. Nearly 3 million people visited the Shoalhaven LGA in 2019, with an average stay of 3 nights (Tourism Research Australia, 2019). In addition, the Illawarra-Shoalhaven Regional Plan 2041 identifies Jervis Bay-St Georges Basin as a Strategic Centre, where the Plan identifies the need to prioritise opportunities for new housing in existing urban areas. The Regional Plan through Strategy 18.1 identifies the need for strategic planning and local plans to consider opportunities to:

- review planning controls so that they are creating flexible and feasible conditions for housing supply
- align infrastructure and service delivery to match housing supply needs
- explore public domain improvements that would increase capacity for growth
- identify policies and processes that could be reviewed to improve certainty and streamline development processes
- promote urban design outcomes to support healthy and vibrant communities.

In addition to the above, Strategy 11.5 of the Illawarra-Shoalhaven Regional Plan 2041 identifies the estuaries of St Georges Basin, Swan Lake and Berrara Creek as sensitive estuaries that need to be protected by implementing the NSW Government's Risk- Based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions.

Forecast population growth between 2021 and 2051 for Sanctuary Point, St Georges Basin and the Sussex Inlet/Berarra areas is presented in Table 2-3. The Sussex Inlet – Swanhaven – Berrara – Cudmirrah areas in particular are forecast to grow at an average of 1% p.a. over that period, outpacing the average forecast population growth rate of the Shoalhaven LGA as a whole.

This population growth is expected to require an additional 891 dwellings in the Sussex Inlet area between 2021 and 2051, 510 additional dwellings in St Georges Basin/Basin View, and 239 additional dwellings in Sanctuary Point (.id, 2023), representing a 21% increase in the number of dwellings at St Georges Basin and a 26% increase at Sussex Inlet. The majority of dwelling growth in the Sussex Inlet area is expected to occur in the Badgee development area, with development in the St Georges Basin area expected to occur at Basin View and in the Island Point Road area. 30.1% of dwellings are unoccupied as at 2021 in the Sussex Inlet area, and 17.8% unoccupied dwellings in St Georges Basin.

Table 2-3 – Forecast population growth within the study area between 2021 and 2051

Area	2021	2026	2031	2036	2041	2046	2051	Total change	Avg. annual % change
Shoalhaven City	108,547	116,775	122,630	128,963	134,312	138,569	142,936	+34,389	0.9
Sanctuary Point	7,872	8,249	8,463	8,613	8,736	8,736	8,745	+873	0.4
St Georges Basin–Basin View	4,801	5,112	5,354	5,542	5,740	5,859	5,980	+1,179	0.7
Sussex Inlet–Swanhaven–Berrara–Cudmirrah & Surrounds	4,654	5,061	5,347	5,611	5,874	6,051	6,242	+1,588	1.0

Source: Population and household forecasts, 2021 to 2051, prepared by .id (informed decisions), March 2023.

http://www.id.com.au

The coastal zone supports activities such as tourism and fisheries that have important economic values for the region and local communities. Key ABS economic statistics to provide an economic profiling for the local population of Sussex Inlet and suburbs surrounding St Georges Basin, Swan Lake and Berrara Creek are presented in **Appendix A**.

2.1.4 Social Values

2.1.4.1 St Georges Basin/Sussex Inlet

In the Shoalhaven region there exists a high proportion of absentee landowners with permanent residential occupancy rates of less than 50%, although all the centres reported are higher than 50%. The age of people in the region is generally high as retirees settle permanently and young adults leave for employment or education. This is especially the case in Worrowing Heights which has a median age of 77 years due to the Coastal Waters Retirement Village being located there. With at least 55% of Shoalhaven's population living in coastal areas the residents have a strong interest in protecting long established values of the coast.

Residents and visitors to Sussex Inlet and St Georges Basin District participate recreationally in swimming, diving, surfing, boating, water skiing, fishing, bush walking, picnics, art and photography, conservation activities, sightseeing and car touring. High social and cultural value is associated with individual, family and community experiences with the natural landscape including around St Georges Basin, Swan Lake, Jervis Bay Territory including Booderee National Park, Conjola National Park and nearby creeks and beaches.

2.1.4.2 Swan Lake

At Cudmirrah and Swanhaven, the percentage of private dwellings occupied in 2016 were slightly higher than average at 51.5% and 58.1%, respectively. The age of people in the region is generally high as retirees settle permanently and young adults leave for employment or education.

Residents and visitors to Cudmirrah and Swanhaven participate recreationally in swimming, diving, surfing, boating, waterskiing, fishing, bush walking, picnics, art and photography, conservation activities, sightseeing and car touring. High social and cultural value is associated with individual, family and community experiences with the natural landscape including around Swan Lake, Conjola National Park and nearby beaches.

2.1.4.3 Berrara Creek

At Berrara, permanent residential occupancy rates are much lower than the Shoalhaven LGA average, at 33.8% of private dwellings being occupied in 2016. The age of people in the region is generally high as retirees settle permanently and young adults leave for employment or education.

Residents and visitors to Berrara participate recreationally in swimming, diving, surfing, boating, water skiing, fishing, bush walking, picnics, art and photography, conservation activities, sightseeing and car touring. High social and cultural value is associated with individual, family and community experiences with the natural landscape including along Berrara Creek, Conjola National Park and nearby beaches.

2.1.5 Key Cultural and Social Issues

Feedback on cultural and social issues and mitigations that were raised by attendees at the Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP Stage 2 engagement workshops and drop-in sessions, held 15th and 16th March 2022 include:

- The key issue that was raised was the lack of knowledge or understanding around Aboriginal and cultural sites in the area, and that signage and education could help this. A site that was specified was the midden at Cudmirrah, which needs better protection, and something to stop people walking over it. A suggestion was also made to rename the St Georges Basin (Bherwherree) to acknowledge the traditional owners.
- Signage and education around parking and camping were also an issue, stemming from visitors blocking fire trails and residential parking.
- Problems with 4 wheel driving around sand dunes were also raised as a problem. Requests for more education to prevent damage to dunes and enforcement by means of fines if necessary. Another suggestion was to rezone the area to higher environmental protection.
- Stakeholders also expressed concerns around perceived illegal fishing and overfishing. Requests were made for monitoring of the situation and possible investigation by Department of Primary Industries – Fisheries if necessary.
- Concerns were also expressed with regards to potential sandmining in the area.

In addition, the Jerrinja Tribal Group identified the following key issues and opportunities for Jerrinja culture including (P. Rowe, personal communication, 30 March 2022):

- Reinforcing that the region has and always will be Jerrinja country.
- Damage has occurred to significant Aboriginal sites.

- Provide access to the environment and to have a 2.5 km zone of the whole coastline to allow for Jerrinja cultural practice to be performed and for the Tribal Group to be able to access the ocean and teach their children and move around country as traditionally, by foot and canoe.
- Access tracks to be made between sites and maintain connection between the sea and with the rest of their lands.

Key cultural and social issues identified during the CMP in St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek are shown in Table 2-4 which applies across all the estuaries in the Study Area.

Table 2-4 – Key Cultural and Social Management Issues applying across all estuaries

Coastal Management Area	Issue	Existing Controls
Coastal Use	Poor community understanding of coastal and estuary issues due to lack of easy-to-digest information, leading to lack of community ownership of issues, community misconceptions leading to poor environmental outcomes	Community education, dissemination of information to schools and community groups, provision of resources for community groups to empower them to undertake local projects and citizen science, effective coasts and estuaries committee, use of social media to communicate with community.
Coastal Environment	Poor communication between stakeholders, community and agencies leading to perceived lack of action on coastal management issues. This can lead to disagreements between stakeholders, responsible agencies for projects, and a perceived lack of action or delays on urgent coastal and estuary rehabilitation projects	Protocols have been put in place following the Shoalhaven CMP Scoping Study (Advisian 2020) to provide effective communication between agencies, Council and stakeholders; including the establishment of a Coastal and Estuary Management Committee with agency representation to help facilitate effective communication between Council, Agencies and the community. A specific CMP working group can be established to focus effort and communication to ensure that the CMP meets its objectives.
Coastal Use	Lack of adequate resources available for management and coordination of delivery of the CMP, with resources stretched over various locations and management responsibilities.	Small Council team currently available to manage delivery of existing CMPs.
Coastal Use	Council's Coastal Management Policies need updating approximately every 10 years, to keep pace with best practice techniques, additional data collection and advances in scientific knowledge.	St Georges Basin Estuary Management Plan 2013
Coastal Use	Damage to or loss of non-Aboriginal and Aboriginal cultural heritage items; coastal hazards affecting cultural heritage e.g. inundation, erosion; lack of understanding from the community, leading to inadvertent or malicious damage, vandalism.	Development controls, existing public education measures.
Coastal Use	Loss of connection between land and sea by Aboriginal people.	Development controls, public education program, Aboriginal heritage mapping, statutory and non-statutory planning controls.
Coastal Use	The presence of undocumented Aboriginal heritage sites means that items that may qualify for heritage listing or status and existing Aboriginal cultural heritage may not be afforded the quality of care or protection that they may require or deserve. This can lead to deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing.	Statutory and non-statutory planning controls, Aboriginal heritage mapping.
Coastal Use	Lack of public access along foreshore and loss of recreational access when estuary water levels are high, buildup of seagrass wrack at bathing areas	Provision of public access at specific locations in public ownership, management of seagrass wrack at designated bathing areas.

2.2 Ecological Environment

2.2.1 Overview

This section provides a synthesis of relevant environmental and ecological background to identify the following environmental attributes:

- Matters of National Environmental Significance (MNES) (environmental) listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act* (1999).
- Key Fish Habitat (NSW DPI).
- Occurrence of protected aquatic vegetation under the NSW *Fisheries Management Act* (FM Act) 1994 (e.g. mangroves, saltmarsh and seagrass as mapped by NSW DPI).
- Location of Coastal Wetlands and Littoral Rainforest (RH SEPP).
- Occurrence of State and Federal Listed threatened and protected flora and fauna.
- Occurrence of any areas of declared Critical Habitat (under the NSW FM Act and Commonwealth EPBC Act) and Areas of Outstanding Biodiversity Value (AOBV) (under the NSW *Biodiversity Conservation Act* 2016).
- Invasive pest species including WeedWise search for priority listed weeds under the NSW *Biosecurity Regulation* 2017.
- A list of key issues relating to the ecology of the estuaries.

In addition to the above, visits to each estuary were undertaken to general ground truth existing data and obtain images of key items of significance/risk. A detailed synthesis of this information is provided in **Appendix B**.

2.2.2 Matters of National Environmental Significance

Environmental/ecological MNES recorded within a 10km search radius of St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek are as follows:

- Six (6) Listed Threatened Ecological Communities occur. One of these communities is aquatic/marine: "Subtropical and Temperate Coastal Saltmarsh". The other communities which occur in the region are: "Coastal Swamp Oak (Casuarina glauca)", "Illawarra and south coast lowland forest and woodland ecological community", and "River-flat eucalypt forest on coastal floodplains". "Littoral Rainforest and Coastal Vine Thickets of Eastern Australia", occur in the general vicinity, but not within the CMP study area.
- Eighty eight (88) Listed Threatened Species occur within the general vicinity.
- Fifty-six (56) Listed Migratory Species occur within the general vicinity.

These are discussed further in **Appendix B**, with a breakdown provided for each estuary.

2.2.3 Key Fish Habitat

The entire St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek are classed as Key Fish Habitat (KFH), defined as "*those aquatic habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally, and the survival and recovery of threatened aquatic species*".

2.2.4 Marine and Estuarine Vegetation

All marine vegetation is protected under the NSW *Fisheries Management Act* 1994. Marine vegetation, such as saltmarsh, mangroves, seagrasses, and macroalgae (seaweeds), provides shelter and nursery areas for aquatic animals and is an essential component of the food chain in estuarine and coastal environments. It also stabilises sediments and shorelines and protects water quality in estuaries for recreational users. NSW DPI administers legislation which protects mangroves, seagrasses and seaweeds on public water land and foreshores. Harming or removal of marine vegetation is generally only permissible by permit.

Updated estuarine macrophyte habitat mapping of St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek was undertaken by NSW DPI in 2004 and 2020 and is presented in **Appendix B**. Habitat mapping is available via https://nsw-dpi.shinyapps.io/NSW_Estuarine_Habitat/.

In summary:

- In St Georges Basin, widespread beds of Posidonia and Ruppia seagrass occur, with smaller areas of Zostera seagrass, in the north-east, and some small areas of saltmarsh and mangroves occur along the Sanctuary Point foreshore. Halophilia seagrass occurs in the north-west.
- At Sussex Inlet, the northern and middle sections are lined with large areas of Posidonia, with mixed Posidonia and Zostera seagrass beds and larger areas of saltmarsh and mangroves in the southern sections of the channel. Deeper areas of the channel have no mapped macrophytes.
- Only Ruppia has been mapped by NSW DPI in Swan Lake. The 2004 estuarine mapping shows that the inlet of Swan Lake and most of the eastern and northeastern sides of the lake are lined with Ruppia seagrass. Recent observations have reported that Charophytes (dense beds of estuarine algae) have largely disappeared from Swan Lake within the past five years. This is thought to be potentially related to the drought in 2019 – 2020.
- At Berrara Creek, mapping from 2005 shows extensive macrophyte growth near the mouth of Berrara Creek and approximately 0.5 km upstream. Zostera and Halophila seagrasses exist in the subtidal / intertidal areas, with small patches of saltmarsh located in the higher intertidal zone.

Changes in macrophyte distribution over time have been analysed, and are presented in the Stage 2 CMP Water Quality and Estuary Health Report (Advisian 2023b)

2.2.5 Coastal Wetlands and Littoral Rainforests

Coastal Wetlands and Littoral Rainforests in and around Sussex Inlet and St Georges Basin were mapped using the NSW DPI Spatial Data Portal. No Littoral rainforests are mapped within the study area. Coastal Wetlands occur through much of Sussex Inlet and also around the north, west and southern foreshores of St Georges Basin (Figure 2-8, Figure 2-9) and along the northern and eastern foreshores of Swan Lake (Figure 2-10).

Figure 2-8– Location of Coastal Wetlands in St Georges Basin (NSW DPI 2021).

Figure 2-9– Location of Coastal Wetlands in Sussex Inlet (NSW DPI 2021).

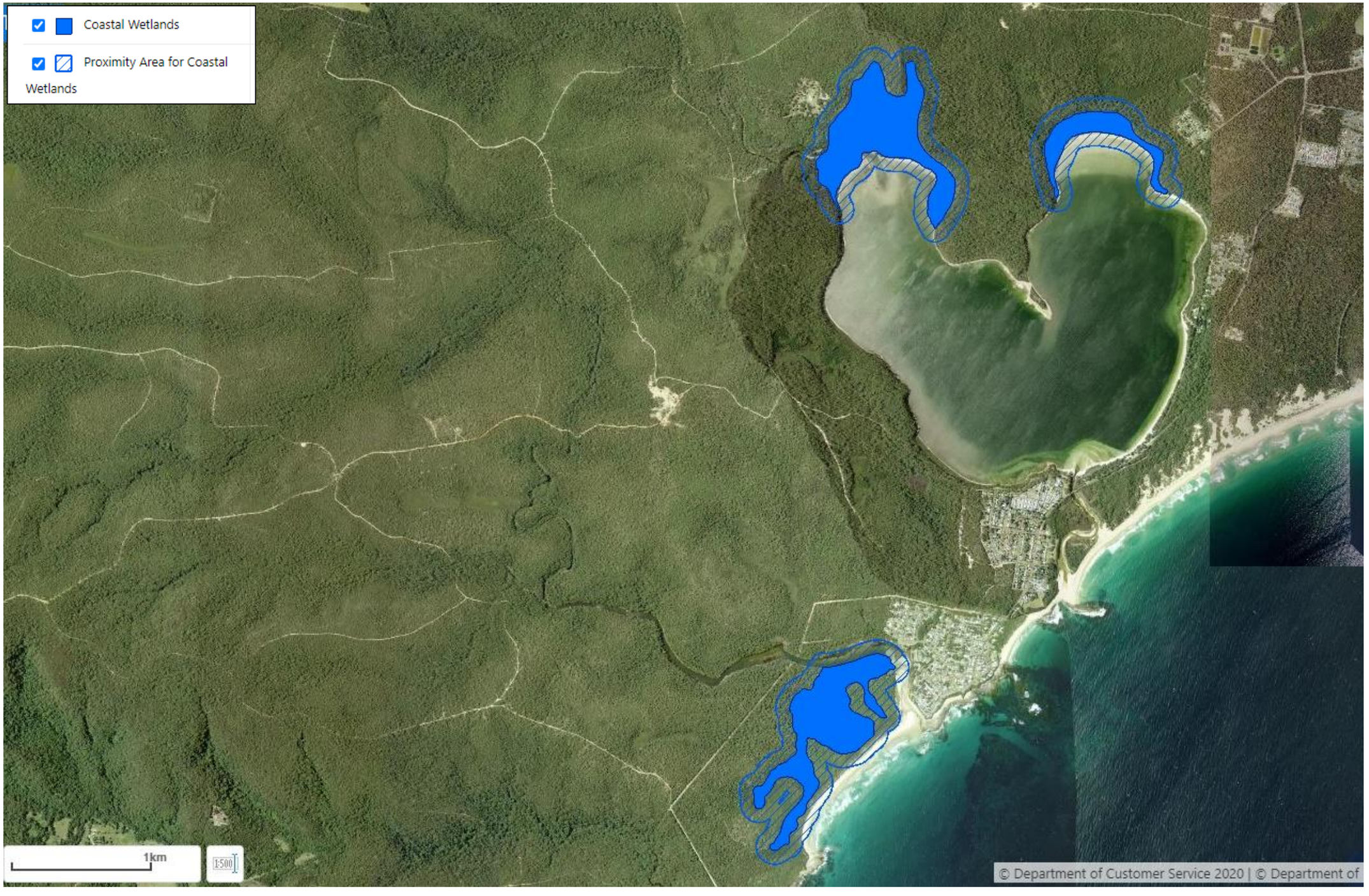


Figure 2-10 - Location of Coastal Wetlands in Swan Lake and Berrara Creek (NSW DPI 2022).

2.2.6 Threatened and Protected Fauna

The estuarine habitats of St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek provide areas for shelter, foraging and breeding/nursery areas for a wide range of mobile and sessile marine fauna. Mobile estuarine vertebrates within the estuary include birds, bats, frogs, bony fishes, marine reptiles (e.g., turtles), marine/migratory birds, sharks and rays. Larger marine mammals (i.e. dolphins and whales) are likely to be located within the offshore waters and not within the estuaries.

Many of these species are listed as threatened or protected under State and/or Commonwealth legislation including the NSW FM Act 1994, NSW BC Act 2016 and Commonwealth EPBC Act 1999. These threatened species are identified in **Appendix B**.

2.2.7 Invasive Pests

Invasive pests are animals or weeds that can have significant impacts on local wildlife, natural bushland or livestock. All stakeholders have a responsibility to manage invasive species on land that they own or manage. The Council manages weeds throughout the LGA on council managed land as outlined in the Commonwealth *Biosecurity Act* 2015 and the NSW *Biosecurity Regulation* 2017. Within the waterways, NSW DPI is responsible for management of marine pests.

2.2.7.1 Weeds

A search of the NSW DPI WeedWise database for aquatic and terrestrial invasive weeds on the South East Coast was made on the 30th June 2022.

There are Priority Weed Management Plans in place within Shoalhaven LGA (Shoalhaven City Council 2022b), for a range of weed species as identified in **Appendix B**.

In addition, garden weeds are identified as an issue for gardens that border onto native bushlands. Garden weeds can spread from suburban gardens by water, wind, birds, bikes, cars, earth-moving equipment, illegal tracks or dumped garden waste (Shoalhaven City Council 2022b). Key plant species that spread easily into neighbouring bushland are identified in **Appendix B**.

2.2.7.2 Feral Animals

Feral pest animals compete with native species for breeding and foraging habits and pose a risk to environmental health. Feral pests across the Shoalhaven region include:

- Foxes
- Wild Rabbits
- Indian Myna birds
- Feral Pigs
- Feral Cats
- Feral goats
- Wild Dogs

The Council participates in control strategies together with other state and federal agencies for foxes, rabbits and Indian Myna birds.

2.2.7.3 Marine Pests

Marine pests are non-native marine plants or animals that harm, or have the potential to harm Australia's marine environment, social amenity or industries that use the marine environment (DPI 2022). No marine pests have been confirmed to occur in Swan Lake or Berrara Creek. The only marine pest species that has been confirmed to have occurred in the past in Sussex Inlet and St. Georges Basin is *Caulerpa* (*Caulerpa taxifolia*), although NSW DPI (https://www.dpi.nsw.gov.au/fishing/aquatic-biosecurity/pests-diseases/marine-pests/seaweed/caulerpa-taxifolia) report that the abundance of Caulerpa in all south coast estuaries including St Georges Basin had declined to a point that none could be found (based on DPI transect surveys undertaken in 2011/2012).

2.2.8 Key Issues

Key ecological issues identified during the CMP in St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek are shown in Table 2-5.

Table 2-5 – Key Ecological Issues applying across all estuaries

Coastal Management Area	Issue	Existing Controls
Coastal Environment	Changes in balance between habitat types, landward migration or loss of macrophyte communities due to future sea level rise and increasing frequency, depth and duration of coastal and tidal inundation. Over time, this may lead to loss or changes to biodiversity, and landward migration of estuarine vegetation. The Sanctuary Point shoreline is particularly vulnerable.	Development controls, state and federal legislation
Coastal Environment	Instances of vandalism of estuarine vegetation have occurred, and there is a lack of understanding of best practice for vegetation management.	Shoalhaven City Council Vegetation Vandalism Prevention Policy
Coastal Environment, Coastal Use	Development pressures resulting in a reduction in estuary health, perceived incorrect zoning of environmentally sensitive areas. E.g. ad-hoc jetties, unapproved structures, subdivisions	Development controls, state and federal legislation.
Coastal Environment, Coastal Wetlands	Threats to shorebirds at estuary entrances and throughout the estuaries of St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek due to human activity and coastal hazards	NSW South Coast Shorebird Recovery Program
Coastal Environment	Limited or out-dated information available on key indicators of estuarine health e.g. erosion rates, estuary entrance berm growth rates following closure, migration and health of estuarine vegetation	Ad-hoc monitoring of environmental parameters.
Coastal Environment	Environment protection works required in some areas to rehabilitate land toward its natural state	Ad-hoc monitoring of environmental parameters.
Coastal Environment, Coastal Wetlands	Climate change causing more frequent extreme events (drought and bushfires)	Ad-hoc monitoring of environmental parameters
Coastal Environment, Coastal Wetlands	Damage to estuarine vegetation and seagrass from boating activities	Boating restrictions/channel navigation aids
Coastal Environment, Coastal Wetlands	Fragmentation of coastal wetland area due to urban encroachment	Development controls, state and federal legislation

Coastal Management Area	Issue	Existing Controls
Coastal Environmen, Coastal Wetlands	General spread of invasive weeds due to urban landuse and unauthorised access, introduced species and threats to wildlife	Local Land Services South East Regional Strategic Weed Management Plan, Shoalhaven City Council Priority Weed Management Plans
Coastal Environment, Coastal Wetlands	Risk to estuarine ecology from unauthorised entrance openings	Signage, public education, ad-hoc monitoring
Coastal Environment, Coastal Wetlands	Degradation of habitat for shorebirds and aquatic ecology (decline in Ruppia seagrasses in 2004 *vs* 1980). Impact of drought and bushfires on perceived decline in charophytes and swans	NSW South Coast Shorebird Recovery Program, ad-hoc environmental monitoring
Coastal Environment	Impact of existing infrastructure e.g. past bridge construction on estuarine morphology	Ad-hoc monitoring of environmental parameters

3 Stage 2 Risk Assessments and Supporting Studies

A series of supporting studies have been undertaken as part of the CMP during Stage 2, to understand in detail what these issues are. The following Stage 2 CMP study reports have been produced for this project, and are referenced herein:

- Advisian (2023) Stage 2 CMP Foreshore Erosion Assessment Report.
- Advisian (2023a) St Georges Basin-Sussex Inlet Water Quality and Estuary Health Study
- Advisian (2023b) Berrara Creek Water Quality and Estuary Health Study
- Advisian (2023c) Swan Lake Water Quality and Estuary Health Study
- Advisian (2023d) Stage 2 CMP Tidal and Coastal Inundation Report
- Advisian (2023e) Stage 2 CMP Risk Assessment
- Advisian (2023f) Stage 2 CMP Boating Study

The supporting studies are summarised below, with key ouctomes, issues and opportunities presented.

3.1 Foreshore Erosion

3.1.1 Overview

A detailed field-based assessment of erosion and foreshore issues affecting the estuary health of St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek has been carried out, and documented in the Stage 2 CMP Foreshore Erosion Assessment Report (Advisian 2023). The shoreline was inspected in detail, including from the water by boat and from land by foot, and features indicative of the coastal processes occurring at the various sites within the study area have been documented.

Key areas that have suffered from erosion include:

- Sussex Inlet – foreshore west of Nielson Lane, Croppers (the Big "S"), The Haven, Alamein, Little Manly, Christian's Minde
- St Georges Basin – especially the south-facing areas along the northern foreshore where the foreshore has been reclaimed with fill materials and where fringing vegetation is absent from the shoreline
- Berrara Creek – northern and eastern foreshores.

Causes of erosion throughout the study area include:

- erosion at outer side of channel bends, caused by natural channel meandering
- erosion at the toe of steep unstable sand banks, caused by vessel wash, slope instability and people accessing the dunes
- erosion of unstable fill materials that do not have sufficient stability to resist wave action

- erosion caused by outflanking of existing foreshore protection works
- erosion caused by wind waves at high water levels, undermining fringing vegetation and toppling of this vegetation by strong winds
- erosion caused by access to the foreshore (e.g. stock access at Wandandian Creek, lack of foreshore vegetation)
- erosion caused by vessel wash (near boat ramps and along Wandandian Creek)
- erosion caused by ad-hoc vessel storage, stormwater/catchment outflows.

Examples of the observed foreshore erosion are provided in Figure 3-1. Potential management actions for the erosion were assessed using the DP&E Decision Support Tool, with specific actions outlined and identified for each area where erosion has been documented. The management actions included:

- management of foreshore vegetation
- placing large woody debris
- cobble beaches
- maintenance and upgrade of existing foreshore works.

