Tweed River Estuary: Coastal Management Program 2022 – 2032




May 2022

Disclaimer:

This report has been prepared on behalf of and for the exclusive use of Tweed Shire Council and is subject to and issued in accordance with the agreement between Tweed Shire Council and Hydrosphere Consulting. Hydrosphere Consulting accepts no liability or responsibility whatsoever for it in respect of any use of or reliance upon this report by any third party.

Copying this report without the permission of Tweed Shire Council or Hydrosphere Consulting is not permitted.

Tweed Shire Council has prepared this document with financial assistance from the NSW Government. This document does not necessarily represent the opinions of the NSW Government.

Project Team:

Tweed Shire Council:

Project Manager: Tom Alletson

Hydrosphere Consulting:

Project Managers: Orla Seccull and Katie Pratt

Project Director: Mick Howland

Project Team: Robyn Campbell, Rod Conroy, Uriah Makings, John Fullerton, Kate Menzies

Suite 6, 26-54 River Street
PO Box 7059, Ballina NSW 2478
www.hydrosphere.com.au

PROJECT 16-051 – TWEED RIVER ESTUARY CMP

REV	DESCRIPTION	AUTHOR	REVIEW	APPROVAL	DATE
0	Pre-exhibition draft for TCWC review	O. Seccull, R. Campbell M. Howland	M. Howland	M. Howland	2 Feb 2018
1	Pre-exhibition draft for Council & agency review	O. Seccull, R. Campbell	M. Howland	M. Howland	28 Mar 2018
2	Working draft post agency comments	O. Seccull	M. Howland	M. Howland	28 Mar 2018
3	Pre-exhibition draft	O.Seccull	M. Howland	M. Howland	11 Jun 2019
4	Pre-exhibition draft with SLR veg migration amendments	O.Seccull	M. Howland	M. Howland	24 July 2019
5	Final draft	O. Seccull	M. Howland	M. Howland	13 Mar 2020
6	Final draft for certification	K. Pratt, U. Makings	R. Campbell	M. Howland	29 Jan 2021
7	Final draft for certification - minor edits	K. Pratt	M. Howland	M. Howland	14 Oct 2021
8	Final draft for certification - minor edits	K. Pratt	M. Howland	M. Howland	26 May 2022

ACKNOWLEDGEMENT TO COUNTRY

Tweed Shire Council (TSC) acknowledges and respects the Tweed Aboriginal community's right to speak for its country and to care for its traditional country in accordance with its laws, customs and traditions and welcomes the Aboriginal people's contribution to protecting, strengthening and enriching the heritage of all Australians within the wider community. Council acknowledges the Nganduwal and Minyungbal people of the Bundjalung nation, in particular the Goodjinburra, Tul-gi-gin and Moorung-moobah clans as being the Traditional Owners and Custodians of the land and water within the Tweed Shire boundaries (TSC, 2017b).

EXECUTIVE SUMMARY

This Coastal Management Program (CMP) for Tweed River estuary recognises the achievements of past management plans and programs, primarily the *Lower Tweed River Management Plan* (PWD, 1991) and the *Upper Tweed Estuary Management Plan* (TRMPAC, 1996) and identifies unresolved issues and new management issues that have arisen since the previous management plans were adopted. The CMP provides the updated plan to direct ongoing management of the estuary and addresses the New South Wales (NSW) coastal management reforms, in particular the requirements of the *State Environmental Planning Policy (Coastal Management) 2018* (CM SEPP) which establishes a new, strategic land use planning framework for coastal management and supports the implementation of the management objectives of the *Coastal Management Act, 2016* (CM Act).

In December 2021, the Minister for Planning and Public Spaces announced that the 45 existing *State Environmental Planning Policies (SEPPs)* will be consolidated into 11 new amalgamated SEPPs. As part of this process, the CM SEPP has been rolled into Chapter 2 of the new *State Environmental Planning Policy (Resilience and Hazards) 2021*. The SEPP consolidation is administrative, and no policy changes have been made. The SEPP consolidation does not change the legal effect of the existing SEPPs, with section 30A of the Interpretation Act 1987 applying to the transferred provisions. For clarity, these provisions are still referred to as the CM SEPP in this document.

This CMP has been developed in accordance with Stages 1 to 4 of the five-stage process for developing and implementing a CMP, as detailed in the *Coastal Management Manual* (OEH, 2018b). The completed stages supporting this CMP (Stage 4 of the process) include the preparation of:

- Stage 1 Scoping Study - which reviewed the status of current issues and management and identifies the focus of the new CMP and several detailed studies to address knowledge gaps;
- Stage 2 Detailed Studies - incorporating a suite of investigations to assess key risks, vulnerabilities and identify opportunities and inform future management; and
- Stage 3 Identification and Evaluation of Strategic Responses - which identified actions to address coastal management issues in an integrated and strategic manner consistent with the provisions of the CM Act.

The study area comprises the reaches of the estuary from the entrance to the extent of the tidal limits including the tidal waterways, foreshore and adjacent land. The estuary is a mature, wave dominated barrier estuary with a permanently open, trained entrance managed jointly by the NSW and Queensland Governments through the Tweed River Entrance Sand Bypassing Project (TRESBP). Major in-stream structures that impact flows in the Tweed River are Clarrie Hall Dam and Bray Park Weir which supply potable water to the Shire. Water quality, agricultural productivity and ecosystem services on the floodplain are shaped by extensive drainage and floodplain modifications (levees and floodgates) carried out to support the dominant land uses on the floodplain (sugar cane cropping and grazing), modification of flows in the upper catchment (e.g. dams, weirs etc.) and land clearing.

Based on a water quality study by ABER (2012), the estuary has been characterised into five broad functional zones which are referenced in the discussion of physical character, ecosystem health, key threats and management actions (Figure 1). The functional zones are identified on Figure 1 and include:

- Lower estuary – from the ocean entrance to Shallow Bay, upstream of Fingal Head (and for the purpose of the CMP study, within the Terranora Inlet downstream of Barneys Point Bridge);
- Transition zone– from Shallow Bay/Tonys Island up to and including the Tweed Broadwater;
- Middle estuary – from the Tweed Broadwater to the village of Condong;
- Upper estuary – from Condong to Bray Park Weir; and

- Rous River estuary – the tidal extent of the Rous River from the confluence with the Tweed River at Tumbulgum to Numinbah Road Bridge at Boat Harbour.

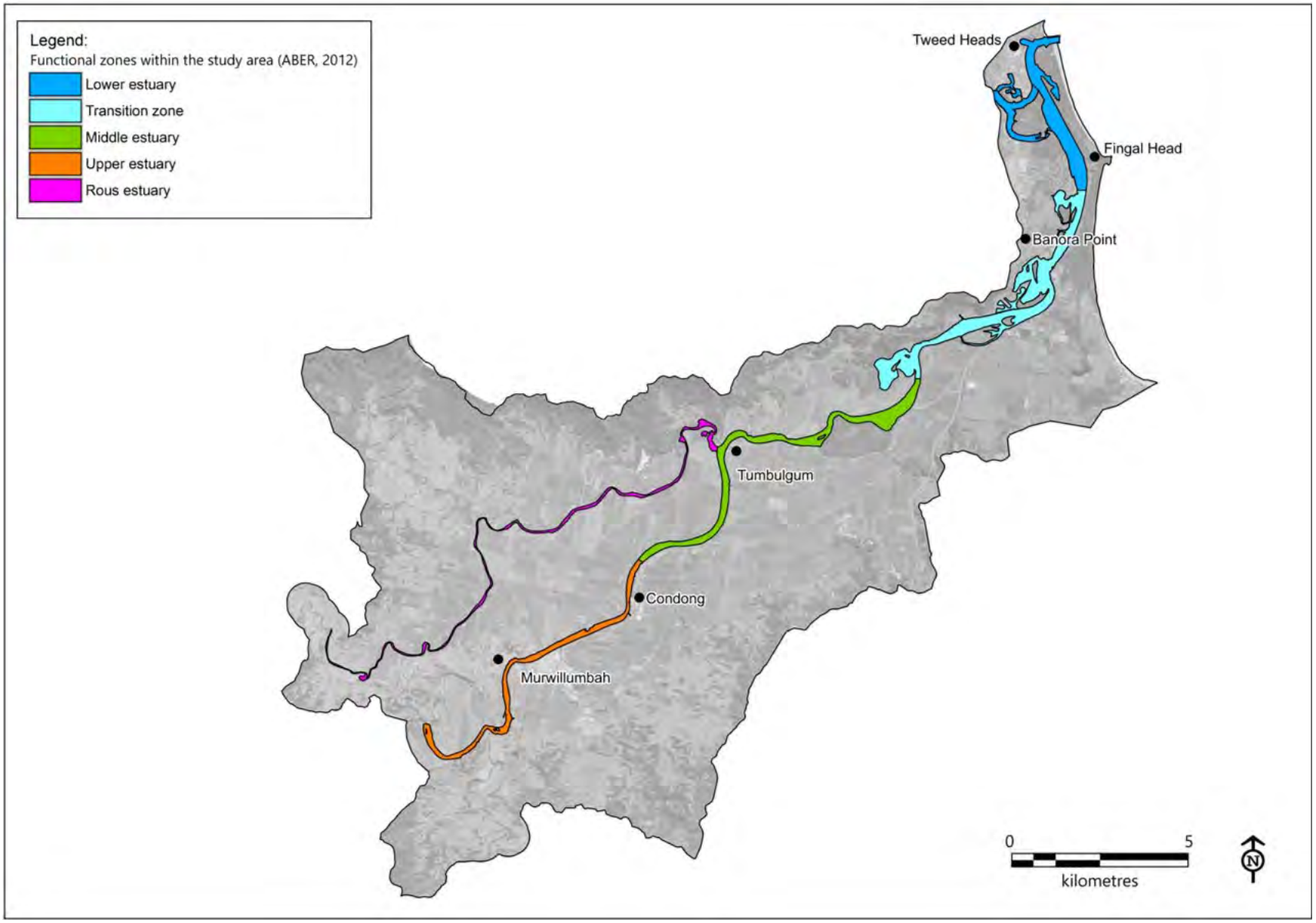

Figure 1: Tweed River functional zone boundaries within the CMP study area

The study area encompasses approximately 15.3 km^2 of environmental conservation areas protected under the *NSW National Parks and Wildlife Act 1974* (NPW Act) including Tweed Heads Historic Site, Ukerebagh Nature Reserve, Stotts Island Nature Reserve, Mooball National Park and Mount Nullum Nature Reserve. Stotts Island is considered a significant natural resource as it comprises the largest stand of lowland sub-tropical rainforest in NSW and is critical habitat for the largest remaining population of the endangered Mitchell's rainforest snail.

Riparian vegetation and terrestrial remnant vegetation in the surrounding catchment, whilst patchy and fragmented, also provides significant habitat for a range of species. Protected terrestrial vegetation communities include several littoral rainforest areas in the lower estuary (downstream of Chinderah) mapped under the CM SEPP. Important estuarine habitats include areas of seagrass and saltmarsh which are typically found downstream of Dodds Island and mangroves which occur up to Murwillumbah and within the lower Rous River. A large majority of these areas are classified as 'Key Fish Habitat' under the *Fisheries Management Act 1994* incorporated into coastal wetland areas under the CM SEPP. The estuary is inhabited by or contains habitat for a number of threatened fauna species including migratory shorebirds (e.g. Terek Sandpiper, Beach Stone Curlew and nesting Australian Pied Oystercatcher), raptors (e.g. Eastern Osprey and White-bellied Sea-Eagle), turtles (e.g. Loggerhead, Leatherback, Green, Flatback and Hawksbill Turtles) and dolphins such as resident populations of Indo-Pacific Bottlenose Dolphin.

The estuary is a recreational area of great importance to the local community as well as users from the densely populated area of south-east Queensland. Community uses of the Tweed River estuary include both commercial and recreational fishing, tourism, motorised and non-motorised water based recreational activities and shore-based activities (e.g. walking, cycling, picnics etc.). The Tweed River estuary includes recreational fishing havens and supports commercial fishing and other marine based industries.

There is a history of large-scale dredging and sand reclamation in the estuary. Present day dredging is conducted by the NSW State government for maintenance of navigational channels and by Tweed Shire Council (TSC) for small-scale ad hoc maintenance of Council facilities. All dredging campaigns are assessed and managed under stringent environmental legislation and approval conditions.

Preparation of this CMP has included consultation with community and agency stakeholders. This consultation assisted in the development of the long-term vision for the CMP:

"The Tweed River estuary is a special place:
a healthy ecosystem supporting lifestyles, culture and productivity."

The following specific local estuary values were developed around this vision and were allocated objectives which guide the development of the CMP and management actions:

- Public access to and use of the river and foreshore;
- Recreational fishing;
- Scenic quality and amenity;
- Aboriginal cultural heritage and practice;
- Natural habitats and biodiversity;
- Stable riverbanks;
- Water quality;
- Economic prosperity; and
- Agricultural productivity.

The Tweed River estuary faces numerous threats and pressures that affect the community and environmental values. Over time, many of these pressures are likely to increase due to population growth, potential land use changes, development within the catchments and the impacts of climate change. The key threats identified in this CMP are:

- Bank erosion – affects visual amenity and estuary health through impacts on water quality, estuarine vegetation and fish stocks, loss of riparian vegetation and risk to public and private property and assets/infrastructure (e.g. boat ramps/pontoons and major roads such as Tweed Valley Way and Tumbulgum Road);
- Habitat loss and barriers to habitat connectivity – primarily through land clearing and drainage, inappropriate design/construction of bank protection structures and beach nourishment works, poor water quality, human-induced damage to seagrass beds, waterway barriers (floodgate operation and fishway design) and coastal squeeze from sea level rise. These issues can limit habitat availability and impede life cycle requirements for terrestrial and aquatic species;
- Degraded estuarine water quality – in particular:
    - elevated sediment and nutrient levels from bank erosion and diffuse source agricultural runoff, wastewater treatment plant discharges and overflows, stormwater and industrial discharges;
    - acid runoff from agricultural areas;
    - turbidity impacts from dredging; and
    - salinity, temperature and dissolved oxygen changes as a result of water storage, extraction and freshwater releases.
- Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets – exacerbated through upstream catchment clearing, inappropriate cropping, inappropriate land use and development, ineffective drainage, inadequate protection works and climate change impacts (sea level rise and increased storminess). Whilst flood risk is addressed under the *Tweed Valley Floodplain Risk Management Plan* (FRMP) (BMT WBM, 2014), current tidal inundation risks in the estuary include overtopping of Bray Park Weir during certain combinations of flows and climatic events (impacting on freshwater supply) and overtopping of revetment structures, in particular in canal estates where significant Council assets are located. Emerging and future risks from tidal inundation have been mapped through this CMP and a range of actions will be implemented to progress adaptation to coastal hazards arising from climate change and sea level rise;
- Loss of or impacts to biodiversity:
    - impacts to shorebirds (waders) from habitat loss, human disturbance and interaction with feral and domestics animals;
    - raptor populations impacted by loss of large nest trees, litter, pollution and loss of foraging and food resources;
    - fish stocks impacted by water quality, fish kills, overfishing, habitat loss and migration barriers; and
    - marine mammals vulnerable to cumulative human-induced pressures and habitat degradation (e.g. reclamation, poor water quality, dredging, port, boating and fishing activities) which affect resource availability as well as habitat usage.
- Lack of access to water and foreshores for non-boat recreation, particularly a lack of sandy beaches. This has been attributed to increasing user pressure, extensive sections of rock wall protection, lack of embayments and access points for recreational purposes;

- Conflict between river users – primarily a lack of separation between compatible uses (e.g. towing versus nature appreciation/conservation and powered craft versus swimming/diving). This issue is exacerbated through a restricted number of access points, high demand at existing facilities and non-compliance with existing management and regulations.
- Reduced stocks of target fish species – affects biodiversity, recreational, commercial and cultural fishing, as well as commercial and tourism values. Contributing causes include reduced water quality causing toxicity and fish kills, overfishing habitat loss (backswamp wetlands, estuarine and riparian vegetation) and degradation of habitat (e.g. through dredging, propeller/mooring damage and eutrophication) and obstruction of fish passage as a result of flood gate design and operation, levees and fishway design.
- Restricted levels of boating infrastructure and facilities or reduced navigability – impacting on user experience and safety, affecting user demand and contributing to user conflict. Specific limitations include lack of disabled facilities, insufficient car and trailer parking, restricted mooring points, dry boat storage and locations for access and storage of sail craft and dinghies and lack of boat beaching areas (e.g. sandy beaches). There is also an expectation that dredging is undertaken to maintain the safety and navigability of the river to support existing boat users.

This CMP provides a management framework that is intended to guide coastal management and planning in the Tweed River estuary, consistent with the estuary vision and in response to the CM Act objectives and the locally derived ecosystem and community values for the estuary. The CMP recognises that the estuary has suffered impacts from past practices such as the construction of training walls, large-scale dredging and reclamation, truncation of the estuary by Bray Park Weir and extensive drainage and floodplain modifications. Future pressures on the estuary have also been recognised including urban and agricultural land use, natural influences such as flooding and climate change and the various recreational and commercial uses of the foreshores and waterways which can result in conflicting uses and management priorities.

The estuary is managed by TSC and State government agencies (primarily NSW Department of Planning and Environment – Crown Lands, hereafter DPE – Crown Lands, DPE Department of Primary Industries – Fisheries, hereafter DPI Fisheries, DPE – Environment, Energy and Science, hereafter DPE, Transport for NSW – Maritime, hereafter, TfNSW - Maritime), landholders and the community. The CMP provides an opportunity to implement a coordinated, sustainable and equitable management approach.

The CMP includes a suite of coastal planning and management actions that aim to protect and conserve estuarine and terrestrial ecosystems for the enjoyment of all stakeholders whilst optimising the value of the floodplain and waterways for existing agricultural, commercial, recreational and cultural users, to protect and enhance natural coastal processes and to improve the resilience of coastal assets. The actions have been developed and prioritised based on the assessed risk of the threats to the estuary values. The CMP actions draw on existing programs and funding, with additional priority actions to be implemented as funding becomes available. Threats to the estuary are the basis upon which management actions have been developed. Threats in the Tweed River estuary are largely consistent with those identified through the *NSW Threat and Risk Assessment* (Marine Estate Management Authority, MEMA, 2015) developed for the *NSW Marine Estate Management Strategy* (MEMS, MEMA, 2018).

Management actions consist of a combination of studies, investigations, education, consultation and communication programs and on-ground works. These were selected to address the key risks to the estuary values based on professional consideration of the legal, technical and engineering feasibility, the economic viability and the acceptability of actions to the community and stakeholders. The CMP management actions are shown on Figure 2 to Figure 7 and provided in Table 1.

A significant concentration of high priority areas for management of bank erosion, riparian revegetation and water quality are located in the Rous River estuary and the upper and middle estuary. A focus on continuing

to work with landowners in the upper and Rous River estuary to protect and rehabilitate riparian vegetation, stabilise banks and continue to improve agricultural best practices would potentially result in the greatest improvement to overall ecosystem value of the estuary.

The CMP actions are expected to be funded through Council and State government contributions, monetary grants and volunteer works by landowners and community organisations, for example on Landcare sites. It will not be possible for TSC to implement all actions identified in this CMP without additional sources of funding. As such, identification of grants and the submission of successful funding applications is an important component of this CMP. Certification of this CMP will facilitate eligibility for funding of key actions through the NSW Coastal and Estuary Grants Program which currently provides $2 for every $1 provided by Council to undertake actions (2:1 ratio). A number of other government funding sources have also been identified to assist in implementation of the CMP. In most cases it is expected that in-kind contributions (e.g. staff time) will be provided by Council and therefore the delivery of recommended actions may be influenced by the availability of this funding as well as human resources. Each action has been assigned a priority according to importance and urgency for implementation.

A Business Plan (Table 2) specifies each action and includes an outline of costs, timing and alignment with Council's Delivery Program under the NSW Integrated Planning and Reporting (IP&R) Framework and potential funding sources. Council responsibilities listed here will be used to inform the ongoing review of Council's Delivery Program and Operational Plan, which are set on four and one-year cycles, respectively. Staff costs and existing program expenditure (e.g. waterways management program, sustainable agriculture program, water supply and waste management budgets) are not included in the Business Plan. Estimated costs of on-ground works are to be confirmed through additional investigations and/or detailed design as required. Delivery of the Tweed River Estuary CMP is estimated to cost $26,215,000 over ten years.