The detailed management suggestions from the Decision Support Tool are provided within the Stage 2 Foreshore Erosion Assessment Report (Advisian 2023) and the Stage 2 CMP Risk Assessment (Advisian 2023e).

3.1.2 Key Issues

Mapping undertaken as part of the foreshore erosion assessment is provided in Figure 3-2 for St Georges Basin, Figure 3-3 for Sussex Inlet, Figure 3-4 for Swan Lake and Figure 3-5 for Berrara Creek. Key issues relating to foreshore erosion applying across all the estuaries are outlined in Table 3-1.

Table 3-1 – Key Issues relating to foreshore erosion applying across all estuaries

Coastal Management Area	Issue	Existing Controls
Coastal Use	Damage to public infrastructure and critical services due to present day and future risk of foreshore erosion.	Council is drafting a Climate Change Adaptation Plan that includes actions to adapt to sea level rise on a city-wide scale. These actions include undertaking risk assessments for council assets to identify and prioritise areas, infrastructure, and assets at risk from erosion, coastal inundation, storms, and flooding, and ensuring that asset management plans consider risk of storms, sea level rise and inundation for Council assets and infrastructure.
Coastal Environment	Damage to the estuarine environment, public infrastructure and critical services due to present day and future risk of foreshore erosion.	No comprehensive management strategy to address erosion along public foreshores within the estuaries is currently available.

Erosion due to undermining of trees at Paradise Beach, St Georges Basin

Large tree toppled over April 2022, Sussex Inlet (The Haven)

Continuing erosion of sandy foreshore, downstream Little Manly, Sussex Inlet

Eroded foreshore behind moored boats, upstream from Nielson Lane Boat Ramp, Sussex Inlet

Ongoing erosion along inside of bend, Swan Lake inlet channel

Undercutting of trees at Lakeland Avenue, Berrara Creek

Figure 3-1 – Examples of foreshore erosion issues at St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek

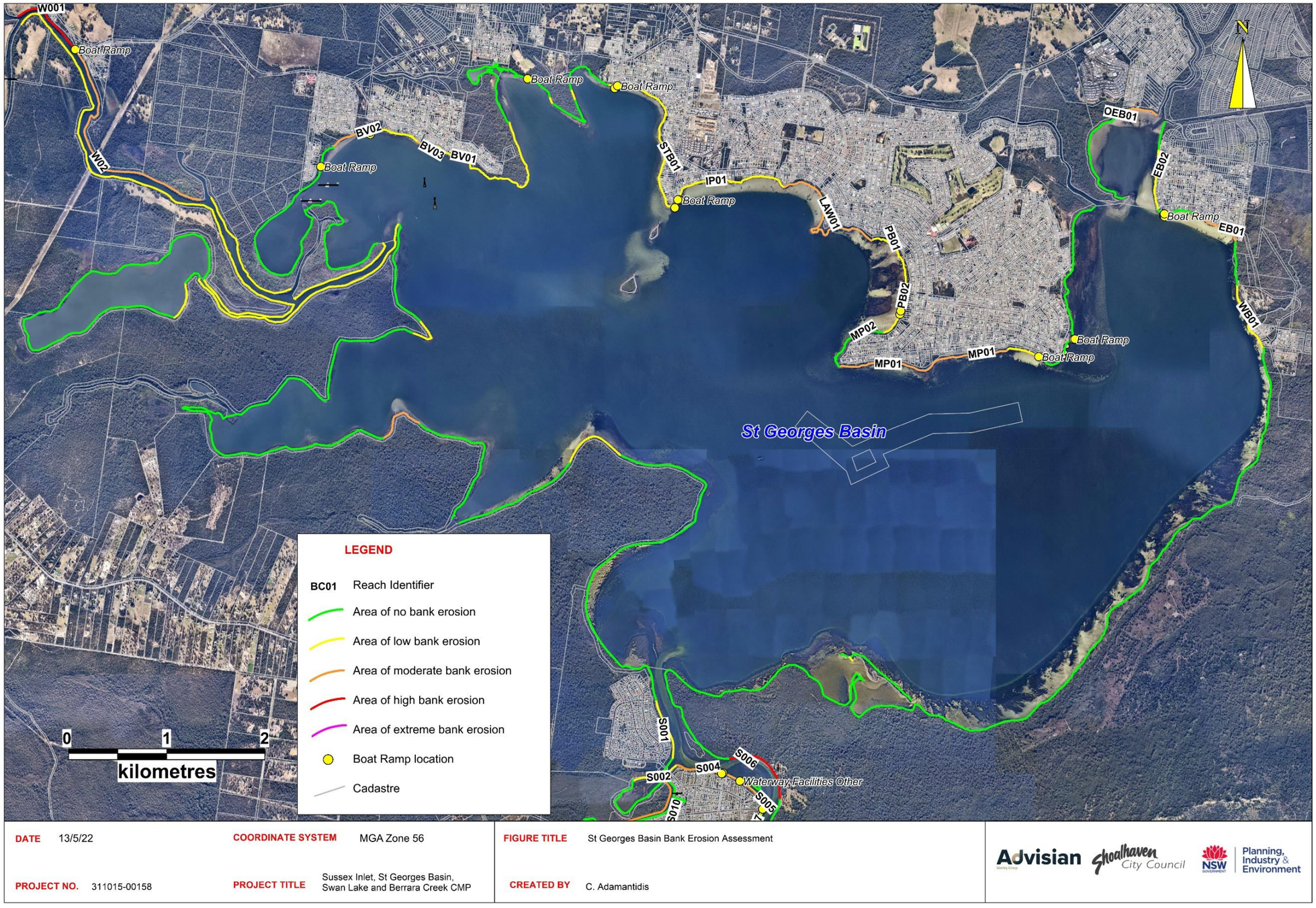


Figure 3-2 – Erosion Assessment Map for St Georges Basin

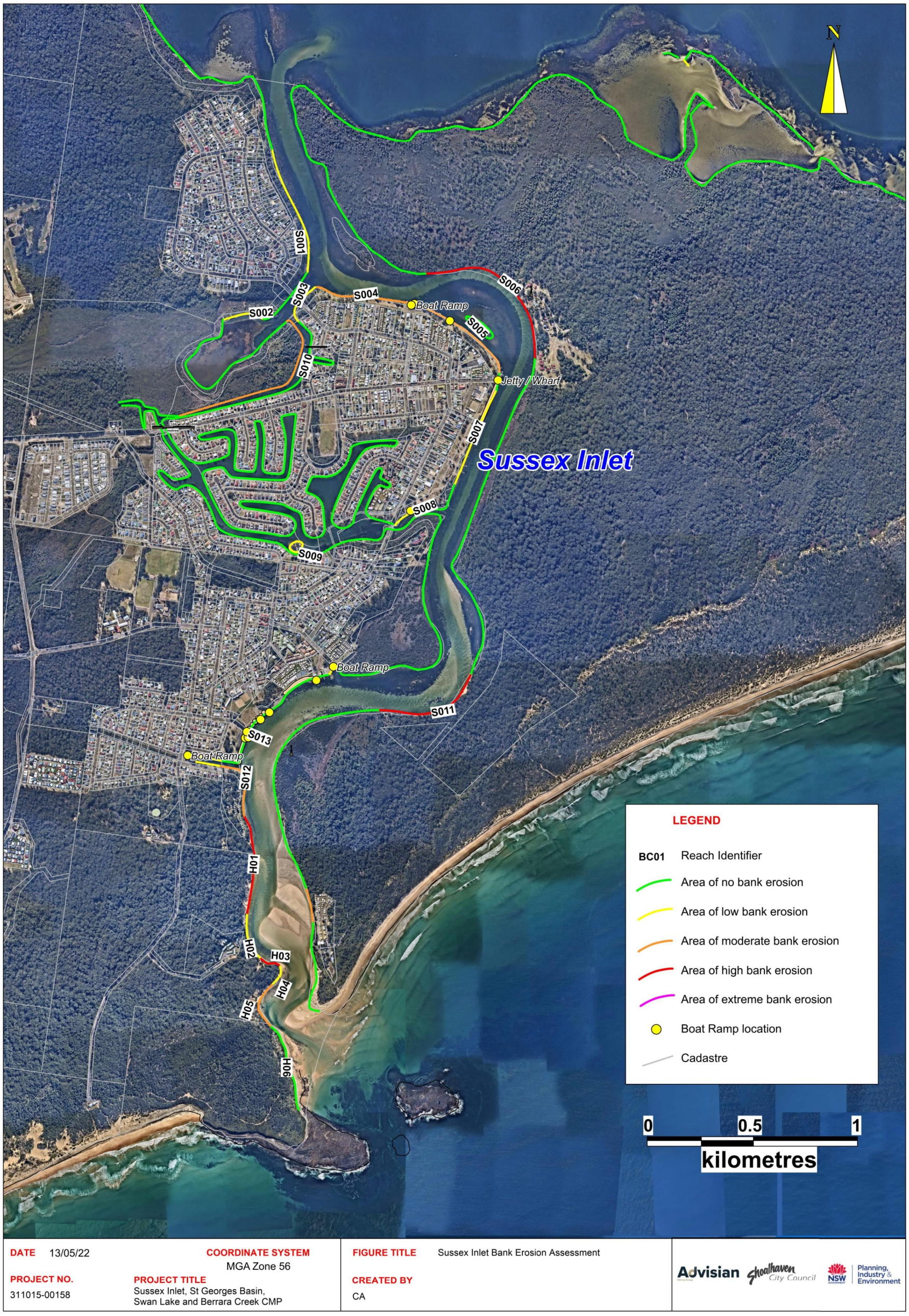


Figure 3-3 – Erosion Assessment Map for Sussex Inlet

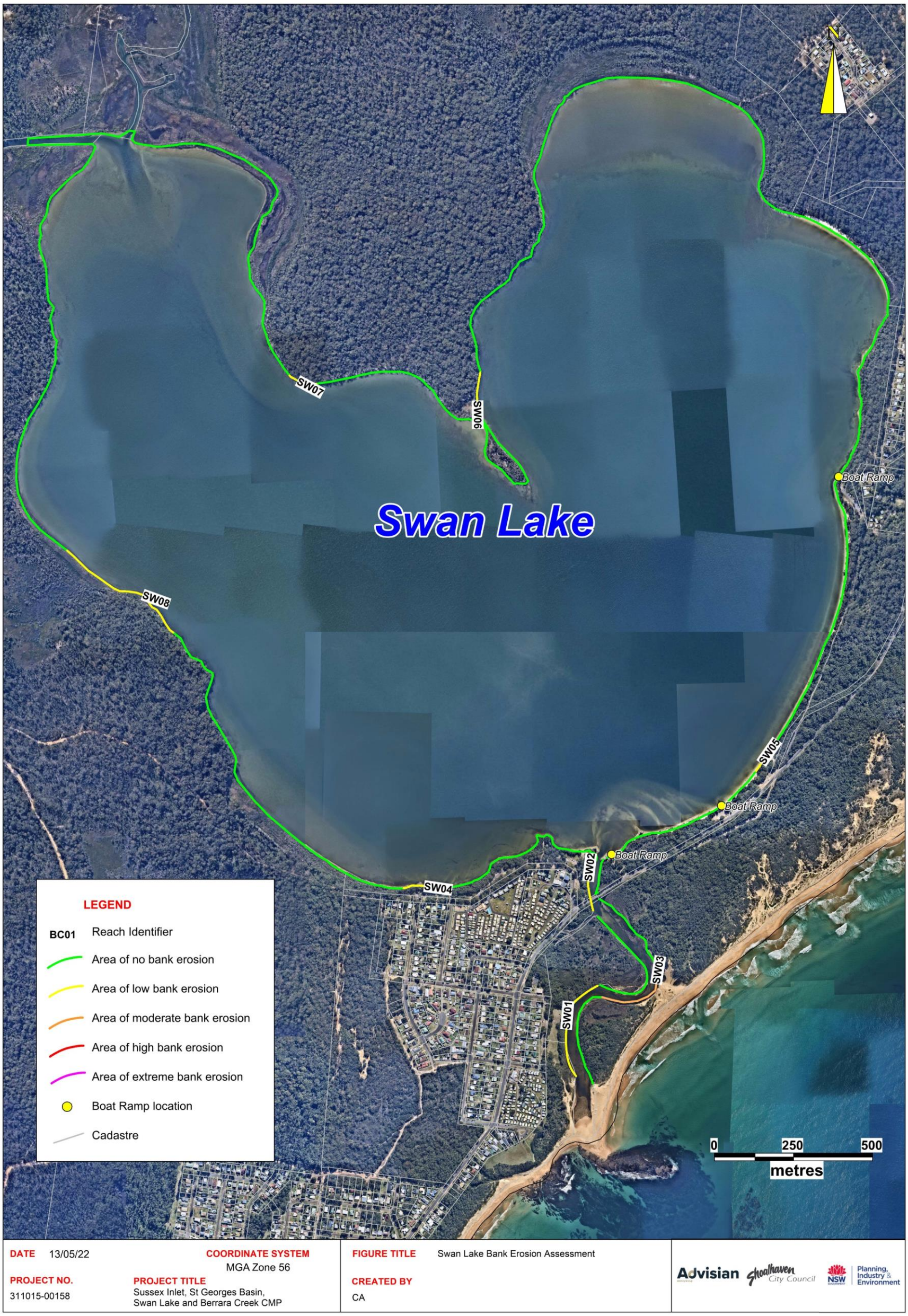


Figure 3-4 – Erosion Assessment Map for Swan Lake

Figure 3-5 – Erosion Assessment Mao for Berrara Creek

3.2 Estuary Entrance Management – Swan Lake and Berrara Creek

3.2.1 Overview

As part of Stage 2 of the CMP, a review of the existing Entrance Management Policy for Swan Lake and the assessment of the potential need for an entrance management policy for Berrara Creek has been undertaken. The review has used additional data collected since the Policy was first formulated in 2002 to address knowledge gaps identified in the Policy, and to assess the appropriateness of the existing Policy with respect to intervention at the Lake entrance.

The review found that the existing management regime for Swan Lake is sound and that the assumptions used to formulate the Policy are largely correct. It should be noted that most openings of Swan Lake have been illegally done by people intervening rather than by Council, and that there have been documented instances of Berrara Creek being opened illegally also. There is a need to understand why these openings are occurring and to implement measures to reduce this, including education on the ecological benefits of allowing water levels to rise (particularly to inundate the coastal wetlands that fringe the lake) and to deter people from future unauthorised openings.

While Swan Lake closely resembles a natural system, it has been impacted by illegal openings below trigger levels, and current trigger levels do not allow for complete inundation of the mapped coastal wetlands at the northern end of the lake. There have been anecdotal reports from the community regarding impacts to Swan Lake's ecology, such as loss of charophytes, potentially decreased numbers of Swans and a documented fish kill event in January 2023. Further investigation is needed to understand these ecological changes and understand any potential changes following the drought and bushfires of 2019-2020. The need for intervention can be reduced to improve the resilience of Swan Lake, and allow Swan Lake to more closely resemble a natural system to improve the estuary's health. Practical measures to reduce the need to intervene with the natural system have been recommended, including minor works to improve flood resilience of infrastructure and measures to improve recreational amenity, reducing the impact of long-term nuisance inundation on the local community when the entrance is closed and Swan Lake's water levels are high. The recommendations for management of the Swan Lake entrance and Berrara Creek entrance are outlined below.

Note that the Entrance Management Policy will be updated with consultation, in parallel to the completion of the CMP.

3.2.2 Recommendations for Swan Lake

The following recommendations are provided for future entrance management of Swan Lake (in order of priority):

3.2.2.1 Intervention Levels – Short Term

- In the short term, raise the 2.2 m AHD minimum intervention for a planned opening in the existing Policy to 2.3 m AHD, to allow sufficient inundation of the Coastal wetland area at the northern end of the lake to occur for a minimum of three months (Note: the existing Entrance Management Policy already specifies this 3 month timeframe). Once the trigger level of 2.3 m AHD is reached, the three month period need not be reset unless the water level falls back below

2.25 m AHD – i.e. if the water level falls slightly below 2.3 m AHD temporarily within the three-month period (but stays above 2.25 m AHD), the three month period need not be reset.

- retain the existing consultation arrangements with National Parks and Wildlife Service to determine the presence of nesting shorebirds or Green and Golden Bell Frogs prior to initiating an opening when water levels are between 2.3 m AHD and 2.5 m AHD.
- retain the existing 2.5 m AHD intervention level for an emergency opening in the short term for opening the lake at the earliest opportunity, but with consultation as per the existing Entrance Management Policy.
- If an artificial opening is required, depending on entrance berm levels, carry out the opening close to but on the northern side of reef to allow some tidal exchange to occur. Opening the entrance on the south side at Location A does not allow lake levels to fall low enough to induce tidal exchange and is opposed by some members of the community due to perceived impacts on surf quality. The exception to this is if the berm level is demonstrably lower (as evidenced by entrance berm survey) on the south side of the reef than the northern side.
- if an artificial opening is required, maintain the existing procedure outlined in the Entrance Management Policy for opening the lake regarding entrance channel excavation width and opening times with respect to tidal levels.

3.2.2.2 Raising of Intervention Levels

It is considered feasible to raise the intervention levels for the lake entrance progressively over time to 3.0 m AHD to return the lake to a more natural opening regime. This would require some infrastructure modifications to raise their levels, as well as other incentives to help deter illegal openings by the public. The staging of this approach would include:

- **Current regime (short term)** - opening the lake at the earliest opportunity, but with consultation as per the existing Entrance Management Policy)
- **Stage 2 (medium term) –** investigate and provide measures to improve recreational amenity when lake levels are high (e.g. pontoons for swimming, or a beach that can be used when lake levels are high, upgrade Ski Beach boat ramp etc.) to deter unauthorised lake openings, also consider signage and enforcement. Enhance community education on water quality (e.g. interpretive signage, inclusion of Swan Lake in Shoalhaven's recreational swimming water testing program to show that water quality is good in the lake regardless of whether open or closed).
- **Stage 3 (long term)–** Raise The Springs Road to 3.0 m AHD and investigate raising of Collier Drive to 3.0 m AHD as well as minor works to reduce inundation impacts on the cabins at Holiday Haven caravan park. Once implemented, introduce a "three month" minimum intervention level for a planned opening at 2.5 m AHD and raise the emergency opening level to 3.0 m AHD.

This staging is illustrated in Figure 3-6.

3.2.2.3 Monitoring

The following ongoing monitoring is recommended:

- monitor entrance berm levels on both sides of the reef on a regular basis (say, once per month following a lake opening for the first three months, then 3-monthly following) to develop an understanding of how the berm level grows after a lake opening and the ultimate berm level likely to be reached.
- monitor berm levels at "The Gap" regularly to assess risk of lake breach at this location. Beach scraping and dune revegetation may be needed to prevent an opening from occurring here which could have major adverse impacts. These major impacts could include major erosion of the surrounding dunes, a rapid drawdown of the lake level, strong currents in the channel, bridge abutment scour, loss of wetland vegetation and erosion of the channel banks.
- maintain record keeping of openings in accordance with the existing Entrance Management Policy.

3.2.3 Recommendations for Berrara Creek

A formal entrance management protocol for Berrara Creek is not considered warranted as there is no known infrastructure at risk when water levels are high. However, community education and increased monitoring are recommended for Berrara Creek to better understand the entrance opening and closing regime. With sea level rise it is likely that water levels may increase in the future. The recommendations for Berrara Creek include:

- improve community education on water quality; *e.g.* include Berrara Creek in Shoalhaven's recreational water quality monitoring program for swimming safety to demonstrate that water quality is usually safe for swimming regardless of whether the creek entrance is open or closed
- improve community education on the natural entrance processes and benefits to its ecology through interpretive signage
- retention of the temporary water level recorder that has been recently installed to assess long-term water levels and allow analysis of creek tidal characteristics and assessment of closure events on an as-needs basis
- monitoring of entrance conditions on a regular basis, including survey of berm levels and documentation of closure and breaching events
- monitor overflows from the sewage pumping station that discharges via a tributary into Berrara Creek, and investigate if any upgrades are necessary
- continued water quality monitoring and analysis of data with respect to monitoring of entrance conditions
- documenting impacts of future inundation events
- Council and Department of Planning and Environment (DPE) liaison with National Parks and Wildlife Service to coordinate future management of the creek entrance and foreshore
- adoption of a formal policy statement that includes the above recommendations and outlines that the entrance to Berrara Creek should not be artificially opened.

Short Term

A. Water level stabilises between 2.3 m AHD and 2.5 m AHD

Is it shorebird breeding season?

Yes

Liaise with NPWS to determine presence of breeding pairs of protected bird species & carry out survey for Green & Golden Bell Frog.

Are protected shorebird / amphibian species present?

Yes

Further consultation with NPWS required to determine appropriateness of opening entrance if lake continues to rise.

No

Monitor lake level, wait three months for wetland inundation before planning ** for entrance opening if agencies concur.

No

Liaise with NPWS re opening prior to breeding season & survey for Green & Golden Bell Frog.

B. Water level at or above 2.5 m AHD

Carry out consultation with state agencies and carry out urgent entrance opening (to be carried out at the top of the first available high tide), noting agency advice.

Stage 1

A. Undertake minor works to raise the access track to The Springs Cabins by 0.5 m to 2.7 m AHD or higher. Once complete, this would remove the need for any entrance intervention measures when the lake is below 2.5 m AHD. Keep existing intervention procedure when lake levels of 2.5 m AHD.

B. Water level at or above 2.5 m AHD

Carry out consultation with state agencies and carry out urgent entrance opening (to be carried out at the top of the first available high tide), noting agency advice.

Stage 2

A. Investigate and provide measures to improve recreational amenity when lake levels are high e.g. pontoons for swimming, or a beach that can be used when lake levels are high, upgrade Ski Beach boat ramp etc. to deter unauthorised lake openings, also consider signage and enforcement. Enhance community education on water quality e.g. interpretive signage, inclusion of Swan Lake in Shoalhaven's Beachwatch program to show that water quality is good in the lake regardless of whether open or closed.

B. Water level at or above 2.5 m AHD

Carry out consultation with state agencies and carry out urgent entrance opening (to be carried out at the top of the first available high tide), noting agency advice.

Stage 3

A. Raise The Springs Road to 3.0 m AHD and investigate raising of Collier Drive to 3.0 m AHD as well as minor works to reduce inundation impacts on the cabins at Holiday Haven caravan park. Once enacted, raise the "three month" minimum intervention level to 2.5 m AHD and raise the opening level to 3.0 m AHD.

A. Water level stabilises between 2.5 m AHD and 3.0 m AHD

Is it shorebird breeding season?

Yes

Liaise with NPWS to determine presence of breeding pairs of protected bird species & carry out survey for Green & Golden Bell Frog.

Are protected shorebird / amphibian species present?

Yes

Further consultation with NPWS required to determine appropriateness of opening entrance if lake continues to rise.

No

Monitor lake level, wait three months for wetland inundation before planning ** for entrance opening if agencies concur.

No

Liaise with NPWS re opening prior to breeding season & survey for Green & Golden Bell Frog.

3.0

B. Water level at or above 2.5 m AHD

Carry out consultation with state agencies and carry out urgent entrance opening (to be carried out at the top of the first available high tide), noting agency advice.

Figure 3-6 – Suggested staging for progressive updates to the Swan Lake Entrance Management Policy

3.3 Water Quality

3.3.1 Overview

An up-to-date assessment of estuarine water quality and health has been carried out across the three estuaries to inform the scope and nature of coastal management actions during the future stages of Council's CMP development and implementation. The assessment is documented in detail in a separate Water Quality and Estuary Health report for each estuary (Advisian 2023a, 2023b, 2023c).

Recommendations were made for an ongoing monitoring program for water quality in terms of sampling sites, frequency, parameters, sampling methodology, limits of reporting (LORs) and applicable trigger values. This is to ensure that the ongoing water quality monitoring program can track improvements towards meeting current water quality objectives.

A review of routine water quality monitoring data from the past decade (2010 – 2021) was undertaken for St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek. The review found that:

- Water quality within Sussex Inlet and St Georges Basin is considered very good with occasional detections of elevated turbidity, elevated chlorophyll-a and low DO. Recreational water quality within St Georges Basin and Sussex Inlet continues to be highly ranked as "Good" for swimming and other water-based activities based on the National Health and Medical Research Council (NHMRC) (2008) guidelines.
- The findings of the water quality study are consistent with previous reports by Council and other relevant agencies that conclude water quality within St Georges Basin and Sussex Inlet is generally very good, but that there is sometimes poorer water quality associated within inflows from the main tributaries Wandandian Creek and Tomerong Creek. Likely contributors of poorer water quality within these tributaries are urban stormwater, foreshore and urban developments, bank erosion, agricultural runoff and sewage effluent from sewage overflows.
- Water quality within Swan Lake within the past decade has generally been good. Overall, recreational water quality within Swan Lake continues to be highly ranked as "Good" for swimming and other water based activities based on the NHMRC (2008) Guidelines. An estuary health assessment prepared by DP&E for Swan Lake had an overall rating of Good (B), and on most occasions there was low algae (chlorophyll-a) and clear water clarity (turbidity). This was a slight decrease in estuary health in comparison to the previous estuary health assessments undertaken by DPIE between 2014-2015 and 2008–2009, which received overall ratings of Excellent (A).
- Limited sampling by the NSW DP&E over the summers of 2014-15 and 2020-21 found Berrara Creek to have good to excellent water quality based on their standard measurements of water clarity (turbidity) and algal abundance (chlorophyll a) (DPIE, 2016). Recreational water quality within Berrara Creek continues to be highly ranked as "Good" for swimming and other water-based activities based on the NHRMC (2008) Guidelines at the mouth of the estuary and upstream (near Fishermans Rock).

3.3.2 Key Issues

Issues that have been raised regarding water quality and estuary health in the Stage 2 CMP Water Quality Assessment (Advisian 2023), previous reports and during the community consultation undertaken as part of the CMP include:

- Occasional poor water quality from catchment inflows (Tomerong Creek and Wandandian Creek) associated with catchment pollution sources including bank erosion (including unrestricted access of cattle to foreshores), onsite sewage management, sewage overflows, agriculture, road runoff and urban stormwater.
- Siltation and stormwater runoff around poorly maintained boat ramps within St Georges Basin and retaining wall disrepair along Sussex Inlet.
- Removal of important habitat and associated decline in ecological health as identified in community consultation including:
    - Removal of terrestrial vegetation (for example along Tomerong Creek).
    - Damage to coastal vegetation in Sussex Inlet, dunes and habitats by four-wheel driving and dogs.
    - Damage to seagrasses and saltmarshes within Sussex Inlet Channel associated with boating and canoe storage.
    - Impacts on fisheries within St Georges Basin thought to be associated with illegal and professional fishing and decline in habitat.
    - Impacts on endangered bird species around Sussex Inlet and St Georges Basin thought to be associated with decline in terrestrial and aquatic habitat including from boating potential declines in fisheries as well as dogs and people disturbing shorebird nesting areas.
    - Inadequate protection of important ecological zones including wildlife corridors and habitat throughout St Georges Basin.
- Maintenance of Riviera Keys within Sussex Inlet Canals – including bank erosion and inadequate stormwater management controls.
- Flooding and inundation impacts associated with sea level rise.
- Water exchange and entrance management
- Future anticipated climate change impacts
- Impacts on water quality associated with the 2019/20 bushfire event.

A summary of estuary health and water quality issues for St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek and potential implications is provided in Table 3-2.

Table 3-2 - Water quality issues and implications.

Issue	Implication
▪ Inconsistent sampling, data maintenance and reporting (e.g. less sampling has occurred in winter months). ▪ Ambiguous values likely related to data entry and/or instrument errors. ▪ Potential overestimation of turbidity. ▪ Inability to separate pollution events and routine monitoring data in Aquadata portal. ▪ Inconsistent sampling of turbidity and chlorophyll–*a* ▪ Insufficient sites monitored for nutrients and chlorophyll-*a*	▪ Reduced ability to assess water quality health and whether water quality objectives are being met ▪ Lack of similarity / consistency in datasets restricts analysis which can be undertaken ▪ Errors in water quality data can carry over into reporting ▪ Reduced ability to discriminate between pollution and routine data can affect interpretation of results.
▪ Pathogen inputs from upsrtream tributaries (e.g. Tomerong Creek, Wandandian Creek)	▪ Potential for excessive nuisance plant and algae growth, human health, amenity and ecological risks due to insufficient understanding of nutrient levels
▪ Removal of trees and coastal vegetation leading to increased siltation	▪ Removal of trees and coastal vegetation results in loss of buffers to filter run-off. ▪ Increased turbidity, reduction in light penetration impacting on seagrasses, reduced dissolved oxygen
▪ Siltation from poorly maintained boat ramps, seawalls, bank erosion	▪ Increased turbidity, reduction in light penetration impacting on seagrasses, reduced dissolved oxygen
▪ Reductions in water quality following flooding and tidal inundation events:	▪ Added rubbish and contaminants being washed into waterways from urban areas during periods of inundation, particularly when combined with storm events ▪ Reduced flushing rates associated with the higher water table and higher tides during inundation events. ▪ Elevated turbidity from catchment inputs associated with development sites and runoff events following heavy rain, although turbidity, dissolved oxygen and nutrient levels within the estuaries are generally good.
▪ Increased catchment runoff and associated sediment and nutrients from burnt areas after the bushfires.	▪ Bushfires can impact on water quality with increased sediment and nutrient loads and increased turbidity, which can generate algae blooms and reduce dissolved oxygen (NSW EPA 2020), as well as impact seagrasses through smothering and blocking of sunlight.
▪ Impacts on water quality caused by unauthorised estuary entrance openings	▪ Impacts on hydrodynamics, ecological processes, water quality within the estuary. ▪ Lower water levels within the lake that can lead to adverse ecological impacts via water quality (for example fish kills or altered vegetation).

3.3.3 Recommended Sampling Program

Recommended monitoring sites for inclusion in future sampling and a summary of the recommended water quality monitoring program is provided in the Stage 2 Water Quality and Estuary Health Reports

(Advisian 2023a, b c). These reports outline improvements to ongoing monitoring to ensure that the program can track improvements towards meeting current water quality objectives.

3.3.4 Recommended locations for Gross Pollutant Traps (GPTs)

A Gross Pollutant Trap (GPT) is a primary stormwater treatment device designed to stop litter, organic waste and sediments from entering the stormwater system and natural waterways, primarily through screening. They can be used in existing conventional drainage systems either in pipes, outfalls or open channels, but also as pre-treatment for other Water-Sensitive Urban Design (WSUD) elements within a stormwater system (e.g. bioretention systems or wetlands).

Advisian has mapped existing GPT locations within the St Georges Basin urban area in **Appendix C,** together with suggested potential locations for additional units. Four additional GPT locations have been suggested at St Georges Basin, four at Sussex Inlet and one at Swan Lake.

In addition, Shoalhaven City Council has undertaken a detailed audit of stormwater treatment devices within the LGA (Optimal Stormwater Pty Ltd 2023). The audit has applied condition ratings to Council's stormwater treatment devices and has made a number of recommendations with regard to ongoing management and maintenance of Council's stormwater treatment system.

3.4 Inundation and Sea Level Rise

3.4.1 Overview

A Tidal and Coastal Inundation Study (Advisian 2023d) has been carried out to predict the possible inundation level and extents under design extreme events and regular tidal conditions defined as per DPE guidelines.

The Study assesses both *coastal inundation* and *tidal inundation*.

Coastal inundation is defined in the NSW Coastal Management Manual (the Manual) Part B (DP&E, 2018) as occurring when a combination of marine and atmospheric processes raises ocean water levels above normal elevations, inundating low-lying areas. It is often associated with storms resulting in elevated still water levels (storm surge), wave setup, wave runup and wave overwash flows. For the estuaries, this type of inundation is the result of water levels at the estuary entrances being elevated above normal levels due to coastal storms, with the elevated water levels propagating inside the estuary.

Tidal inundation is defined in the Manual as the inundation of land by tidal action under average meteorological conditions. Tidal inundation may include shorter-term incursion of seawater onto low-lying land during an elevated water level event such as a "king" or spring tide or more permanent inundation due to land subsidence, changes in tidal range or sea level rise.

A three-dimensional hydrodynamic model of the study area has been developed to investigate how the tide propagates upstream into the estuaries and assess the impacts of tidal and coastal inundation on the coastal zone, including coastal wetlands and littoral rainforests, resources, assets and essential infrastructure, both under present day conditions and under future sea level rise.

Modelling of coastal and tidal inundation was undertaken in Advisian (2023d) for a range of scenarios for sea level rise (as shown in Figure 3-7), ocean boundary conditions (including the 1% and 5% *Annual Exceedance Probability*[1] ocean boundary conditions), entrance berm conditions and wind speeds, for a total of 18 model scenarios for coastal inundation, and seven for tidal inundation.

Mapping of both coastal and tidal inundation has been undertaken in Advisian (2023d). Examples of this mapping are provided in Figure 3-8 and Figure 3-9.

[1] *Annual Exceedance Probability (AEP)* refers to the probability that a particular event will be exceeded in any given year. A 1% AEP coastal inundation event refers to coastal inundation that has a 1% chance of being exceeded in any given year, equivalent to an event that would occur, on average, once in 100 years. A 5% AEP coastal inundation event has a 5% chance of being exceeded in any given year, equivalent to an event that would occur, on average, once in 20 years.

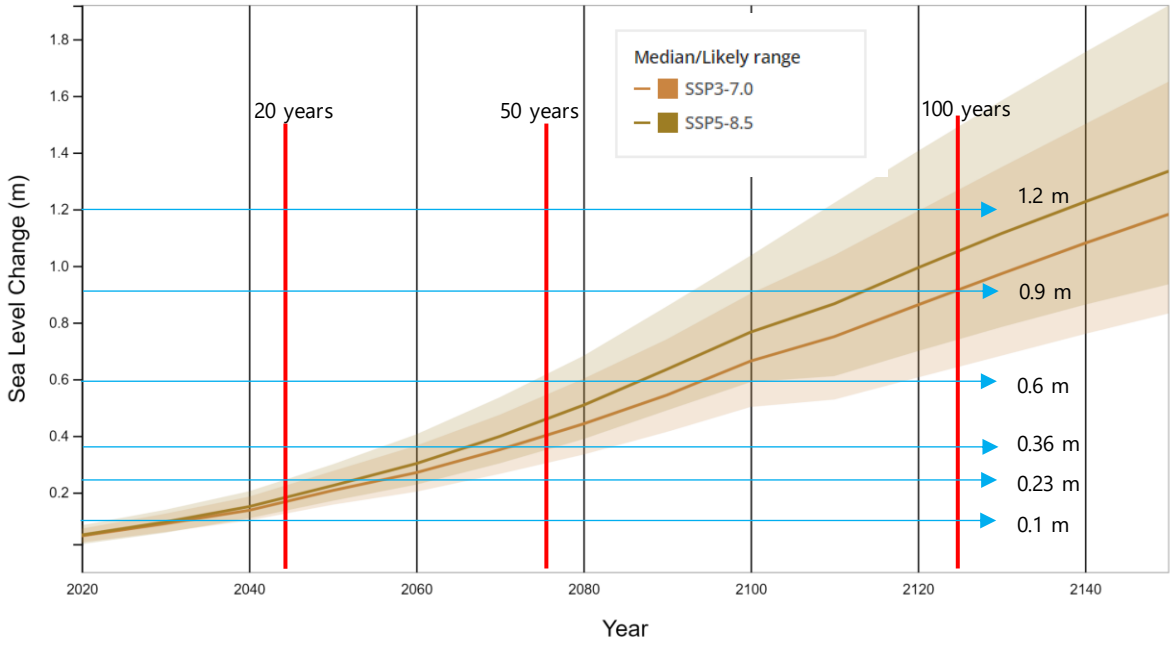


Figure 3-7 – IPCC (2022) sea level rise projections from Sixth Assessment Report at Jervis Bay for SSP3-7.0 and SSP5-8.5[2], and corresponding sea level rise for 20 year, 50 year and 100 year planning periods. Modelled sea level rise scenarios shown in blue.

It was found that:

- At St Georges Basin, there are extensive areas around Sanctuary Point, Old Erowal Bay, Erowal Bay, Basin View and St Georges Basin Village that will be impacted by 1% *Annual Exceedance Probability* (AEP) coastal inundation under current conditions, with additional areas impacted under future sea level rise scenarios (refer Advisian 2023d). This includes the potential for areas to be isolated by inundation for up to several days. The northern foreshore of St Georges Basin is particularly vulnerable to coastal inundation when combined with strong southerly winds, which induce both wind and wave setup along the shoreline, elevating water levels above what would otherwise occur in the absence of these winds. Maximum depths over areas where critical infrastructure is affected may reach 0.5 m at Basin View, 0.9 m at St Georges Basin and Sanctuary Point, and may exceed 1 m at Erowal Bay. Foreshore reserves and waterside infrastructure around Sanctuary Point, St Georges Basin, Erowal Bay and Basin View are currently subject to tidal inundation. The impact to these areas will increase with sea level

[2] **SSP3-7.0** is a medium to high reference scenario resulting from no additional climate policy under the SSP3 socioeconomic development narrative. SSP3-7.0 has particularly high non-CO2 emissions, including high aerosols emissions.
SSP5-8.5 is a high reference scenario with no additional climate policy. Emission levels as high as SSP5-8.5 are not obtained by Integrated Assessment Models (IAMs) under any of the SSPs other than the fossil fueled SSP5 socioeconomic development pathway.

rise in the next 20 to 50 years, particularly impacting on waterside infrastructure, critical sewer infrastructure and several residential lots in Sanctuary Point, Erowal Bay and Basin View.

- At Sussex Inlet, the town centre is affected by 1% AEP coastal inundation under present day conditions, with the depth and frequency of inundation expected to increase under future projected sea level rise. Under the various sea level rise scenarios, both coastal and tidal inundation will affect large areas of the town centre, with depths reaching 1 m, and access to and within the township is likely to be cut off by inundation. Tidal inundation is likely to become more common with sea level rise over the next 20 to 50 years with predictions that areas of Sussex Inlet, including the main CBD, will be inundated by more than 20cm up to twice per month during extreme high tides.
- At Swan Lake and Berrara Creek, tidal inundation is expected to have relatively minor impacts. However, under 1% AEP coastal inundation conditions with future sea level rise projections, there is potential for the main access to Berrara and Cudmirrah to be cut off at Collier Drive, and inundation for several hours up to 0.25 m depth to occur at low lying parts of the Holiday Haven Swan Lake caravan park. Coastal inundation of critical water infrastructure at Berrara including a water pumping station and water and wastewater mains is predicted under future sea level rise projections of 0.9 m or above that may occur beyond a 50 year timeframe.

Coastal and tidal inundation in combination with future sea level rise has the potential to impact on the aquatic vegetation within the study area, in the following ways:

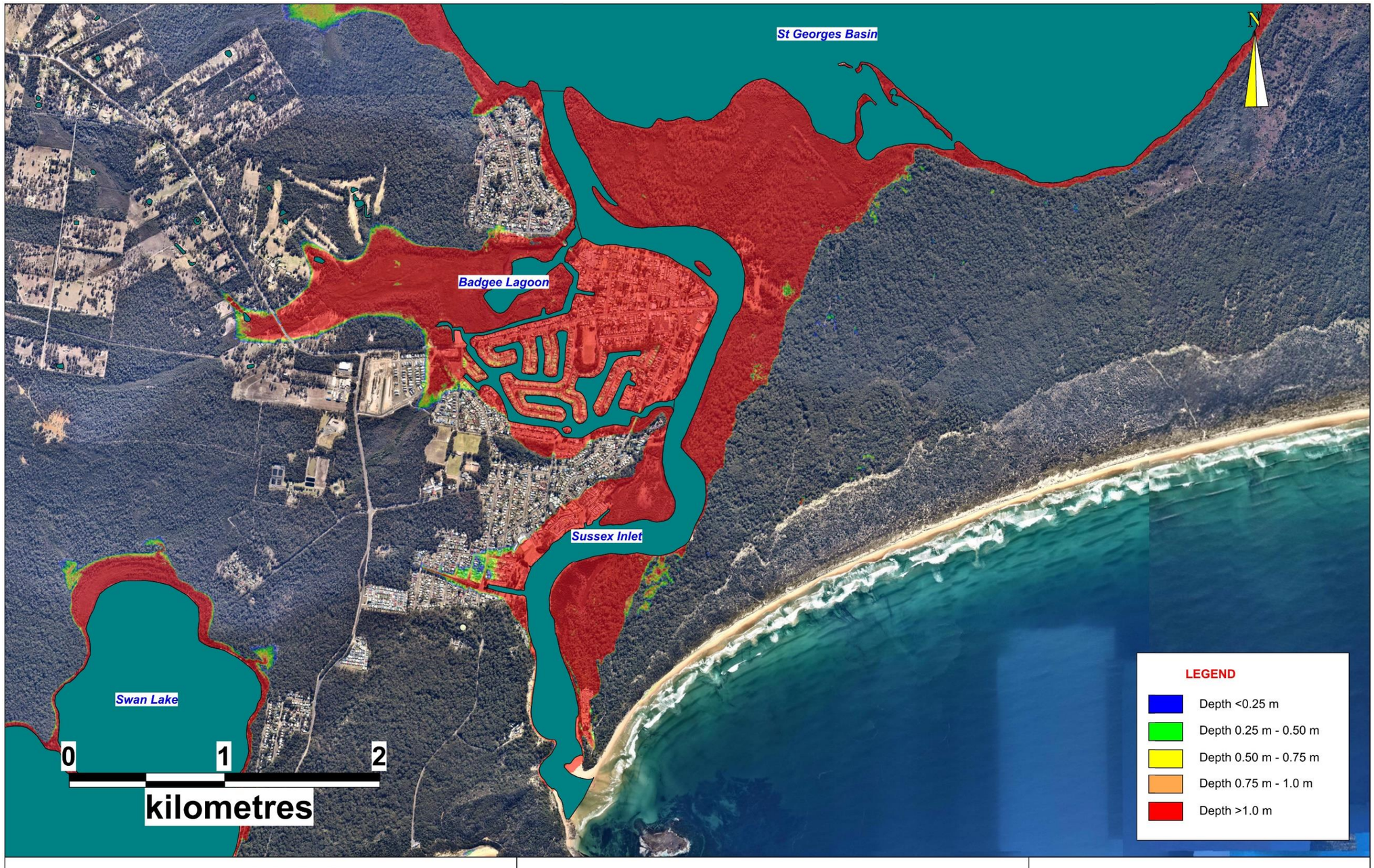
a) landward migration of macrophyte or coastal vegetation species,

b) shift in dominant species or

c) reduced or loss of biodiversity, due to a lack of suitable areas available for migration of macrophyte and coastal vegetation species.

Mapping of the potential migration areas which may be suitable for mangrove and saltmarsh habitat under future sea level rise is provided in Advisian (2023d), with an example provided in Figure 3-10. This mapping shows that:

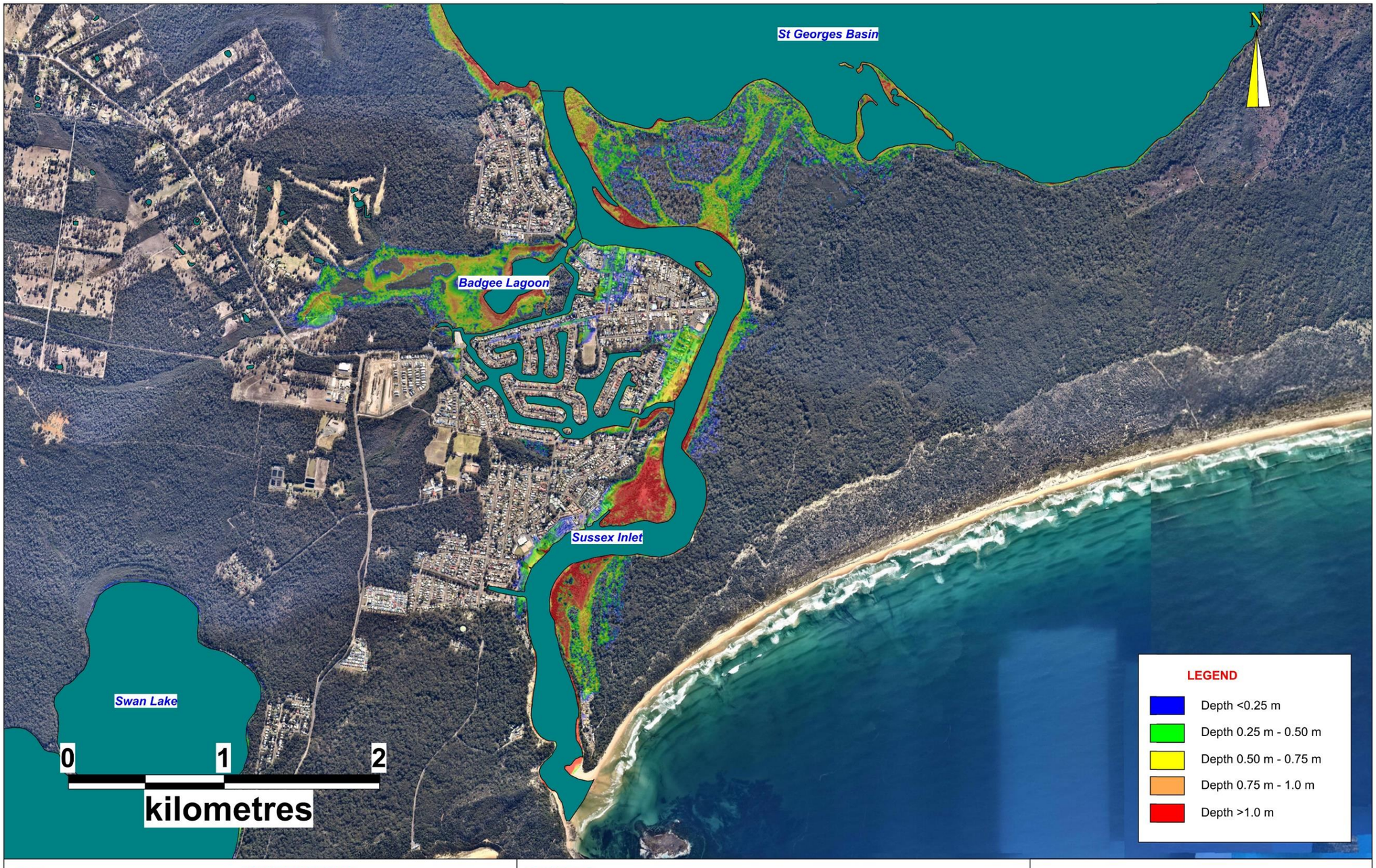
- For St Georges Basin, there is potential for saltmarsh and mangroves to expand in the low-lying areas around Old Erowal Bay, and in fringing areas along the shoreline around Sanctuary Point and Basin View as well as around Wandandian Creek and Tullarwalla Inlet
- For Sussex Inlet, there is potential for saltmarsh and mangroves to expand in the areas around Badgee Lagoon, as well as low-lying areas to the east of the main channel, around the boundaries of existing areas of mangroves and saltmarsh and in some limited locations along the existing foreshore reserves
- For Swan Lake, there is potential for saltmarsh to expand into the coastal wetland areas in the north of the Lake, and some limited potential for expansion around the Lake foreshores.
- For Berrara Creek, there is potential for saltmarsh to expand into the existing coastal wetland area to the west of the creek channel, and some potential for mangroves and saltmarsh to colonise the fringes of the lake foreshore and within the reserve at Lakeway Avenue.



DATE	14/6/22	COORDINATE SYSTEM	MGA Zone 56	FIGURE TITLE	Sussex Inlet Coastal Inundation 0.9m SLR 1% AEP storm surge and Southerly wind
PROJECT NO.	311015-00158	PROJECT TITLE	Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	CREATED BY	C. Adamantidis

Advisian Shoalhaven City Council NSW Government Planning, Industry & Environment

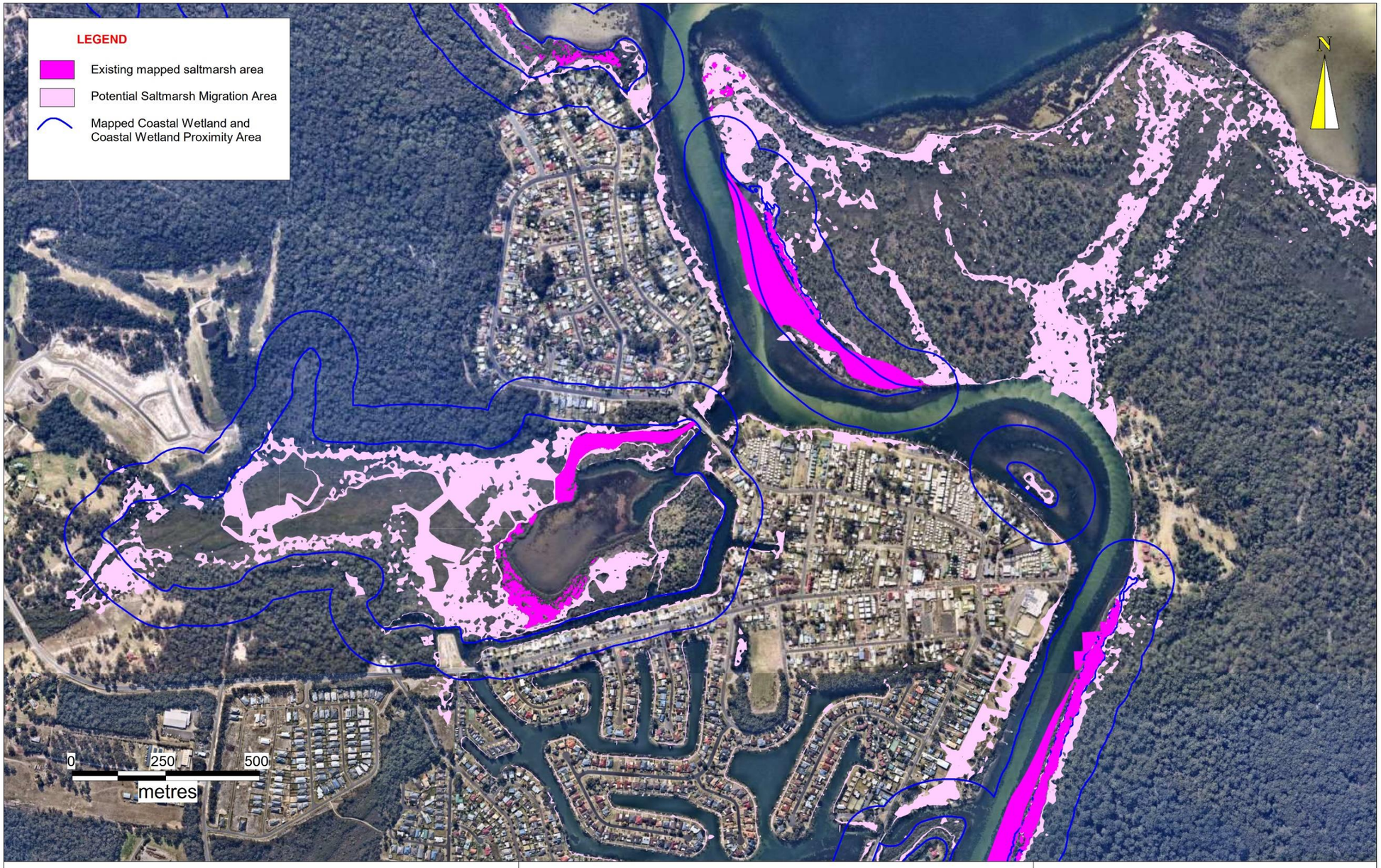
Figure 3-8 – Sussex Inlet Coastal Inundation Map, 1% AEP, southerly wind, 0.9 m sea level rise



DATE	14/6/22	COORDINATE SYSTEM	MGA Zone 56	FIGURE TITLE	Sussex Inlet Tidal Inundation 0.9m SLR HHWS
PROJECT NO.	311015-00158	PROJECT TITLE	Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	CREATED BY	C. Adamantidis

Advisian Shoalhaven City Council NSW Government Planning, Industry & Environment

Figure 3-9 – Sussex Inlet Tidal Inundation, HHWSS, 0.9 m sea level rise



DATE	29/8/2023	COORDINATE SYSTEM	MGA Zone 56	FIGURE TITLE	Sussex Inlet North Potential Saltmarsh Migration Area 0.9m SLR
PROJECT NO.	311015-00158	PROJECT TITLE	Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek CMP	CREATED BY	C. Adamantidis

Figure 3-10 – Example Estuarine Macrophyte Migration Area for Sussex Inlet, 0.9 m sea level rise

3.4.2 Key Issues

Key issues relating to coastal and tidal inundation within the study area include:

- Damage to public infrastructure and critical services due to increased frequency and duration of inundation due to future sea level rise and coastal/tidal inundation.
- Increasing depth, duration and frequency of coastal and tidal inundation of urban areas.
- Whether Council's existing sea level rise projections for planning purposes are appropriate, given the most recent advice from the Intergovernmental Panel on Climate Change (IPCC)
- Sea level rise and coastal inundation have the potential to raise water tables in low-lying areas; the impact of this on the foundations of existing and future development is poorly understood.
- Threat to public safety as a result of increased frequency and duration of coastal and tidal inundation events.