Other government agency management programs and community organisations and initiatives also contribute to achievement of the CMP objectives including:

- The Tweed Coast and Waterways Committee (TCWC);
- The Tweed Byron Local Aboriginal Land Council (TBLALC);
- The Tweed Aboriginal Advisory Committee (AAC);
- Tweed Landcare;
- BirdLife Northern Rivers;
- Dolphin Research Australia Inc.;
- The Tweed Cane Growers Association;
- North Coast Local Land Services extension officer and related projects;
- DPI regulation of NSW Fisheries;
- NSW Food Authority oyster monitoring and management program;
- DPI Key Fish Habitat Protection programs;
- Transport for NSW - Maritime (TFNSW - Maritime) Coastal Dredging Strategy and Boating Access Dredging Grants Program;
- TfNSW – Maritime Boating Now Program;
- 2018-2028 *Marine Estate Management Strategy* (MEMA, 2018);
- The NSW Environment Protection Authority (EPA); and
- National Parks and Wildlife Service (NPWS) management of National Parks and Nature Reserves.

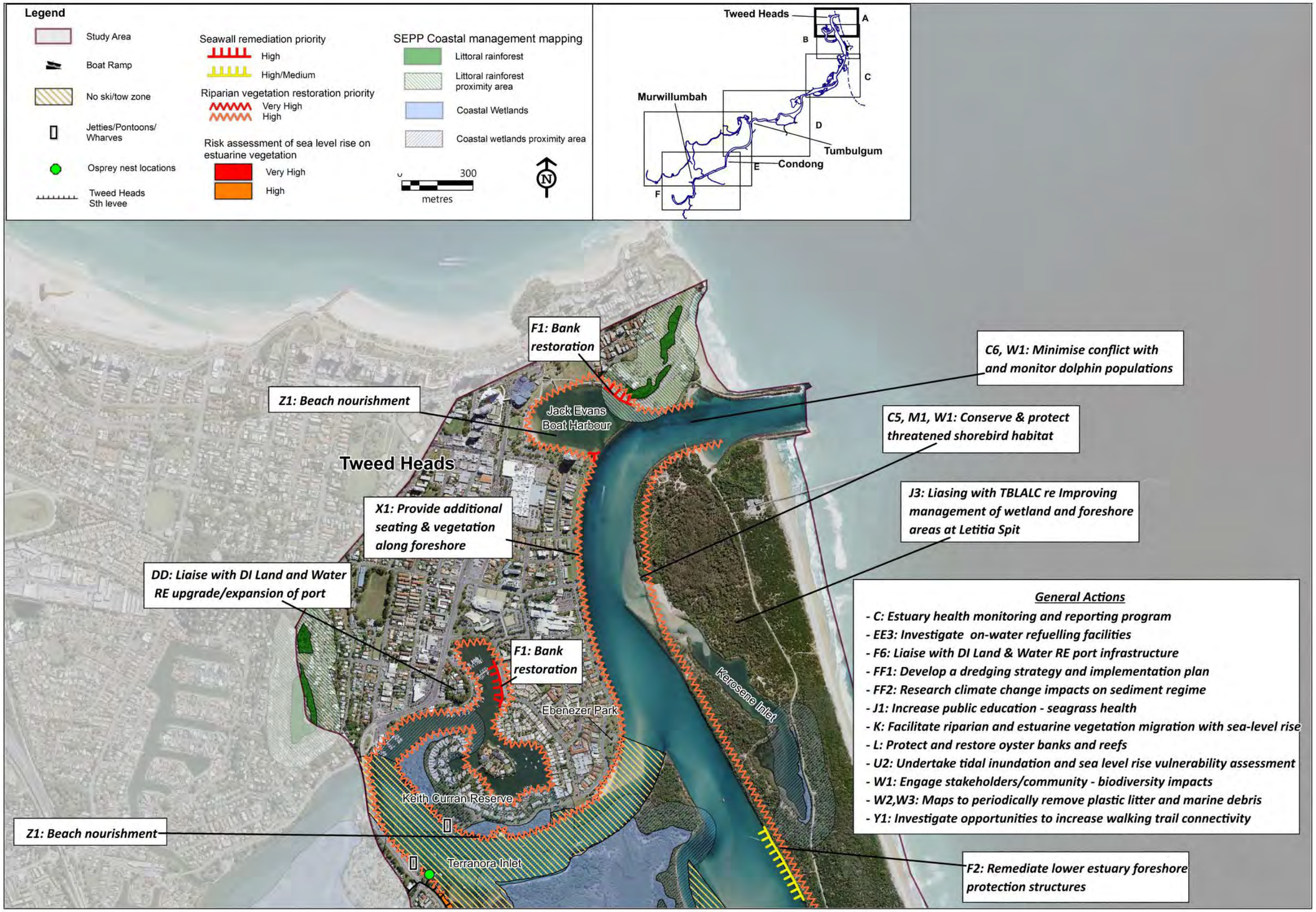

Figure 2: Tweed River estuary CMP on-ground actions – lower estuary - entrance reach, Terranora Inlet and Southern Boat Harbour

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

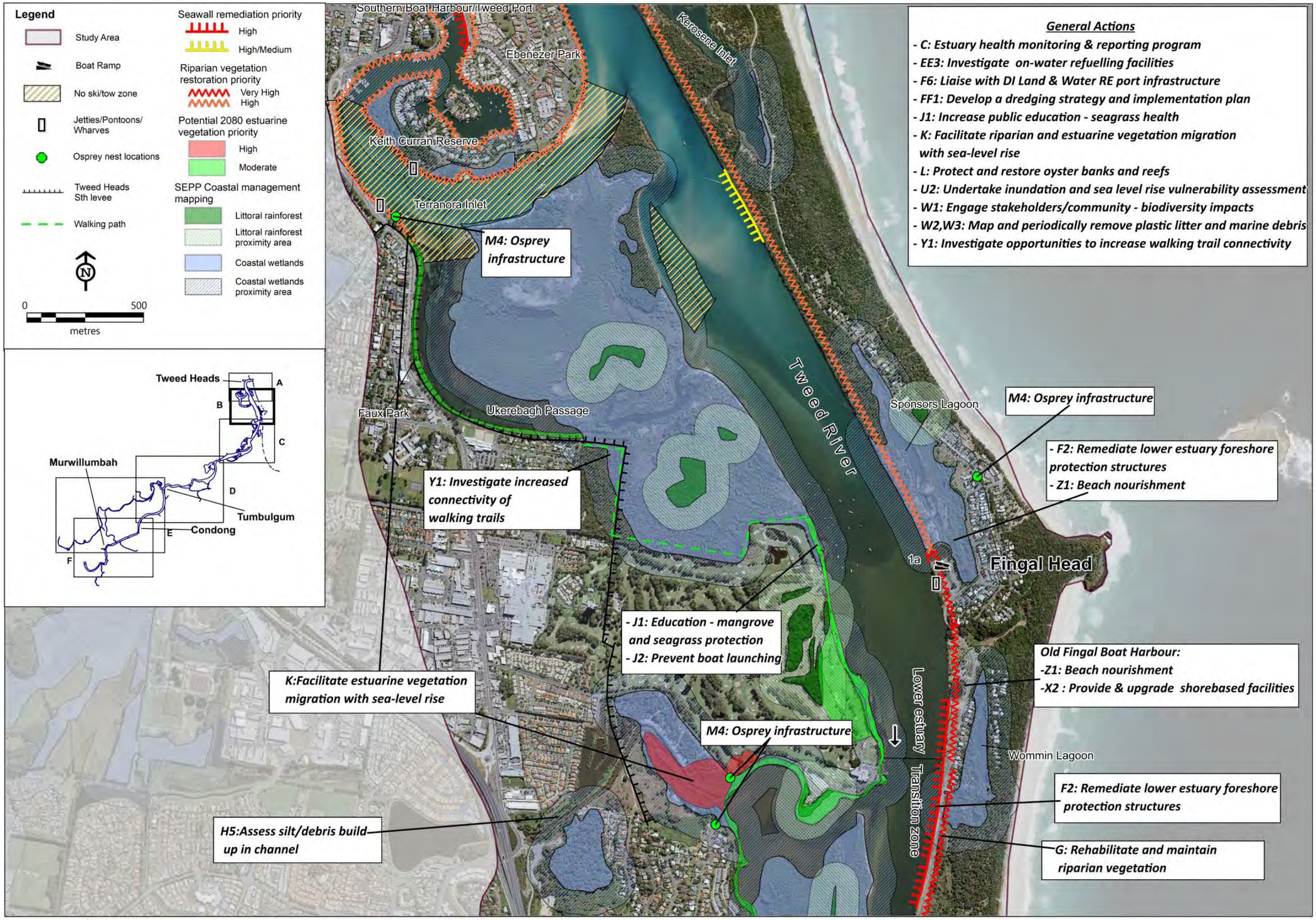

Figure 3: Tweed River estuary CMP on-ground actions – lower estuary – Ukerebagh Island to Fingal Head

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

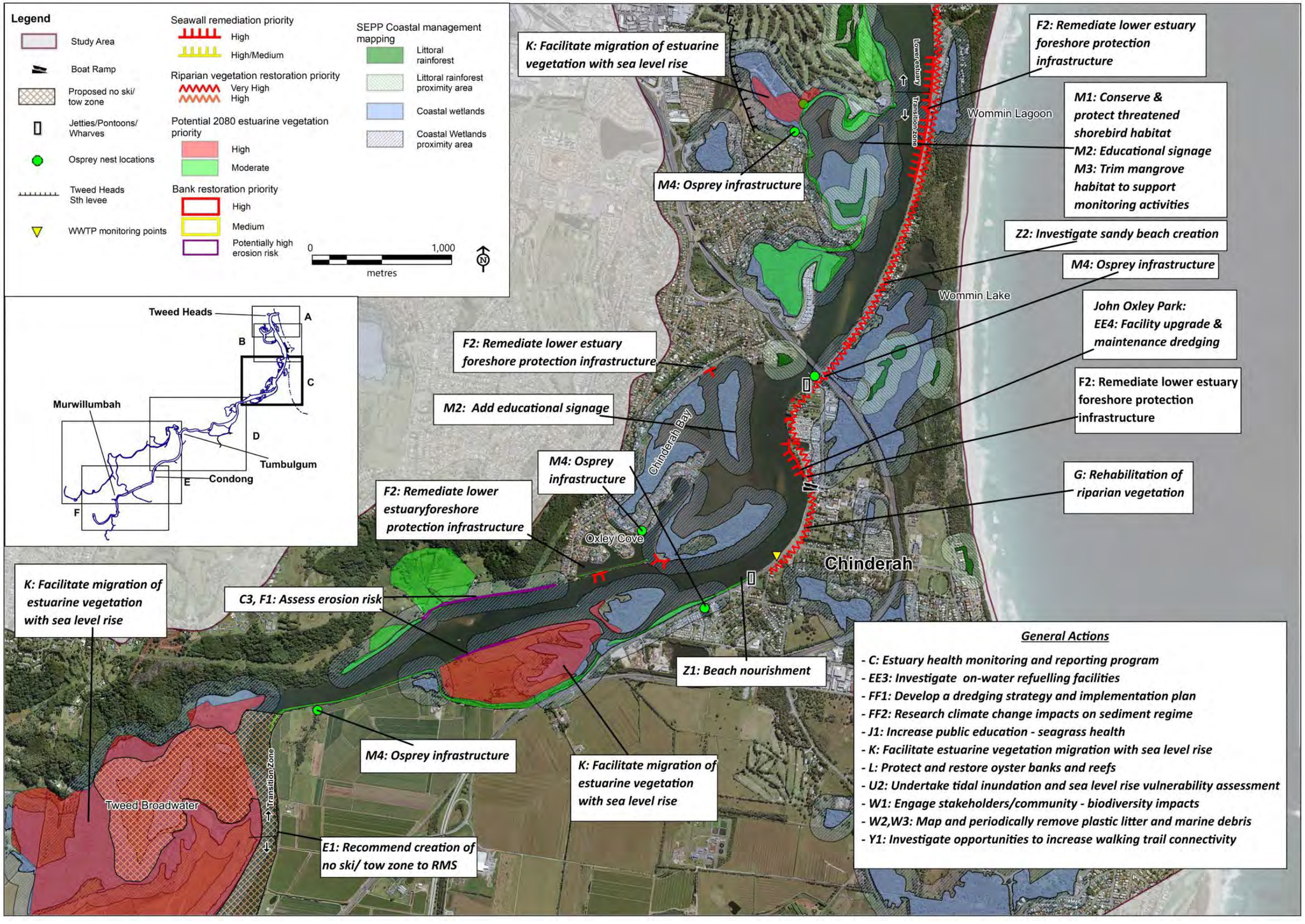

Figure 4: Tweed River estuary CMP on-ground actions – transition zone

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

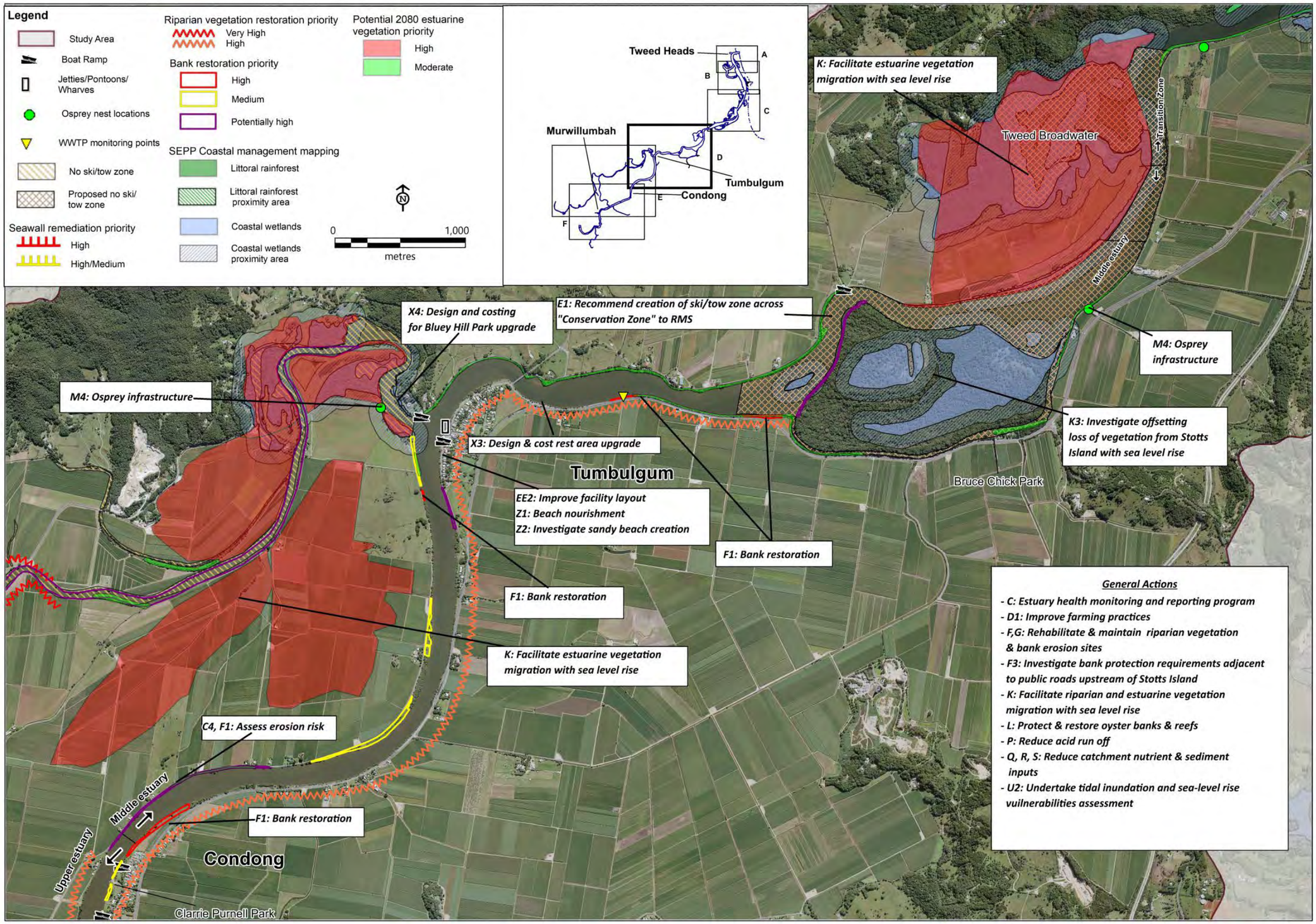

Figure 5: Tweed River estuary CMP on-ground actions – middle estuary

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

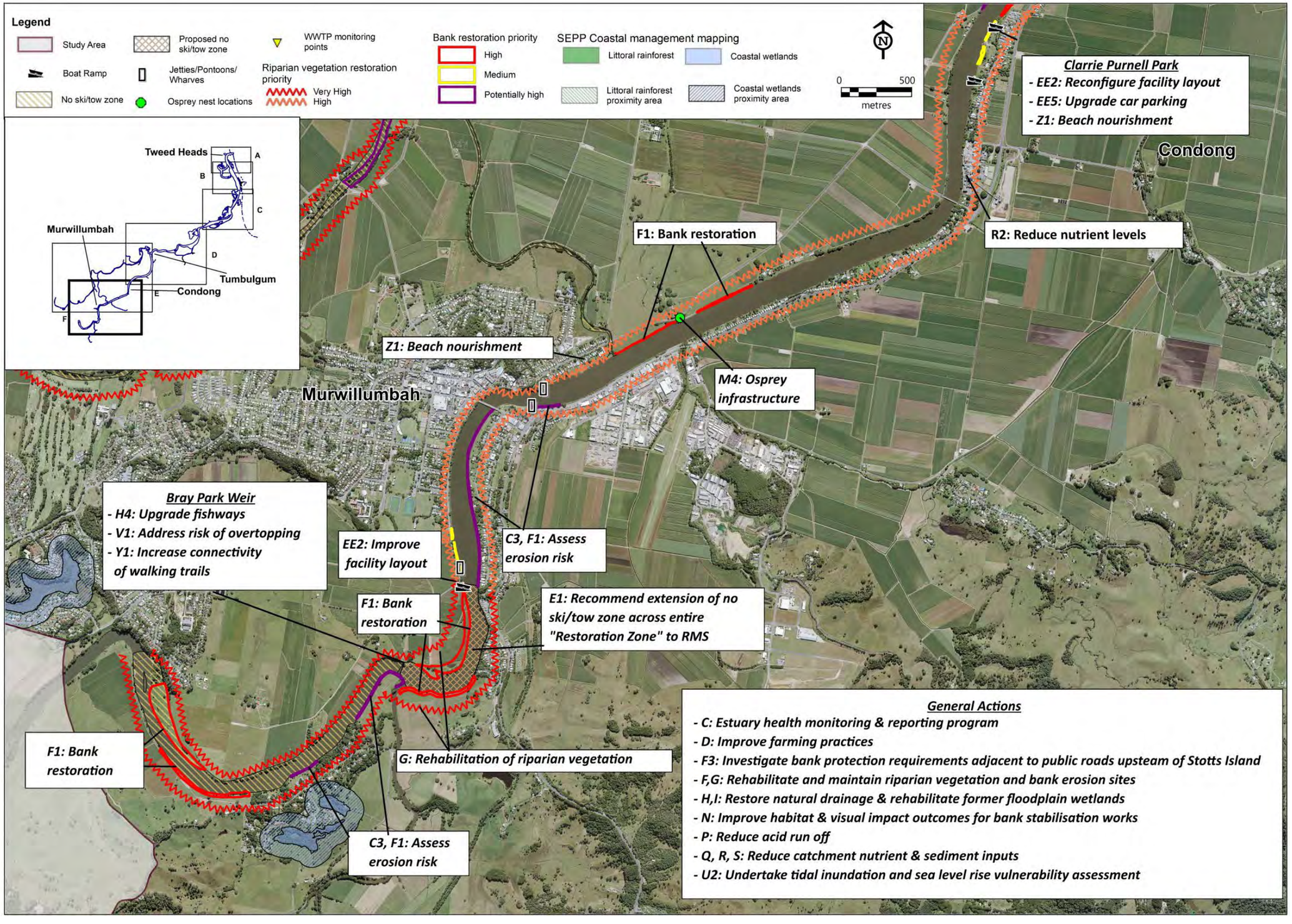

Figure 6: Tweed River estuary CMP on-ground actions – upper estuary

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

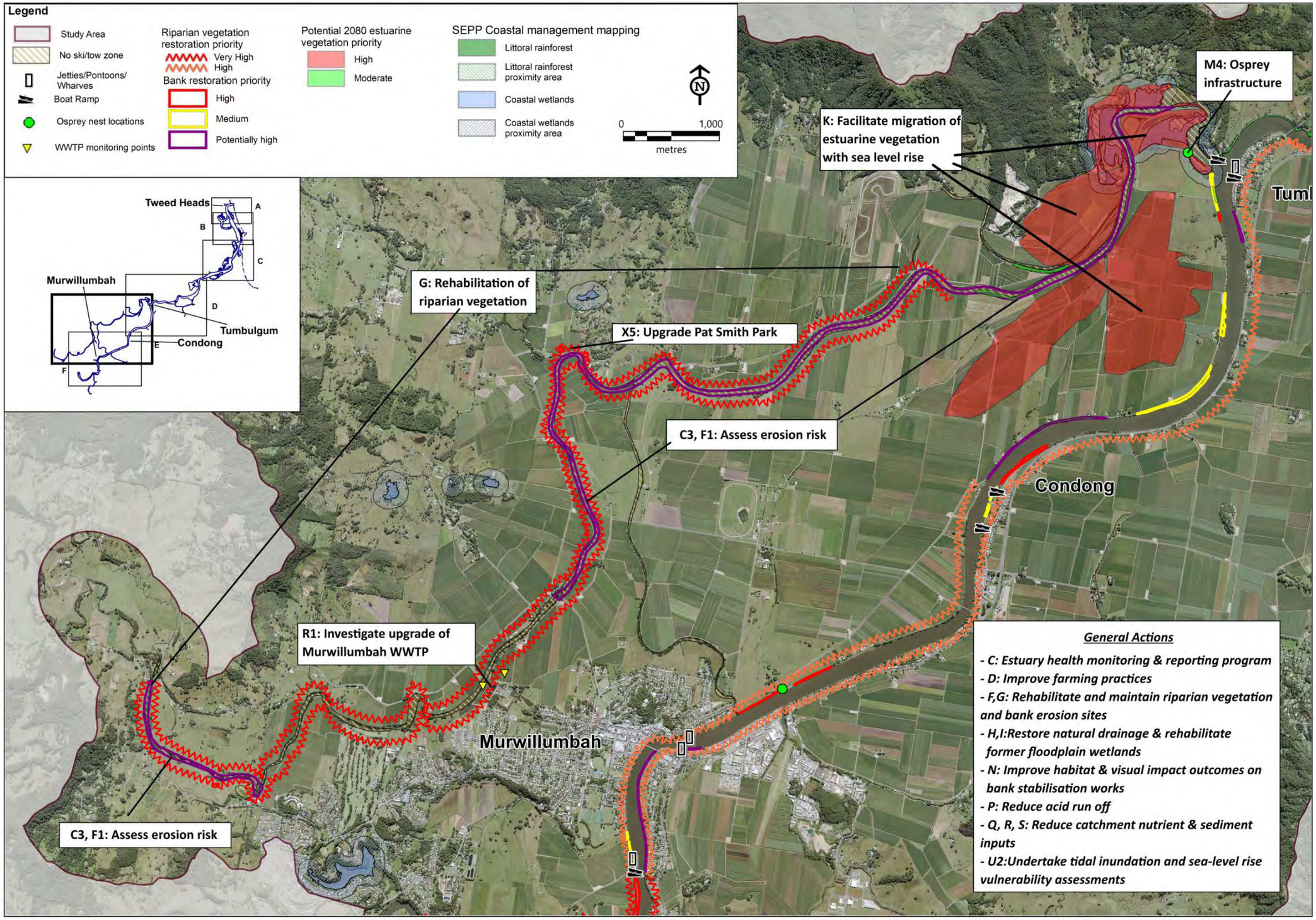

Figure 7: Tweed River estuary CMP on-ground actions – Rous River estuary

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

Table 1: Action Plan – CMP management actions

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
Fundamental Management Actions					
A	**Governance and administration**		The implementation of priority actions in this CMP will require continued collaboration between TSC, relevant State Government Agencies, Industry and affiliated community stakeholder groups. The TCWC meets every two months and brings these parties together to provide advice to Council on the management of the estuary.		
A1	F	Administration of the CMP through TSC Waterways Management Program overseen by TCWC.	Council will provide governance and administration services so that the CMP can be implemented effectively and efficiently, through both the TSC Waterways Management Program and through the ongoing resourcing and operation of the TCWC. The committee should continue integrated decision making between Council, community and state government agencies, such that all planning activities, contribute to the overall objectives of this CMP. The committee should promote open information exchange between all decision-making agencies, actively seek opportunities for improvement and continue to consider a balanced approach to management of the estuary. Key responsibilities of the TCWC include the review of CMP progress (yearly at a minimum) as detailed in Section 5. An external mid-term review of CMP progress to be undertaken at commencement of DP 2026-2029.	TSC, TCWC	Ongoing, mid-term review DP 2026-2029
A2	F	Support implementation of programs and strategies complimentary to the CMP.	Existing related strategies and management programs are listed in Sections 3.4 (TSC managed) and 3.4.2 (agency managed). TSC should ensure continuing implementation and support of existing strategies and programs where these are consistent with the aims of this CMP. In particular Council should adopt, implement or consider the following to inform decision making during Council's land use planning and assessment process: • *Tweed River Domestic Structures Strategy* (DoL *et al*., 2008); • Any bank management strategy(ies) developed for the estuary under Marine Estate Management (MEM) Strategy Action 2.3.3; and • *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* (OEH, 2017).	TSC	Ongoing
A3	H	Ensure future Crown land Plans of Management (PoM) are consistent with the CMP.	Several PoM are currently used for management of Crown land within the study area including for Stotts Island Nature Reserve (NPWS, 2001), the Tweed Heads Historic Site and Ukerebagh Nature Reserve (NPWS, 1999) and for the Tweed Coast Regional Crown Reserve. Under the *Crown Land Management Act 2016*, which commenced 1 July 2018, Council will also need to categorise and prepare PoM under the *Local Government Act 1993*, for Crown reserves for which Council is the Crown land manager. Amendments to existing PoM and any new PoM within the study area will need to be consistent with this CMP.	TSC NPWS, DPE – Crown Lands	Ongoing
A4	H	Periodic review of Coastal Management Areas (CMAs) to ensure accuracy and relevance.	During the lifecycle of the CMP, review the extent and efficacy of the Coastal Management Areas in view of the findings of the tidal inundation mapping and risk assessment (refer Action U), amendments to DPI mapping of marine vegetation and amendments made by DPE. This includes consideration of the: • Extension of the Coastal Environment Area to encompass the Coastal Wetlands Area; • Sufficiency of the Coastal Environment Area given the influence of the broader floodplain on estuary health and coastal values and the importance of appropriate zoning throughout whole hydrological units for effectively managing threats and risks to hydrology and inundation across coastal floodplains (DPI, 2019); and • Investigate why the lower end of McLeods Creek (a highly modified floodplain channel) is mapped as Coastal Environment Area CMA, when no other floodplain channels are included in the mapping. Linked to Action U5 re consideration of including a Coastal Vulnerability Area (tidal inundation) into the CM SEPP.	TSC DPE	Opportunistic
B	**Stakeholder and community engagement**				
B1	F	Develop and implement a Stakeholder Engagement Strategy.	Development and implementation of a Stakeholder Engagement Strategy to guide education, engagement and consultation activities and to coordinate relevant educational/engagement sub-actions in this CMP. Ongoing stakeholder and community involvement will be required to ensure successful implementation of the CMP and the overall satisfaction of stakeholders. This will include: • Ongoing consultation with interested and committed community groups, typically represented through the TCWC; • A high degree of engagement and collaboration with landholders; • On-ground participation in management actions, particularly local community groups such as Landcare and fishing groups; • Consultation and collaboration with local Aboriginal representatives and groups through the TBLALC and the AAC; and • Education programs. Achievement of the CMP objectives is reliant on stakeholder and community understanding and effective involvement in the management process. The strategy would be developed to ensure alignment with existing engagement activities such as TSC's environmental, cultural and sustainable agriculture programs.	TSC, TCWC	Ongoing
B2	F	Co-ordination and consultation with local Aboriginal community and NPWS.	Involve representatives of the Aboriginal community in the implementation of the CMP to ensure their values are prioritised appropriately. Feedback during the consultation process identified that the Aboriginal people are avid users of the estuary and the Aboriginal community wants to have a voice in rehabilitation projects, take ownership of actions and be involved in implementation of the CMP including on-ground actions.	TSC, AAC TBLALC	Ongoing
B3	F	Raise awareness of Aboriginal cultural heritage significance of the Tweed River estuary.	Work with representatives of the Aboriginal community and DPE(NPWS) to raise awareness of the Aboriginal cultural heritage significance of the Tweed Shire including history, values and cultural practices associated with the estuary, both historic and ongoing. Education and engagement activities should be cognisant with the Aboriginal people being "keepers" of their cultural heritage. TSC should provide educational material such as signage and interpretative boards at Aboriginal sites where appropriate. TBLALC has suggested the roll-out of school-based education campaigns such as that currently undertaken by TBLALC at Fingal Head Public School.	TSC, AAC TBLALC	Ongoing

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
B4	M	Provide additional nature-based educational opportunities including signage and information.	Recommended locations include: • The proposed Ukerebagh Passage Conservation Zone; • The proposed Stotts Island Conservation Zone (e.g. at Bruce Chick Park); • Bluey Hill Park, Tumbulgum (in conjunction with Action X4); • Pat Smith Park and off Rous River Way, Murwillumbah, Rous River estuary (in conjunction with Action X5); • Commercial Road Boat Ramp; and • Condong Boat Ramp. Additional education and engagement activities for specific key threats to the estuary are detailed under actions for the relevant threat below.	TSC DPE	Ongoing
C	**Estuary health monitoring and reporting program**				
C1	F	Annual estuary health report card.	Continue the production and annual release of an easy to understand, estuary health report card. The estuary health report card focuses on reporting the results of the Estuary Health Monitoring and Reporting Program (Action C2) and is also to incorporate results of other estuary health monitoring as it becomes available such as the riparian vegetation and bank condition monitoring (Action C3), monitoring of oyster banks and reefs (Action C4), avifauna monitoring (Action C5) and monitoring of other higher order predators such as dolphins and osprey (Action C6). The monitoring program and report card would be used to: • Track how well the estuary is being managed over time, • Inform the community of the current health of the estuaries; and • Provide TSC with an understanding of whether management approaches need to change.	TSC DPE	Ongoing – annual reporting
C2	F	Estuary Health Monitoring and Reporting Program.	Currently, estuary health is monitored through a series of disconnected monitoring programs at a variety of timescales and is rarely reported in a holistic and easily comprehensible manner. Feedback from the community and stakeholder consultation process indicated a desire for ongoing monitoring and an easy-to-read annual report card for the Tweed estuary (primarily on water quality). Continue routine and event-based water quality sampling at key sites within the Tweed River catchment. Report results to the community through an annual estuary health report card (see Action C1). Conduct comprehensive technical review of water quality data every five years to assess longer term trends, identify likely controlling process and any major changes in water quality over time including changes associated with implementation of the CMP. The last technical review was carried out in 2017 (Hydrosphere Consulting, 2018), therefore future technical reviews are recommended in 2022 and 2027.	TSC DPE	Ongoing
C3	F	Riparian vegetation and bank condition monitoring.	Undertake detailed riparian vegetation and bank condition monitoring and reporting for the whole estuary every five years and additionally following major flooding events. The assessment should build upon monitoring work carried out as part of this CMP (refer Hydrosphere Consulting, 2020) and be expanded to encompass the whole estuary including the Rous River estuary, natural banks in the lower estuary (e.g. Ukerebagh Island and areas of Chinderah foreshore) as well as bank erosion on private land. Whilst Council is not responsible for funding or initiating works to remediate bank erosion on private land, such erosion still has the ability to impact on the health of the estuary and Council plays a role in the approvals process for bank stabilisation works. The expanded assessment should include revegetation sites completed as part of this CMP and potential opportunities for future rehabilitation (i.e. Action F1). Results should be used to inform the Estuary Health Monitoring and Reporting Program (Action C2), reported in relevant estuary health report cards (Action C1) (when timing coincides with this reporting) and assist in interpretation of water quality data during technical data review (Action C2).	TSC DPE	Every 3 years
C4	H	Monitor oyster banks and reefs.	Establish a mapping and reporting program for restored oyster banks and reefs. Monitoring and evaluation of oyster recruitment and fish assemblages at proposed restoration sites is required to assess the success of restoration projects in terms of provision of additional fish habitat. Results of the monitoring should be reported in the relevant annual estuary health report card (Action C1) and used to inform the Estuary Health Monitoring Program (Action C2). Subject to Action L3. Also linked to Action L2. Note that implementation of this action is dependent on DPI Fisheries successfully accessing external funding.	DPI Fisheries TSC, DPE	Every 5 years
C5	H	Support monitoring of avifauna by volunteer groups.	TSC should continue to support existing monitoring and reporting activities undertaken by volunteer groups through in-kind support and through acknowledgement of these volunteer groups in any media reporting on the monitoring undertaken. Results of the monitoring should be reported in the annual estuary health report card (Action C1) and used to inform the Estuary Health Monitoring Program (Action C2).	TSC	Ongoing
C6	H	Support monitoring of other higher order predators.	TSC should provide in-kind support for any continuing dolphin monitoring program (e.g. by Dolphins Research Australia Inc. and Tweed Osprey Monitoring Group) for promotion etc. for example, via media announcements/web page information. Results of the monitoring should be reported in the annual estuary health report card (Action C1) and used to inform the Estuary Health Monitoring Program (Action C2).	TSC	Ongoing
C7	H	Increase training and resourcing for compliance monitoring staff.	Increase training and resourcing for compliance monitoring staff with a particular focus on collecting evidence of water pollution and vegetation clearing. The community expects Council to respond effectively to incidents of environmental pollution, acknowledging that compliance work has a high demand on resources and requires significant levels of staff expertise. It is recommended that Council allocate additional resources to the issue.	TSC	Ongoing

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
Threat 1 - Bank Erosion					
D	**Increased adoption of best management practices to mitigate pollution of surface and groundwater and enhance biodiversity**				
D1	H	Landholder communication and liaison.	Work with landholders to increase awareness of the impacts of both soil and riverbank erosion and to increase uptake of mitigation measures, including greater landholder adoption of best management practice, particularly in regard to water quality. Such measures may include: • Catchment revegetation to reduce flood peaks; • Soil conservation practices (phosphorus is strongly associated with sediment transport); • Maintaining vegetative cover; • Optimising dung beetle management in pastures; • Minimising excess fertiliser use; • Establishing and maintaining vegetation in riparian zones including suitable vegetation types/methods; • Retention of old and dead trees on farmland, riverbanks and riparian zones for provision of essential habitat for birds and small mammals; • Employing erosion and sediment controls where vegetative cover cannot be maintained; • Stormwater treatment; and • Management of agricultural land and drains to minimise low dissolved oxygen (DO) floodwaters developing and reaching the estuary, particularly in the middle estuary and Rous River estuary.	TSC Landcare, LLS	Ongoing
E	**Promotion of the diversity of river uses**				
E1	H	Liaison with TfNSW – Maritime regarding *Tweed River Recreational Use Strategy and character zones.*	Recommend to TfNSW - Maritime that the following measures be considered in any future revision of boating management measures applied to the Tweed River estuary: • Create a no-tow zone within the "Conservation Zone" (Stotts Island) to prevent wake damaging sensitive environmental habitat, whilst increasing the areas suitability for tranquil and passive recreational uses; and • Extending the no ski/tow zone within the "Restoration Zone" (Bray Park Weir to Commercial Road Boat Ramp) to reduce the risk of further wake induced bank erosion and increase the likelihood of existing erosion being able to be stabilised with bioengineered works, whilst increasing the areas suitability for tranquil and passive recreational uses. The assignment of character zones (Section 3.3.2) and associated waterway usage restrictions would assist in the management of bank erosion, user conflicts, limited waterway and foreshore access and infrastructure restrictions, whilst also promoting the continuation of active and passive recreational use, commercial use and environmental restoration/conservation. To be successful, this approach needs to be supported by regulatory controls, signage, monitoring and enforcement and these measures would all depend upon TfNSW - Maritime supporting the towing restrictions advocated by Council in the Recreational Use Strategy and this CMP. In addition, the provision of sufficient infrastructure to cater for the needs of the recreational uses planned for each zone (refer Actions X to FF) must be considered. In particular, significant bank protection works (and associated maintenance requirements) will be required where wake generating boat use would be consolidated and banks subjected to repeated exposure to high energy, i.e. in the recommended Active Use Zone from Stotts Island to Commercial Road Boat Ramp, Murwillumbah. It is noted that for a large part of this zone, riverbank stabilisation works will be required to address existing severe bank erosion and protect roads, regardless of the ongoing presence of wake generating boating activities. The aims of each character/usage zone should be promoted through education in order to support compatible recreational use and environmental conservation in keeping with the long-term vision for the estuary.	TSC	DP 2023-2025
E2	H	Public promotion of *Tweed River Recreational Use Strategy*.	Promote and provide educational materials to encourage safe and sustainable boating and minimising wash.	TSC	DP 2023-2025 signage. Ongoing promotion
E3	H	Motorised Water Recreation Business Policy.	Develop a policy on Motorised Water Recreation Businesses and amend the Tweed LEP 2014 via addition of a clause, to allow for definition and assessment of Motorised Water Recreation Businesses, consistent with the environmental values and objectives of the Tweed River Estuary CMP. Such a policy would include non-commercial organised events including multiple participants using motorised vessels. In order to ensure that commercial vessel use of the river complies with the objectives of the CMP, Council needs to develop a guiding policy to confirm the threshold point at which commercial use will be classified as development and will require assessment. It is also considered that the impacts of certain high impact water sports are contrary to the objectives and intent of the Tweed Estuary CMP and as such activities that generate such impacts will be assessed through the development of objectives and assessment criteria, in an LEP clause. High impact water sports would be classified as those involving high levels of noise, wake, speed, risk or pollution.	TSC TfNSW - Maritime	DP 2023-2025

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
F	**Rehabilitate and maintain priority bank erosion sites**				
F1	F	Bank stabilisation works at high priority sites on public land including riparian vegetation rehabilitation.	High and moderate priority areas for bank rehabilitation, as identified in investigations undertaken for this CMP, are specified in Appendix C. Specific actions to address bank erosion are listed below. Related actions include Action D, Action G and Action Z1. Progressively carryout bank stabilisation works in accordance with prioritised sites identified in Appendix C. Works should be undertaken through a staged approach targeting grant funding programs as they become available. Works would be undertaken by TSC's Waterways Program focussing on sites that have environmental outcomes as a priority and by TSC's Roads Program, focussing on the protection of roads (and incorporating revegetation/habitat best practice where feasible). Cost estimates have been based on the estimates provided in the *Tweed Riverbank Erosion Management Plan* (TSC, 2014). Note that the sites prioritised for bank stabilisation in M2 do not generally include a detailed assessment of erosion affecting the Tweed Valley Way and Tumbulgum Road (exceptions include sites N1 and N2). See action F3. Alternatives to rock walls should be considered, taking into account benefit cost (including life cycle costs), project risks and funding availability. Design of bioengineering and structural works should include: • An allowance for sea level rise (e.g. the ability to add to the height of the rock fillets and revetments in the future); • Consideration of public foreshore access, use and aesthetic impact; • Consideration of the design principles specified in the guidelines for Environmentally Friendly Seawalls (DECC, 2009) and in the *Tweed Riverbank Erosion Management Plan* 2014 to maximise habitat diversity, complexity and surface area in the structure; • Consider the incorporation of instream vegetation structure for fish habitat; and • Allow for the establishment and maintenance of compensatory riparian habitat (e.g. revegetation/bioengineering designs) where full height structural works are required on either public or private land.	TSC DPE, DPI Fisheries	Ongoing
F2	H	Detailed design and restoration of lower estuary foreshore protection structures on Council managed land.	Undertake engineering investigations, design, cost estimation and carry out restoration for high and high-medium lower estuary foreshore protection structures on Council managed land (2.3 km) as identified in Appendix C when funding is available. Liaise with DPE - Crown Lands, TfNSW - Maritime and TBLALC as required where sites are wholly or partially outside of TSC managed land. Refer to details of Action F1 regarding consideration of alternatives to rock walls and the requirements for design of bioengineering and structural works. Consultation with DPE – Crown Lands should be undertaken in any instance of structures being located on Crown land (including submerged Crown Lands) to confirm management arrangements and any authorisations required.	TSC DPE - Crown Lands, TfNSW – Maritime, TBLALC	DP 2023-2025
F3	H	Detailed design and restoration of riverbank erosion adjacent to the Tweed Valley Way and Tumbulgum Road.	Undertake a detailed investigation of existing and predicted riverbank erosion sites adjacent to the Tweed Valley Way and Tumbulgum Road between Stott's Island and Murwillumbah (11.6 km). Prepare detailed designs, costs, priorities and timeframes for implementation of a ten-year program of works that will stabilise erosion, protect roads and enhance aquatic ecosystem service provision. Council will use the information generated to plan for investment in erosion stabilisation, particularly as it relates to road protection and to prepare and justify large scale grant applications for the implementation of future Tweed Riverbank stabilisation works. It is likely that engineered rock erosion stabilisation works will be required in a significant proportion of this reach, however Council and the community hold strong concerns about the cumulative impact of traditional rock revetment on the river environment, due to the already extensive scale of erosion present. Due to the close proximity of roads in this reach, a "no action" or "revegetation" approach to bank stabilisation will be impractical. Council's aim is to implement riverbank erosion stabilisation works that will protect road infrastructure while reducing the water quality and sedimentation impacts of erosion and optimise visual and ecological outcomes in the Tweed River Estuary. The study area will comprise both banks of the river from the upstream point of Stott's Island to the bridge in Murwillumbah.	TSC DPE, DPI Fisheries, DPE – Crown Lands	DP 2023-2025
F4	M	Monitor bank stabilisation works and improve/refine methods.	Carry out monitoring of erosion stabilisation techniques employed to increase the resilience of vulnerable riverbanks and update design advice for bank stabilisation works as required.	TSC DPE, DPI Fisheries	Ongoing
F5	H	Support MEMA reforms of development application process for bank stabilisation works.	Support MEMA reforms of development application process for best practice riverbank erosion stabilisation.	TSC	Ongoing
F6	L	Port infrastructure liaison with TfNSW - Maritime.	Continued liaison with TfNSW – Maritime on matters concerning port infrastructure including the condition of the lower estuary protective infrastructure (as identified in this CMP and from any ongoing monitoring). Bioengineered designs incorporating vegetation plantings and aquatic habitat should be incorporated into any future rock wall remediation works, where feasible.	TSC TfNSW - Maritime	