These issues are outlined in Table 3-3.

Table 3-3 – Key Issues and potential estuary-wide management actions relating to Inundation and Sea Level Rise

Issue	Existing Controls
Damage to public infrastructure and critical services due to increased frequency and duration of inundation due to future sea level rise and coastal/tidal inundation.	Council is drafting a Climate Change Adaptation Plan that includes actions to adapt to sea level rise on a city-wide scale. These actions include undertaking risk assessments for council assets to identify and prioritise areas, infrastructure, and assets at risk from coastal inundation, storms, and flooding, and ensuring that asset management plans consider risk of storms, sea level rise and inundation for Council assets and infrastructure.
Increasing depth, duration and frequency of coastal and tidal inundation of urban areas.	Development controls, monitoring, flood warning system and flood evacuation procedures.
The Intergovernmental Panel on Climate Change (IPCC) has revised global sea level rise projections in 2022 through its Sixth Assessment Report. The Shoalhaven Council Sea Level Rise Framework are no longer consistent with the most recent advice from the IPCC.	Shoalhaven Council Sea Level Rise Framework.
Sea level rise and coastal inundation have the potential to raise water tables in low-lying areas; the impact of this on the foundations of existing and future development is poorly understood.	Council Development Control Plan
Threat to public safety as a result of increased frequency and duration of coastal and tidal inundation events.	Development controls, monitoring, flood warning system and flood evacuation procedures.
Impact of SLR on tidal inundation on sporting grounds, parks and recreation facilitie, roads and infrastructure	Upgrade of materials for park furniture/playgrounds to improve resilience against inundation, emergency asset assessments and prioritisation for upgrade. Implement learnings from previous storm events to make roads more resilient against increased inundation frequency, e.g. investigate more resilient pavement design, repair methodology
Potential for community isolation in an inundation event, emergency management	Community education on risk of not following evacuation orders, community education to enhance understanding of inundation risk, works to raise key evacuation routes above inundation levels

3.5 Navigation and Safety

3.5.1 Overview

A study on boating facilities and an assessment of navigation conditions within Sussex Inlet and St Georges Basin, as well as Swan Lake and Berrara Creek has been carried out, to determine whether there is sufficient capacity for vessels and whether there is a need to improve existing facilities or reduce the impact of boating on the environment. The supporting study is intended to inform Stage 2 of the Coastal Management Program (CMP) for St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek (Advisian 2023f). It identifies the key issues, risks and opportunities relating to boating and navigation within the St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek estuaries. The study is based on extensive community and stakeholder engagement, as well analysis and site observations undertaken by the Study Team.

The Study details the following:

- A description of the boating facilities and issues within the study area, based on information gathered during site inspections of each area.
- Key risks and issues pertaining to boating and navigation within the study area, based on analysis of historical information and the results of community engagement specifically targeted to boating and navigation.
- Key suggested management opportunities to take forward into Stage 3 of the CMP.

Community engagement undertaken to inform the Study included:

- A Boating and navigation questionnaire that was advertised on Council's "Get Involved" webpage and at local boat ramps between November 2021 and January 2022. The questionnaire received 180 responses.
- On-site information drop-in sessions with stakeholders at St Georges Basin and Sussex Inlet, held in November 2021.
- Community workshops and an online mapping survey in March 2022 capture community perspective on all major issues including boating and navigation.
- Individual meetings held with stakeholders with a specific interest in boating and navigation, including Sussex Inlet Marine Rescue, Safe Navigation Action Group (SNAG) and the Sussex Inlet Bowling and Fishing Club.
- Submissions that were received by members of the community through other channels.

Opportunities for future management regarding upgrade of community infrastructure, education of the boating community regarding impacts on the local environment have been provided, together with an assessment of the navigation conditions within Sussex Inlet.

3.5.2 Key Issues

Based on these assessments and feedback, key issues have been identified and a suite of potential management actions relating to boating and navigation for each estuary has been developed, and provided in Advisian (2023f). The key issues are outlined in Table 3-4.

The Sussex Inlet and St Georges Basin areas experience high demand for waterway access, and there is the potential for conflict between waterway groups. There are numerous existing facilities for boating and navigation, which are in varying states of repair across the estuaries.

Further, a review of the most recently available bathymetric survey for Sussex Inlet has identified areas where the existing channel is shallower than the Australian Standards requirements for navigation for the largest vessels that currently use Sussex Inlet.

Safety concerns have been raised across the St Georges Basin and Sussex Inlet areas due to difficulties faced by inexperienced recreational boaters navigating local waters in the Study area.

Key issues and opportunities relating to boating safety and navigation at Sussex Inlet, St Georges Basin, Swan Lake and Berrara Creek include:

- the need to improve or upgrade local launching facilities at Lions Park, Nielson Lane and at Sussex Road to meet the needs of the community (refer preliminary concepts for the upgrades in the Boating Study)
- the need to improve safety for boat users by providing lights on navigation aids and a monitoring camera at the entrance
- education of boat users (particularly users from outside the area who may not be familiar with local conditions) on the dangers of crossing the entrance bar
- the need to address navigation issues caused by channel depths in some locations not meeting requirements set by Australian Standards, by localised channel deepening as described in the Boating Study (Advisian 2023f).
- Boating infrastructure within St Georges Basin is generally in a good state of repair. However, based on feedback received from stakeholders and the community and from Advisian's own assessment, there is an opportunity to improve safety by upgrading infrastructure in a number of locations, as well as to reduce conflicts between waterway users and reduce the impact of boating activities on the environment of St Georges Basin and Wandandian Creek.
- For Swan Lake, it is suggested that the existing level of recreational boating is appropriate and that the single launching location for motorised craft be maintained, with monitoring and enforcement of existing restrictions regarding separation of swimmers and low-speed areas for the protection of shorebirds.
- For Berrara Creek, there is a desire based on consultation with stakeholders and the community to ensure the Berrara Creek areas remains in as natural state as possible with an emphasis on passive recreation.

Table 3-4 – Estuary-wide issues relating to navigation and safety

Area	Issue/Concern
All estuaries	• The Sussex Inlet and St Georges Basin areas experience high demand for waterway access, and there is the potential for conflict between waterway groups. There are numerous existing facilities for boating and navigation, which are in varying states of repair across the estuaries
All estuaries	• A review of the most recently available bathymetric survey for Sussex Inlet has identified areas where the existing channel is shallower than the Australian Standards requirements for navigation for the largest vessels that currently use Sussex Inlet.
All estuaries	• Safety concerns due to difficulties for inexperienced recreational boaters navigating local waters in the Study area.
Sussex Inlet	
Sussex Inlet – all areas	• limited/no lighting on channel navigation markers making night-time boating unsafe • lack of lighting of port marker at Croppers Cabins and on navigation aids within Sussex Inlet in general making night-time navigation unsafe • Better education of the boating community needed • Impact of boating infrastructure on seagrasses and environment e.g. private moorings, jetties and pontoons
St. Georges Basin Mouth	• shallow water at the mouth of St Georges Basin where it connects with Sussex Inlet • need for an additional starboard channel marker at the "goal posts" at the entrance to St Georges Basin
Sussex Inlet Little Manly	• Localised shallow areas where dredging may be beneficial • fallen trees across channels at Sussex Inlet • trees have fallen in and are blocking the channel at Little Manly due to ongoing bank erosion.
Sussex Inlet Marine Rescue Area	• Shallow area "pinch point" in channel in front of Marine Rescue
Sussex Inlet Between Lions Park and Alamein	• Shallow areas in channel between Alamein and The Haven
Sussex Inlet Sussex Inlet Alamein (downstream)	• Channel area between Alamein and The Haven is very changeable and difficult to navigate with shoals resulting in the need for boaters to cross over the channel
Sussex Inlet The Haven (downstream)	• Channel area between Alamein and The Haven is very changeable and difficult to navigate with shoals resulting in the need for boaters to cross over the channel
Sussex Inlet The Entrance Area	• Difficulty or unable to access the open ocean over the entrance bar at low tide, safety of navigating the bar, bar is poorly marked.

Area	Issue/Concern
	• There is a need for improved communication between Transport for NSW Maritime and Marine Rescue. There is good communication between Croppers Cabins (located at the Sussex Inlet entrance) and Marine Rescue regarding conditions at the entrance bar
Sussex Inlet Lions Park Boat Ramp	• Concerns with the stability and condition of the existing ramp and pontoon • land subsidence behind foreshore wall at Lions Park • no formal wash-down facility
Sussex Inlet Nielson Lane Boat Ramp	• concerns regarding water supply, flow of traffic and lack of sufficient carparking at Nielson Lane boat ramp • cars have dropped off the edge of the ramp at low tide • lack of line markings, ad-hoc storage of hire craft and other water craft • insufficient trailer parking to cater for peak demand • inadequate capacity at existing ramp to cater for demand • no pontoon facility • ramp can often become submerged when water levels in the Inlet are high.
Sussex Inlet Seacrest Boat Ramp (Pelican Shores)	• poor carpark surface • narrow ramp and safety concerns due to steep drop-off
Sussex Inlet Local ramps (Chris Creek, Cater Crescent, Edgewater Avenue)	• some require minor maintenance to improve safety
St Georges Basin	
St Georges Basin All Areas	• Better education of the boating community needed • Lack of all-ability access to boating facilities • Impact of boating activities on bank erosion
Wandandian Creek Entrance and Tullarwalla Inlet	• Shallow depth and difficulty navigating into Wandandian Creek entrance due to insufficient channel markers • Speed limit within Wandandian Creek too high contributing to bank erosion
Basin View Boat Ramp	• Ramp is very exposed to southerly winds making launching or retrieval difficult in adverse weather
St Georges Basin Boat Ramp (Island Point Road), pontoon and jetty	• Gradient of ramp is too shallow making launching and retrieval difficult • Pontoon at the end of the jetty is unsuitable for the conditions at the site i.e. it is too small to provide protection from southerly winds
Sanctuary Point Boat Ramp	• Shallow depth and stirring up of sediment by boat motors (signage not adhered to)

Area	Issue/Concern
Erowal Bay Boat Ramp	• Major concern and safety issues regarding lack of car and trailer parking, trailers parking in turning area and along Naval Parade • Wind and wave erosion along the western edge of the ramp
Swan Lake	
Swan Lake (all)	• Boat users not following Maritime rules including speeding • Better education of the boating community needed • Impact of boating activities on bank erosion • Clearing of foreshore vegetation and illegal foreshore structures for boating access
Swan Lake – Dyball Reserve	• Conflict between swimmers and boaters, with speed limits not being adhered to and swimmers difficult to see in the water, with the ramp sometimes being used for motorised craft, despite it being designated exclusively for non-motorised craft
Swan Lake Ski Beach Boat Ramp	• Car park needs line markings • Limited overhead clearance at some boat ramps, with the need to trim some trees • Concerns regarding the condition of the boat ramp at the ski park were raised including exposure of reinforcement at the base of the ramp, ramp not extending far enough into the water when water levels are low.
Swan Lake – Yaroma Avenue	• When lake levels are high there is no longer a beach to pull up boats onto and for recreational activities – this appears to be a factor contributing to the continued illegal opening of the lake entrance by the public to reduce water levels • Ramp sometimes being used for motorised craft, despite it being designated exclusively for non-motorised craft • Ad-hoc storage of non-motorised craft
Natural Launching area at Springs Road Cudmirrah	• No formalised access, ad-hoc storage of craft, damage to riparian vegetation
Berrara Creek	
Berrara Creek	• There are no amenities at Lakeland Avenue reserve • There are no facilities for storage of kayaks and unpowered craft, and these are currently stored over the reserve in an ad-hoc fashion

4 Key Issues and Risks

4.1 Introduction

Information gathered throughout the development of the CMP, including from community and stakeholder engagement and the results of the supporting studies, has been compiled into a detailed Risk Assessment to identify the key issues and risks throughout the three estuaries of St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek. A First Pass Risk Assessment was undertaken during the Stage 1 Scoping Study, which has now been updated to a Detailed Risk Assessment as part of Stage 2 (Advisian 2023e). The sources of information included:

- Stage 1 Scoping Study (Advisian 2020), which included a review of pre-existing information as well as community and stakeholder engagement
- Stage 2 Community Workshops and meetings with community groups
- a review of the risks and actions previously identified in the St Georges Basin Revised Estuary Management Plan (2013) and Swan Lake and Berrara Creek Natural Resources Management Strategy (2002)
- Community Online Place Tool Survey
- Workshops with relevant Government Agencies who will be responsible for many of the actions identified in the final CMP
- Workshops with Council personnel to identify key risks to public assets
- The results of studies undertaken specifically for Stage 2 of the CMP.

4.2 Key Issues

The key management issues identified through the CMP process relate to the following six themes:

1. Cultural and social issues
2. Foreshore Erosion
3. Ecological Environment
4. Water Quality
5. Inundation and Sea Level Rise
6. Navigation and Safety.

A First-pass Risk Assessment was undertaken during the Scoping Study (Advisian 2020), with this Risk Assessment updated as described in Figure 4-1 to assign a risk severity in the present day, and for planning timeframes of 20 years, 50 years and 100 years, as stipulated by the NSW Coastline

Management Manual. The consideration of these planning timeframes allows a range of possible future scenarios to be incorporated into the assessment, including future scenarios for climate change, population growth, development and use of the coast. As outlined in the CM Manual, when considering future scenarios for critical infrastructure or long-term land use planning decisions, it is appropriate to gain an understanding of the full range of risks over longer timeframes and high range projections.

4.3 Detailed Risk Assessment

Risk can be quantified as the integration of probability (i.e., frequency analysis of the hazard) and consequences. The Risk Assessment documented herein has taken into account both the "likelihood" (or probability) of the hazard occurring and the "consequence" to define the level of risk.

The Risk Assessment is documented in detail in the Stage 2 Risk Assessment Report (Advisian 2023e). The steps involved in the risk management process are outlined in Figure 4-1 and Figure 4-2.

The risk matrix applied to quantify the risk is provided in Table 4-1.

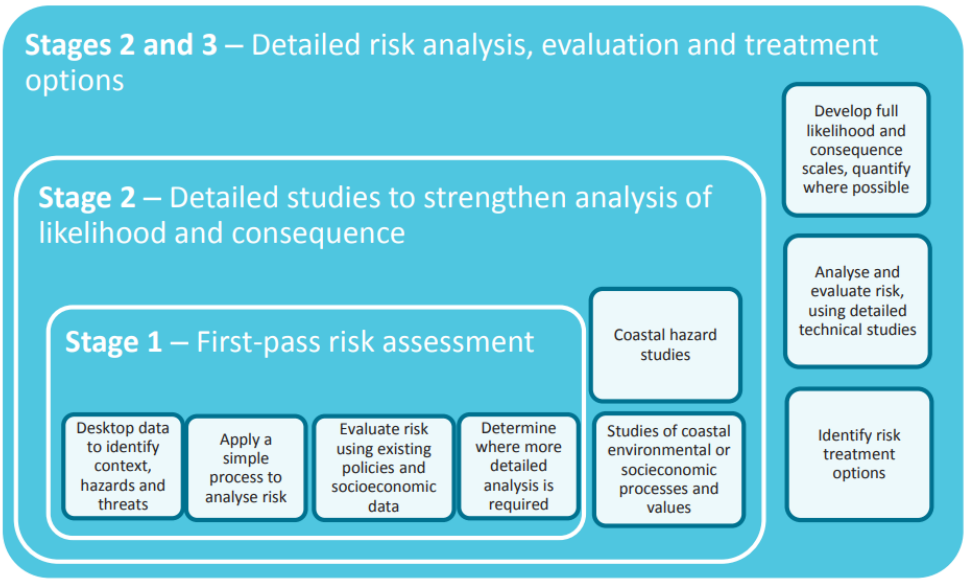


Figure 4-1 – Detailed Risk Assessment Process (from NSW Coastal Management Manual 2018)

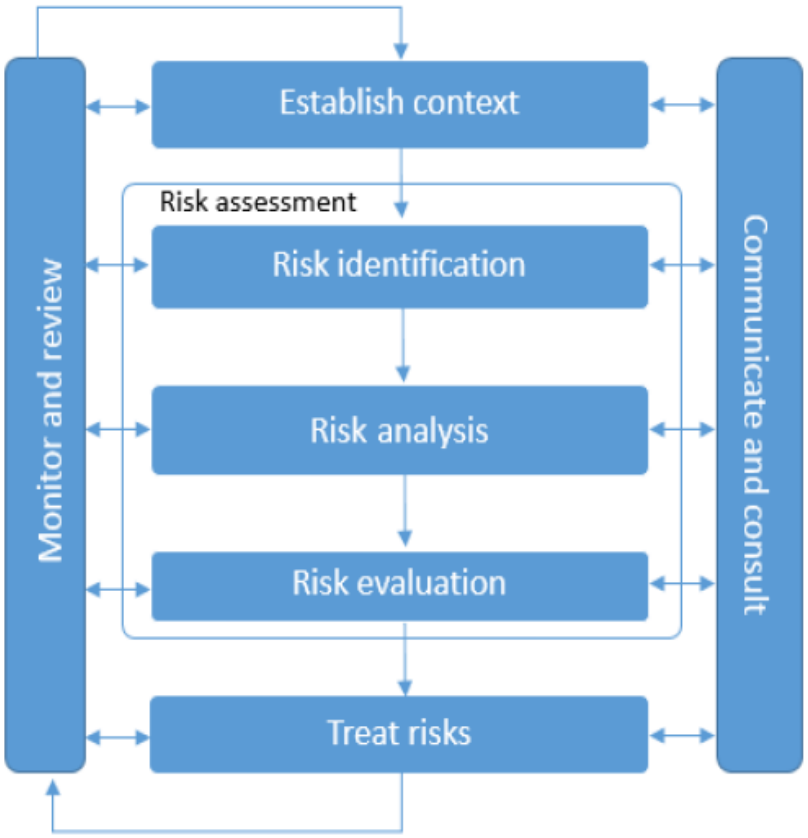


Figure 4-2 – Risk Management Process (AS/NZS ISO 31000: Risk Management – Principles and Guidelines, as documented in the NSW Coastal Management Manual 2018)

Table 4-1 – Risk Matrix applied to evaluate risk

Risk Rating Matrix					
Likelihood	**Consequence**				
	Insignificant 1	Minor 2	Moderate 3	Major 4	Catastrophic 5
Almost Certain 5	MODERATE	HIGH	HIGH	EXTREME	EXTREME
Likely 4	LOW	MODERATE	HIGH	HIGH	EXTREME
Possible 3	LOW	MODERATE	HIGH	HIGH	HIGH
Unlikely 2	LOW	LOW	MODERATE	MODERATE	HIGH
Rare 1	LOW	LOW	LOW	LOW	MODERATE

4.3.1 Results

The results of the risk assessment for the St. Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek estuaries are summarised below, with the risks identified as having a "HIGH" or "EXTREME" rating based on the existing controls listed in Table 4-2 for the risks that apply to all three estuaries.

The full risk register, which identifies all the issues including those with a "Moderate" and "Low" risk rating is provided in Stage 2 CMP Risk Assessment (Advisian 2023e), which also provides the Asset Risk Register for asset classes affected by coastal vulnerability, including foreshore erosion, coastal inundation and tidal inundation.

Many of the key risks are common across several areas and some are occurring at specific locations rather than throughout an entire estuary. These risks generally have existing management controls in place or management controls that can be readily implemented, but an assessment has been made of what further management actions could be implemented to reduce these risks and to monitor the effectiveness of the actions. Some of the identified risks have varying root causes – for example, poor water quality could be the result of agricultural or urban runoff, or poor water quality may be exacerbated by sedimentation from bank erosion.

4.3.2 Key Issues identified during Community and Stakeholder Engagement

Key issues were those that were identified as posing a "High" or "Extreme" level of risk, either now or in the future. The key issues at each estuary, their identified root cause, consequence and existing controls in place to address those issues are detailed in the Stage 2 CMP Detailed Risk Assessment (Advisian 2023e) and have been captured within the Risk Register.

Through the CMP process, it was identified that many issues were common across all three estuaries – those issues have been identified as Estuary-wide issues and are outlined in Table 4-2.

Table 4-2 – Identified High or Extreme Risks applying to all estuaries (St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek)

KEY: Likelihood: AC = Almost Certain, L = Likely. P = Possible, U = Unlikely, R = Rare
Consequence: C = Catastrophic, Maj = Major, Mod = Moderate, Min = Minor, I = Insignificant

						Present Day						20 years						50 years						100 years and beyond					
Coastal Management Area	**Risk Category**	**Risk Description**	**Root Cause**	**Consequence**	**Existing Controls**	**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**	
Coastal Wetlands and Littoral Rainforest	Ecological Environment	Changes in balance between habitat types, landward migration or loss of macrophyte communities	Sea Level Rise and inundation	Loss or changes to biodiversity, landward migration of estuarine vegetation. The Sanctuary Point shoreline is particularly vulnerable	CMP including inundation mapping, development controls, state and federal legislation	4	L	4	Maj	16	High	4	L	4	Maj	16	High	5	AC	5	C	25	Extreme	5	AC	5	C	25	Extreme
Coastal Vulnerability	Coastal Inundation, Tidal Inundation and Sea Level Rise	Damage to public infrastructure and critical services due to increased frequency and duration of inundation	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services to infrastructure	Measures developed in Climate change and inundation Adaptation Report	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High
Coastal Vulnerability	Coastal Inundation, Tidal Inundation and Sea Level Rise	Inundation of Crown Land with third party infrastructure e.g. caravan parks	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death	Measures developed in Climate change and inundation Adaptation Report	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High
Coastal Vulnerability	Coastal Inundation, Tidal Inundation and Sea Level Rise	Increasing depth, duration and frequency of inundation of urban areas	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services, injury or death, economic loss	Development controls, monitoring, flood warning system and flood evacuation procedures	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High
Coastal Vulnerability	Coastal Inundation, Tidal Inundation and Sea Level Rise	Rising water table and impact on existing and future development	Sea Level Rise and inundation	Damage to infrastructure, loss of critical services to infrastructure	none	2	U	4	Maj	8	Mod	3	P	4	Maj	12	High	4	L	4	Maj	16	High	4	L	4	Maj	16	High
Coastal Vulnerability	Coastal Inundation, Tidal Inundation and Sea Level Rise	Development approved in inappropriate locations	Inadequate or inappropriate sea level rise projections for planning purposes	Future increased risk to Infrastructure	Community education, planning controls, Council resolutions on sea level rise projections	3	P	4	Maj	12	High	3	P	4	Maj	12	High	4	L	4	Maj	16	High	5	AC	4	Maj	20	Extreme
Coastal Use	Cultural and Social	Poor community understanding of coastal and estuary issues	Lack of easy-to-digest information	Lack of community ownership of issues, community misconceptions leading to poor environmental outcomes	Community education, dissemination of information to schools and community groups, provision of resources for community groups to empower them	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High	4	L	3	Mod	12	High

						Present Day						20 years						50 years						100 years and beyond					
Coastal Management Area	**Risk Category**	**Risk Description**	**Root Cause**	**Consequence**	**Existing Controls**	**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**		**Lkihood (1-5)**		**Consq.(1-5)**		**Pre Treatment Rating**	
					to undertake local projects and citizen science, effective coasts and estuaries committee, use of social media to communicate with community																								
Coastal Environment	Water Quality	Water quality and estuary health monitoring programs	Inconsistent monitoring of water quality and estuary health	Compromised ability to assess long term trends in water quality and estuary health	Water quality monitoring program, DP&E Estuary Health program, NSW DPI macrophyte mapping	**5**	**AC**	**3**	**Mod**	**15**	**High**	**5**	**AC**	**3**	**Mod**	**15**	**High**	**5**	**AC**	**3**	**Mod**	**15**	**High**	**5**	**AC**	**3**	**Mod**	**15**	**High**
Coastal Use	Navigation and Safety	Conflict between waterway users	High demand for waterway access	Amenity, safety	Signage and innovations in facility design	**5**	**AC**	**3**	**Mod**	**15**	**High**	**5**	**AC**	**3**	**Mod**	**15**	**High**	**5**	**AC**	**3**	**Mod**	**15**	**High**	**5**	**AC**	**3**	**Mod**	**15**	**High**
Coastal Environment	Cultural and Social	Poor communication between stakeholders, community and agencies leading to perceived lack of action on coastal management issues	Disagreements between stakeholders, responsible agencies for projects	Perceived lack of action or delays on urgent coastal and estuary rehabilitation projects	Effective communication between agencies, Council and stakeholders	**5**	**AC**	**3**	**Mod**	**15**	**High**	**5**	**AC**	**3**	**Mod**	**15**	**High**	**5**	**AC**	**3**	**Mod**	**15**	**High**	**5**	**AC**	**3**	**Mod**	**15**	**High**
Coastal Environment	Water Quality	Overflows from sewage pumping network stations (all catchments)	Wet weather including more frequent inundations. Dry weather from blockages, power failures etc.	Recreational and human health impacts	STP EPLs, Pollution Incident Response Management Plan (PIRMP), Risk Assessment, Risk Minimisation and Incident Management Strategy, Water Quality Monitoring Program	**4**	**L**	**3**	**Mod**	**12**	**High**	**4**	**L**	**3**	**Mod**	**12**	**High**	**4**	**L**	**3**	**Mod**	**12**	**High**	**4**	**L**	**3**	**Mod**	**12**	**High**
Coastal Environment	Water Quality	Potential contaminants associated with urban area runoff and stormwater - litter/gross pollutants, hydrocarbons, metals, pesticides	Inundation and urban runoff	Estuary health and recreational impacts	Development controls	**4**	**L**	**3**	**Mod**	**12**	**High**	**4**	**L**	**3**	**Mod**	**12**	**High**	**4**	**L**	**3**	**Mod**	**12**	**High**	**4**	**L**	**3**	**Mod**	**12**	**High**
Coastal Environment	Ecological Environment	Development resulting in a reduction in estuary health	Perceived incorrect LEP zoning of areas	Threats to estuary health	CMP, development controls, state and federal legislation	**3**	**P**	**3**	**Mod**	**9**	**High**	**3**	**P**	**3**	**Mod**	**9**	**High**	**3**	**P**	**3**	**Mod**	**9**	**High**	**3**	**P**	**3**	**Mod**	**9**	**High**
Coastal Use	Cultural and Social	Damage to or loss of non-Aboriginal and Aboriginal cultural heritage items (e.g. midden at Cudmirrah)	Inundation, erosion, lack of understanding from the community, malicious	Loss of cultural heritage	Development controls, public education program, 4WD access management	**3**	**P**	**4**	**Maj**	**12**	**High**	**3**	**P**	**4**	**Maj**	**12**	**High**	**3**	**P**	**4**	**Maj**	**12**	**High**	**3**	**P**	**4**	**Maj**	**12**	**High**

Coastal Management Area	Risk Category	Risk Description	Root Cause	Consequence	Existing Controls	Present Day						20 years						50 years						100 years and beyond					
						Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating		Lkihood (1-5)		Consq.(1-5)		Pre Treatment Rating	
			damage, vandalism																										
Coastal Use	Cultural and Social	Aboriginal loss of connection between land and sea	Inundation, erosion, lack of understanding from the community, malicious damage, vandalism	Loss of cultural heritage	Development controls, public education program, Aboriginal heritage mapping, statutory and non-statutory planning controls	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High
Coastal Use	Cultural and Social	Lack of understanding of Aboriginal heritage	Inadequate education and communication	Compromised Aboriginal heritage values	Community education, Aboriginal Advisory Committee (Council), Council engagement strategy and supporting articles	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High
Coastal Use	Cultural and Social	Important loss of cultural significance	Lack of interpretive signage for educating the community about heritage and environment	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	Statutory and non-statutory planning controls, mapping tools.	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High
Coastal Use	Cultural and Social	Severe deterioration of natural beauty or heritage value of heritage listed items	Human damage to culturally significant sites and artefacts	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	Statutory and non-statutory planning controls, mapping tools.	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High
Coastal Use	Cultural and Social	Deterioration of heritage items due to erosion	Foreshore erosion due to human impacts as well as coastal hazards	Inadvertent damage to sites e.g. at Berrara Ck. Deterioration of heritage items, significant loss of historical authenticity for items that are listed or those items that may qualify for heritage listing	CMP - erosion mapping in relation to heritage items	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High	3	P	3	Mod	9	High

5 Summary and Conclusions

This report has provided a synthesis of the studies undertaken for Stage 2 of the St Georges Basin-Sussex Inlet, Swan Lake and Berrara Creek Coastal Management Program. The purpose of this stage is to identify, analyse and evaluate risks, vulnerabilities and opportunities that exist and the impact of these to the environmental, social, cultural, and economic values of St. Georges Basin, Sussex Inlet, Berrara Creek, and Swan Lake. As identified in the NSW Coastal Management Manual (Part B Stage 2), studies prepared in Stage 2 provide information to support decision-making in later stages of the planning process. The additional information assists communities to better understand coastal management issues and to analyse and evaluate coastal risks and opportunities.