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
G	**Rehabilitate and maintain riparian vegetation**				
G1	H	Rous River Estuary Riparian Zone Management Plan.	Very high and high priority areas for riparian restoration works are identified in Appendix C. Specific actions are listed below. Related actions include Action D and Action F. Develop and implement a Riparian Zone Management Plan for the Rous River estuary to compliment the potential restoration sites identified in the *Tweed Riverbank Erosion Management Plan* (TSC, 2014). The Plan should include: • Identification of hotspots; • Identification of opportunities to revegetate; • The identification of stock access prevention, bank stabilisation, revegetation and riparian weed management techniques appropriate for the estuary and hotspots; • Consideration of shade and off-stream stock watering requirements where fencing is recommended to prevent stock access to the waterways; • Working with the cane industry, farmers and riparian landowners to identify potential bank stabilisation and revegetation projects; • Identify potential sources of funding for riparian rehabilitation projects including focused promotion and prioritisation of the Rous River estuary; • The promotion and implementation of bank stabilisation and revegetation projects; and Council should lead by example and ensure that all of its own infrastructure protection projects demonstrate BMP by minimising rock where practical and incorporating vegetation and fish habitat features.	TSC DPE, DPI Fisheries	DP 2023-2025
G2	H	Improve development application process to facilitate riparian rehabilitation projects on private land.	Ensure consistency in the application of rehabilitation planning in the development assessment and approvals process, including the use of conditions to require development impacts to be offset as directed by the Biodiversity DCP (TSC, 2017b). To facilitate and encourage private landholders to carry out riparian revegetation and rehabilitation projects on private land.	TSC	Ongoing
Threat 2 - Habitat loss and barriers to habitat connectivity					
H	**Restore natural drainage and reinstate tidal exchange**				
H1	M	Manage barriers to fish passage.	• Audit floodgate management practices (Council managed), status of floodgates and location of fish gates. • Identify priority fish passage barriers for removal/modification following on from previous work by DPI Fisheries, i.e. additional floodgates for upgrading and installation of fish gates. Work in conjunction with TSC's flood and sustainable agriculture programs, Floodgate Management Groups, DPI, Drainage Unions and landholders. • Review TSC's *Floodgate Management Protocol* and the floodgate management plans and agreements for management of modified floodgates both with and without volunteer operators. • Consider future tidal inundation.	TSC DPI Fisheries	DP 2023-2025
H2	M	Cost-benefit analysis and feasibility study(ies) of alternative floodplain land use options.	Undertake a cost-benefit analysis (CBA) and feasibility study(s) of alternative floodplain land use options to support decision making for land holders of low-lying agricultural land that, under current management practices, may become unviable in the face of rising sea levels and more frequent tidal inundation, i.e. identify: • Costs to protect agricultural land and the value of drained and flood protected landscapes for agricultural production; • Potential fisheries value from restoration of natural drainage, reinstatement of tidal exchange and rehabilitation of former wetland and backswamp areas in marginal/ low lying agricultural lands on the floodplain which would otherwise require increased protection against inundation events; • Potential for carbon storage in restored wetlands and backswamps as a future revenue source; and • Value of ecosystem services provided by accommodating landward retreat of estuarine vegetation communities. This action supports the ongoing and high value existing agricultural production on the floodplain where feasible and considers that other uses may be more viable in some locations in the future. A particular focus will be on identifying economically viable and socially acceptable strategies for implementation. The assessment should include broad consideration a range of factors including, but not limited to: • Land ownership scenarios; • Potential carbon sequestration benefits; • Potential impacts on farm viability and cash flow; and • Potential funding streams for farmers to undertake hydrological works, e.g. market-based approaches, public-private investment strategies and collective arrangements that promote cooperative action, financial incentives (e.g. grants, price signals and trading mechanisms, which are of particular importance where hydrological works are required to alter drainage patterns), non-financial measures (e.g. Government extension services) and regulatory frameworks (DEWHA, 2009).	TSC DPE, DPI Fisheries	DP 2026-2029
H3	H	Upgrade Bray Park Weir fishways.	Undertake upgrades to the existing fishways at Bray Park Weir to ensure adequate fish passage upstream and downstream of the weir under all conditions. Fishway design will be carried out as part of any Bray Park Weir upgrade works or funded as part of other projects (e.g. Clarrie Hall Dam upgrade). Include consideration of Clarrie Hall Dam raising and environmental flow requirements. Also linked to Action V.	TSC DPI Fisheries	DP 2023-2025

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
H4	L	Floodgate management investigation.	Assess which creeks and drains experience a build-up of silt and debris downstream of floodgates and investigate the management responsibilities for drain sections between the river and the first flood gate, streamlining of approval requirements and identifying opportunities for remediating these areas. The *Condong Creek Drainage Management Plan* has been developed to optimise flow in this system. Whilst most other creeks and drains draining to the estuary have floodgates only 50 to 80 m upstream of the confluence with the main rivers and management of these areas is undertaken by Council at an operational level, there are several creeks where the floodgates are located well upstream of the confluence that may require more formalised management arrangements (e.g. Dulguigan Creek and the outlet channel between Lake Kimberley and Shallow Bay). DPE - Crown Lands role would be focused on the investigation of management responsibilities (as opposed to on-ground assessments).	TSC Drainage Unions, DPE - Crown Lands, DPI Fisheries	DP2022-2025
H5	H	Support MEMA drainage management plan for the Tweed floodplain.	DPI Fisheries have stated that the Tweed floodplain is one of eight large coastal floodplains where, as part of the MEMS (Action 2.4), data will be collated to inform the development of strategic, evidence-based drainage management plans that streamline and better integrate the existing regulatory complexity. Drainage management plans will consider cumulative impacts, prioritise actions, investment planning and support decision making. Once developed the plans will also reduce red tape by permitting landholders to make informed and accountable decisions to mitigate and mange risks where the landscape and soil constraints are manageable and where threat and risk to use of the marine estate by other stakeholders is minimal. It will, however, take up to two years to develop the full legal framework to underpin the preparation of drainage management plans, given that no such plans exist and to consult on the complex nature of the issues involved like variations in land ownership and drainage unions.	TSC MEMA, DPI Fisheries	DP 2023-2025
I	**Investigate the potential for rehabilitation of former floodplain wetlands**				
I1	M	Identify sites for potential regeneration of floodplain wetlands.	The rehabilitation of former wetland or backswamp areas is a potential management action for maximising ecosystem benefits provided by the floodplain, whilst minimising the impact of agriculture on estuary ecosystems. This is particularly the case for former backswamps that were once important habitat areas or fish nurseries, or priority areas for riparian rehabilitation and/or acid sulfate soil (ASS) remediation. The best opportunities for rehabilitation are typically on waterlogged/tidally affected land of low agricultural value. Develop a methodology and undertake assessment (based on criteria such as elevation, tenure, soils, vegetation etc.) of areas of the floodplain that may have potential for regeneration of floodplain wetlands. To be developed in consultation with floodplain agricultural users including the NSW Sugar industry. Consult and work with cane and grazing industry representatives to find opportunities for improving ecosystem services in agriculturally marginal, low-lying/water-logged/tidally affected soils and identify potential outcomes that would benefit (improve farm efficiency or increase productivity) and motivate landholders. • Recommend suitable site(s) for pilot floodplain wetland rehabilitation site (see Action I3). Provide cost estimate for rehabilitation works. Linked with Actions H1-H6.	TSC DPI Fisheries, DPE, LLS, MEMA	DP 2023-2025
I2	M	Promote existing successful floodplain restoration projects.	Identify and promote successful examples of floodplain wetland rehabilitation projects (such as ponded pasture and reforestation projects). Promote through media, online, existing collaboration and education programs.	TSC DPI Fisheries, DPE, Landcare, Tweed Cane Growers Association, Sunshine Sugar	Ongoing
I3	M	Pilot floodplain wetland rehabilitation site.	Implement a pilot floodplain wetland rehabilitation project that has multiple benefits. Revegetate with lowland species with consideration given to species that would have been indigenous to the floodplain prior to clearing and appropriate for maximising ecological benefit.	TSC DPI Fisheries, DPE, LLS, MEMA	DP 2026-2029
J	**Protect significant estuarine vegetation - improve condition and extent**				
J1	H	Estuarine vegetation education program.	Design and deliver an education project to reduce boating impacts on seagrass beds, in particular from propeller tracking and trampling during boat beaching.	DPI Fisheries, TfNSW - Maritime DPE, TSC	DP 2023-2025 for signage/ brochure. Ongoing extra Fisheries Officer presence at boat ramps
J2	L	Protection of estuarine vegetation off Alf Rush Memorial Drive.	Protect estuarine vegetation along Alf Rush Memorial Drive through the management of vehicle access/ boat launching across the foreshore. Any rationalisation, formalisation and/or prevention of vehicle and boat launching access in this area would be undertaken in consultation with TfNSW – Maritime with regards to use of the foreshore to access the adjacent mooring field.	TSC DPI Fisheries, TfNSW - Maritime, DPE	DP 2023-2025

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
J3	L	Letitia Spit Wetland Management.	The 1991 *Lower Tweed Estuary River Management Plan* identified that the spit was at threat from weed infestation, land degradation, habitat destruction, rubbish dumping and other problems associated with general neglect. Liaise with TBLALC to improve the management of degraded wetland and foreshore areas at Letitia Spit through the control and prevention of vehicular access and powered motorboat access and encouragement of recreational use away from fragile wetland areas. Tweed River Entrance Sand Bypassing Company (TRESBCo) has a land lease over parts of Letitia Spit for the Tweed Sand Bypass Project.	TSC TBLALC, DPI Fisheries, DPE	DP 2026-2029 for initial works and ongoing liaison.
J4	H	MEMA Tweed Intertidal Marine Vegetation Strategy.	Support MEMA development of an Intertidal Marine Vegetation Strategy for the estuary (MEMS Action 2.3.2). DPI Fisheries (2019) has indicated that as part of MEMS Action 2.3.2, that the Tweed is one of two locations in which an estuary-wide marine vegetation management strategy is to be developed as an evidence-based estuary-wide document that informs decision making about intertidal marine vegetation. These strategies aim to direct decision making toward maximise resilience, accommodate sea level rise, address key threats (clearing & drainage, cattle grazing, four-wheel drives on saltmarsh), facilitate rehabilitation opportunities and reduce red tape for low impact works (e.g. mangrove trimming for safe traffic sight lines).	MEMA TSC, DPI Fisheries	Ongoing
K	**Plan for and facilitate the migration of significant riparian and estuarine vegetation with sea level rise**				
K1	M	Review LEP zoning to incorporate areas for estuary vegetation migration.	Using tidal inundation maps, review LEP zoning in High and Moderate priority areas for mangrove and saltmarsh migration, as identified in Appendix C. Identify opportunities for incorporation of estuary vegetation migration areas into E or RU6 zones, particularly on public land. Identify these and appropriate additional areas that warrant detailed consideration under TSC's Development Control Plan (DCP) A19 clause C4, '*Bushland or Wetland Vegetation on the Coastal Floodplain'*	TSC	DP 2026-2029
K2	M	Provision of buffer zones to facilitate estuary vegetation migration.	Using incentive schemes and land holder agreements (e.g. TSC River Health Grants/Biodiversity Grants) continue to work with floodplain landholders to create buffer zones around existing waterways, wetlands and riparian areas, to accommodate dynamic changes to waterway, wetland and riparian vegetation boundaries, associated with sea level rise. Landholder agreements could involve restrictions on grazing or cropping.	TSC	DP 2026-2029
K3	M	Identify offsets for Stotts Island vegetation loss	Investigate a suitable location (s) for the establishment of lowland sub-tropical rainforest on the floodplain to offset the potential loss of this vegetation community from Stotts Island.	TSC	DP 2026-2029
L	**Support the conservation and recovery of shellfish ecosystems**				
L1	H	Shellfish ecosystem education.	Raise the profile of shellfish ecosystems by increasing education and communication on their function and value. There is growing recognition that in addition to policy tools for the protection of existing shellfish ecosystems, active repair and restoration is required to restore shellfish ecosystems and their ecological functions. Protection and re-establishment of shellfish ecosystems is likely to have positive implications for fish assemblages, water quality (as oysters filter the water), bank protection, overall ecosystem health, Aboriginal cultural heritage values and economic prosperity, fishing and tourism in particular. Specific actions as recommended by Gillies *et al*., (2018). This action aligns with actions within the MEMS Initiative 1 focused on developing a framework for state-wide oyster reef rehabilitation.	DPI Fisheries, TSC DPE	DP 2023-2025
L2	H	Baseline mapping of oyster reefs.	Undertake baseline mapping to determine the location, extent and vulnerability of any remaining oyster reefs and banks in the estuary and determine eligibility for protection of identified areas under Commonwealth and State Government laws subject to ecological community nomination determination. Linked to Action C4. Note that implementation of this action is dependent on DPI Fisheries successfully accessing external funding.	DPI Fisheries TSC, DPE	DP 2023-2025
L3	M	DPI Fisheries oyster reef collaboration.	Collaborate with DPI Fisheries to invest in and develop local restoration projects for native oyster species.	TSC, DPI Fisheries	DP 2023-2025
M	**Support the protection of bird habitat**				
M1	H	Support existing bird conservation projects.	Conserve and protect threatened shorebird and raptor habitat through continued support of projects at key habitat sites in and surrounding the Tweed River estuary.	TSC DPE, Landcare, volunteer groups (BirdLife Northern Rivers)	Ongoing
M2	H	Tony's Bar signage.	Install educational signage at Tonys Bar discouraging beaching of boats and providing information regarding the importance of the high tide roost to waders. Related to Action J1.	TSC TfNSW - Maritime	DP 2023-2025
M3	M	Mangrove maintenance.	Trim mangroves at observation points adjacent to key shorebird habitat to allow continued visibility for monitoring activities. Liaison with NSW Fisheries regarding permits and approvals (e.g. if a permit to harm marine vegetation will be required) and inclusion of mangrove trimming into TSC annual maintenance permit.	TSC DPI Fisheries	DP 2023-2025
M4	H	Osprey infrastructure maintenance.	Maintain Council managed Osprey infrastructure through periodic inspection and condition assessment to ensure continued provision of breeding sites and to address risks to public safety.	TSC	Ongoing

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
M5	H	Habitat tree plantings.	Incorporate plantings of large tree species suitable for raptor nesting habitat in riparian zones on Council managed land. For consideration as part of Actions F1 and G1.	TSC DPE – Crown Land	Ongoing
N	**Improve habitat and visual impact outcomes for riverbank erosion stabilisation works**				
N1	H	Encourage incorporation of bioengineering principles into private bank stabilisation works.	Where bank remediation is not wholly possible through revegetation alone, the criteria listed below should apply to protective infrastructure works. • Ensure design conditions for all bank stabilisation and coastal protection works incorporate bioengineering principles wherever feasible; • Use development consent conditions in facilitating this action; • In many cases, small scale works on private land involve creating or upgrading revetment walls on residential lots. In these cases, bioengineered approaches (e.g. incorporating estuarine/ riparian revegetation and/ or fish habitat) may be feasible; and • In all cases, where Council or NSW Agency approval is required, conditions should be applied which result in the establishment and maintenance of appropriate fish habitat, estuarine vegetation and/or native riparian plant species wherever feasible.	TSC DPE – Crown Lands, DPI Fisheries	Ongoing
Threat 3 - Degraded estuarine water quality					
O	**Ensure adequate development controls and compliance**				
O1	H	Stormwater controls.	Ensure that requirements for stormwater detention and treatment are achieved for all future developments, including erosion and sediment control requirements during the construction phase.	TSC	Ongoing
P	**Reduce acid runoff**				
P1	H	Remediate priority ASS areas.	Work with the sugar industry and floodplain landholders to reduce acid runoff wherever possible, primarily in the upper estuary, middle estuary and Rous River estuary and in particular, in amended priority ASS remediation areas (those which recorded low pH levels in drain waters during recent event sampling, i.e. upstream of Dulguigan Creek in the Rous River estuary, the northern side of the Main Trust Canal, Condong Creek, Blacks Drain and the floodplain between Bray Park and Murwillumbah). Existing management strategies include planning controls, drain shallowing, laser levelling, liming, tidal flushing etc.	TSC Sunshine Sugar, DPI Fisheries, DPE	Ongoing
P2	M	Audit of floodplain drain pH.	Follow-up audit of pH levels in key drains during or following a moderate-to-high flow event and where possible, additional sampling to isolate discrete problem areas for ASS export. Sampling should be undertaken close to the sampling trigger being reached, i.e. prior to full flushing of drains which may occur in large or continuing rainfall events.	TSC	DP 2023-2025
P3	M	Automatic pH loggers.	Deploy automatic pH loggers in agricultural drains in priority ASS remediation areas to monitor acidity levels and flushing behaviour during a variety of weather events. Coast estimation based on deployment of three pH loggers.	TSC	DP 2023-2025
P4	M	Identify sites for pilot ASS remediation projects.	Identify opportunities for local, on-ground trials and monitoring of wet-acid containment projects. As per Action I2, identify a site where ASS rehabilitation can be undertaken with the dual aim of creating floodplain wetland(s) and improving floodplain ecosystem service delivery.	TSC DPI Fisheries, DPE	DP 2023-2025
P5	M	Ongoing improvements in ASS management.	Work with the NSW sugar industry to continually improve the self-regulation of ASS with a view to improving the overall level of ecosystem services on the floodplain. This should include: • Addressing existing risks or new hotspots in ASS areas; • Controlling the discharge of poor-quality water; • Improving connectivity between waterways and floodplain drains where appropriate (in conjunction with related Actions H1 and H2); • Providing for the revegetation of drains (allowing for drain maintenance requirements); • Controlling aquatic weeds; • Improving the public availability and transparency of reporting; and • Examining the consent requirements and extent of land to which Production Entitlement Areas (PAEs) apply.	TSC Sunshine Sugar	DP 2023-2025
Q	**Reduce catchment nutrient inputs to the estuary**		Management effort should focus on reducing inputs of both nitrogen and phosphorus to the estuary. Specific actions are listed below along with related actions, Action D to Action G.		
Q1	H	Green Banks Initiative.	Undertake revegetation of floodplain agricultural drain banks using *Lomandra* spp. and other native species through TSC Sustainable Agriculture Programs ‘Green Banks” initiative.	TSC DPE, DPI Fisheries	Ongoing

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
R	**Improve wastewater and effluent management**				
R1	H	Upgrade Murwillumbah WWTP.	Reduce the effect of WWTP discharges to the estuary by reducing point source loadings of bioavailable nitrogen in particular, by upgrading the Murwillumbah WWTP, focussed on reducing nutrient loads to the Rous River estuary during low-moderate flows. Options that could be investigated to achieve this may include: • Improving effluent quality; • Beneficial reuse of effluent; and • Discharge to less sensitive environments.	TSC	Unknown
R2	M	Investigate causes of high nutrient levels in Tweed River at Condong.	Work with Cape Byron Power to understand and identify opportunities to reduce nutrient levels in the estuary in the vicinity of Condong Sugar Mill. Particular aspects to investigate include potential nutrient loading from mill cooling water discharge (noting that this comes from Murwillumbah WWTP), as well as discharge from adjacent drains and stormwater outlets in the vicinity.	TSC	DP 2023-2025
S	**Reduce sediment inputs to the estuary**		Elevated levels of TSS, primarily of concern in the middle estuary and Rous River estuary, can be managed through specific related actions, Action D to Action G, Action O and Action R.		
T	**Reduce the human health risk of faecal contamination in the estuary**				
T1	L	Investigate sources of pathogens in Tweed River.	Investigate sources and relative loadings of pathogen inputs (i.e. human or animal sources and key locations) to better assess the risk to human health and to direct management effort to specific areas of the estuary.	TSC	DP 2026-2029
T2	M	Public health education regarding high-risk swimming periods.	Undertake community education regarding high-risk periods and locations for swimming throughout the estuary. Swimming is not advisable in the Rous River estuary most of the time. Include education measures to reduce faecal loading to the estuary (e.g. pet droppings, illegal sewer connections etc.).	TSC	Ongoing
Threat 4 - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets					
U	**Increase resilience of land, assets and people to impacts of sea level rise and increased tidal inundation**				
U1	M	Council asset vulnerability assessment.	Undertake a vulnerability assessment of Council assets, incorporating risk from coastal hazards, particularly sea level rise and tidal inundation. Incorporate risks into design, maintenance planning and replacement of existing and planned assets.	TSC DPE	DP 2023-2025
U2	M	Future development area vulnerability assessment.	Undertake a vulnerability assessment of existing and future development areas and LEP zonings, incorporating risk from coastal hazards, particularly sea level rise and tidal inundation. Incorporate sea level rise and tidal inundation risk into LEP and sub-division DCP review.	TSC DPE	DP 2023-2025
U3	M	Mosquito breeding habitat assessment	Undertake an assessment of potential changes in mosquito breeding habitat under future tidal inundation scenarios and determine potential health and wellbeing impacts on existing and future residential areas and populations. Likely to consist of a number of consultant engagements in addition to significant staff time commitment. Linked to Action U6.	TSC NSW Health	DP 2026-2029
U4	M	Develop sea level rise adaptation strategy.	Using the outcome of asset vulnerability assessments, develop long term adaptation strategies to manage the impacts of sea level rise, including the development of triggers that identify when strategies need to be implemented, modified or reviewed.	TSC DPE	DP 2026-2029
U5	H	Consider planning proposal for inclusion of Coastal Vulnerability Area in CM SEPP.	Consider preparation of a planning proposal to seek formal inclusion of a Coastal Vulnerability Area (tidal inundation) into the CM SEPP. Linked to and pending outcome of Action A4.	TSC DPE	DP 2023-2025
U6	H	Mosquito controls.	Continue to implement current controls regulating mosquito breeding in line with TSC's Pest Management Program, best management practice and developing science. Linked to Action U3.	TSC	Ongoing
U7	L	Coastal hazard education.	Develop and implement a communication strategy that ensures the impacts of sea level rise, future tidal inundation and adaptation responses are understood by the community and stakeholders.	TSC	Ongoing
U8	M	Liaison with DPI Agriculture re: alternative floodplain crops.	Recommend to DPI Agriculture that further research is required into the viability of alternative crops more suited to waterlogging and saline intrusion in response to increased flooding and predicted sea level rise impacts (e.g. trials of native tree food species and timber plantation species). DPI Agriculture or Research Australia Ltd (Rural R&D Corp) could potentially administer as a grant for post-graduate research.	TSC DPI Agriculture	DP 2030-2033

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
V	Address risk of overtopping of Bray Park Weir				
V1	H	Bray Park Weir Project Reference Group actions.	Project Reference Group to implement solutions including: • Review of Council operational procedure for monitoring and assessing the risk of overtopping at Bray Park Weir in light of findings from WRL (2017) and more recent Council investigations which identifies the probability of residual high tides in the estuary (i.e. a higher degree of sandbagging/concrete blocking during particular astronomical events may be required); • Concept design and environmental studies associated with any proposal to mitigate the risk of saltwater ingress into the water supply. Linked to Action H4; and • Evaluation of the current and likely future effectiveness of freshwater releases from Clarrie Hall Dam in preventing saline intrusion.	TSC	DP 2023-2025
Threat 5 - Loss of or impacts to biodiversity					
W	Conserve and rehabilitate key habitat and reduce conflicts between threatened species and estuary users				
W1	M	Threatened species education.	Support stakeholder and community education and engagement re conservation of existing populations of threatened fauna e.g. shorebird, raptor and dolphin populations in the Tweed River estuary. Minimising conflict between these populations and anthropogenic uses of the estuary (fishing, boating, port use etc.).	TSC DPE, Landcare, Dolphin Research Australia Inc., BirdLife Northern Rivers	Ongoing
W2	H	Marine debris hotspot mapping.	Undertake a mapping assessment to determine locations of marine and intertidal hotspots for accumulation of plastic litter and marine debris. It is likely that the majority of litter and marine debris is concentrated in specific locations such as in the vicinity of stormwater outlets, popular fishing locations and embayments. Mapping of the current hotspots will drive more time efficient and cost-effective future clean-up activities. Linked to Action O1 and W3.	TSC MEMA, DPE, DPI Fisheries, marine research and volunteer organisations	DP 2023-2025
W3	H	Monitoring and removal of marine debris.	Monitor accumulation and undertake periodic removal of marine debris from key locations. Linked to Action O1 and W2.	TSC MEMA, DPE, DPI Fisheries, marine research and volunteer organisations	Ongoing
Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly lack of sandy beaches					
X	Improvements to foreshore parks and recreational facilities		Related actions: Action E		
X1	L	Seating improvements Ebenezer Park and Keith Compton Drive foreshore.	Provide additional seating and vegetation at Ebenezer Park and Keith Compton Drive foreshore.	TSC DPE, TfNSW - Maritime	DP 2026-2029
X2	H	Upgrade facilities at Old Fingal Boat Harbour.	Provide and upgrade shore-based facilities on the upstream (southern) side of Old Fingal Boat Harbour. Improvements including erosion stabilisation, picnic tables, shelters, shower, pathway and access improvements would increase the amenity of this area.	TSC TfNSW - Maritime, DPE, DPE – Crown Lands, DPI Fisheries	DP 2023-2025
X3	L	Detailed design of Growers Market rest area at Tumbulgum upgrade.	Develop a detailed design and costing for upgrade of the Growers Market rest area at Tumbulgum. Upgrade to resemble a designated rest area to maximise the usage and safety of this popular location for all users e.g. by reducing the speed of drive-through traffic, enhancing foreshore vegetation, installing amenities and picnic facilities and improving the visibility of stalls to passing motorists.	TSC DPE – Crown Lands	DP 2030-2033

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
X4	L	Detailed design Bluey Hill Park upgrade.	Develop detailed design and costing for upgrade to Bluey Hill Park (North Tumbulgum). Upgrade to support passive recreational use of the lower Rous River estuary and middle estuary including provision of nature-based education opportunities, consideration of a canoe launching facility for canoes/kayaks/stand-up paddleboards (SUPs), native tree planting for shade, picnic facilities and vegetation restoration. A concept plan was included in the 1996 Management Plan.	TSC DPE, TfNSW - Maritime, DPE – Crown Lands	DP 2030-2033
X5	L	Enhance opportunities for nature-based education.	Provide nature-based education opportunities and consider installation of a canoe launching facilities for canoes/kayaks/SUPs. Suggested areas for consideration include Pat Smith Park (at the Dungay Creek confluence with Rous River estuary) and off Rous River Way, Murwillumbah. Upgrade to support passive recreational use of the Rous River estuary. A concept for a canoe/walking trail was included in the 1996 Management Plan	TSC DPE, TfNSW - Maritime	DP 2030-2033
Y	Maintain and improve facilities for connectivity of public access along the foreshore				
Y1	L	Investigate opportunities to increase connectivity with walking trails.	There is an extensive network of footpaths and cycleways in the lower estuary, but the opportunity to establish linkages between existing walkways and cycleways should be pursued to achieve a sense of completion, to enhance the value of investment already made and to maximise public recognition of the project. A specific opportunity to be investigated through development of a concept design and cost estimate is increasing connectivity with walking trails in the Tweed Heads historic site and Tweed Heads South levee.	TSC DPE, TBLALC, TfNSW - Maritime	DP 2026-2029
Z	Maintain amenity of existing estuary beaches and create additional artificial sandy beaches				
Z1	M	Maintain amenity of existing sandy beaches in the estuary.	Existing sandy beaches that would benefit from beach nourishment include: • Jack Evans Boat Harbour; • The northern side of the Terranora Inlet (Ebenezer Park); • New and Old Fingal Boat Harbours; • Chinderah; • Tumbulgum; • Condong; and • Murwillumbah Rowing Club. Beach nourishment of Jack Evans Boat Harbour should be in accordance with the existing engineering concept design (GHD, 2016) involving construction of a sill to retain nourished material. The design would provide for an all-tide sandy recreational beach, support seagrass growth in the area and reduce the frequency of current sand management works in the harbour. Design of any beach creation and beach nourishment works in the estuary should minimise impact on riparian vegetation and adjacent estuarine vegetation (e.g. seagrasses) including consideration of grain size suitability (for both amenity and seagrass vulnerability), beach slope and the potential for “slumping” of nourishment material. TfNSW - Maritime to include consideration of this action in the beneficial reuse of any maintenance dredged material from the bed of the estuary.	TSC, TfNSW – Maritime, DPE - Crown Lands	Opportunistic
Z2	H	Feasibility assessment for sandy beach creation.	Investigate the feasibility and document concept designs for the creation and maintenance of additional accessible sandy beaches for both non-boat recreation and for increased capacity for boat beaching (minimum recommended length = 30m). This action is suggested in conjunction with the investigation of additional boating infrastructure and ancillary features (Actions DD to GG). Suggested areas for consideration of additional sandy beaches include Fingal Peninsula, north of Wommin Lake Crescent and Tumbulgum. The optimal location(s) and feasibility of establishing additional artificial community beaches should consider beach longevity, recreational demand, environmental impacts (e.g. smothering of seagrass, disturbance to ASS), proximity to nourishment sand sources, ongoing maintenance requirements and associated costs.	TSC TfNSW - Maritime	DP 2021-2025
AA	Reduce river user conflict through provision of adequate access and infrastructure and through sufficient separation of incompatible uses		The mitigation of conflict between users of the estuary is achieved through related actions: Action E, Action X to Action Z and Actions DD to FF.		
BB	Continue to work with TfNSW - Maritime to improve compliance with and policing of boating rules and recommend towing restrictions in conservation and restoration character zones. TfNSW - Maritime is responsible for boating and navigation infrastructure in the Tweed Estuary.				
BB1	H	Boating safety education and enforcement.	Continue educational campaigns (such as talking to boat ramp users) and enforcement to: • Inform the community of boating rules; • Increase compliance with and policing of existing rules; • Raise awareness of environmental impacts of boating and safety risks to other waterway users; and • Encourage consideration of other users of waterways, foreshore and nearby residents.	TfNSW – Maritime TSC	Ongoing
BB2	M	Vessel number surveys.	TfNSW - Maritime undertakes surveys of vessel numbers using the river.	TfNSW - Maritime TSC	DP 2021- 2025
Threat 8 - Reduced stocks of target fish species					

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
CC	Improve the status of fish assemblages in the estuary				
CC1	H	DPI Fisheries education program.	Collaborate with DPI Fisheries on an education/engagement program to improve community understanding of commercial fishing impacts and benefits and the science-based management of the industry. This action aligns with actions under MEMS Initiative 6 which includes actions to foster the industry to develop its social licence (MEMS Action 6.8).	DPI Fisheries, TSC	Ongoing
Threat 9 - Restricted levels of boating infrastructure and facilities or reduced navigability					
DD	Continue to liaise with stakeholders regarding the upgrade and expansion of Tweed Port in line with Council and community requirements				
DD1	M	Consultation regarding port development.	TSC should continue to liaise with the above stakeholders to ensure that the requirements of Council and the community are considered in all port development activities. Any proposal to upgrade the Tweed Boat Harbor precinct area would involve key stakeholders including Council and the community. TfNSW - Maritime convenes a Tweed Harbour User Group. DPE - Crown Lands are also important stakeholders.	TSC TfNSW – Maritime, DPE-Crown Lands	Ongoing
EE	Maintain and improve boating infrastructure, access and ancillary facilities for boaters		The majority of actions revolve around the formalisation and consolidation of existing facilities and access arrangements to optimise facility performance and reduce user conflict in the estuary. Related actions: Action E, Action X to Action Z.		
EE1	H	Increase funding to TSC's Boating Facilities Management program.	Increase funding to TSC's Boating Facilities Management program, primarily for the pro-active maintenance of TSC's waterways infrastructure.	TSC TfNSW - Maritime, DPE	Ongoing
EE2	M	Improve boat ramp facilities.	Improve the facility layout at existing boat ramps and identify opportunities to increase efficiency and reduce congestion. Consultation will be undertaken with the key user groups of each ramp to ensure consideration of priority needs. Considerations include the provision of direct access between ramps and pontoons and the installation of mooring bollards in the vicinity of popular locations with limited mooring and beaching access (e.g. Tumbulgum). There are five ramps at which efficiency improvement projects could be undertaken.	TSC TfNSW - Maritime, DPE	DP 2026-2029
EE3	L	Assist private sector to undertake feasibility assessment for on-water re-fuelling facilities.	Comments raised during stakeholder consultation indicate at least some demand for on-water re-fuelling facilities although no detailed evaluation has been undertaken. Responsibility for providing a fuel facility for boating would need to be considered in accordance with the NSW Maritime Infrastructure Plan 2019-2024. Council staff would support private sector led investigations. DPE - Crown Lands role would be limited to providing appropriate authorisations under the *Crown Land Management Act 2016*, if / when required.	TSC TfNSW - Maritime, DPE - Crown Lands, DPE	DP 2030-3031
EE4	M	Boat ramp improvements at John Oxley Park, Chinderah.	Maintenance dredging at John Oxley Park boat ramp is planned however there is limited space available to significantly upgrade this boat ramp to accommodate additional lanes or trailer parking spaces. Note that the role of DPE - Crown Lands in this action would be limited to providing appropriate authorisations under the *Crown Land Management Act 2016* if required	TSC TfNSW - Maritime, DPE - Crown Lands, DPE	DP 2023-2025
EE5	L	Boat ramp improvements at Condong Road Boat Ramp.	Upgrade car parking facilities at Condong Road Boat ramp (Clarrie Purnell Park) including asphalting and line markings.	TSC TfNSW - Maritime, DPE	DP 2026-2029
FF	Ensure adequate planning, assessment and control of dredging and sand extraction in the estuary				
FF1	L	Minor dredging associated with TSC managed infrastructure and canals.	Continue maintenance dredging activities associated with Council managed infrastructure (e.g. boat ramp access channels) and Council managed canals (i.e. Anchorage Island Estate and Oxley Cove) as needed to maintain function, access and safety. The depth of maintenance dredging is to be sufficient to accommodate shallow draft vessels consistent with current use. TSC to consider co-contributions towards dredging projects where there is additional community benefit e.g. the reuse of dredged material within the estuary. The need for a local dredging strategy and implementation plan for the estuary will be considered in consultation with relevant stakeholders.	TSC TfNSW - Maritime	Opportunistic (as required)
FF2	M	TRESBP Environmental Monitoring System data review.	Undertake a review of existing data collected thus far through the TRESBP Environmental Monitoring System to determine the net direction of sediment movement in the estuary, the threshold for exportation of sand from the system via dredging and sand extraction under existing conditions and the impact of climate change on that regime. It is important to understand whether the flood tide infeed of marine sands to the estuary is generally greater than or less than the ebb tide transport of sand, i.e. whether shoals will continue to grow or whether they will erode with a net export of sediment and how this regime will progress into the future in response to dredging and sand extraction activities and to emerging risks such as sea level rise and potential for increased erosion. This information would be considered in the development and any reiterations of Action FF1. Council will work with DPE – Crown Lands and the TRESBP team to clarify the scope of such an investigation.	TfNSW - Maritime DPE TSC	DP 2023-2025

Table 2: Business Plan – CMP management actions

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
Fundamental Management Actions												
A	Governance and administration											
A1	F	Administration of the CMP through TSC Waterways Management Program overseen by TCWC	20	20				20		100% public	a, b	2
A2	F	Support implementation of programs and strategies complimentary to the CMP	To be implemented under TSC DP operating budget							100% public	a	1
A3	H	Ensure future Crown land Plans of Management are consistent with the CMP	To be implemented under TSC DP operating budget							100% public	a	1
A4	H	Periodic review of Coastal Management Areas to ensure accuracy and relevance	To be implemented under TSC DP operating budget							100% public	a, b	1
B	Stakeholder and community engagement											
B1	F	Develop and implement a Stakeholder Engagement Strategy	To be implemented under TSC DP operating budget							100% public	a	1
B2	F	Co-ordination and consultation with local Aboriginal community and NPWS	To be implemented under TSC DP operating budget							100% public	a, h, p	1
B3	F	Raise awareness of Aboriginal cultural heritage significance of the Tweed River estuary	15	15			15			100% public	a, b, h, p	2
B4	M	Provide additional nature based educational opportunities including signage and information	30	30			10	10	10	100% public	a, b, p	2
C	Estuary health monitoring and reporting program											
C1	F	Annual estuary health report card	To be implemented under TSC DP operating budget							100% public	a, b	1
C2	F	Estuary Health Monitoring and Reporting Program	120	120			40	40	40	100% public	a, b	1
C3	F	Riparian vegetation and bank condition monitoring	75	75			25	25	25	100% public	a, b, d	2
C4	H	Monitor oyster banks and reefs	40	40			20		20	100% public	a, b, i	2
C5	H	Support monitoring of avifauna by volunteer groups	To be implemented under TSC DP operating budget							100% public	a	1
C6	H	Support monitoring of other higher order predators	To be implemented under TSC DP operating budget							100% public	a	1
C7	H	Increase training and resourcing for compliance monitoring staff	440		440		160	160	120	100% public	a, b	3
Threat 1 - Bank Erosion												
D	Increased adoption of best management practices to mitigate pollution of surface and groundwater and enhance biodiversity											
D1	H	Landholder communication and liaison	To be implemented under TSC DP operating budget							100% public	a, b, q	1
E	Promotion of the diversity of river uses											
E1	H	Liaison with TfNSW regarding Tweed River Recreational Use Strategy	To be implemented under TSC DP operating budget							100% public	a	1
E2	H	Public promotion of Tweed River Recreational Use Strategy	20	20			20			100% public	a, b	2
E3	H	Motorised Water Recreation Business Policy	To be implemented under TSC DP operating budget							100% public	a	1
F	Rehabilitate and maintain priority bank erosion sites											
F1	F	Bank stabilisation works at high priority sites on public land including riparian vegetation rehabilitation	8500	8,200		300	3,500	2,500	2,500	100% public	a, b, d, l, n, p, q, r	2
F2	H	Detailed design and restoration of lower estuary foreshore protection structures on TSC managed land	3560	3,440		120	1,060	1,500	1,000	100% public	a, b, d	3
F3	H	Detailed design and restoration of river banks adjacent to the Tweed Valley Way and Tumbulgum Road	9150	8,800		350	1,950	5,400	1,800	100% public.	a, b, d, m, i	3
F4	M	Monitor bank stabilisation works and improve/refine methods	To be implemented under TSC DP operating budget							100% public	a,b	1
F5	H	Support MEMA reforms of development application process for bank stabilisation works	To be implemented under TSC DP operating budget							100% public	a	1