The supporting studies provided an in-depth assessment of the following, for each of the three estuaries in the study area:

- Aboriginal and non-Aboriginal Heritage
- Social and economic characteristics and a summary of social values and issues at each estuary
- Field Based assessments of erosion and foreshore issues
- Ecological values of the estuaries
- A review of the existing Swan Lake Estuary Entrance Management Policy
- Water Quality and Environmental Health Study of the estuaries, including identification of opportunities for urban runoff treatment
- Tidal and Coastal Inundation, through hydrodynamic modelling
- Boating and navigation/safety issues.

These studies have been summarised within this Stage 2 Synthesis report, together with the study outcomes. The detailed methodology and outcomes can be found in the separate suite of Stage 2 Study Reports that accompany the CMP.

The outcome of these studies, as well as the community and Agency engagement that has been carried out throughout the project, has enabled the key issues at each estuary to be identified and risks quantified through a separate Detailed Risk Assessment. From the Risk Assessment and the outcome of the individual studies, a suite of potential management actions has been developed and categorised in terms of the issues and particular locations which they relate to.

The potential management actions will be presented to the community for their feedback during Stage 3 of the CMP process.

5.1 Need for Planning Proposal

The Coastal Management Manual outlines that CMPs need to identify whether there should be any changes to planning controls, and whether a planning proposal is needed to update the mapping of the Coastal Management Areas provided in the RH SEPP.

It is not considered that the Coastal Wetlands Area, Coastal Wetlands Proximity Area, Coastal Environment Area or Coastal Use Area mapping needs to be updated as a result of the Stage 2 studies carried out for the St Georges Basin/Sussex Inlet, Swan Lake or Berrara Creek CMPs. However, it is noted that the RH SEPP does not provide mapping of a Coastal Vulnerability Area. Mapping of the coastal hazards of tidal inundation, coastal inundation and foreshore erosion has been carried out as part of Stage 2 of the CMPs, which could form the basis of Coastal Vulnerability Mapping for the estuaries. Further, mapping of the areas where coastal wetlands may migrate to with future sea level rise has been carried out, which could form the basis of future updates to mapping of the Coastal Wetland Area and Coastal Wetland Proximity Areas at St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek.

6 References

Advisian (2020). Shoalhaven CMP Scoping Study. A report produced for Shoalhaven City Council by Advisian.

Advisian (2023) Stage 2 CMP Foreshore Erosion Assessment Report. A report undertaken as part of the CMP for Shoalhaven City Council by Advisian.

Advisian (2023a) St Georges Basin-Sussex Inlet Water Quality and Estuary Health Study, report for Shoalhaven City Council.

Advisian (2023b) Berrara Creek Water Quality and Estuary Health Study, report for Shoalhaven City Council.

Advisian (2023c) Swan Lake Water Quality and Estuary Health Study, report for Shoalhaven City Council.

Advisian (2023d) Stage 2 CMP Tidal and Coastal Inundation Study, A report undertaken as part of the CMP for Shoalhaven City Council by Advisian.

Advisian (2023e) Stage 2 CMP Risk Assessment. A report undertaken as part of the CMP for Shoalhaven City Council by Advisian.

Advisian (2023f) Stage 2 CMP Boating Study, A report undertaken as part of the CMP for Shoalhaven City Council by Advisian.

ANZECC (2000). Guidelines for Fresh and Marine Water Quality, Oct 2000. Australian and New Zealand Environment & Conservation Council / Agriculture and Resource Management Council of Australia and New Zealand (2000).

ANZG (2018). Australian and New Zealand Guidelines for Fresh and Marine Water Quality. Australian and New Zealand Governments and Australian state and territory governments, Canberra ACT, Australia. Available at www.waterquality.gov.au/anz-guidelines.

Australian Bureau of Statistics (2021). 2016 Census QuickStats.

Burns, C. and Davey, G. (2010). Oceans of Life – ours to explore; ours to restore. http://www.mesa.edu.au/seaweek2010/saltmarsh.asp.

Commonwealth of Australia (2015). *Biosecurity Act 2015*. https://www.legislation.gov.au/Details/C2020C00127

Commonwealth of Australia (2021). Register of Critical Habitat. http://www.environment.gov.au/cgi-bin/sprat/public/publicregisterofcriticalhabitat.pl

Creese, R.G., Glasby, T.M., West, G., and Gallen, C. (2009). Mapping the habitats of NSW estuaries. Industry & Investment NSW, Nelson Bay, Australia, 95pp.

Cudmirrah Berrara Swanhaven Progress Association Inc. (undated). History & Photos of Berrara, Cudmirrah & Swanhaven. Available at: https://www.sussexinlet.info/cbspa/history.html.

DAWE (2018). Marine Pest Plan 2018 – 2023. https://www.marinepests.gov.au/what-we-do/publications/marine-pest-plan

DEC (2005). Water Quality Objectives for the estuaries on the NSW South Coast. Available from: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Water/Water-quality/marine-water-quality-objectives-nsw-ocean-waters-south-coast-05582.pdf?la=en&hash=4C2F104FAE1B284A85B033D00A828EE1024BA474.

DECCW (2010). Seabed Habitat Mapping of the Continental Shelf of NSW, DECCW 2010/1057 December 2010

Director of National Parks (2015). Booderee National Park Management Plan 2015 - 2025

DP&E (2018) NSW Coastal Management Manual – Part B (Stage 2)

DP&E (2022). Berrara Creek Estuary Health and Features. Available from: Berrara Creek | NSW National Parks. Accessed in February 2022.

DP&E (2022). Biodiversity Conservation. https://www.environment.nsw.gov.au/topics/animals-and-plants/biodiversity

DP&E / Shoalhaven City Council (in preparation at time of reporting in March 2022). Shoalhaven City Council Estuary Health Report Cards 2020-2021.

DPIE (2016). NSW Natural Resources Monitoring, Evaluation and Reporting Program. Available from: Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols | NSW Environment, Energy and Science. NSW Department of Planning, Infrastructure and Environment (DPIE).

DPIE (2020) Sanitary Inspection Report template for beaches and estuaries. Available from: Protocol – Appendix A: Sanitary inspection report | NSW Environment and Heritage. Accessed: June 2022.

DPIE (2021) "NSW Wildlife and Conservation Bushfire Recovery, Medium-term Response Plan", February.

DPIE (2021). Form and Function of NSW Intermittently closed and open lakes and lagoons. Available from: Form and function of NSW intermittently closed and open lakes and lagoons: Implications for entrance management.

DPIE (2021). State Environmental Planning Policy (Resilience and Hazards) 2021. https://www.planning.nsw.gov.au/-/media/Files/DPE/Factsheets-and-faqs/Policy-and-legislation/SEPP-2021/Fact-Sheet---Resilience-and-Hazards-SEPP.pdf?la=en.

DPIE / Shoalhaven City Council (2012). Shoalhaven City Council Estuary Health Report Cards 2010-2011.

Ecoplanning (2023). Assessment of Endangered Ecological Communities in Coastal Hazard Areas, Report no. 2022-103 for Shoalhaven City Council, June.

Environment Australia (2001). Directory of Important Wetlands. Available from: Directory of Important Wetlands in Australia - DAWE. Accessed in January 2022.

Evans K, Bax N, Bernal P et al. (eds) (2016), The first global integrated marine assessment: world ocean assessment 1, United Nations, New York.

Heritage NSW (2022). Australian Heritage Information Management System. Available from Aboriginal Heritage Information Management System (AHIMS) Web Services (nsw.gov.au). Accessed in January 2022.

Hewitt, C and Martin, R (1996). Port Surveys for Introduced Marine Species - Background Considerations and Sampling Protocols. CSIRO. Division of Fisheries. https://publications.csiro.au/rpr/download?pid=procite:999bdaaf-5227-4d7d-a96e19ee7a1ee01b&dsid=DS1.

.id (informed decisions) 2023. Population and household forecasts, 2021 to 2051, prepared by .id (informed decisions), March 2023. http://www.id.com.au

Jones, M.V., West, R.J., 2005. Spatial and temporal variability of seagrass fishes in intermittently closed and open coastal lakes in southeastern Australia. Estuar. Coast Shelf Sci. 64 (2–3), 277–288.

Marine Spatial Planning (2009). A Step-by-Step Approach towards Ecosystem-based Management. https://www.mspglobal2030.org/wp-content/uploads/2019/03/Marine-spatial-planning-a-step-by-step-approach.pdf.

Mcleod, E., Chmura, G.L., Bouillon, S., Salm, R., Bj ork, M., Duarte, C.M., Lovelock, C.E., Schlesinger, W.H., Silliman, B.R., 2011. A blueprint for blue carbon: toward an improved understanding of the role of vegetated coastal habitats in sequestering CO2. Front. Ecol. Environ. 9 (10), 552–560.

National Health and Medical Research Council (2008). Guidelines for Managing Risks in Recreational Water. Australian Government, February 2008.

NSW DPI (2013). Policy and Guidelines for Fish Habitat Conservation and Management (update 2013). https://www.dpi.nsw.gov.au/__data/assets/pdf_file/0009/468927/Policy-and-guidelines-for-fish-habitat.pdf

NSW DPI (2021). Marine Protected Areas. https://www.dpi.nsw.gov.au/fishing/habitat/protecting-habitats/mpa.

NSW DPI (2022). Estuarine Habitat Dashboard and Change Analysis Tool. Available online: NSW Estuarine Mapping (shinyapps.io). Accessed in March 2022.

NSW DPI (2022). Fisheries Spatial Data Portal. https://www.dpi.nsw.gov.au/about-us/research-development/spatial-data-portal

NSW DPI (2022a). Marine pests. https://www.dpi.nsw.gov.au/fishing/aquatic-biosecurity/pests-diseases/marine-pests.

NSW NPWS (2009). Conjola National Park Plan of Management. https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Parks-plans-of-management/conjola-national-park-plan-of-management-090329.pdf.

NSW NPWS (2012) Corramy Regional Park Plan of Management. https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Parks-plans-of-management/corramy-regional-park-plan-of-management-120265.pdf

NSW NPWS (2021). Conjola National Park. https://www.nationalparks.nsw.gov.au/visit-a-park/parks/conjola-national-park/map.

NSW NPWS (2021a). Corramy Regional Park. https://www.nationalparks.nsw.gov.au/visit-a-park/parks/corramy-regional-park

OEH (2012) "Environmentally Friendly Seawalls –A Guide to Improving the Environmental Value of Seawalls and Seawall-lined Foreshores in Estuaries". Published by: Office of Environment and Heritage on behalf of Sydney Metropolitan Catchment Management Authority, first published May 2009, reprinted with updated contact details May 2012.

OEH (2016). Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols. NSW Natural Resources Monitoring, Evaluation and Reporting Program. Available from: Assessing estuary ecosystem health: Sampling, data analysis and reporting protocols (nsw.gov.au)

Optimal Stormwater Pty Ltd (2023). Shoalhaven Stormwater Treatment Device Audit (Stages 1, 2 and 3) – Summary Report, for Shoalhaven City Council, March 2023.

Peter Freeman Pty Ltd (2003). Shoalhaven Heritage Study 1995 – 1998. Available at https://www.shoalhaven.nsw.gov.au/Council/Access-to-Information/Heritage-Studies.

Sainty, G., Hosking, J., Carr, G., and Adam, P (Eds.) (2012). Estuary plants and what's happening to them in South-East Australia. Sainty and Associates Pty Ltd.

Scanes, P., Ferguson, A. and Potts, J. (2020) Catastrophic events and estuarine connectivity influence presence of aquatic macrophytes and trophic status of intermittently-open coastal lagoons in eastern Australia. Estuarine, Coastal and Shelf Science, 238: 10672.

Scanes, Johnson and Wright (2023, in progress). NSW Estuary Water Quality Guideline Values. How new water quality Guideline Values for estuaries in NSW were derived.

Shoalhaven City Council (2008). Swan Lake Entrance Management Policy. Policy Number POL05/41. Available from: Swan Lake Entrance Management Plan (nsw.gov.au).

Shoalhaven City Council (2013) St Georges Basin Revised Estuary Management Plan 2013.

Shoalhaven City Council (2022b). Pests and Weeds. Available from: Pests & Weeds (Biosecurity) | Shoalhaven City Council (nsw.gov.au)

Tourism Research Australia (2019). Local Government Area Profiles, available at https://www.tra.gov.au/Regional/Local-Government-Area-Profiles/local-government-area-profiles

Waycott, M., Duarte, C.M., Carruthers, T.J., Orth, R.J., Dennison, W.C., Olyarnik, S., Calladine, A., Fourqurean, J.W., Heck, K.L., Hughes, A.R., Kendrick, G.A., 2009. Accelerating loss of seagrasses across the globe threatens coastal ecosystems. Proc. Natl. Acad. Sci. Unit. States Am. 106 (30), 12377–12381.

West, G., and Glasby, T.M., (2021). Interpreting long-term patterns of seagrasses abundance: how seagrass variability is dependent on genus and estuary type. Estuaries and Coasts.

West, R.J., Thorogood, C.A., Walford, T.R. and Williams R.J. (1985). An estuarine inventory for New South Wales, Australia. Fisheries Bulletin 2. Department of Agriculture, New South Wales. 140 pp.

Appendix A
Demographic and Economic Background Information

A.1 Social Characteristics

A.1.1 St Georges Basin/Sussex Inlet

Section 3.4 of the Stage 1 Scoping Study (Advisian 2020) included a community profile for the LGA which noted the population is primarily concentrated along the coast in major centres and numerous small centres. Sussex Inlet and the St Georges Basin District are identified as major centres. Cudmirrah, Berrara and Swanhaven are small centres located to the south of Sussex Inlet.

A review of the available Australian Bureau of Statistics (ABS) data was undertaken to understand the social characteristics of the local population for Sussex Inlet and suburbs surrounding St Georges Basin, Swan Lake and Berrara Creek. The key social statistics as derived from the 2016 Census data are presented in Table 6-1. Data collected by the ABS from 2021 Census was not yet available at the time of writing. Bream Beach was excluded as this suburb only had a population of 13 persons and ABS did not provide detailed data due to the small population.

Table 6-1 - 2016 Census social statistics for Sussex Inlet and St Georges Basin suburbs

Statistic	2016 Sussex Inlet	Basin View	St Georges Basin	Sanctuary Point	Worrowing Heights	Old Erowal Bay	Erowal Bay	Wrights Beach
Total population	3,575 persons	1,554 persons	2,913 persons	7,225 persons	506 persons	1,038 persons	623 persons	132 persons
Median age	60 years	45 years	50 years	48 years	77 years	41 years	47 years	51 years
Aboriginal and Torres Strait Islander	3.4% of total population	6.6% of total population	4.6% of total population	7.6% of total population	0% of total population	8.5% of total population	8.1% of total population	15.4% of total population
Children aged 0-14 years	11.0% of total population	18.9% of total population	16.4% of total population	17.0% of total population	3.7% of total population	21.3% of total population	15.6% of total population	16.3% of total population
People aged 65 years and over	42.0% of total population	24.6% of total population	29.9% of total population	27.6% of total population	85.4% of total population	16.7% of total population	25.1% of total population	25.2% of total population
People born overseas	21.6% of total population	19.1% of total population	19.4% of total population	21.4% of total population	29.6% of total population	19.2% of total population	14.1% of total population	18.5% of total population
Total private dwellings	2,329 with 68.2% occupied	718 with 77.6% occupied	1,381 with 79.0% occupied	4,004 with 72.5% occupied	217 with 94.3% occupied	502 with 77.9% occupied	425 with 57.2% occupied	69 with 71.0% occupied
Private dwellings structure	84.7% separate houses, 3.0% semi-detached, 3.7% flats, 8.1% other dwellings	91.4% separate houses, 6.1% flats, 2.5% semi-detached	88.9% separate houses, 7.7% semi-detached, 0.9% flats, 2.5% other dwellings	95.2% separate houses, 2.8% semi-detached, 1.2% flats, 0.7% other dwellings	92.1% separate houses, 7.9% semi-detached	100% separate houses	100% separate houses	100% separate houses
Tenure	57.2% of private dwellings owned outright, 18.1% owned with a mortgage and 19.6% rented	37.8% of private dwellings owned outright, 37.3% owned with a mortgage and 16.8% rented	46.5% of private dwellings owned outright, 28.7% owned with a mortgage and 16.9% rented	44.4% of private dwellings owned outright, 25.2% owned with a mortgage and 26.6% rented	55.0% of private dwellings owned outright, 4.3% owned with a mortgage and 6.6% rented	30.6% of private dwellings owned outright, 38% owned with a mortgage and 26.6% rented	43.3% of private dwellings owned outright, 33.9% owned with a mortgage and 19.6% rented	57.1% of private dwellings owned outright, 31.0% owned with a mortgage and 11.9% rented
Household size	Average 2 persons per household	Average 2.5 persons per household	Average 2.4 persons per household	Average 2.3 persons per household	Average 1.7 persons per household	Average 2.5 persons per household	Average 2.4 persons per household	Average 2.4 persons per household
Number of registered	44.9% of occupied private dwellings had one vehicle	33.3% of occupied private dwellings had one vehicle	38.7% of occupied private dwellings had one vehicle	45.0% of occupied private dwellings had one vehicle	64.8% of occupied private dwellings had one vehicle	40.2% of occupied private dwellings had one vehicle	32.8% of occupied private dwellings had one vehicle	35.6% of occupied private dwellings had one vehicle

Statistic	2016 Sussex Inlet	Basin View	St Georges Basin	Sanctuary Point	Worrowing Heights	Old Erowal Bay	Erowal Bay	Wrights Beach
motor vehicles	garaged, 31.3% two vehicles and 11.5% had three or more vehicles	garaged, 36.0% two vehicles and 21.6% had three or more vehicles	garaged, 37.0% two vehicles and 18.4% had three or more vehicles	garaged, 33.0% two vehicles and 12.2% had three or more vehicles	garaged, 17.8% two vehicles and 5.0% had three or more vehicles	garaged, 34.2% two vehicles and 15.9% had three or more vehicles	garaged, 43.2% two vehicles and 16.8% had three or more vehicles	garaged, 48.9% two vehicles and 15.6% had three or more vehicles

A.1.2 Swan Lake

A review of the available Australian Bureau of Statistics (ABS) data was undertaken to understand the social characteristics of the local population of Cudmirrah and Swanhaven. Table 6-2 presents the 2016 Census key social statistics. Data collected by the ABS from 2021 Census was not yet available at the time of writing.

Table 6-2 - 2016 Census social statistics for Cudmirrah and Swanhaven

Statistic	2016	
	Cudmirrah	Swanhaven
Total population	275 persons	193 persons
Median age	52 years	59 years
Aboriginal and Torres Strait Islander	3.7% of total population	0% of total population
Children aged 0-14 years	11.1% of total population	13.2% of total population
People aged 65 years and over	30.2% of total population	39.0% of total population
People born overseas	13.2% of total population	23.4% of total population
Total private dwellings	229 with 51.5% occupied	136 with 58.1% occupied
Private dwellings structure	80.5% separate houses, 19.5% other dwellings	53.2% separate houses, 46.8% other dwellings
Tenure	58.0% of private dwellings owned outright, 25.0% owned with a mortgage and 17.0% rented	63.9% of private dwellings owned outright, 21.7% owned with a mortgage and 10.8% rented
Household size	Average 2.2 persons per household	Average 2 persons per household
Number of registered motor vehicles	43.9% of occupied private dwellings had one vehicle garaged, 40.4% two vehicles and 10.5% had three or more vehicles	54.5% of occupied private dwellings had one vehicle garaged, 29.9% two vehicles and 11.7% had three or more vehicles

A.1.3 Berrara Creek

Berrara is a small centre located to the south of Sussex Inlet. A review of the available Australian Bureau of Statistics (ABS) data was undertaken to understand the social characteristics of the local population of Berrara. Table 6-3 presents the 2016 Census key social statistics. Data collected by the ABS from 2021 Census was not yet available at the time of writing.

Table 6-3 - 2016 Census social statistics for Berrara

Statistic	2016
Total population	297 persons

Statistic	2016
Median age	54 years
Aboriginal and Torres Strait Islander	4.4% of total population
Children aged 0-14 years	12.7% of total population
People aged 65 years and over	24.7% of total population
People born overseas	12.9% of total population
Total private dwellings	331 with 33.8% occupied
Private dwellings structure	100% separate houses
Tenure	52.2% of private dwellings owned outright, 33.6% owned with a mortgage and 10.6% rented
Household size	Average 2.3 persons per household
Number of registered motor vehicles	37.6% of occupied private dwellings had one vehicle garaged, 33.9% two vehicles and 18.3% had three or more vehicles

A.2 Economic Characteristics

A.2.1 St Georges Basin/Sussex Inlet

The coastal zone supports activities such as tourism and fisheries that have important economic values for the region and local communities. Table 6-4 presents the key ABS economic statistics to provide an economic profiling for the local population of Sussex Inlet and suburbs surrounding St Georges Basin. Bream Beach was excluded as this suburb only had a population of 13 persons and ABS did not provide detailed data due to the small population.

Table 6-4 - 2016 Census economic statistics for Sussex Inlet and St Georges Basin suburbs

Statistic	2016 Sussex Inlet	Basin View	St Georges Basin	Sanctuary Point	Worrowing Heights	Old Erowal Bay	Erowal Bay	Wrights Beach
Occupation (top 5 responses)	Technicians and Trades Workers (18.7%), Community and Personal Service Workers (16.0%), Professionals (12.0%), Labourers (11.8%), Clerical and Administrative Workers (11.4%)	Technicians and Trades Workers (18.6%), Community and Personal Service Workers (15.0%), Professionals (12.7%), Labourers (12.4%), Sales Workers (11.8%)	Technicians and Trades Workers (16.8%), Community and Personal Service Workers (14.8%), Professionals (13.3%), Labourers (12.4%), Clerical and Administrative Workers (13.3%)	Technicians and Trades Workers (18.6%), Community and Personal Service Workers (18.0%), Labourers (13.6%), Sales Workers (12.7%), Clerical and Administrative Workers (10.8%)	Professionals (24.2%), Labourers (24.2%), Clerical and Administrative Workers (12.1%), Sales Workers (12.1%), Managers (9.1%)	Professionals (17.9%), Community and Personal Service Workers (16.3%), Technicians and Trades Workers (15.4%), Labourers (13.0%), Sales Workers (10.8%)	Technicians and Trades Workers (22.6%), Professionals (17.9%), Community and Personal Service Workers (13.2%), Labourers (12.1%), Clerical and Administrative Workers (11.7%)	Professionals (25.0%), Clerical and Administrative Workers (18.2%), Technicians and Trades Workers (15.9%), Sales Workers (15.9%), Community and Personal Service Workers (11.4%),
Industry of employment (top responses)	Aged Care Residential Services (7.2%), Supermarkets (4.3%), Accommodation (4.3%), Clubs (Hospitality) (4.1%), Primary Education (3.0%)	Aged Care Residential Services (6.4%), Hospitals (4.6%), Defence (4.4%), Supermarkets (4.2%), Local Government Administration (3.8%)	Defence (6.4%), Supermarkets (4.8%), Aged Care Residential Services (4.3%), Hospitals (3.6%), House Construction (3.2%)	Aged Care Residential Services (6.4%), Supermarkets (5.7%), Defence (3.6%), Social Assistance Services (3.0%), Building and Other Industrial Cleaning Services (2.9%)	Secondary Education (23.8%), Defence (19.0%), House Construction (14.3%), Postal Services (14.3%),	Aged Care Residential Services (7.4%), Supermarkets (6.4%), Local Government Administration (5.1%)	Cafes and Restaurants (9.1%), Defence (5.7%), Supermarkets (4.3%), Buildings and Other Industrial Cleaning Services (3.9%)	Defence (20.0%), Hospitals (20.0%), Carpentry (15.0%), Accommodation (15.0%), Primary Education (15.0%)
Labour Force	1,048 persons	617 persons	1,102 persons	2,433 persons	39 persons	405 persons	278 persons	38 persons
Unemployed	7.3%	7.0%	7.4%	9.8%	7.7%	9.9%	7.6%	7.9%
Median weekly personal income	$451	$495	$470	$455	$444	$474	$531	$476
Travel to work	Car, as driver (65.0%), Worked at home (6.6%), Car, as passenger (3.8%), Walked only (3.4%), Truck (1.8%)	Car, as driver (79.3%), Car, as passenger (4.3%), Worked at home (2.0%), Walked only (1.6%), Truck (0.9%)	Car, as driver (73.9%), Car, as passenger (5.0%), Worked at home (4.2%), Walked	Car, as driver (70.4%), Car, as passenger (5.6%), Worked at home (3.7%), Walked only (2.1%), Truck (1.3%)	Car, as driver (80.0%), Worked at home (10.0%)	Car, as driver (67.6%), Car, as passenger (8.2%), Worked at home (5.7%), Bicycle (1.6%), Bus (0.8%)	Car, as driver (73.9%), Worked at home (4.3%), Car, as passenger (3.2%), Truck (2.4%)	Car, as driver (66.7%), Walked only (8.9%), Car, as passenger (6.7%), Worked at home (6.7%)

Statistic	2016 Sussex Inlet	Basin View	St Georges Basin	Sanctuary Point	Worrowing Heights	Old Erowal Bay	Erowal Bay	Wrights Beach
			only (1.4%), Truck (1.4%)					

A.2.2 Swan Lake

Table 6-5 presents the key ABS economic statistics to provide an economic profiling for the local population of Cudmirrah and Swanhaven.