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
F6	L	Port infrastructure liaison with DPIE - Crown Lands	To be implemented under TSC DP operating budget							100% public	a	1
G	Rehabilitate and maintain riparian vegetation											
G1	H	Rous Estuary Riparian Zone Management Plan	Cost of implementation provided in F1.							100% public	a, b, d	2
G2	H	Improve development application process to facilitate riparian rehabilitation projects on private land.	To be implemented under TSC DP operating budget							100% public	a,b	1
Threat 2 - Habitat loss and barriers to habitat connectivity												
H	Restore natural drainage and reinstate tidal exchange											
H1	M	Manage barriers to fish passage	30	30			30			100% public	a, b, i	2
H2	M	Cost-benefit analysis and feasibility study(ies) of alternative floodplain land use options	50	50				50		100% public	a, b, c, i, o	2
H3	H	Upgrade Bray Park Weir fishways	1650	1600		50	100	1,500	50	100% public	a,b	3
H4	L	Floodgate management investigation	100	100			100			100% public	a,b	1
H5	H	Support MEMA drainage management plan for the Tweed floodplain	To be implemented under TSC DP operating budget							100% public	a,b	1
I	Investigate the potential for rehabilitation of former floodplain wetland											
I1	M	Identify sites for potential regeneration of floodplain wetlands	50	50			50			100% public	a, b, c, i, o, s	2
I2	M	Promote existing successful floodplain restoration projects	To be implemented under TSC DP operating budget							100% public	a,b	1
I3	M	Pilot floodplain wetland rehabilitation site	310	300		10	100	200	10	100% public	a, b, c, i, o, s	3
J	Protect significant estuarine vegetation - improve condition and extent											
J1	H	Estuarine vegetation education program	65	15	50		35	20	10	100% public	a, b, i	2
J2	L	Protection of estuarine vegetation off Alf Rush Memorial Drive	5	5			5			100% public	a, b, i	2
J3	L	Letitia Spit Wetland Management	46	40		6		40	6	100% public	a, b, i	2
J4	H	MEMA Tweed Intertidal Marine Vegetation Strategy	To be funded under MEMS							100% public	s	1
K	Plan for and facilitate the migration of significant riparian and estuarine vegetation with sea level rise											
K1	M	Review LEP zoning to incorporate areas for estuary vegetation migration	To be implemented under TSC DP operating budget							100% public	a,b	1
K2	M	Provision of buffer zones to facilitate estuary vegetation migration	To be implemented under TSC DP operating budget							100% public	a,b	3
K3	M	Identify offsets for Stotts Island vegetation loss	To be implemented under TSC DP operating budget							100% public	a,b	1
L	Support the conservation and recovery of shellfish ecosystems											
L1	H	Shellfish ecosystem education	To be implemented under TSC DP operating budget							100% public	a, b, i	1
L2	H	Baseline mapping of oyster reefs	20	20			20			100% public	a, b, i	2
L3	M	DPI Fisheries oyster reef collaboration	To be implemented under TSC DP operating budget							100% public	a, b, i	1
M	Support the protection of bird habitat											
M1	H	Support existing bird conservation projects	To be implemented under TSC DP operating budget							100% public	a,b	1
M2	H	Tony's Bar signage	Costs included in J1							100% public	a	2
M3	M	Mangrove maintenance	To be implemented under TSC DP operating budget							100% public	a,b	1
M4	H	Osprey infrastructure maintenance	30			30	10	10	10	100% public	a, b	2

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
M5	H	Habitat tree plantings	30	27		3	10	10	10	100% public	a, b, d	2
N	Improve habitat and visual impact outcomes for river bank erosion stabilisation works											
N1	H	Encourage incorporation of bioengineering principles into private bank stabilisation works	To be implemented under TSC DP operating budget							100% public	a,b	1
Threat 3 - Degraded estuarine water quality												
O	Ensure adequate development controls and compliance											
O1	H	Stormwater controls	To be implemented under TSC DP operating budget							100% public	a,b	1
P	Reduce acid runoff											
P1	H	Remediate priority ASS areas	450	435		15	150	150	150	100% public	a,b	1
P2	M	Audit of floodplain drain pH	To be implemented under TSC DP operating budget							100% public	a,b	1
P3	M	Automatic pH loggers	15	15			15			100% public	a,b	1
P4	M	Identify sites for pilot ASS remediation projects	50	50			50			100% public	a,b	1
P5	M	Sugar Industry self-regulation of ASS	To be implemented by sugar industry							100% public	a	1
Q	Reduce catchment nutrient inputs to the estuary											
Q1	H	Green Banks Initiative	240	225		15	80	80	80	100% public	a, b, d, i	2
R	Improve waste water and effluent management											
R1	H	Upgrade Murwillumbah WWTP	To be implemented under TSC DP operating budget							100% public	a	3
R2	M	Investigate sources of high nutrient levels in Tweed River at Condong	To be implemented under TSC DP operating budget							100% public	a, b	1
S	Reduce sediment inputs to the estuary Elevated levels of TSS, primarily of concern in the middle estuary and Rous estuary, can be managed through specific related actions. Refer Action D to Action G, Action O and Action R.											
T	Reduce the human health risk of faecal contamination in the estuary											
T1	L	Investigate causes of pathogens to Tweed River	60	60				60		100% public	a, b	2
T2	M	Public health education re: high-risk swimming periods.	To be implemented under TSC DP operating budget							100% public	a	1
Threat 4 - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets												
U	Increase resilience of land, assets and people to impacts of sea level rise and increased tidal inundation.											
U1	M	Council asset vulnerability assessment	100	100			100			100% public	a, b, c	2
U2	M	Future development area vulnerability assessment	100	100			100			100% public	a, b, c	2
U3	M	Mosquito breeding habitat assessment	50	50				50		100% public	a, b, c	2
U4	M	Develop sea level rise adaptation strategy	50	50				50		100% public	a, b, c	1
U5	H	Consider planning proposal for inclusion of Coastal Vulnerability Area in CM SEPP.	To be implemented under TSC DP operating budget							100% public	a, b	1
U6	H	Mosquito controls	To be implemented under TSC DP operating budget							100% public	a	1
U7	L	Coastal hazard education	To be implemented under TSC DP operating budget							100% public	a, b	1
U8	M	Liaison with DPI Agriculture re: alternative floodplain crops	To be implemented under TSC DP operating budget							100% public	a, b	1
V	Address risk of overtopping of Bray Park Weir											
V1	H	Bray Park Weir Project Reference Group actions	To be implemented under TSC DP operating budget							100% public	a, b, c	1
Threat 5 - Loss of or impacts to biodiversity												

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
W	Conserve and rehabilitate key habitat and reduce conflicts between threatened species and estuary users											
W1	M	Threatened species education	To be implemented under TSC DP operating budget							100% public	a, b	1
W2	H	Marine debris hotspot mapping	20	20			20			100% public	a, b, e, i	2
W3	H	Monitoring and removal of marine debris	30	30			10	10	10	100% public	a, b, e, i	2
Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly lack of sandy beaches												
X	Improvements to foreshore parks and recreational facilities											
X1	L	Seating improvements Ebenezer Park and Keith Compton Drive foreshore	50	48		2		50		100% public	a, b, j	2
X2	H	Upgrade facilities at Old Fingal Boat Harbour	300	280		20		290	10	100% public	a, b, c, d, f, j, i	2
X3	L	Detailed design Growers Market rest area at Tumbulgum upgrade	140	135		5			140	100% public	a, b, c, d, f, j, i	2
X4	L	Detailed design Bluey Hill Park upgrade	140	135		5			140	100% public	a, b, c, d, f, j, i	2
X5	L	Enhance opportunities for nature-based education	50	47		3			50	100% public	a, b, c, d, f, j, i	2
Y	Maintain and improve facilities for connectivity of public access along the foreshore											
Y1	L	Investigate opportunities to increase connectivity with walking trails	20	20				20		100% public	a, b, l	2
Z	Maintain amenity of existing estuary beaches and create additional artificial sandy beaches											
Z1	M	Maintain amenity of existing sandy beaches in the estuary	500	450		50	200	200	100	100% public	a, b, k	3
Z2	H	Feasibility assessment for sandy beach creation	50	50				50		100% public	a, b, k	2
Threat 7 - Conflict between river users												
BB	Continue to work with TfNSW to improve compliance with, and policing of boating rules, and recommend towing restrictions in conservation and restoration character zones											
BB1	H	Boating safety education and enforcement	Included in J1							100% public	a, b, i, j	2
BB2	M	Vessel number survey	To be implemented by TfNSW - Maritime							100% public	a, j	1
Threat 8 - Reduced stocks of target fish species												
CC	Improve the status of fish assemblages in the estuary											
CC1	H	DPI Fisheries education program	To be implemented under TSC DP operating budget							100% public	a, b, i	1
Threat 9 - Restricted levels of boating infrastructure and facilities or reduced navigability												
DD1	M	Consultation regarding port development	To be implemented under TSC DP operating budget							100% public	a	1
EE	Maintain and improve boating infrastructure, access and ancillary facilities for boaters											
EE1	H	Increase funding to TSC's Boating Facilities Management program	600	600			240	240	120	100% public	a, b, f, j	2
EE2	M	Improve boat ramp facilities	300	280		20		280	20	100% public	a, b, f, j	2
EE3	L	Feasibility assessment for on-water re-fuelling facilities	30	30					30	100% public	a, b, f, j	2
EE4	M	Boat ramp improvements at John Oxley Park, Chinderah.	100	95		5	95	3	2	100% public	a, b, f, j	2
EE5	L	Boat ramp improvements at Condong Rd Boat Ramp	100	95		5		95	5	100% public	a, b, f, j	2

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
FF	Ensure adequate planning, assessment and control of dredging and sand extraction in the estuary											
FF1	L	Minor dredging associated with TSC managed infrastructure and canals	To be implemented under TSC DP operating budget							100% public	a, b, j, k	1
FF2	M	TRESBP Environmental Monitoring System data review	To be implemented under TSC DP operating budget							100% public	a,b	1
		TOTALS	**27,901**	**26,397**	**490**	**1,014**	**8,320**	**13,113**	**6,468**			

Business Plan Notes:

1. DP - Delivery Program within Council's IP&R framework. Years correspond to end of financial year i.e. DP 2023 - 2025 is the 1st four-year Delivery Program (start 1st July 2022, end 30th June 2025) etc. Timing may be dependent on certification of CMP and approval of funding where applicable.

2. Potential Funding Sources:

a. TSC funds (including River Health Grants, Biodiversity Grants, Land for Wildlife etc.) and staff time – TSC

b. NSW Coastal and Estuary Grants Program -DPE (2:1 funding)

c. Increasing Resilience to Climate Change program -DPE

d. Crown Reserves Improvement Fund Program- DPE-Crown Lands

e. The NSW Environment Trust -DPE

f. The NSW Community Building Partnership program - NSW Department of Premier and Cabinet

g. NSW EPA Waste Less, Recycle More initiative - EPA

h. Commonwealth Community Led Grants – Commonwealth of Australia

i. Habitat Action Grants funded from Recreational Fishing Trusts – DPI Fisheries

j. NSW Boating Now Program – TfNSW - Maritime

k. Coastal Dredging Strategy and Boating Access Dredging Grants Program – TfNSW - Maritime (1:1 funding)

l. Walking and Cycling program - TfNSW

m. Regional Roads Funding Assistance – NSW Local Government

n. The Emissions Reduction Fund – Australian Government Clean Energy Regulator

o. Clean Coastal Catchments On-Farm Grants Program – LLS (MEMA)

p. NPWS funds – DPE-NPWS

q. Landcare – Landcare Australia

r. Coastcare - Coastcare Australia

s. Marine Estate Management Strategy - MEMA

Funding is subject to grant availability and approval.

3. Business Plan Categories:

Category 1 – economic analysis complete, action funded under normal operating budget or existing programs and grants and not expected to impact on current resourcing levels.

Category 2 – economic analysis complete, action subject to funding.

Category 3 – no economic analysis, action subject to detailed costing, economic analysis and funding.

CONTENTS

TABLES

FIGURES

1. INTRODUCTION

The Tweed River estuary is located within Tweed Shire on the north coast of New South Wales (NSW). This Coastal Management Program (CMP) provides a ten-year strategic plan for the implementation of key actions that are recommended to meet the objectives and intent of the *Coastal Management Act 2016* and to achieve the specific local management objectives developed for the estuary, as discussed in Section 1.7. This CMP has been developed in accordance with Stages 1 to 4 of the five-stage process for developing and implementing a CMP, as detailed in the *Coastal Management Manual* (OEH, 2018b). The completed stages supporting this CMP include:

- A Scoping Study;
- Several detailed studies to address knowledge gaps;
- A risk assessment of threats and opportunities; and
- The identification and evaluation of strategic responses to each of the key threats to the estuary.

Tweed Shire Council (TSC) acknowledges and respects the Tweed Aboriginal community's right to speak for its country and to care for its traditional country in accordance with its laws, customs and traditions and welcomes the Aboriginal people's contribution to protecting, strengthening and enriching the heritage of all Australians within the wider community. Council acknowledges the Nganduwal and Minyungbal people of the Bundjalung nation, in particular the Goodjinburra, Tul-gi-gin and Moorung-moobah clans as being the Traditional Owners and Custodians of the land and water within the Tweed Shire boundaries (TSC, 2017b).

In December 2021, the Minister for Planning and Public Spaces announced that the 45 existing *State Environmental Planning Policies (SEPPs)* will be consolidated into 11 new amalgamated SEPPs. As part of this process, the CM SEPP has been rolled into Chapter 2 of the new *State Environmental Planning Policy (Resilience and Hazards) 2021*. The SEPP consolidation is administrative, and no policy changes have been made. The SEPP consolidation does not change the legal effect of the existing SEPPs, with section 30A of the Interpretation Act 1987 applying to the transferred provisions. For clarity, these provisions are still referred to as the CM SEPP in this document.

1.1. The Study Area

The Tweed River estuary is located between the towns of Tweed Heads and Murwillumbah on the NSW north coast and wholly located within the Tweed Local Government Area (LGA). Tweed River is the northern-most river in NSW.

The estuary runs approximately 35 km from the Bray Park Weir to its confluence with the ocean at Tweed Heads. The boundary of the Tweed River estuary CMP study area follows the topographical catchment for the Tweed River estuary as shown in Figure 8, with Bray Park Weir (Figure 10) at the upstream extent of the study area on the Tweed River. The study area also includes the Terranora Inlet and Ukerebagh Passage (Figure 9) and the Rous River estuary, i.e. the tidal extent of the Rous River, downstream of Numinbah Road Bridge at Boat Harbour, to its confluence with the Tweed River at Tumbulgum (Figure 10). The study area encompasses the mapped Coastal Environment Area (CEA), Coastal Use Area (CUA) and Coastal Wetland and Littoral Rainforests Area (CWLRA) under the *State Environmental Planning Policy (Coastal Management) 2018* (CM SEPP, refer Section 1.6) along with the adjacent coastal floodplain.

The upper, non-tidal catchment areas of the Tweed and Oxley Rivers are not part of the primary study area, however activities or processes occurring in the catchment have been shown to affect the coastal hazards, ecosystem health, cultural heritage and/or community use of the main estuary. Similarly, areas of the floodplain beyond the mapped boundary of the CEA, CUA and CWLRA include hazards and processes which can significantly impact on estuary health. As such, actions have been included that address key risks from upper non-tidal catchment areas and floodplains.

The study area also excludes the Cobaki and Terranora systems upstream of Boyds Bay Bridge. An existing Coastal Zone Management Plan (CZMP) is in place for the Cobaki Broadwater and Terranora Broadwater (AWC, 2010) and the sufficiency and validity of the CZMP is recognised by the Tweed Coast and Waterway Committee (TCWC) in appropriately managing these areas. The Cobaki and Terranora CZMP will be reviewed at the completion of its ten-year implementation period and if necessary, updated to bring it into line with the *Coastal Management Act 2018* and *SEPP (Coastal Management) 2018*.

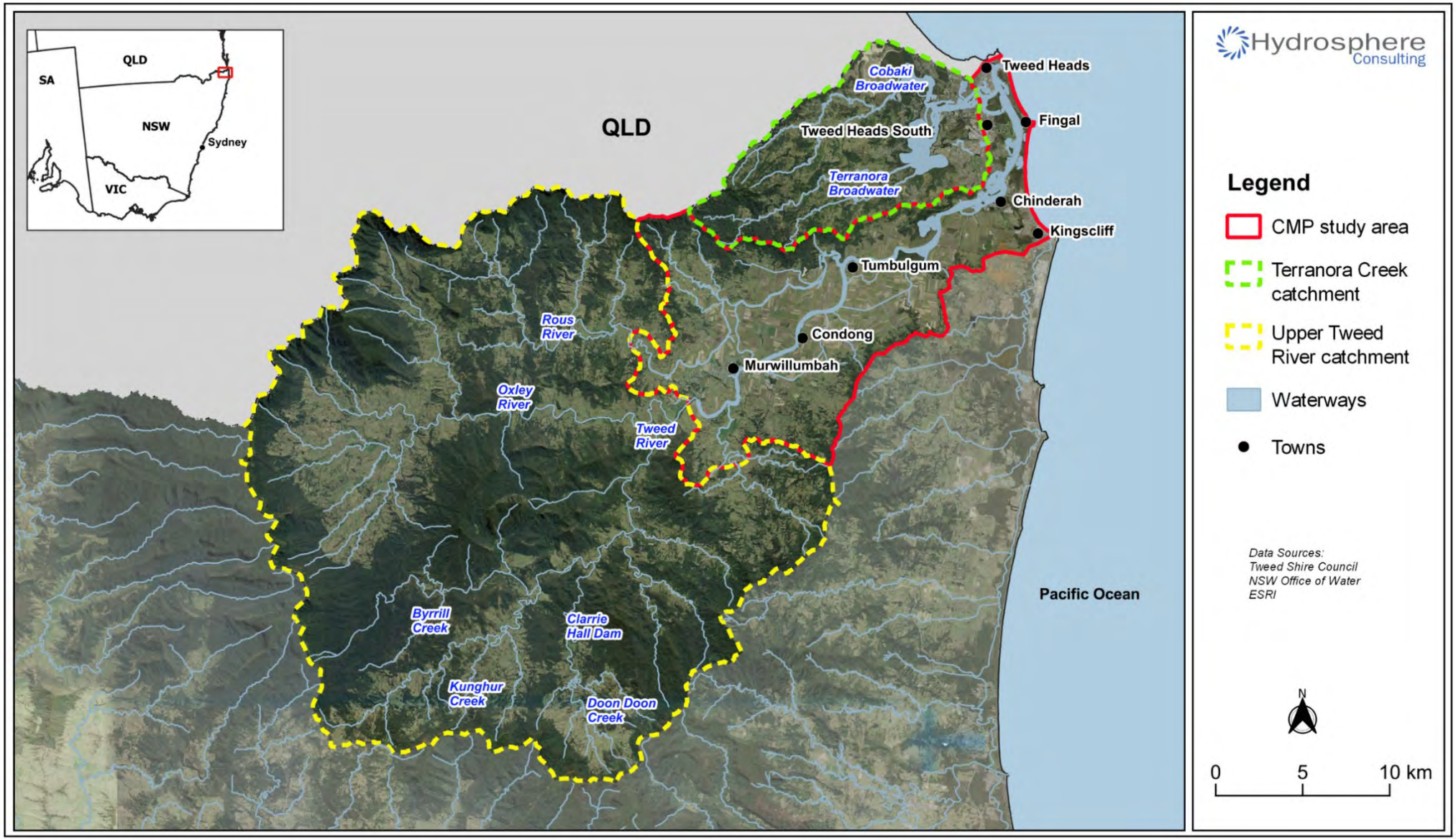

Figure 8: Tweed River catchment, major waterways and study area for the Tweed River estuary CMP

Figure 9: The lower Tweed River estuary showing Terranora Inlet, Ukerebagh Passage (lower right of image) and Nature Reserve and the ocean entrance at Tweed Heads

Source: TSC (2003)

Figure 10: The upper Tweed River estuary aerial view from Byangum across the floodplain to Tumbulgum showing Bray Park Weir, Murwillumbah and the Rous River estuary.

Source: Google Earth Pro (2017)

The open coast of the Tweed Shire LGA, from Duranbah Beach, Tweed Heads, to just south of Wooyung are also excluded from this CMP, other than where activities or processes occurring on the open coast have been shown to affect the coastal hazards, ecosystem health, cultural heritage and/or community use of the main estuary (e.g. the Tweed River Estuary Sand Bypassing Project (TRESBP) and tidal processes affected by oceanic processes or erosion in the lower estuary).

1.2. CMP Timeframe

Mandatory Requirement 2 of the *Coastal Management Manual* (OEH, 2018b) specifies that "*A CMP is to consider a range of timeframes and planning horizons including immediate, 20 years, 50 years, 100 years and (if council considers it relevant based on expert advice) beyond*." Whilst this CMP provides a strategic plan for the ten-year period from 2020 to 2029, it includes actions that will need to be commenced within this ten-year timeframe (e.g. planning measures and design requirements) to mitigate and adapt to emerging and intensifying risks which are beyond the timeframe of the CMP.