Table 6-5 - 2016 Census economic statistics for Cudmirrah and Swanhaven

Statistic	2016	
	Cudmirrah	Swanhaven
Occupation (top 5 responses)	Technicians and Trades Workers (34.4%), Clerical and Administrative Workers (18.3%), Professionals (12.9%), Labourers (12.9%), Community and Personal Service Workers (8.6%)	Community and Personal Service Workers (22.0%), Professionals (18.0%), Technicians and Trades Workers (18.0%), Machinery Operators and Drivers (14.0%), Labourers (10.0%),
Industry of employment (top responses)	Accounting Services (12.1%), Accommodation (8.6%), Carpentry Services (5.2%), Pharmaceutical, Cosmetic and Toiletry Goods Retailing (5.2%), Engineering Design and Engineering Consulting Services (5.2%)	Gardening Services (22.2%), Clubs (Hospitality) (11.1%), Computer System Design and Related Services (11.1%), Building and Other Industrial Cleaning Services (11.1%), Local Government Administration (11.1%)
Labour Force	99 persons	52 persons
Unemployed	11.1%	9.6%
Median weekly personal income	$517	$428
Travel to work	Car, as driver (64.6%), Car, as passenger (9.4%), Worked at home (7.3%), Bicycle (3.1%), Walked only (3.1%),	Car, as driver (64.6%), Car, as passenger (9.4%), Worked at home (7.3%), Bicycle (3.1%), Walked only (3.1%),

A.2.3 Berrara Creek

Table 6-6 presents the key ABS economic statistics to provide an economic profiling for the local population of Berrara.

Table 6-6 - 2016 Census economic statistics for Berrara

Statistic	2016
Occupation (top 5 responses)	Technicians and Trades Workers (19.5%), Community and Personal Service Workers (17.1%), Professionals (13.8%), Clerical and Administrative Workers (13.8%), Managers (13.0%)
Industry of employment (top responses)	Aged Care Residential Services (11.3%), Accommodation (8.5%), State Government Administration (8.5%), Plumbing Services (7.0%), Takeaway Food Services (7.0%)
Labour Force	118 persons
Unemployed	2.5%
Median weekly personal income	$476
Travel to work	Car, as driver (65.8%), Worked at home (11.4%), Car, as passenger (5.3%), Truck (2.6%), Walked only (2.6%)

Appendix B
Synthesis of Ecological Data

B.1 Matters of National Environmental Significance

B.1.1 St Georges Basin/Sussex Inlet

Matters of National Environmental Significance (MNES) recorded in the area covering Sussex Inlet and St Georges Basin were identified in a Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) Protected Matters Report which was generated on 25 January 2022 (see search area mapped in Figure 6-1).

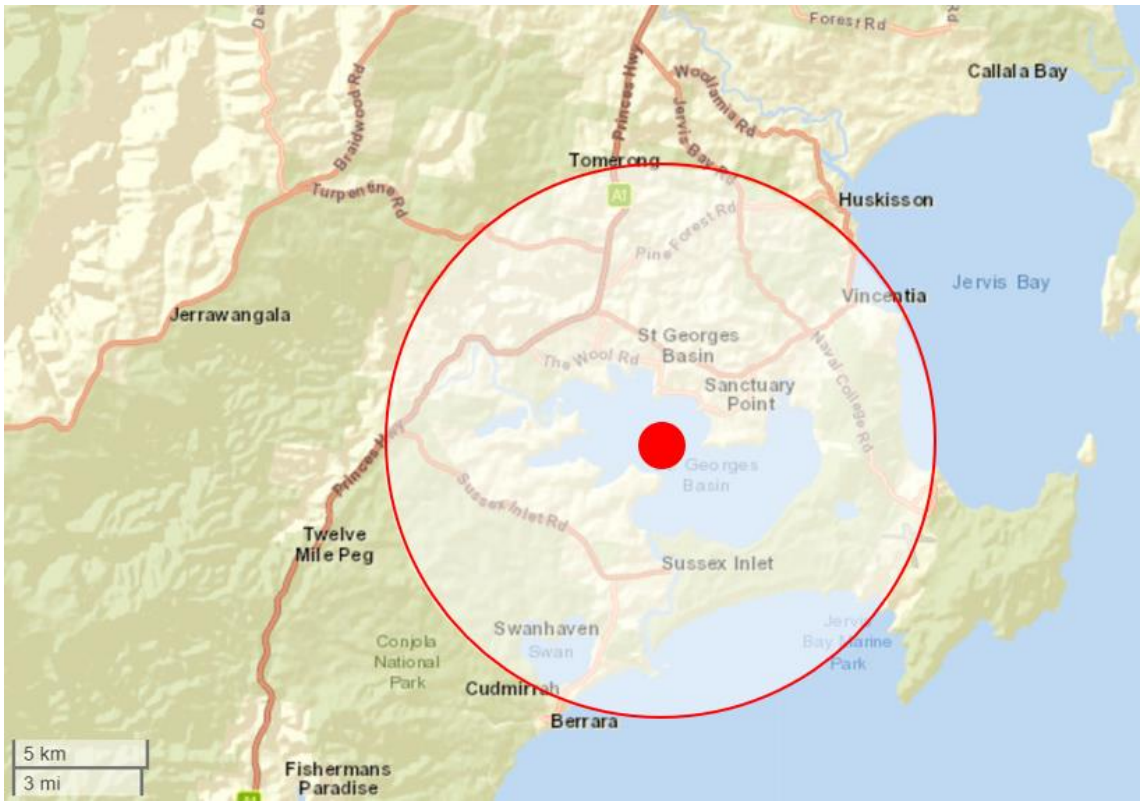


Figure 6-1 - Commonwealth EPBC Act Protected Matters Search Area for Sussex Inlet and St Georges Basin.

Environmental/ecological MNES recorded within this area are as follows:

- Six (6) Listed Threatened Ecological Communities occur. One of these communities is aquatic/marine: "Subtropical and Temperate Coastal Saltmarsh". The other communities which occur in the region are: "Coastal Swamp Oak (Casuarina glauca)", "Illawarra and south coast lowland forest and woodland ecological community", "Littoral Rainforest and Coastal Vine Thickets of Eastern Australia", and "River-flat eucalypt forest on coastal floodplains".
- Eighty eight (88) Listed Threatened Species occur within the study area.
- Fifty-six (56) Listed Migratory Species occur within the study area.

"Other Protected Matters" listed under the Commonwealth EPBC Act 1999 (relating to marine habitats) include:

- Seventy-eight (78) Listed Marine Species occur within 5 km of the study area.

- Twelve (12) Whales and Other Cetaceans occur within 5 km of the study area.
- No Critical Habitats occur within 5 km of the study area.
- No Australian Marine Parks occur within 5 km of the study area.
- Two (2) Nationally Important Wetlands (St Georges Basin and Jervis Bay) occur within 5 km of the study area.
- No Key Ecological Marine Features occur within 5 km of the study area.

B.1.2 Swan Lake

Matters of National Environmental Significance (MNES) associated within the marine environment occurring within 5 km of the study area (Swan Lake) were identified in a Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) Protected Matters Report which was generated on 25 January 2022.

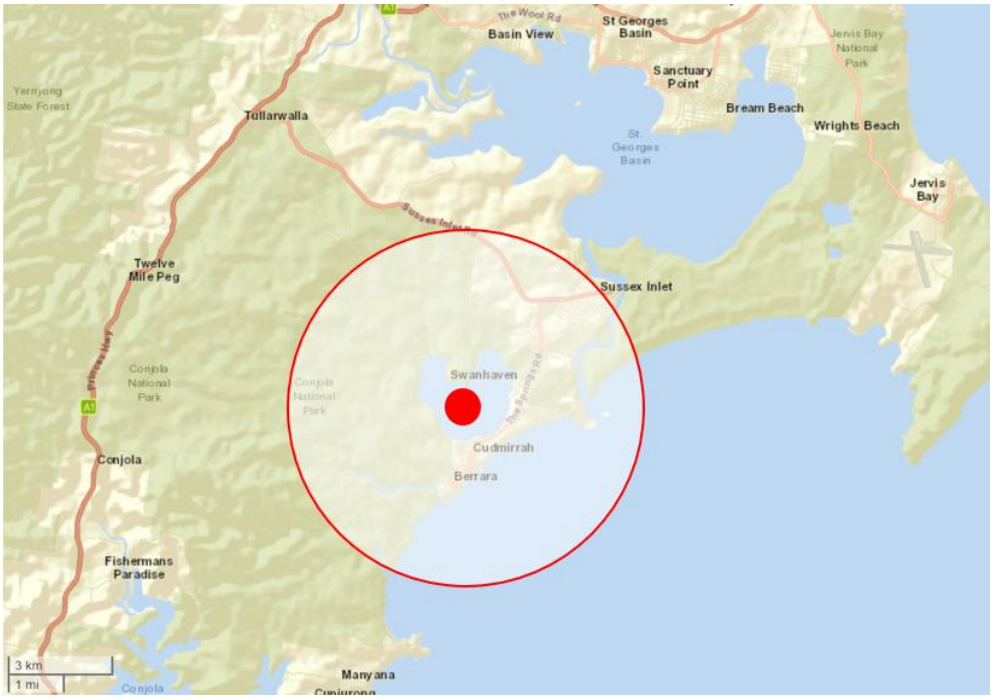


Figure 6-2 - Commonwealth EPBC Act Protected Matters Search Area for Swan Lake

Environmental/ecological MNES recorded within this area are as follows:

- No World Heritage Properties occur within 5 km of the study area.
- No National Heritage Properties occur with 5 km of the study area.
- No Wetland of International Significance occur within 5 km of the study area.
- Six (6) Listed Threatened Ecological Communities occur within the study area. One of these communities is aquatic/marine: "Subtropical and Temperate Coastal Saltmarsh". The other communities which occur in the region are: "Coastal Swamp Oak (Casuarina glauca)", "Coastal

Swamp Sclerophyll Forest of New South Wales and South East Queensland", "Illawarra and south coast lowland forest and woodland ecological community", "Littoral Rainforest and Coastal Vine Thickets of Eastern Australia", and "River-flat eucalypt forest on coastal floodplains".

- Seventy-nine (79) Listed Threatened Species occur within the study area.
- Fifty-five (55) Listed Migratory Species occur within the study area.

"Other Protected Matters" listed under the Commonwealth EPBC Act 1999 (relating to marine habitats) include:

- Seventy-seven (77) Listed Marine Species occur within 5 km of the study area.
- Twelve (12) Whales and Other Cetaceans occur within 5 km of the study area.
- No Critical Habitats occur within 5 km of the study area.
- No Australian Marine Parks occur within 5 km of the study area.
- No Nationally Important Wetlands occur within 5 km of the study area.
- No Key Ecological Marine Features occur within 5 km of the study area.

B.1.3 Berrara Creek

Matters of National Environmental Significance (MNES) associated within the marine environment occurring within 5 km of the study area (Berrara Creek) were identified in a Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* (EPBC Act 1999) Protected Matters Report which was generated on 25 January 2022 (see the searched area map in Figure 6-3).

Figure 6-3 - Commonwealth EPBC Act Protected Matters Search Area for Berrara Creek

Environmental/ecological MNES recorded within this area are as follows:

- No World Heritage Properties occur within 5 km of the study area.
- No National Heritage Properties occur within 5 km of the study area.
- No Wetland of International Significance occur within 5 km of the study area.
- The Commonwealth Marine Area does not occur within 5 km of the study area.
- Six (6) Listed Threatened Ecological Communities occur within the study area. One of these communities is aquatic/marine: "Subtropical and Temperate Coastal Saltmarsh". The other communities which occur in the region are: "Coastal Swamp Oak (Casuarina glauca)", "Coastal Swamp Sclerophyll Forest of New South Wales and South East Queensland", "Illawarra and south coast lowland forest and woodland ecological community", "Littoral Rainforest and Coastal Vine Thickets of Eastern Australia", and "River-flat eucalypt forest on coastal floodplains".
- Seventy-nine (79) Listed Threatened Species occur within the study area.
- Fifty-five (55) Listed Migratory Species occur within the study area.

"Other Protected Matters" listed under the Commonwealth EPBC Act 1999 (relating to marine habitats) include:

- Seventy-seven (77) Listed Marine Species occur within 5 km of the study area.

- Twelve (12) Whales and Other Cetaceans occur within 5 km of the study area.
- No Critical Habitats occur within 5 km of the study area.
- No Australian Marine Parks occur within 5 km of the study area.
- No Nationally Important Wetlands occur within 5 km of the study area.
- No Key Ecological Marine Features occur within 5 km of the study area.

B.2 Key Fish Habitat

One of the objectives of the NSW *Fisheries Management Act* 1994 (FM Act) is to 'conserve key fish habitats'. To achieve the objectives of the FM Act, DPI Fisheries has identified Key Fish Habitat (KFH) as "*those aquatic habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally, and the survival and recovery of threatened aquatic species*".

A policy definition of the term KFH was developed to guide the compilation of maps. KFH was defined to include all marine and estuarine habitats up to highest astronomical tide level (that reached by 'king' tides) and most permanent and semi-permanent freshwater habitats including rivers, creeks, lakes, lagoons, billabongs, weir pools and impoundments up to the top of the bank.

KFH in the study area was mapped using the NSW DPI Fisheries Spatial Data Portal. The entire St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek are classed as KFH (Figure 6-4).

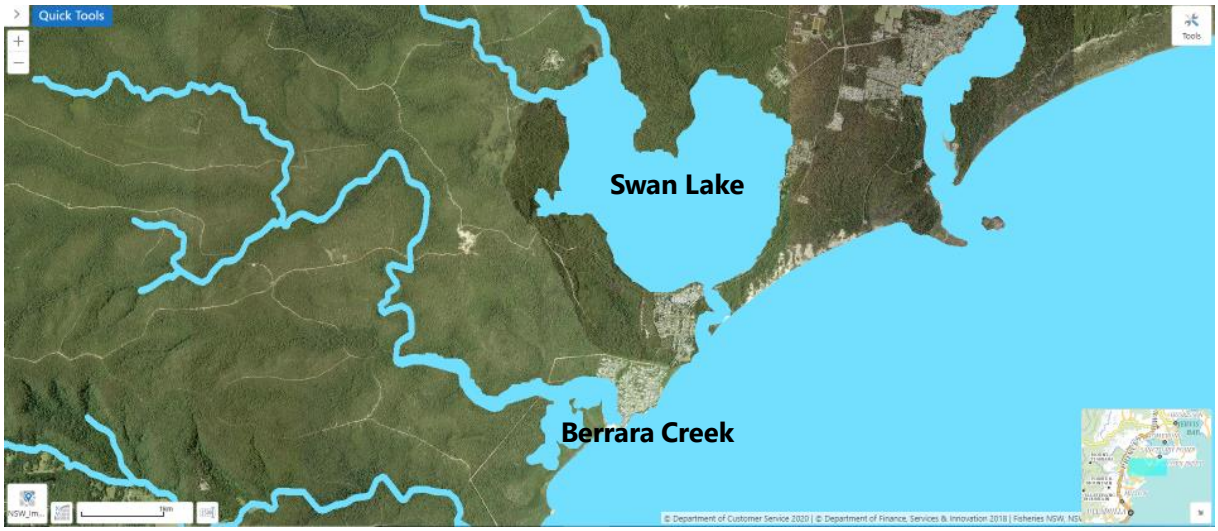


Figure 6-4 - Key Fish Habitat within the study area (NSW DPI 2022).

B.2.1 Waterway and Fish habitat Classification

Under the *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (NSW DPI 2013) (Table 2 of the Policy), the waterways of Sussex Inlet, St. Georges Basin and Swan Lake would be considered as a *CLASS 1 – Major Key Fish Habitat*, i.e. *"a marine or estuarine waterway or permanently flowing or flooded freshwater waterway (e.g. river or major creek), habitat of a threatened or protected species or 'critical habitat'"*. Berrara Creek would be considered as a *CLASS 2 – Moderate Key Fish Habitat*, i.e. *"a non-permanently flowing (intermittent) stream, creek or waterway (generally named) with clearly defined bed and banks with semi-permanent to permanent water in pools or in connected wetland areas. Freshwater aquatic vegetation is present"*.

Considering the specific attributes of estuarine habitat in the general study area and in accordance with Table 1 of the Policy, the habitat within the vicinity of Sussex Inlet and St Georges Basin and Berrara Creek would be considered as *TYPE 1 – Highly Sensitive Key Fish Habitat* as Posidonia is present, Zostera, Halophila and coastal saltmarsh are >5 m^2 (NSW DPI 2013). Habitat within the vicinity of Swan Lake would be considered as *TYPE 1 – Highly Sensitive Key Fish Habitat* as Ruppia beds are >5 m^2 and it has a natural opening and closing regime (NSW DPI 2013).

B.3 Protected Marine and Estuarine Vegetation

B.3.1 St Georges Basin/Sussex Inlet

Updated estuarine macrophyte habitat mapping of St Georges Basin and Sussex Inlet was undertaken by NSW DPI in 2020 and is presented in Figure 6-5. Habitat mapping is available via https://nsw-dpi.shinyapps.io/NSW_Estuarine_Habitat/.

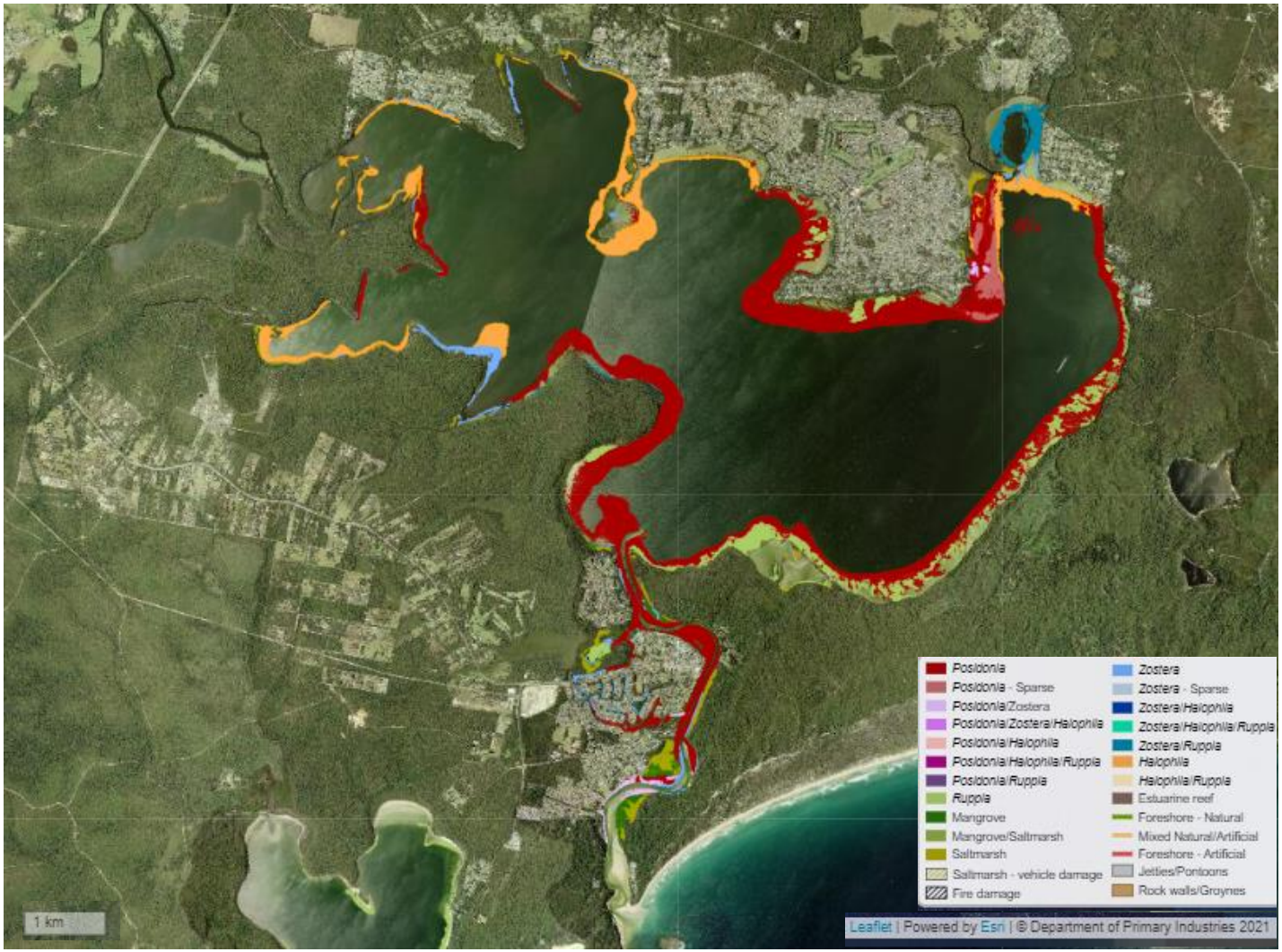


Figure 6-5 - St Georges Basin and Sussex Inlet NSW DPI estuarine macrophyte mapping for 2020.

B.3.2 Swan Lake

All marine vegetation is protected under the NSW FM Act 1994. Marine vegetation, such as saltmarsh, mangroves, seagrasses, and macroalgae (seaweeds), provides shelter and nursery areas for aquatic animals and is an essential component of the food chain in estuarine and coastal environments. It also stabilises sediments and shorelines and protects water quality in estuaries for recreational users. NSW DPI administers legislation which protects mangroves, seagrasses and seaweeds on public water land and foreshores. Harming or removal of marine vegetation is generally only permissible by permit.

NSW DPI undertakes macrophyte mapping of most estuarine habitats within NSW using methods developed over decades (Creese et al. 2019; Sainty 2012; West et al. 1985; West and Glasby 2021). Mapping for Swan Lake was last undertaken in 2004.

Estuarine macrophyte mapping is available via the Estuarine Habitat Dashboard (NSW DPI 2022) which includes the ability to view mapping and undertake a change analysis comparing the percentage mapped macrophyte area between mapping times.

Estuarine macrophyte habitat mapping undertaken by NSW DPI in 2004 is presented in Figure 6-6.

Only Ruppia has been mapped by NSW DPI in Swan Lake. The 2004 estuarine mapping shows that the inlet of Swan Lake and most of the eastern and northeastern sides of the lake are lined with Ruppia seagrass.

Recent observations have reported that Charophytes (dense beds of estuarine algae) have largely disappeared from Swan Lake within the past five years. This is thought to be potentially related to the drought in 2019 – 2020. Charophytes are a major food source for Swans, which have also been observed to have decreased in Swan Lake in recent years. This is a similar pattern to what has been observed in other NSW estuaries due to droughts (eg. Nadgee Lagoon) where Charophyte abundance declined because of a drop water levels exposing beds or elevated nutrients (Scanes et al. 2020).

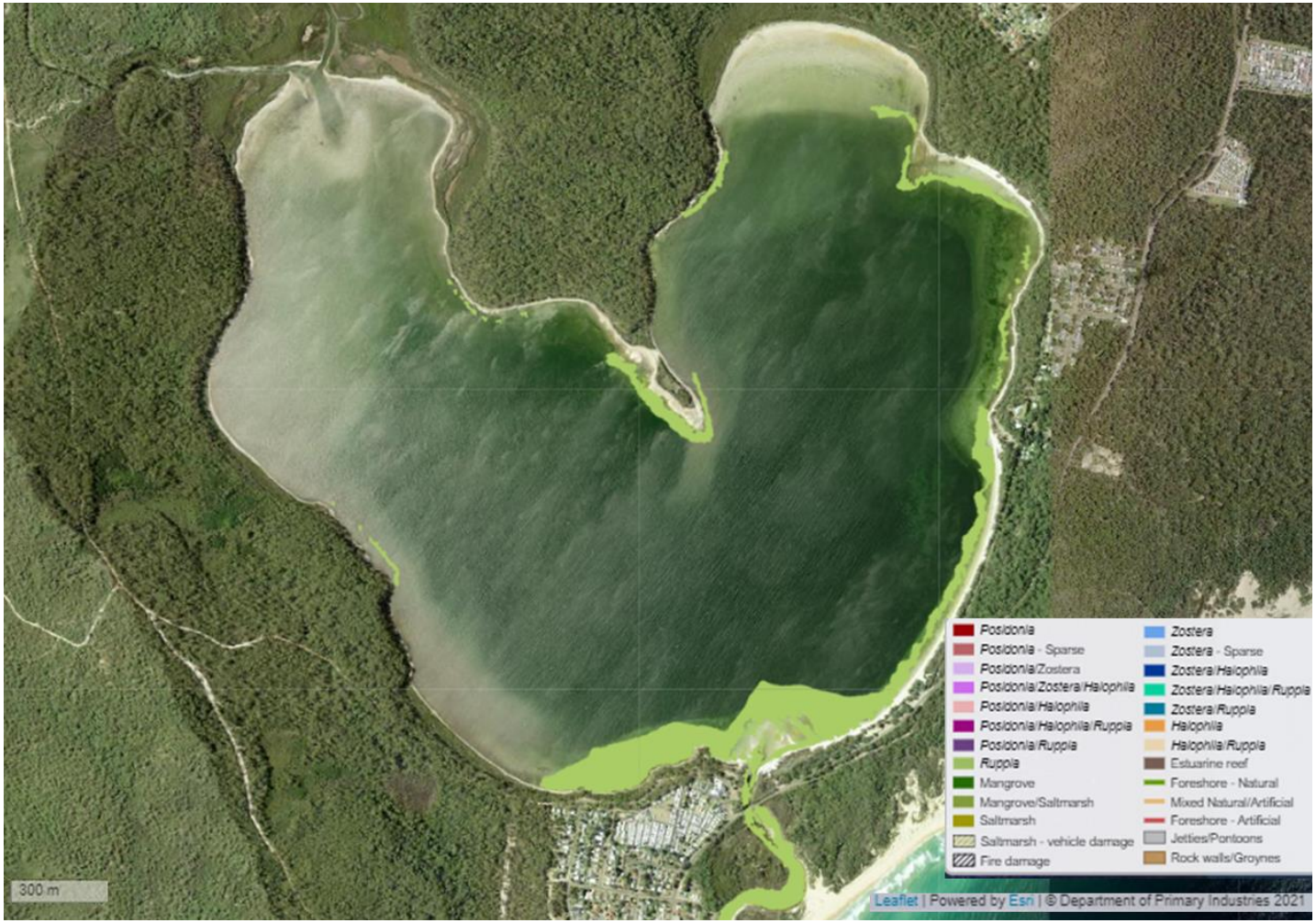


Figure 6-6 - NSW DPI estuarine macrophyte mapping of Ruppia in Swan Lake in 2004 (NSW DPI 2004).

B.3.3 Berrara Creek

Estuarine macrophyte habitat mapping undertaken by NSW DPI in 2004 is presented in Figure 6-7. Habitat mapping is available via https://nsw-dpi.shinyapps.io/NSW_Estuarine_Habitat/.

The mapping shows extensive macrophyte growth with the mouth of Berrara Creek and approximately 0.5 km upstream is lined with the seagrass species Zostera and Halophila in the subtidal / intertidal areas, with small patches of saltmarsh located in the higher intertidal zone.

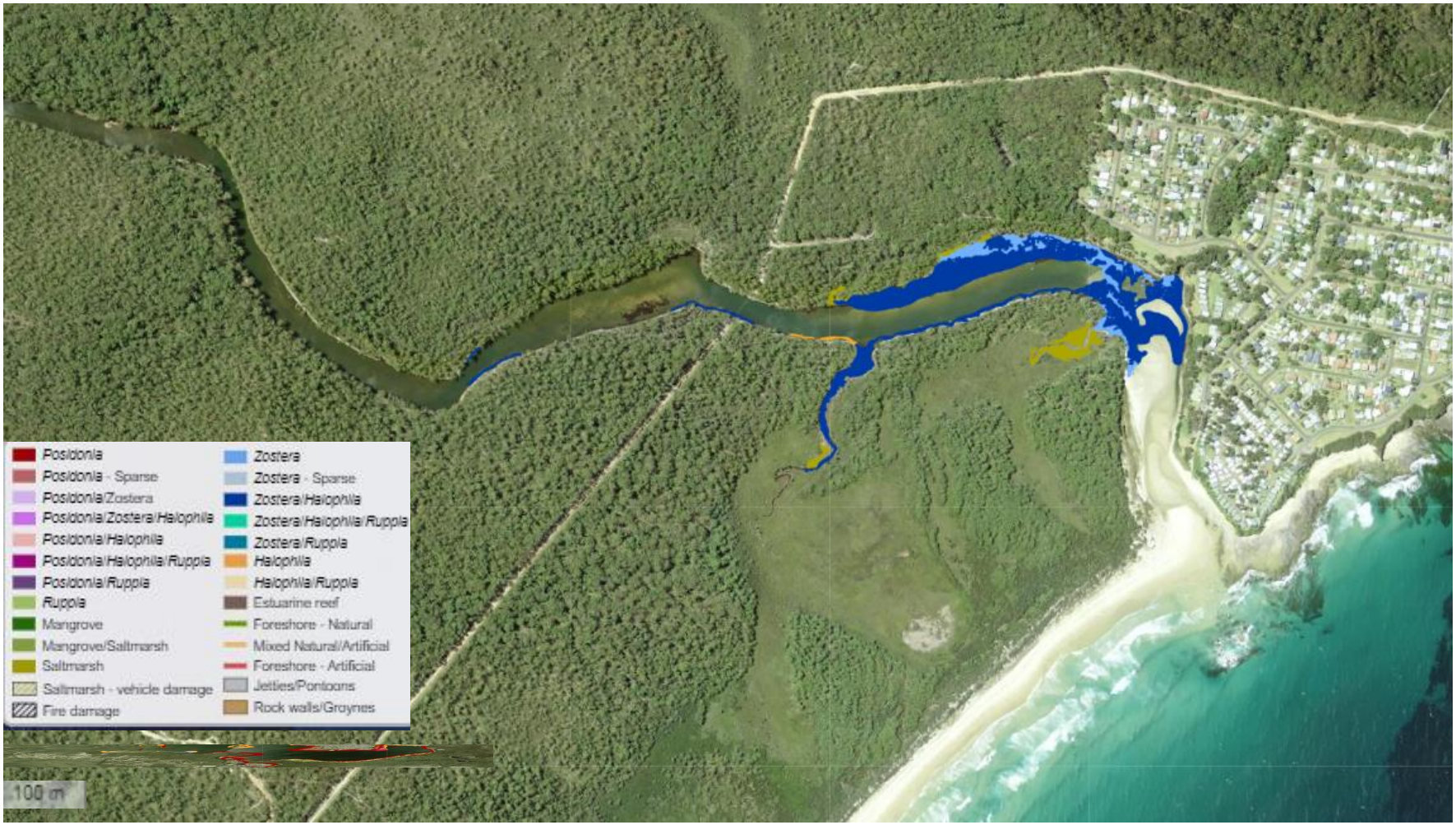


Figure 6-7 - NSW DPI estuarine macrophyte mapping for Berrara Creek in 2004 (NSW DPI 2022).

B.4 Protected Areas

B.4.1 Corramy Regional Park

Corramy Regional Park covers an area of 292 ha (Figure 6-8), most of which lies within the CMP study area. The park contains a range of vegetation, including six ecological communities, two of which are endangered: Swamp Oak Floodplain Forest, and River-flat Eucalypt Forest on Coastal Floodplains. Other rare or threatened plants which are found within the park include the biconvex paperbark, White Feather Honeymyrtle, and Magenta Lillypilly (NSW NPWS 2012). Fauna throughout the park is also diverse, with a range of species found here. Fauna include the sugar glider, southern boobook, and long-nosed bandicoot (NSW NPWS 2021a).

Corramy Regional Park offers a range of recreational and tourist actives, making it a popular family attraction. Activities on offer include birdwatching, canoeing, fishing, sailing, swimming, and walking (NSW NPWS 2021a).

Figure 6-8 - Corramy Regional Park in relation to the St Georges Basin (NSW NPWS 2021a).

B.4.2 Conjola National Park

Conjola National Park covers an area of 11,060 ha (Figure 6-9). The national park contains 18 different vegetation communities, including four endangered ecological communities: Coastal Saltmarsh, Swamp Sclerophyll Forest, Swamp Oak Floodplain Forest, and Bangalay Sand Forest. It also contains five threatened plant species and twenty-five species of threatened fauna (NSW NPWS 2009). The national park is also a significant area for threatened fauna species. Five endangered and twenty vulnerable species have been recorded in and around the parks. The local fauna include wombats, echidnas, possums, cockatoos, parrots, and herons.

Conjola National Park is a popular tourist location with the park offering a range of recreational and tourism facilities. Popular activities include birdwatching and wildlife encounters, walking cycling, and fishing.

Part of the national park lies within the CMP study area. It surrounds Swan Lake to the south, west and north and entirely surrounds Berrara Creek.

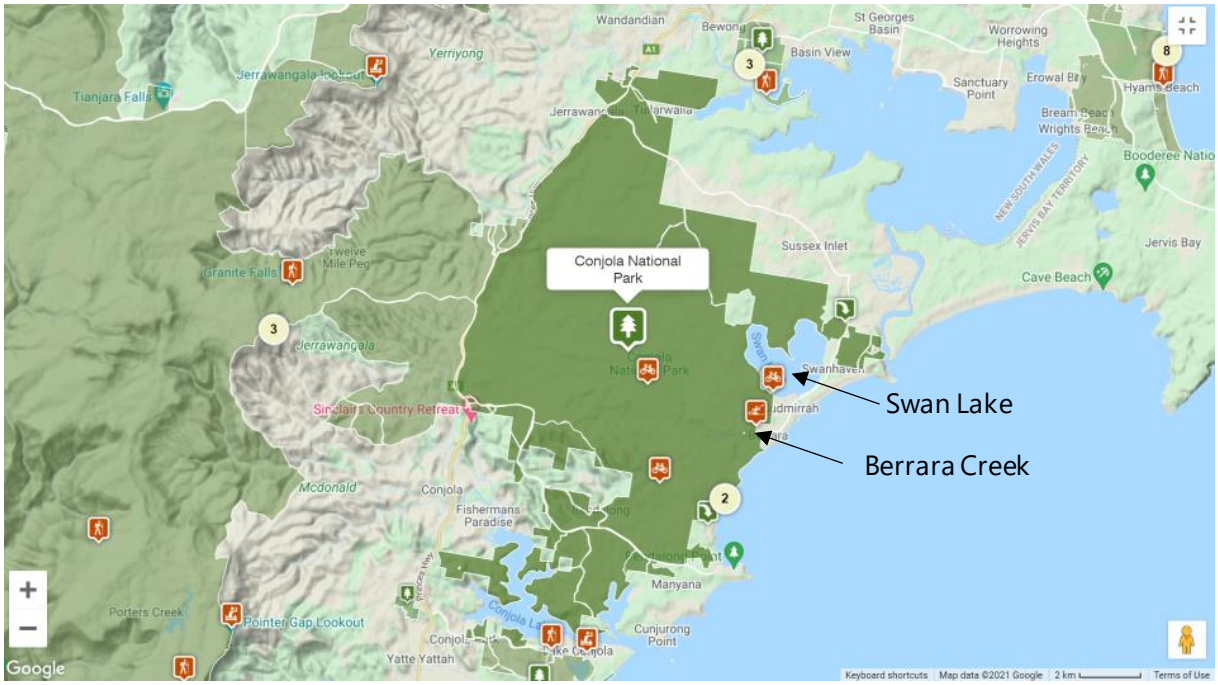


Figure 6-9 - Conjola National Park in relation to Swan Lake and Berrara Creek (NSW NPWS 2021b).

B.4.3 Wetlands

B.4.3.1 Wetlands of International Importance (RAMSAR Wetlands)

No Wetlands of International Importance were recorded in the Commonwealth EPBC Act Protected Matters Search which covers the Sussex Inlet and St Georges Basin areas.

B.4.3.2 Directory of Important Wetlands

The Directory of Important Wetlands (Environment Australia 2001) is a co-operative project between the Commonwealth, State and Territory Governments of Australia and is coordinated by The Department of Environment and Energy (DoEE) to identify Nationally Important Wetlands. The Directory lists 698 nationally important wetlands which are classified into 40 different wetland types in three categories. Two Important Wetlands are in proximity of the study area: St. Georges Basin, and Jervis Bay (although Jervis Bay is not included within the study area). Swan Lake and Berrara Creek are not identified as Nationally Important Wetlands.

St. Georges Basin has an area of 4400 ha, and is classified as a *Marine and Coastal Zone Wetland* with the following attributes:

- Subtidal aquatic beds; includes kelp beds, seagrass, tropical marine meadows (A2).
- Estuarine waters; permanent waters of estuaries and estuarine systems of deltas (A6).
- Intertidal mud, sand or salt flats (A7).

- Intertidal marshes; which includes saltmarshes, salt meadows, saltings, raised salt marshes, tidal brackish and freshwater marshes (A8).
- Intertidal forested wetlands; includes mangrove swamps, nipa swamps and tidal freshwater swamp forests (A9).

The criteria for determining Nationally Important Wetlands in Australia, and hence inclusion in the Directory, are those agreed to by the ANZECC Wetlands Network in 1994. St. Georges Basin meets the following criteria for inclusion:

- It is a good example of a wetland type occurring within a biogeographic region in Australia (Criterion 1).
- It is a wetland which is important as the habitat for animal taxa at a vulnerable stage in their life cycles or provides a refuge when adverse conditions such as drought prevail (Criterion 3).

B.4.4 Critical Habitat / Areas of Outstanding Biodiversity Value

B.4.4.1 Land Identified as Critical Habitat

This section identifies any land declared as Critical Habitat located within the study area as listed under the Commonwealth EPBC Act 1999 and NSW FM Act 1994. There are no areas of Critical Habitat in the vicinity of St Georges Basin, Sussex Inlet, Swan Lake or Berrara Creek for species listed under the Commonwealth EPBC Act 1999.

B.4.4.2 Areas of Outstanding Biodiversity Value

The NSW *Biodiversity Conservation Act 2016* (BC Act 2016) gives the Minister for the Environment the power to declare Areas of Outstanding Biodiversity Value (AOBV). AOBVs are special areas that contain irreplaceable biodiversity values that are important to the whole of NSW, Australia or globally. They are explained in more detail at http://www.environment.nsw.gov.au/biodiversity/outstandingbiodivvalue.htm (NSW DP&E 2022). The Biodiversity Conservation Regulation 2017 establishes the criteria for declaring AOBVs. The criteria have been designed to identify the most valuable sites for biodiversity conservation in NSW.

There are no AOBVs near the study area.

B.4.4.3 Biologically Important Areas

Biologically important areas (BIAs) are spatially defined areas where aggregations of individuals of a species are known to display biologically important behaviour such as breeding, foraging, resting or migration. These have the potential for flow on impacts from coastal management decisions.

Regionally Significant Marine Species adjacent to the sites (under the Commonwealth EPBC Act 1999) have been identified for the following species:

- Indo-Pacific Bottlenose Dolphin (*Tursiops aduncus*) – Breeding
- Grey Nurse Shark (*Carcharias taurus*) – Foraging
- Humpback Whale (*Megaptera novaeangliae*) – Foraging

- Wedge-tailed Shearwater (*Ardenna pacifica*) – Foraging
- Short-tailed Shearwater (*Ardenna tenuirostris*) – Foraging
- White-faced Storm-petrel (*Pelagodromaa marina*) – Breeding

B.4.4.4 Key Ecological Marine Features

Key Ecological Marine Features (KEFs) are parts of the marine ecosystem that are important for the biodiversity or ecosystem functioning and integrity of the Commonwealth Marine Area. No marine KEFs occur within a 5 km radius of the study area.

B.5 Threatened and Protected Fauna

B.5.1 NSW *Biodiversity Conservation Act* 2016 & Commonwealth *Environment Protection and Biodiversity Conservation Act* 1999

Online database searches for threatened and protected species listed under the Commonwealth EPBC Act (via the Protected Matters Search Tool) and the NSW BC Act (via the BioNet Atlas of NSW Wildlife) were undertaken in January 2022. A list of the threatened and protected marine species listed under these Acts is provided in Table 6-7 covering St Georges Basin/Sussex Inlet, Swan Lake and Berrara Creek.

Table 6-7 - Threatened and protected marine species listed under the Commonwealth EPBC Act 1999 and NSW BC Act 2016 with the potential to occur within Sussex Inlet, St. Georges Basin, Swan Lake and Berrara Creek

Common Name	Species Name	NSW BC Act 2016	Commonwealth EPBC Act 1999	Likelihood of Occurrence*
Birds				
Regent Honeyeater	*Anthochaera phrygia*	-	CE	Species or species habitat known to occur within area
Australasian Bittern	*Botaurus poiciloptilus*	-	E	Species or species habitat known to occur within area
Red Knot	*Calidris canutus*	-	E	Species or species habitat known to occur within area
Curlew Sandpiper	*Calidris ferruginea*	-	CE	Species or species habitat may occur in area
Greater Sand Plover, Large Sand Plover	*Charadrius leschenaultii*	-	V	Species or species habitat likely to occur in area*
Eastern Bristlebird	*Dasyornis brachypterus*	E1	E	Species or species habitat known to occur in area

Common Name	Species Name	NSW BC Act 2016	Commonwealth EPBC Act 1999	Likelihood of Occurrence*
Antipodean Albatross	*Diomedea antipodensis*	-	V	Foraging, feeding or related behaviour likely to occur within area
Gibson's Albatross	*Diomedea antipodensis gibsoni*	-	V	Foraging, feeding or related behaviour likely to occur within area
Southern Royal Albatross	*Diomedea epomophora*	-	V	Foraging, feeding or related behaviour likely to occur within area
Wandering Albatross	*Diomedea exulans*	-	V	Foraging, feeding or related behaviour likely to occur within area
Northern Royal Albatross	*Diomedea sanfordi*	-	E	Foraging, feeding or related behaviour likely to occur within area
Grey Falcon	*Falco hypoleucos*		V	Species or species habitat may occur in area
White-bellied Storm Petrel	*Fregetta grallaria grallaria*	-	V	Species or species habitat may occur in area
Painted Honeyeater	*Grantiella picta*	-	V	Species or species habitat likely to occur in area
White bellied sea eagle	*Haliaeetus leucogaster*	V	-	-
Sooty Oystercatcher	*Haematopus fuliginosus*	V	-	-
Pied Oystercatcher	*Haematopus longirostris*	E1	-	-
White-throated Needletail	*Hirundapus caudacutus*	-	V	Species or species habitat known to occur in area
Swift Parrot	*Lathamus discolor*	-	CE	Species or species habitat known to occur in area
Nunivak Bar-tailed Godwit	*Limosa lapponica baueri*	-	V	Species or species habitat known to occur in area
Southern Giant-Petrel	*Macronectes giganteus*	E1	E	Species or species habitat may occur in area

Common Name	Species Name	NSW BC Act 2016	Commonwealth EPBC Act 1999	Likelihood of Occurrence*
Northern Giant Petrel	*Macronectes halli*	V	V	Species or species habitat may occur in area
Orange-bellied Parrot	*Neophema chrysogaster*	-	CE	Species or species habitat may occur in area
Eastern Curlew	*Numenius madagascariensis*	-	CE	Species or species habitat known to occur in area
Sooty Tern	*Onychoprion fuscata*	V	-	-
Fairy Prion (southern)	*Pachyptila turtur subantarctica*	-	V	Species or species habitat known to occur in area
Eastern Osprey	*Pandion cristatus*	V	-	-
Sooty Albatross	*Phoebetria fusca*	-	V	Species or species habitat may occur in area
Gould's Petrel	*Pterodroma leucoptera leucoptera*	-	E	Species or species habitat may occur in area
Kermadec Petrel	*Pterodroma neglecta neglecta*	-	V	Species or species habitat may occur in area
Australian Painted Snipe	*Rostratula australis*	-	E	Species or species habitat known to occur in area
Australian Fairy Tern	*Sternula nereis nereis*	-	V	Species or species habitat known to occur in area
Little Tern	*Sternula albifrons*	E1	-	-
Buller's Albatross	*Thalassarche bulleri*	-	V	Species or species habitat may occur in area
Northern Buller's Albatross	*Thalassarche bulleri platei*	-	V	Species or species habitat may occur in area
Indian, Yellow-nosed Albatross	*Thalassarche carteri*	-	V	Species or species habitat likely to occur in area
Shy Albatross	*Thalassarche cauta*	V	E	Foraging, feeding or related behaviour likely to occur within area

Common Name	Species Name	NSW BC Act 2016	Commonwealth EPBC Act 1999	Likelihood of Occurrence*
Chatham Albatross	*Thalassarche eremita*	-	E	Foraging, feeding or related behaviour likely to occur within area
Campbell Albatross	*Thalassarche impavida*	-	V	Species or species habitat may occur in area
Black-browed Albatross	*Thalassarche melanophris*	-	V	Species or species habitat may occur in area
Salvin's Albatross	*Thalassarche salvini*	-	V	Foraging, feeding or related behaviour likely to occur within area
White-capped Albatros	*Thalassarche steadi*	-	V	Foraging, feeding or related behaviour likely to occur within area
Eastern Hooded Plover or Dotterel	*Thinornis cucullatus cucullatus*	E4	V	Species or species habitat known to occur in area
Black Bittern	*Ixobrychus flavicollis*	V	-	-
Bats				
Yellow-bellied Sheathtail-bat	*Saccolaimus flaviventris*	V	-	-
Eastern Coastal Free-tailed Bat	*Micronomus norfolkensis*	V	-	-
Eastern False Pipistrelle	*Falsistrellus tasmaniensis*	V	-	-
Southern Myotis	*Myotis macropus*	V	-	-
Greater Broad-nosed Bat	*Scoteanax rueppellii*	V	-	-
Large Bent-winged Bat	*Miniopterus orianae oceanensis*	V	-	-
Large-eared Pied Bat	*Chalinobus dwyeri*		V	Species or species habitat likely to occur within area
Fish and Syngnathids				
Australian Grayling	*Prototroctes maraena*	-	V	Species or species habitat likely to occur within area

Common Name	Species Name	NSW BC Act 2016	Commonwealth EPBC Act 1999	Likelihood of Occurrence*
Black Rockcod	*Epinephelus daemelii*	-	V	Species or species habitat likely to occur within area
White's Seahorse	*Hippocampus whitei*	-	E	Species or species habitat known to occur within area
Grey Nurse Shark	*Carcharias taurus*	-	CE	Species or species habitat likely to occur within area
Great White Shark	*Carcharodon carcharias*	-	V, M	Species or species habitat known to occur within area
Oceanic Whitetip Shark	*Carcharhinus longimanus*	-	M	Species or species habitat may occur within area
Porbeagle	*Lamna nasus*	-	M	Species or species habitat likely to occur within area
Whale Shark	*Rhincodon typus*	-	V, M	Species or species habitat may occur within area
Giant Manta Ray	*Mobula birostris*	-	M	Species or species habitat may occur within area*
Frogs				
Giant Burrowing Frog	*Heleioporus australiacus*	-	V	Species or species habitat known to occur within area
Green and Golden Bell Frog	*Litoria aurea*	E1	V	Species or species habitat known to occur within area
Stuttering Frog	*Mixophyes balbus*	-	V	Species or species habitat may occur in area
Reptiles				
Loggerhead Turtle	*Caretta caretta*	-	E, M, L	Breeding likely to occur within area
Green Turtle	*Chelonia mydas*	V, P	V, M, L	Breeding likely to occur within area
Leatherback Turtle	*Dermochelys coriacea*	-	E, M, L	Breeding likely to occur within area
Hawksbill Turtle	*Eretmochelys imbricata*	-	V, M, L	Breeding likely to occur within area

Common Name	Species Name	NSW BC Act 2016	Commonwealth EPBC Act 1999	Likelihood of Occurrence*
Flatback Turtle	*Natator depressus*	-	V, M	Breeding likely to occur within area
Marine Mammals				
Minke Whale	*Balaenoptera acutorostrata*	-	W	Species or species habitat may occur within offshore marine area
Blue Whale	*Balaenoptera musculus*	-	E, M, W	Species or species habitat may occur within offshore marine area
Southern Right Whale	*Eubalaena australis*	E1	E, M, W	Species or species habitat known to occur within offshore marine area
Humpback Whale	*Megaptera novaeangliae*	V	V, M, W	Species or species habitat known to occur within offshore marine area
Killer Whale	*Orcinus orca*	-	W, M	Species or species habitat likely to occur within offshore marine area
Bryde's Whale	*Balaenoptera edeni*	-	M, W	Species or species habitat may occur within offshore marine area
Pygmy Right Whale	*Caperea marginata*	-	M, W	Foraging, feeding or related behaviour may occur within offshore marine area
Indian Ocean Bottlenose Dolphin	*Tursiops aduncus*	-	W	Species or species habitat likely to occur within area
Bottlenose Dolphin	*Tursiops truncatus s. str.*	-	W	Species or species habitat may occur within area
Common Dolphin	*Delphinus delphis*	P	W	Species or species habitat may occur within area

Common Name	Species Name	NSW BC Act 2016	Commonwealth EPBC Act 1999	Likelihood of Occurrence*
Risso's Dolphin	*Grampus griseus*	-	W	Species or species habitat may occur within area*
Dusky Dolphin	*Lagenorhynchus obscurus*	-	M, W	Species or species habitat may occur within area*
Dugong	*Dugong dugon*	-	M	Species or species habitat may occur within area
New Zealand Fur Seal	*Arctocephalus forsteri*	-	L	Species or species habitat may occur within area
Australian Fur Seal	*Arctocephalus pusillus*	-	L	Species or species habitat may occur within area
Leopard Seal	*Hydrurga leptonyx*	p	-	Known to occur within area

B.5.2 NSW *Fisheries Management Act* 1994

Threatened and protected marine species listed under Schedules 4 to 5 of the NSW FM Act were reviewed in order to satisfy requirements of the *Fisheries NSW Policy and Guidelines for Fish Habitat Conservation and Management* (NSW DPI 2013).

Marine species, populations and ecological communities currently listed as endangered, critically endangered and/or vulnerable (i.e. Schedule 4, 4A and 5) under the NSW FM Act with the potential to occur in the general study area are listed below.