The risk assessment of threats and opportunities (refer Section 3.1 and Appendix C) undertaken in developing management actions considered potential future risks such as climate change, sea level rise, changing agricultural activities on the floodplain, expansion of urban and rural development and water resource development (Hydrosphere Consulting, 2017b). The following long-term planning timeframes were considered for specific studies:

- Barriers to migration of intertidal macrophytes with sea level rise – 2080 planning timeframe in accordance with Council's adopted sea level rise scenario for coastal planning purposes at the time of that assessment; and
- Tidal inundation assessment (BMT WBM, 2019) – present day, 2030, 2050, 2080 and 2120 for three sea level rise projections (RCP2.5, 6.0 and 8.5 respectively) outlined in CSIRO and BoM (2015) and both with and without upkeep of existing floodplain infrastructure).

1.3. Structure of this Coastal Management Program

The main body of this CMP describes the coastal management context, community values, issues and threats facing the Tweed River estuary, as well as the recommended management actions, their costs and timing. The main sections of the document are as follows:

- Section 1: Introduction: describes the study area and location of mapped coastal management areas (CMAs), the status of previous management actions, the coastal management planning process, the management context and community and stakeholder consultation activities and outcomes;
- Section 2: Snapshot of Issues: provides a summary of key estuary processes and estuary health status, key issues and threats affecting the health of the estuary;
- Section 3: Management Actions: presents a risk assessment to assist with prioritisation of responses, discusses the potential range of management responses, the management strategy and the recommended CMP actions;
- Section 4: Business Plan: provides the recommended funding strategy for CMP implementation in line with Council's IP&R Framework and Delivery Program; and
- Section 5: Monitoring, Evaluation and Reporting Program.

Additional background information is provided in appendices and detailed supporting studies undertaken to inform and guide the development of the CMP.

Appendices:

- Appendix A – Mandatory Requirements of the NSW Coastal Management Manual

- Appendix B – Status of Previous Related Management Plans and Programs;
- Appendix C – Risk Assessment;
- Appendix D – Links to the Objects of the *Coastal Management Act 2016* and the *Marine Estate Management Act 2014*; and
- Appendix E – Links to the Marine Estate Threat and Risk Assessment and to the Marine Estate Management Strategy.

Detailed Supporting Studies:

- *Coastal Management Program for the Tweed River Estuary: Literature Review* (Hydrosphere Consulting, 2017a);
- *Coastal Management Program for the Tweed River Estuary: Assessing the Impacts of Future Catchment Development* (Hydrosphere Consulting, 2017b);
- *Coastal Management Program for the Tweed River Estuary: Coastal Hazards and Risk Identification and Assessment Report* (Hydrosphere Consulting, 2020a);
- *Coastal Management Program for the Tweed River Estuary: Community Values Study* (Hydrosphere Consulting, 2017c);
- *Coastal Management Program for the Tweed River Estuary: Ecological Assessment* (Hydrosphere Consulting, 2019);
- *Coastal Management Program for the Tweed River Estuary: Recreational Use Study and Strategy* (Hydrosphere Consulting, 2017d);
- *Coastal Management Program for the Tweed River Estuary: Water Quality Assessment and Improvement Strategy* (Hydrosphere Consulting, 2018);
- *Coastal Management Program for the Tweed River Estuary: Community Engagement Strategy* (Hydrosphere Consulting, 2017e);
- *Coastal Management Program for the Tweed River Estuary: Key Management Issues and Threats (Hydrosphere Consulting 2021); and*
- *Tweed Coastal Management Program Stage 1 Scoping Study* (Water Technology, 2020).

This CMP also draws on technical information from previous studies and plans prepared for the management of the Tweed River estuary, in particular the *Lower Tweed Estuary River Management Plan* (PWD, 1991) and the *Upper Tweed Estuary Management Plan* (TRMPAC, 1996) as discussed in the following section.

1.4. Previous Estuary Management Programs

1.4.1. Lower Tweed Estuary River Management Plan and review

The *Lower Tweed Estuary River Management Plan* (EMP) was prepared by Public Works in 1991. The study area of the Plan extends from the ocean entrance to Barneys Point Bridge and included the Cobaki and Terranora Broadwaters. The overall goal for management of the lower estuary in the 1991 EMP was:

"…to sustain and enhance a healthy estuarine system."

Management objectives were also developed to address the primary areas of concern:

- Fishery – to preserve and enhance the river as a fish nursery and habitat area and thereby sustain and hopefully enhance current levels of productivity;

- Ecology – to enhance the extent and value of habitat areas;
- Visual amenity – to preserve or improve the visual amenity of the river and its immediate surrounds;
- Recreation – to encourage recreation in suitable areas including planning for future needs;
- Navigation – to maintain navigation channels;
- Heritage – to ensure development proposals are cognisant of areas of archaeological significance;
- Discharges – to minimise the adverse water quality impact of all point source and diffuse pollution loads; and
- Implementation – to maximise public involvement and establish an effective means of implementation and monitoring.

The outcomes of the EMP were based on a series of technical studies in the disciplines of ecology, influent impact, hydrodynamics, recreation, archaeology and visual assessment.

A variety of options (structural and non-structural measures) were compiled from the technical studies to address the above management objectives. The lower estuary was divided into eighteen areas which include the waterway and adjacent foreshore land. In each of these areas, specific consideration has been given to shoaling problems, visual amenity, habitat value, recreational potential and the impacts of urban runoff.

1.4.2. Upper Tweed Estuary Management Plan (1996)

The *Upper Tweed Estuary Management Plan* was prepared in 1996 by the Tweed River Management Advisory Committee. The study area of the Plan extends from Barneys Point Bridge to Bray Park Weir at Murwillumbah and includes the tidal extent of the Rous River. The objective for the Upper Tweed EMP was:

"…to provide an integrated programme of works and measures which will:

- *identify, enhance, and protect significant habitat areas;*
- *protect heritage areas;*
- *provide integrated waterway and foreshore recreational facilities;*
- *increase foreshore facilities for walking, fishing, and picnicking;*
- *encourage boating activities;*
- *provide opportunities for ecology-oriented recreation e.g. canoe trails and wetland boardwalks as well as the development of environmental awareness/education facilities;*
- *address riverbank erosion in key areas*
- *improve water quality in the areas upstream of Stotts Is., particularly in the Rous River;*
- *minimise acid soil impacts; and*
- *conserve the magnificent scenic qualities of the river."*

A variety of options (structural and non-structural measures) were developed as part of the EMP to address the above management objectives. Management tasks were then proposed to address the primary management issues of pollution, siltation, recreation and ecology.

1.4.3. Review of Tweed River Estuary Management Plans

Reviews of the Tweed River EMPs were undertaken in 1997 (Lower River EMP only) and 2001 (both EMPs). The 1997 review provided a summary of actions undertaken by the Tweed River Committee in the Lower

River 5 years after completion of the plan. It documents further actions required by the committee and included re-prioritisation of actions based on current conditions.

The 2001 review addressed income and expenditure over the ten years and made suggestions about how future expenditure might best be directed. The review found that approximately $3 million had been expended on implementation over the ten years from 1991 to 2001 (CARE Engineering, 2001). A further $1.25 million was available for the 2001/2002 year and subsequent years. The NSW Treasury had contributed the majority of funds for the works with Council contribution estimated as just $320,000 in administration expenditure. At the time of the review, the majority of works had been directed to the area downstream of Barneys Point Bridge and this was attributed largely to the five-year head start for the lower estuary EMP. Problems with implementation of the plan were identified with regard to Tonys Island, Fingal Peninsula Wetlands and Cobaki Wetlands and Ukerebagh Passage. In these locations it was reported that little result had been achieved despite considerable effort. The review recommended no further significant project expenditure in these areas without written agreement from relevant parties to ensure outcomes could be realised. The review also provided broad recommendations and direction for future expenditure and future funding sources for estuary management. These included directing more effort to the upper estuary actions.

To assist in the development of this CMP, an assessment of the status of actions from both the 1991 and 1996 EMPs was undertaken, as provided in Appendix B and Hydrosphere Consulting (2017a).

1.5. Background to the Coastal Management Program

In 2015/16 TSC received funding through the NSW Government Coastal and Estuary Grants Program to develop a new plan of management to capture changing views within the community as to how the estuary should be managed. This CMP for the Tweed River estuary aims to achieve integrated management of the estuaries, consistent with the principles of ecologically sustainable development, the aspirations of the community and the 12 high-level statutory objects of the *Coastal Management Act, 2016*. The CMP has been prepared in accordance with the *Coastal Management Manual* (OEH, 2018b). The CMP was completed in consultation with DPE.

The CM SEPP commenced in 2018 establishing a new, strategic land use planning framework for coastal management and support implementation of the management objectives set out in the *Coastal Management Act, 2016*. The *Coastal Management Manual* (OEH, 2018b) provides guidance for developing a CMP and assists councils in addressing the requirements of the *Coastal Management Act, 2016*. The manual outlines the mandatory requirements and provides guidance on the preparation, development, adoption and content of a coastal management program. It includes a process for councils to follow when identifying and assessing the vulnerability of coastal environmental, social and economic values and evaluating management actions. It also contains guidance on the integration of a CMP into Council's Integrated Planning and Reporting (IP&R) framework and land use planning. The manual outlines a five-stage process for developing and implementing a CMP (Figure 11).

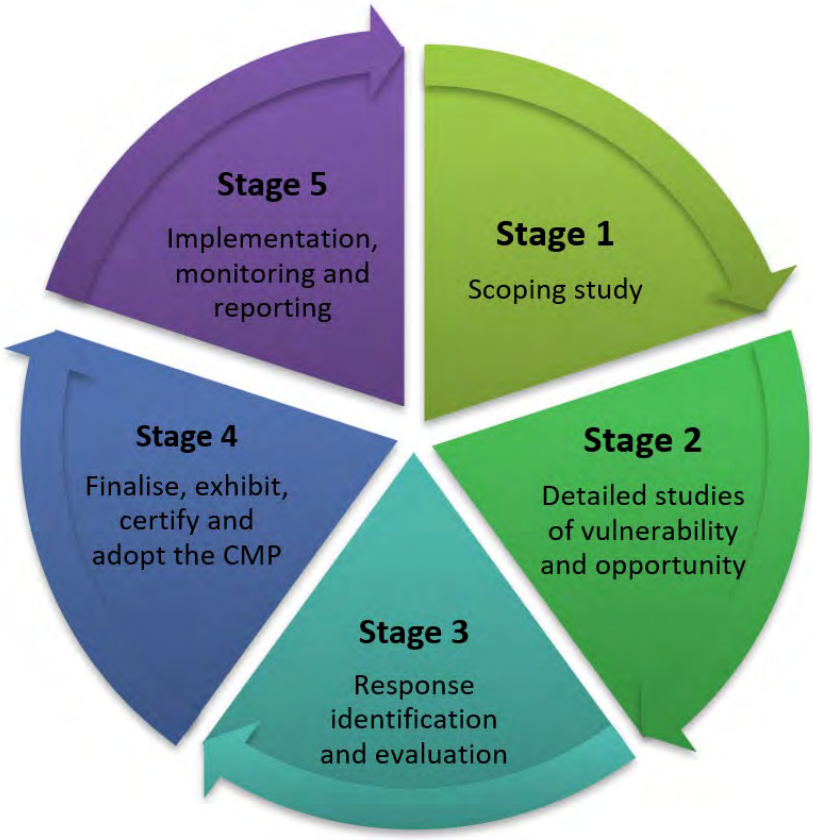

Figure 11: Five stage process for developing a coastal management program.

Source: OEH (2015)

The five steps have been applied to this CMP as discussed below and shown in Figure 12:

- Stage 1: Scoping study – TSC and DPE provided a list of detailed studies and stakeholder engagement requirements as part of the project brief. A Literature and Information Review (Hydrosphere Consulting, 2017a) and an audit of current management practices (Appendix B) also identified gaps in the current knowledge and management approaches to be addressed in the development of the CMP. At the request of DPE, a Scoping Study (TSC, 2018) was subsequently prepared drawing heavily on these documents and reviewed by DPE under the *draft Coastal Management Manual* (OEH, 2015) current at that time. The original Scoping Study (TSC, 2018) has since been superseded by a more recent shire-wide Scoping Study (Water Technology, 2020). All references to the Scoping Study from herein refer to Water Technology (2020).
- Stage 2: Community and stakeholder consultation activities (summarised in Section 1.9) and detailed studies of estuary processes and health status (summarised in Section 2), vulnerabilities (summarised in Section 2.2) and potential management opportunities (Section 3).
- Stage 3: Response identification and evaluation – Strategic responses to the identified threats have been developed using a risk assessment methodology based on the *Threat and Risk Assessment Framework for the NSW Marine Estate* (Marine Estate Management Authority, 2015). The threats to the estuary values have been prioritised based on the risk (a combination of likelihood of a threat occurring and consequence of the threat) they pose to community values, so that management efforts can focus on addressing the most important issues. This is designed to assess the adequacy of current management approaches and alternative options for addressing priority threats and implement the most cost-effective management actions to address the threats (refer Section 3.1);
- Stage 4: Preparing, exhibiting, finalising, certifying and adopting a CMP – A range of responses to the identified threats have been developed from the assessed level of risk and the timeframe and

spatial extent of the threats. The proposed actions and strategic management approach are provided in Section 3. The draft CMP was publicly exhibited as per the *Community and Stakeholder Engagement Strategy* (Hydrosphere Consulting, 2017e) and Council has considered feedback received in finalisation of the CMP. As it is intended that the CMP will be submitted to the Minister for Environment for certification, the CMP has been developed according to the mandatory requirements of the *Coastal Management Manual* (OEH, 2018b) (refer Appendix A). The CMP provides several strategy statements including:

- Implementation Strategy (Section 3.3.1);
- Recreational Use Strategy provided as a component of the *Recreational Use Study* (Hydrosphere Consulting, 2017d) and summarised in Section 3.3.2;
- *Water Quality Improvement Strategy* provided as a component of the *Water Quality Assessment* (Hydrosphere Consulting, 2018) and summarised in Section 3.3.3; and
- Dredging Strategy Statement (Section 3.3.4).

- Stage 5: Implementation, monitoring, evaluating and reporting – The proposed actions and strategic management approach for implementation of the CMP in alignment with Council's IP&R Framework is provided in Section 1.8.5 and Section 4, along with Monitoring, Evaluation and Reporting requirements Section 5.

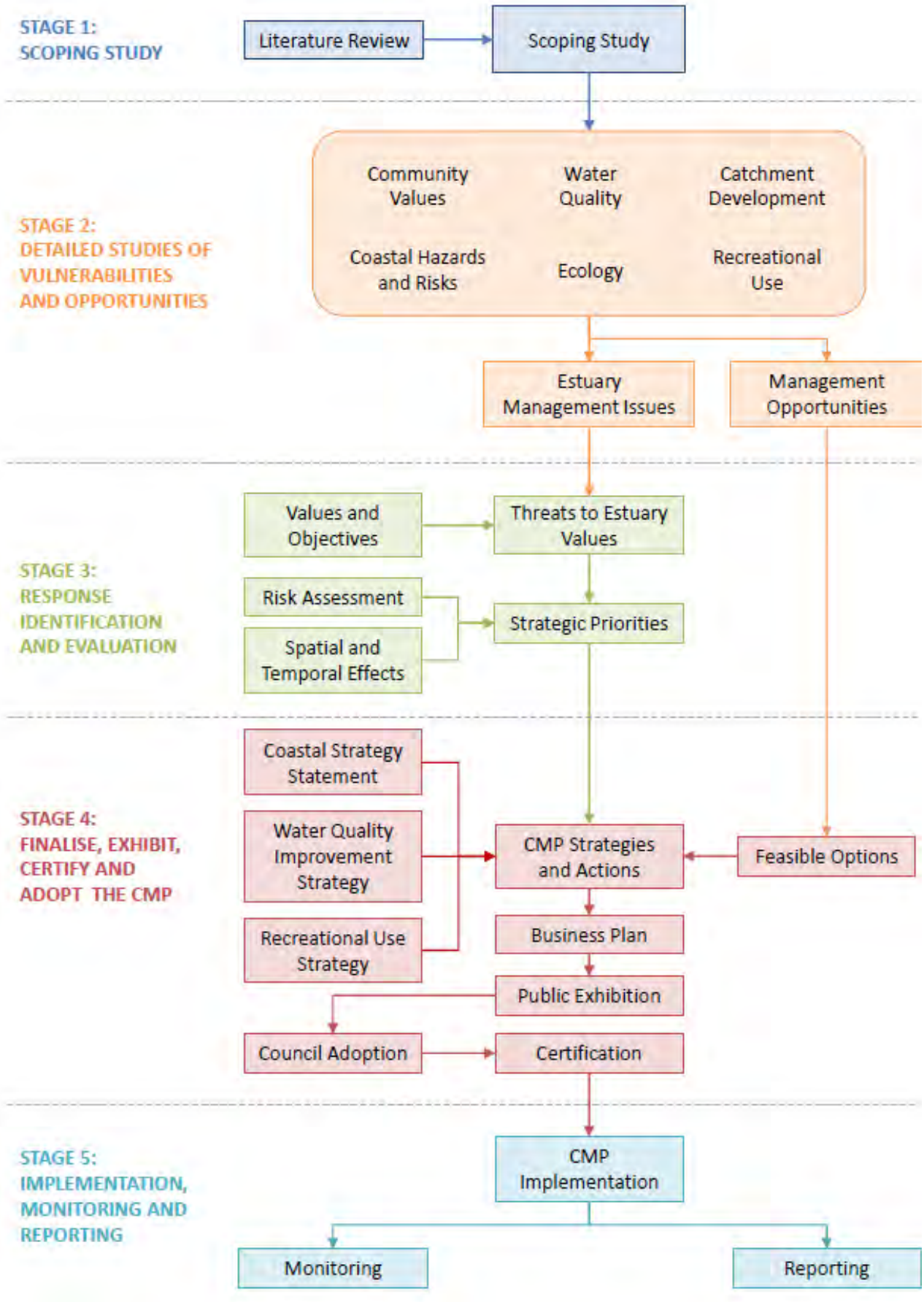

Figure 12: Development of the Tweed River estuary CMP

1.6. Coastal Management Areas

The *Coastal Management Act, 2016* re-defines the definition of the coastal zone from the *former Coastal Protection Act, 1979* and describes four coastal management areas (CMAs) which have specific management objectives. The CMAs currently mapped within the study area are shown in Figure 13 and described as follows:

- Coastal Wetlands and Littoral Rainforests Area (CWLRA) – based on areas which display the characteristics of coastal wetlands or littoral rainforests previously protected under SEPP 26 and SEPP 14 (updated to account for natural changes in their boundaries and distribution) with the addition of a 100 m proximity (buffer) area. Within the study area, this CMA includes numerous small areas of littoral rainforest primarily along the shores of Banora Point and the Fingal Peninsula as well as patches along the hillsides of Point Danger at the entrance. Significant areas of coastal wetlands occur within the estuary, primarily downstream of the Rous River confluence with the Tweed River as well as several small patches towards the upper limits of the estuary.
- Coastal Vulnerability Area (CVA) – although the CVA is not currently mapped in the CM SEPP, the study area is subject to coastal hazards including current and future beach erosion, shoreline recession, entrance instability, coastal inundation, tidal inundation, coastal cliff or slope instability and foreshore tidal erosion.
- Coastal Environment Area (CEA)– areas that are characterised by natural coastal features such as beaches, rock platforms, undeveloped headlands, coastal lakes and marine and estuarine waters. The area is based on the coastal zone as previously defined under the *Coastal Protection Act 1979*, with some modification to include land around coastal lakes. The area is made up of estuaries, beaches, dunes, coastal lakes and lagoons and undeveloped coastal headlands and rock platforms. The CMA is mapped to the extent of the tidal limit and landward to 500m within this study area. Within the study area, this CMA encompasses the entire Tweed River estuary and Rous River estuary but excludes some wetland areas (otherwise mapped as Coastal wetlands and littoral rainforest areas and their proximity area), primarily on the Chinderah-Kingscliff floodplain as well as several smaller wetland areas in the upper estuary.
- The Coastal Use Area (CUA)– land adjacent to coastal waters, estuaries and coastal lakes and lagoons. Within the study area, this CMA extends 250 m landward from the estuary and sits within the coastal environment area. Similarly, some areas of wetlands are mapped separately.

This CMP has been developed to address threats and risks to the CMAs shown in Figure 13 and examines where current and future coastal hazards are expected to impact on the study area. The existing CM SEPP mapping is considered suitable for the management of the Tweed River Estuary and no changes to existing CMA mapping are proposed by this CMP.