Schedule 4: Endangered Species, Populations and Ecological Communities

- White's seahorse (*Hippocampus whitei*) – endangered species
- Eastern freshwater cod (*Maccullochella ikei*) – endangered species
- Trout cod (*Maccullochella macquariensis*) – endangered species
- Macquarie perch (*Macquaria australasica*) – endangered species
- Southern purplespotted gudgon (*Mogurnda adspersa*) – endangered species
- Southern pygmy perch (*Nannoperca australis*) – endangered species
- Oxleyan pygmy perch (*Nannoperca oxleyana*) – endangered species
- Australian grayling (*Prototroctes maraena*) – endangered species

- Scalloped hammerhead shark (*Sphyrna lewini*) - endangered species
- Southern bluefin tuna (*Thunnus maccoyii*) - endangered species

Schedule 4A: Critically Endangered Species and Ecological Communities

- Grey nurse shark (*Carcharius taurus*) - critically endangered species
- Murray hardyhead (*Craterocephalus fluviatilis*) – critically endangered species
- Fitzroy falls spiny crayfish (*Euastacus dharawalus*) – critically endangered species
- Stocky galaxias (*Galaxias tantangara*) – critically endangered species
- Hanley's river snail (*Notopala hanleyi*) – critically endangered species
- Darling river snail (*Notopala sublineata*) – critically endangered species
- Marine slug (*Smeagol hilaris*) - critically endangered species

Schedule 5: Vulnerable Species and Ecological Communities

- Silver perch (*Bidyanus bidyanus*) – vulnerable species
- Buchanans fairy shrimp (*Branchinella buchananensis*) – vulnerable species
- Great white shark (*Carcharodon carcharias*) - vulnerable species
- Black cod (*Epinephelus daemelii*) - vulnerable species
- Murry crayfish (*Euastacus armatus*) – vulnerable species
- Bousfieds marsh-hopper (*Microrchestia bousfieldi*) – vulnerable species
- Great hammerhead shark (*Sphyrna mokarran*) – vulnerable species

Protected Species

- All species of the families 'Syngnathidae', 'Solenostomidae' and 'Pegasidae' (i.e. seahorses, sea dragons, pipefishes, pipehorses)
- Ballina angelfish, *Chaetodontoplus ballinae*
- Bluefish, *Girella cyanea*
- Eastern blue devil fish, *Paraplesiops bleekeri*
- Elegant wrasse, *Anampses elegans*
- Estuary cod, *Epinephelus coioides*
- Giant Queensland groper, *Epinephelus lanceolatus*
- Herbsts nurse shark, *Odontaspis ferox*

Considering the estuarine nature of the site, habitats present in the study area and the required habitat and conservation status of each of the species listed under the FM Act, the species which are considered to most likely to occur within the St Georges Basin and Sussex Inlet area are:

- Black cod (*E. daemelii*) - vulnerable (potential to be present around the inshore artificial rocky reef).
- Syngnathids – protected / endangered (potential to be present in nearby macroalgae beds or around existing wharf piles).

B.6 Aquaculture

There is no licensed aquaculture activity in the Sussex Inlet, St Georges Basin, Swan Lake or Berrara Creek areas. Risks identified during the CMP are not expected to impact aquaculture activities outside of the study area.

B.7 Invasive Pests

Invasive pests are animals or weeds that can have significant impacts on local wildlife, natural bushland or livestock. All stakeholders have a responsibility to manage invasive species on land that they own or manage. The council manages weeds throughout the LGA on council managed land as outlined in the Commonwealth *Biosecurity Act* 2015 and the NSW *Biosecurity Regulation* 2017. Within the waterways, NSW DPI is responsible for management of marine pests.

B.7.1 Weeds

A search of the NSW DPI Weedwise database for aquatic and terrestrial invasive weeds on the South East Coast was made on the 30th June 2022.

For each state level priority weed, there are defined management objectives and requirement including either a Prohibited Matter, Biosecurity Zones, Control Orders and Mandatory Measures. A control order is in place from the 19th June 2017 for the weed *Chrysanthemoides monilifera* subspecies *monilifera* (Boneseed).

There are Priority Weed Management Plans in place within Shoalhaven LGA (Shoalhaven City Council 2022b), for the following weed species:

- Alligator weed
- Bitou bush
- Blackberry
- Boneseed
- Coolatai grass
- Fireweed
- Giant Parramatta grass
- Lantana

- Salvinia
- Water hyacinth

Council has identified some key plant species that spread easily into neighbouring bush land include:

- Privet
- Cotoneaster
- Hawthorn
- Olives
- Broom
- Agapanthus
- Cootamundra Wattle
- Lavender
- Freesia
- Watsonia
- Arum Lily
- Blue Periwinkle
- Cassia or Senna
- Genist

There are 106 weeds that are listed as priority for the South East region. Of these, there are 22 listed aquatic weeds although most of these are freshwater species and would not be present within the partially saline estuarine waters. Not all of these weeds would be present within the Shoalhaven LGA or

In addition, garden weeds are identified as an issue for gardens that border onto native bushlands. Garden weeds can spread from suburban gardens by water, wind, birds, bikes, cars, earth-moving equipment, illegal tracks or dumped garden waste (Shoalhaven City Council 2022b).

Ecoplanning (2023) has undertaken an assessment of engdangered ecological communities in coastal hazard areas. They identified the following weeds at St Georges Basin, Sussex Inlet, Swan Lake and Berrara Creek:

- St Georges Basin – Woody weeds observed include *Senna pendula*, *Ligustrum sinense* (Small-leaf Privet), *Ligustrum lucidum* (Large-leaf Privet), and *Solanum mauritianum*, Two priority weeds were observed, in St Georges Basin, including *Asparagus aethiopicus* and *Senecio madagascariensis*
- Sussex Inlet – Woody weeds observed included *Senna pendula*, *Chrysanthemoides monilifera subsp. rotundata*, *Phoenix canariensis* and *Erythrina x sykesii*. Priority weeds that were observed included *Asparagus aethiopicus*, *Rubus fruticosus spp. agg.*, and *Senecio madagascariensis*, *Chrysanthemoides monilifera subsp. rotundata*.

- At Swan Lake, woody weeds observed included *Senna pendula* and *Ochna serrulata*. *Asparagus aethiopicus* is highly prevalent.
- At Berrara Creek, woody weeds observed included *Senna pendula*, *Ochna serrulata* (Mickey Mouse Plant) and *Morus alba* (White Mulberry). Herbaceous weeds included *Tradescantia fluminensis* (Trad). Three priority weeds were observed, including *Asparagus scandens* (Snakefeather), *Asparagus aethiopicus* and *Rubus fruticosus spp. agg.*.

B.7.2 Marine Pests

Marine pests are non-native marine plants or animals that harm, or have the potential to harm Australia's marine environment, social amenity or industries that use the marine environment (DPI 2022a). If introduced, they have the potential to prey on native species or compete with them for food, severely impacting the environment. In Australia there are an estimated 250 introduced marine species introduced to the waters in various ways including in ballast waters or attached to the hulls of ships. There have been over 100 introduced marine species reported in Australian waters, with the majority unintentionally introduced via mariculture and shipping (Hewitt and Martin 1996).

To protect NSW waters, DAWE have implemented the national *Marine Pest Plan* 2018 – 2023 which aims to prevent the introduction and translocation of introduced marine species, strengthen the national marine pest surveillance system, provide a national emergency preparedness and response for outbreaks, support national research and development and engagement with marine stakeholders (DAWE 2018). NSW DPI also has an advisory program to raise awareness of marine pests including how to identify and prevent the spread of them (NSW DPI 2022a).

Appendix C Gross Pollutant Trap Locations

C.1 Background

A Gross Pollutant Trap (GPT) is a primary stormwater treatment device designed to stop litter, organic waste and sediments from entering the stormwater system and natural waterways, primarily through screening. They can be used in existing conventional drainage systems either in pipes, outfalls or open channels, but also as pre-treatment for other Water-Sensitive Urban Design (WSUD) elements within a stormwater system (e.g. bioretention systems or wetlands).

Various types of GPTs are available, with these being proprietary products. They include:

- Traps that use gravity to separate pollutants that float or settle, using a series of baffles or booms to separate pollutants of different densities into chambers, without the use of screens
- Devices that incorporate screens to directly screen out gross pollutants from stormwater flows (e.g. trash rack, refer Figure 6-10)
- Vortex-type devices that direct flow to produce vortices, allowing hydrodynamic separation of pollutants from the flow
- Continuous Deflective Separation (CDS) devices that combine a vortex-type unit with a screening system (refer example in Figure 6-11).

Sizing of GPTs depends on the size of the catchment served and catchment pollutant load. GPTs are generally sized to treat between the 3-month to 1-year ARI peal flow. Smaller GPT units can serve small, neighbourhood-scale catchment areas, whereas larger devices are needed for regional catchments, with larger devices including racks or booms across rivers or major stormwater flow corridors.

Figure 6-10 – Example trash rack at Sanctuary Point (Google Maps street view)

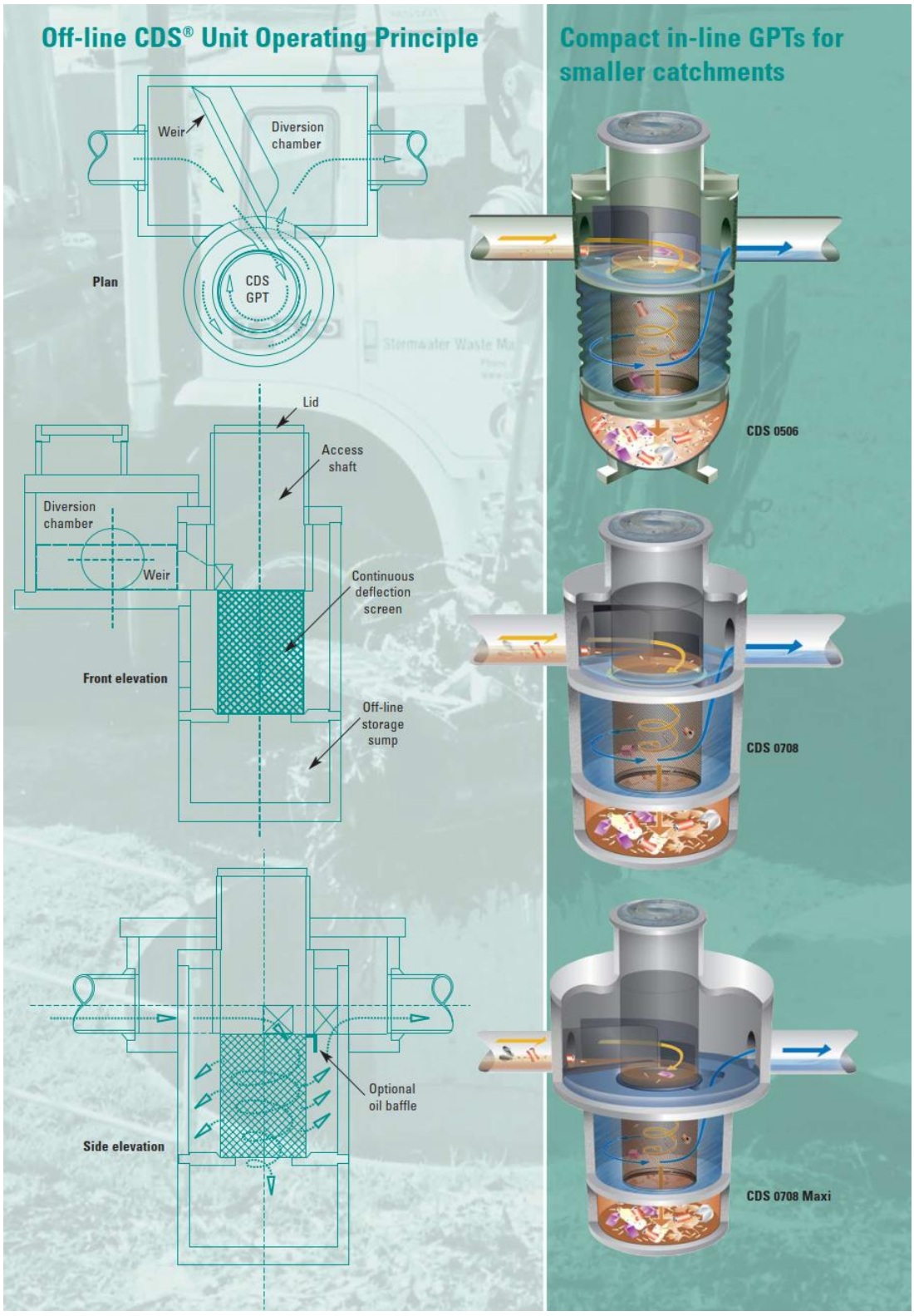


Figure 6-11 – Example Vortex-type GPT incorporating a screen (Continuous Deflective Separation, CDS® Unit, Rocla Pty Ltd)

C.2 St Georges Basin

Existing GPT locations within the St Georges Basin urban area are shown in Figure 6-12, together with suggested potential locations for additional units.

The suggested locations for GPT units or other Water Sensitive Urban Design (WSUD) feature, together with rationale and approximate catchment area, are shown in Table 6-8. The type of GPT unit or WSUD treatment required would be subject to detailed design and catchment pollutant modelling.

Table 6-8 – Suggested locations for GPTs or other WSUD stormwater treatment, St Georges Basin

ID	Location	GPS coordinates (MGA94 Zone 56)	Approximate Catchment Area	Treatment type (indicative)	Rationale
GPT01	Near 87 Loralyn Avenue, St Georges Basin	281343E, 6113437N	0.32 km^2	CDS GPT or similar	Urban catchment area, small catchment
GPT02	Near 80 Cammaray Drive St Georges Basin	282010E, 6113616N	0.466 km^2	Wetland or vegetated swale	Urban area, relatively large catchment with natural vegetated overland flow path
GPT03	Near 22 Sanctuary Point Road, Sanctuary Point	284394E, 6113140N	0.273 km^2	CDS GPT or trash rack	Existing open drain with culvert, suited to trash rack installation or off-line CDS unit
GPT04	Near 164 Walmer Avenue Sanctuary Point	283310E, 6112184N	0.497 km^2	Trash rack	Existing open channel with culvert, suited to trash rack

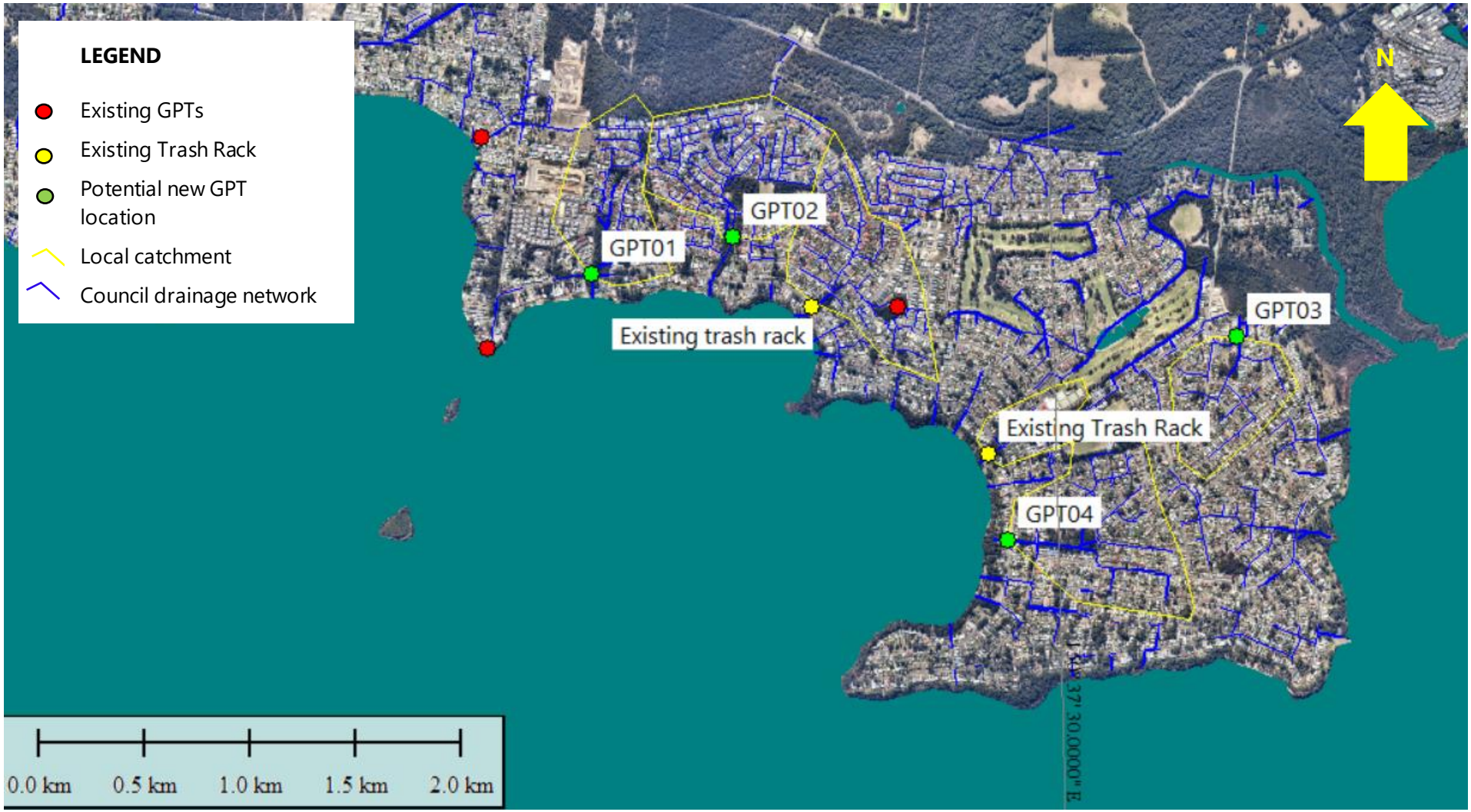


Figure 6-12 – Potential and existing GPT locations at St Georges Basin

There are no existing GPT locations within the Sussex Inlet urban area recorded on Shoalhaven Council's GIS database. However, suggested GPT locations are shown in Figure 6-13.

The suggested locations for GPT units or other Water Sensitive Urban Design (WSUD) feature, together with rationale and approximate catchment area, are shown in Table 6-9. The type of GPT unit or WSUD treatment required would be subject to detailed design and catchment pollutant modelling.

Table 6-9 – Suggested locations for GPTs or other WSUD stormwater treatment, Sussex Inlet

ID	Location	GPS coordinates (MGA94 Zone 56)	Approximate Catchment Area	Treatment type (indicative)	Rationale
GPT05	Lakehaven Drive near Edgewater Avenue	280516E, 6105321N	0.228 km^2	CDS GPT	Piped drainage area at high profile location, urban catchment
GPT06	Jacobs Drive	281748E, 6106944N	0.065 km^2	In-line CDS GPT	Small, urban catchment in commercial area, high profile location
GPT07	Downstream of new estate at Sussex Inlet Road near Jacobs Drive	280013E, 6106618N	0.435 km^2	CDS GPT or trash rack	New urban development catchment area, small catchment, sensitive area need to capture sediment
GPT08	Cnr Boatharbour Dr and Pacificana Dr	280257E, 6105151N	0.378 km^2	Trash Rack	Urban area, open channel with culvert; could potentially replace gabions weir on downstream side

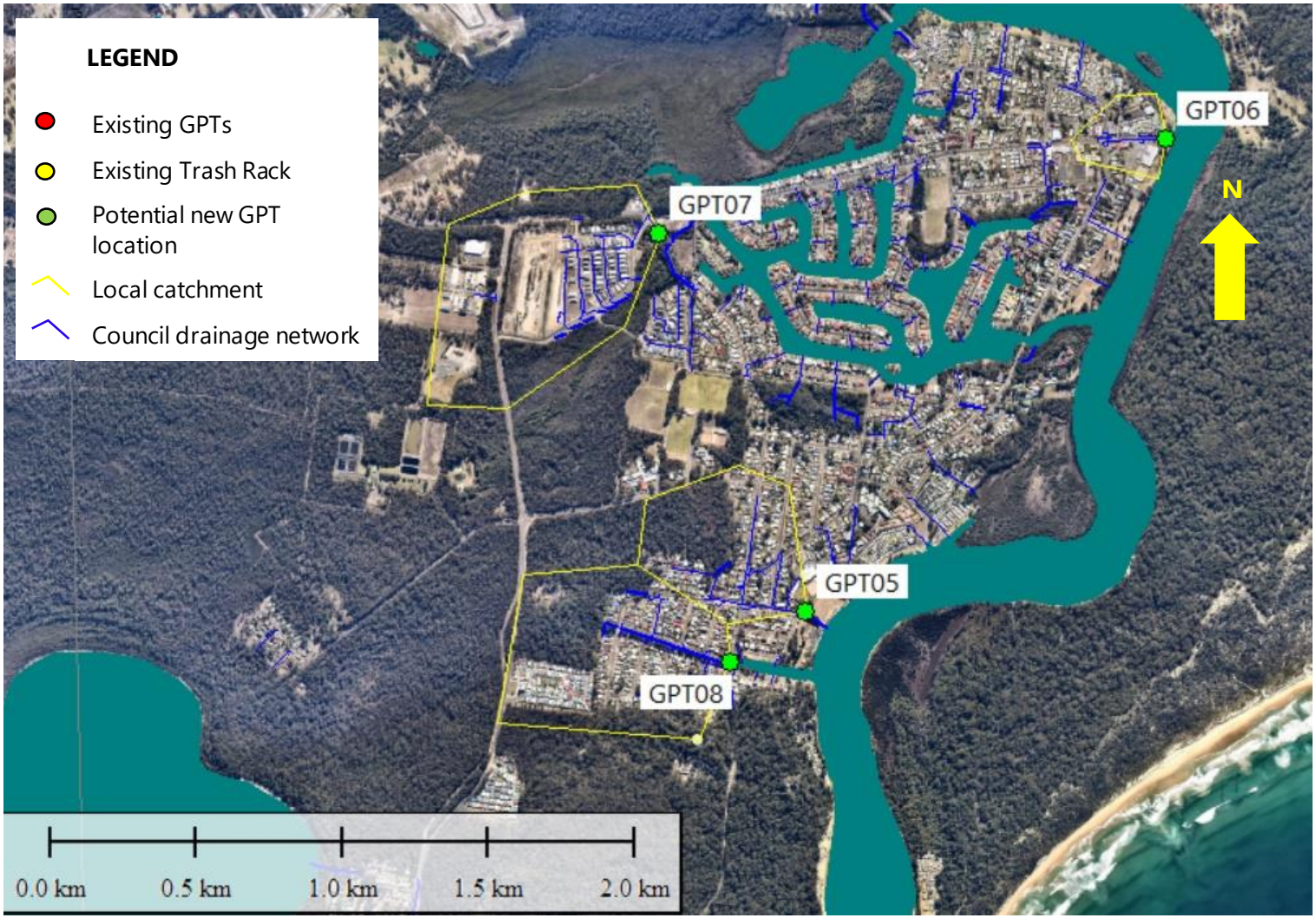


Figure 6-13 – Suggested GPT locations at Sussex Inlet

C.3 Swan Lake

There are no existing GPT locations within the Swan Lake area shown on Shoalhaven City Council's GIS database. However, there is one suggested GPT location shown in Figure 6-14.

The suggested locations for GPT units or other Water Sensitive Urban Design (WSUD) feature, together with rationale and approximate catchment area, are shown in Table 6-10. The type of GPT unit or WSUD treatment required would be subject to detailed design and catchment pollutant modelling.

Table 6-10 – Suggested locations for GPTs or other WSUD stormwater treatment, Swan Lake

ID	Location	GPS coordinates (MGA94 Zone 56)	Approximate Catchment Area	Treatment type (indicative)	Rationale
GPT09	Cnr First Avenue and Koolyn Drive Cudmirrah	277754E, 6102243N	0.13 km^2	CDS GPT or similar	Urban catchment area, captures large proportion of Cudmirrah urban area

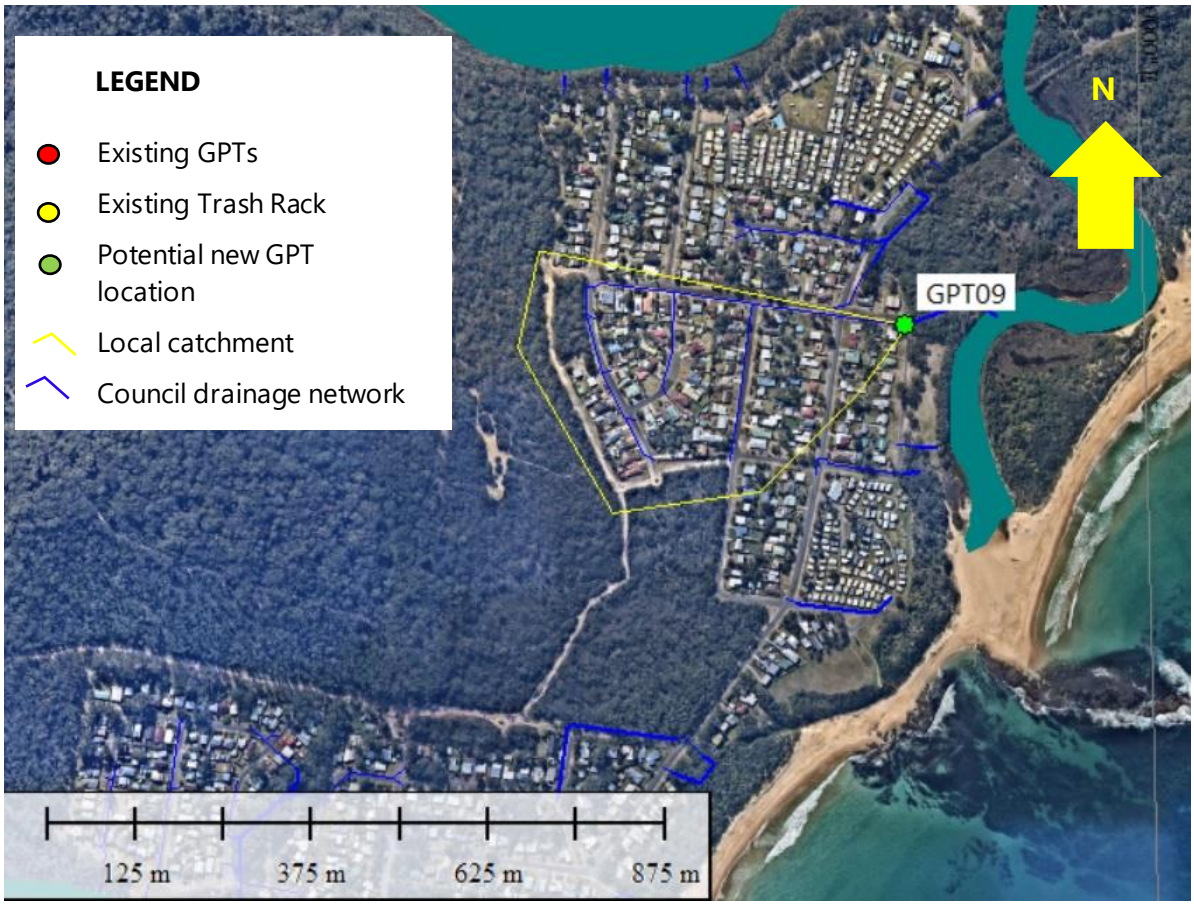


Figure 6-14 – Recommended GPT locations in Swan Lake area