CM SEPP mapping is currently not available for the coastal vulnerability area. The elements related to a potential coastal vulnerability area addressed in this CMP comprise those relevant to the estuary, i.e. estuary foreshore/bank erosion, tidal inundation and entrance instability. Bank erosion and tidal inundation have been mapped as coastal hazards in this CMP. Entrance management is also discussed in Hydrosphere Consulting (2021). Further review of the suitability of the mapped coastal management area and consideration of inclusion of a coastal vulnerability area will be undertaken during the CMP implementation phase (refer Section 3.6).

Digital mapping of these CMA areas is also available for higher resolution viewing online at:
http://webmap.environment.nsw.gov.au/PlanningHtml5Viewer/?viewer=SEPP_CoastalManagement

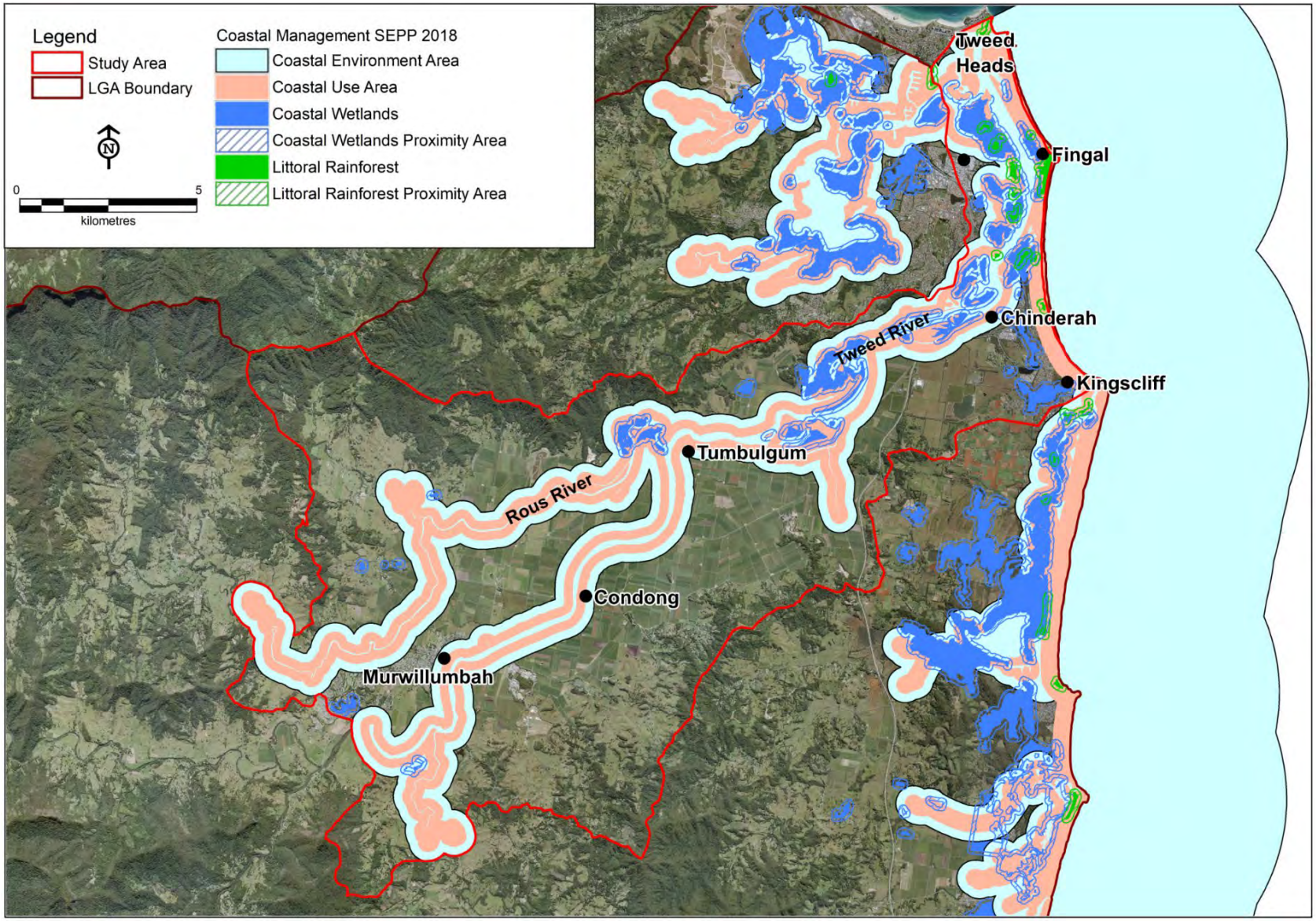

Figure 13: Coastal Management Areas within Tweed Shire and the CMP study area

Source: Coastal SEPP Mapping (NSW DP&E, 2018); base data (TSC, 2018).

1.7. Vision and Coastal Management Objectives

The purpose of a CMP is to set the long-term strategy for the coordinated management of land within the coastal zone with a focus on achieving the objects of the *Coastal Management Act 2016* (refer Appendix D).

The Tweed River estuary CMP provides a management framework to guide coastal management and planning for the Tweed River estuary, in response to the relevant objectives for each coastal management area from the *Coastal Management Act, 2016* (Table 3). The CMP also focuses on the protection of specific local objectives (Table 3), based on the community values for the estuary.

Table 3: Coastal Management Area objectives adopted from the *Coastal Management Act, 2016*

Coastal Management Areas	Coastal Management Area objectives
Coastal Wetlands and Littoral Rainforests (CWLRA)[1]	1. To protect coastal wetlands and littoral rainforests in their natural state, including their biological diversity and ecosystem integrity; 2. To promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests; 3. To improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration; 4. To support the social and cultural values of coastal wetlands and littoral rainforests; and 5. To promote the objectives of State policies and programs for wetlands or littoral rainforest management.
Coastal Vulnerability Area (CVA)	6. Managing current and future risks from foreshore/bank erosion, coastal lake instability and tidal inundation; 7. Maintaining public access, use and amenity of foreshores; 8. Encourage land use that reduces exposure to coastal hazards over time; 9. Avoiding adverse impacts on adjoining land, resources, and assets; 10. Maintaining essential infrastructure; and 11. Improving the resilience of coastal communities.
Coastal Environment Area (CEA)	12. To protect and enhance the coastal environmental values and natural processes of the estuaries; 13. To enhance natural character, scenic value, biological diversity, and ecosystem integrity; 14. To reduce threats to, and improve the resilience of the estuaries; 15. To maintain and improve water quality and estuary health; 16. To maintain the presence of natural features of foreshores; and 17. To maintain and, where practicable, improve public access, amenity and use of estuary foreshores.
Coastal Use Area (CUA)	18. To support sustainable coastal economies and ecologically sustainable development; and 19. To protect and enhance the scenic, social, and cultural values of the study area through: • appropriate type, size, and scale of development; • providing adequate public open space and associated public infrastructure; and • avoiding adverse impacts of development on cultural and built environment heritage.

1. Objectives also apply to the 'proximity area' surrounding the vegetated area, to ensure that development near the coastal wetlands and littoral rainforest considers downstream effects.

The long-term vision for the estuary, the community values for the estuary and specific, local objectives relevant to those values are based on four main sources of information:

- The values, threats and management priorities identified in the *Community Values Study* (Hydrosphere Consulting, 2017c) incorporating the findings of the community surveys;
- A Tweed Coast and Waterway Committee's Vision Workshop "top of mind" exercise undertaken in May 2017;
- The relevant management objectives set out in the *Coastal Management Act 2016*; and
- The objectives of the TSC *Community Strategic Plan 2011 – 2021*.

The long-term vision for the Tweed River estuary developed by the Tweed Coast and Waterways Committee (TCWC) is:

"The Tweed River estuary is a special place:
a healthy ecosystem supporting lifestyles, culture and productivity"

The key values of the estuary held by the local community, along with locally specific objectives determined for those values are provided in Table 4. The alignment of these objectives with the objects of *the Coastal Management Act 2016* and the objects of the *Marine Estate Management Act 2014* is identified in Appendix D.

The CMP incorporates management actions and strategies to support a diversity of uses into the future. Strategies have been developed to balance and manage uses so that they are compatible with the environmental, social and economic values of the estuary. Longer-term pressures such as climate change and sea level rise have been considered in the formulation of management actions to ensure resilience against future threats and the conservation of the values of the estuary for future generations.

Figure 14: Natural habitat of the Tweed River estuary, mid estuary and Ukerebagh Passage in the lower estuary

Table 4: Locally specific Tweed River estuary management values and objectives

Values of the CMP study area	Locally specific CMP objectives for the Tweed River estuary
Environmental Values	
Natural habitats and biodiversity	Protect, restore and enhance natural habitats and their connectivity, including littoral rainforests, coastal wetlands, riverbanks, riparian vegetation and fish habitat. Improve the capacity of the estuary to withstand and recover from intense weather events and adapt to future increases in tidal inundation, by allowing for migration of fringing habitats with sea level rise.
Stable riverbanks	Increase resilience of riverbanks to erosion. Stabilise eroding banks using techniques that increase habitat value and enhance amenity. Manage riverbank erosion by bank rehabilitation and through encouraging compatible use of the waterway and riparian zone.
Water quality	Improve water quality by reducing the inflow of nutrients, acid runoff, sediments, faecal contamination and treated effluent. Achieve greater compliance with Tweed River Flow Objectives and Water Quality Objectives and ensure that river water is clean and safe and can support abundant native aquatic life and safe recreational uses.
Social and Recreational Values	
Public access to and use of the river and foreshore	Improve public access to the river and foreshore for both land and water-based activities. Provide and maintain a diverse range of user appropriate, well connected and easily accessed open space and facilities. Reduce user conflicts.
Coastal risk and adaption to climate change	Identify coastal hazard risks and develop actions that increase the adaptive capacity of Council, the community and natural systems to the predicted impacts of climate change, including increased storm intensity and sea level rise.
Recreational fishing	Improve recreational fishing opportunities by protecting fish habitat, improving fish passage and increasing water quality. Enhance foreshore fishing opportunities and promote sustainable fishing practices.
Scenic quality and amenity	Protect and enhance the quality of views to and from waterways and foreshores through appropriate designs and measures to mitigate visual impacts of development and other uses.
Education, engagement and public opinion	Increase engagement with the community and other stakeholders to improve understanding of the river ecosystem, its condition and key threats and benefits associated with appropriate use of the waterways.
Aboriginal cultural heritage and practice	Protect cultural sites and promote Aboriginal cultural values of the estuary through education and sustainable use of the estuary.
Commercial Values	
Economic prosperity	Protect and increase the economic prosperity and sustainability of industries supported by the estuary.
Agricultural productivity	Encourage and promote sustainable agricultural activities and enhance productivity through education, adoption of best management practices and adaption to social, economic and environmental changes.

Figure 15: Scenic quality of the Tweed River at sunset and in the early morning

1.8. Management Context

The Tweed River estuary catchment consists of many different land uses and a range of natural and modified landscapes. These include farming land, extractive industries, waste disposal facilities, coastal wetlands, National Parks and Reserves, Crown land, Council reserves, recreational areas, urban areas and rural-residential areas.

1.8.1. Public Agencies

The estuary is managed and regulated by the following organisations:

- TSC is responsible for the management of public spaces, assets and facilities around the Tweed River estuary. The Tweed Local Environmental Plan (LEP) 2014 and LEP 2012 guide planning decisions within the LGA. Council is also responsible for the operation of the Tweed Shire water supply and sewerage systems, stormwater, roads, floodgates and other public assets and has a key role in managing the environment consistent with the principles of ecologically sustainable development. TSC manages the bed of the Oxley Cove and Anchorage Island Estate waterways as well as significant areas of Crown land along the estuary foreshores, managed as Community Land under the *Local Government Act 1993*;
- The NSW Department of Planning, Industry and Environment, hereafter, DPE – Crown Lands, is responsible for the sustainable management of the Crown land estate in accordance with the *Crown Land Management Act 2016* which encompasses the dry land and the submerged land of the State's waterways 5.5 km out to sea and includes the ocean floor, most coastal estuaries, many large riverbeds and some coastal wetlands. The majority of rock walls in the lower estuary are wholly or partially located on Crown land. DPE – Crown Lands also manages the TRESBP on behalf of the NSW and Queensland Governments under specific legislation;

  Note that where CMP actions are considered or proposed in, on or adjacent to public land and boundaries are not already marked, boundaries of public land may need to be identified by survey.

  Where works or actions are proposed or to be implemented on Crown land, not under Council management, an appropriate authorisation from DPE – Crown Lands will be required prior to the works commencing. Authorisations under the *Crown Land Management Act 2016* will be particularly relevant where works or actions are proposed to be implemented on Crown land not under Council management. Authorisation may be provided by way of licence or potentially the appointment of Council as the reserve manager to streamline future management arrangements. This issue may be

relevant to a number of actions in the CMP. Note that adequate lead time (at least six months) is required for the Department to assess and issue authorisation (licence) works on Crown land.

Whilst there are currently no native titles, native title claims, or indigenous land use agreements (ILUAs) over part of the study area, where actions are proposed on Crown land, consideration of any Aboriginal Land Claims, at that time, lodged under the *Aboriginal Land Rights Act 1983* (NSW) will need to be undertaken. Any works will need to be compliant with the *Native Title Act 1993* (Cth).

NSW Transport for NSW – Maritime (TfNSW – Maritime) manages boating, navigation infrastructure, oil spill and vessel-based pollution and the Pacific Highway and associated infrastructure which crosses the lower estuary at Banora Point. They are responsible for the delivery of a number of programs relevant to the Tweed River including:

- NSW Maritime Infrastructure Plan 2019-2024 (i.e. management of lower Tweed River estuary break walls and training walls); and
- Coastal Dredging Strategy and Boating Access Dredging Grants Program.

- The NSW Department of Primary Industries – Fisheries (DPI Fisheries) administers *the Fisheries Management Act 1994* (FM Act) and the *Marine Estate Management Act 2014* (MEM Act). Under the FM Act, DPI Fisheries is responsible for ensuring that fish stocks are conserved and that there is "no net loss" of key fish habitats upon which they depend. DPI Fisheries achieves this through regulating recreational and commercial fishing and assessing activities under Part 4 and Part 5 of the *Environmental Planning and Assessment Act 1979* that are located on or adjacent to key fish habitats in accordance with the objectives of the FM Act, the aquatic habitat protection and threatened species conservation provisions in Parts 7 and 7A of the FM Act and the associated and Policy and Guidelines for Fish Habitat Conservation and Management (2013 Update). Key fish habitats include third order and greater freshwater waterways, Coastal Wetlands and tidal waters up to the Highest Astronomical Tide (HAT) level;

  Under the MEM Act, DPI Fisheries is responsible for ensuring strategic and integrated management of the whole marine estate – marine waters, coasts and estuaries. The MEM Act does this by:

  - Providing for the management of the marine estate consistent with the principles of ecologically sustainable development;
  - Establishing two advisory committees, a Marine Estate Management Authority and Marine Estate Expert Knowledge Panel;
  - Requiring the development of a Marine Estate Management Strategy (MEMS) to address priority threats identified through threat and risk assessment;
  - Facilitating the maintenance of ecological integrity and economic, social, cultural and scientific opportunities;
  - Promoting the coordination of government programs; and
  - Providing for a comprehensive system of marine parks and aquatic reserves.

- The Marine Estate Management Authority (MEMA) functions under the MEM Act to advise the NSW Government on the management of the NSW Marine Estate. MEMA brings together the heads of the four NSW Government agencies with key marine estate responsibilities (DPI Fisheries, DPE– Coast and Estuaries, DPE – Planning and Environment and TfNSW) and undertakes threat and risks assessments, develops management strategies, promotes collaboration between public authorities and fosters consultation with the community. TSC will partner with MEMA to implement relevant MEMS actions that address priority threats and risks and to seek funding where relevant, over the life of the ten-year CMP;

- The North Coast Local Land Services (LLS) (formerly Catchment Management Authority) plays a key role in the management of catchment activities and natural resources relevant to the Tweed River estuary and surrounding lands;
- DPE– Coast and Estuaries works closely with local councils and communities to reduce threats from flooding and coastal storms and ensure that people in NSW are well informed about these risks and better equipped to adapt to climate change. DPE– Coast and Estuaries also works with local councils and communities to maintain or improve the health of estuaries;
- The NSW Environment Protection Authority (EPA) licenses and regulates the operation of industrial premises including:
    - Wastewater treatment plants at Banora Point, Tumbulgum and Murwillumbah;
    - Condong Sugar Mill;
    - Commercial sand extraction in the upper estuary;
    - Stotts Creek Resource Recovery Centre; and
    - Quarries at Environ Road, Harrys Road, Dulguigan and Stotts Creek.
- The National Parks and Wildlife Service (NPWS) manages the Ukerebagh Nature Reserve, Tweed Heads Historic Site, Stotts Island Nature Reserve, Mount Nullum Nature Reserve and Mooball National Park in accordance with the objectives of the *National Parks and Wildlife Act 1974* and associated Plans of Management (PoM); and
- The Department of Planning, Industry and Environment – Water, hereafter DPE – Water is responsible for managing access to surface and groundwater in accordance with the *Water Sharing Plan Tweed River Area Unregulated and Alluvial Water Sources.*

1.8.2. Community Stakeholders

Many community and business organisations have a role in the management of the catchment including:

- The TCWC – formerly the Tweed Entrance Community Liaison Committee established by Council in 1989, the Tweed River Management Plan Advisory Committee and the Tweed River Committee (TRC). The TCWC is a stakeholder based advisory committee consisting of Council, government agency, community and industry representatives. The committee is the peak strategic-level advisory committee to TSC regarding ecological health, coastal hazard risk and recreational use of the Tweed coast and waterways. The TCWC's role is to advise Council on the preparation and implementation of long-term, strategic-level coast and estuary management plans and works, including this CMP;
- The Tweed Byron Local Aboriginal Land Council (TBLALC) manages Aboriginal heritage interests in the Tweed and owns a large part of the Fingal Peninsula in the lower estuary;
- The Tweed Aboriginal Advisory Committee (AAC) is the peak advisor to Council on Aboriginal matters. The primary objective of the AAC is to provide advice to Council in order to encourage and facilitate the development of the Tweed Aboriginal and Torres Strait Islander Community in the Tweed Shire;
- The Tweed Cane Growers Association includes members of the cane industry in the Tweed Valley;
- The Gold Coast Airport, although situated outside of the study area, is partly located within the upper catchment of the Tweed River estuary. The airport is managed by the private company Gold Coast Airport Pty Ltd. It is situated on Commonwealth land and governed primarily by Federal legislation; and
- Tweed Landcare is a community-based organisation which has been active in weed management and revegetation activities on private land within the catchment.

1.8.3. Prior and Ongoing Investigations, Policy and Projects

Management programs prepared by TSC, government agencies, statutory bodies and community groups (Section 3.4) are being implemented in parallel with the preparation of this CMP. Many of these initiatives are related to the management of the Tweed River estuary, foreshore areas and catchment. As there are many organisations responsible for land use management in the study area, effective coordination is required to address management issues. This CMP complements and informs existing and proposed plans of management.

Since the 1991 and 1996 EMPs were prepared, TSC has progressively implemented many of the management actions in those plans, whilst other recommended actions have either been low priority or subject to changing circumstances and legislative requirements.

In addition to the EMPs produced in 1991 and 1996, a range of other initiatives are directly relevant to the management of the Tweed River estuary including management plans and strategies addressing boating and navigation, bank erosion, foreshore structures, sewerage and stormwater, water quality, vegetation, sustainable agriculture and scenic landscapes. These initiatives include:

- *Recreational Management Plan for the Upper Tweed Estuary* (Centre for Coastal Management UNE, 1992);
- A *Spatially Intensive Approach to Water Quality Monitoring in the Rous River Catchment* (Eyre and Pepperell, 1997);
- *Tweed River Estuary Bank Management Plan* (Patterson Britton & Partners, 1998);
- *Sustainable Land Management of Coastal Floodplains-Tweed River* (Riches and Huegill, 2001);
- *Tweed Vegetation Management Strategy* (Ecograph, 2004);
- *Reducing the Impact of Road Crossings on Aquatic Habitat – Tweed Shire* (Department of Primary Industries, 2005a);
- *Tweed Coast Regional Crown Reserve Plan of Management* (Land and Property Management Authority, 2005);
- *Tweed Estuary Boating Plan 2006-2010* (NSW Maritime, 2006);
- *Tweed River Domestic Structures Strategy* (DoL *et al*., 2008) (see below);
- *Bringing Back the Fish – Improving fish passage and aquatic habitat in coastal NSW* (DPI Fisheries, 2009);
- *Tweed River Murwillumbah Reach Bank Enhancement Master Plan* (TSC, 2008a);
- *Tweed River Estuary Recreational Boating Facilities Study* (Patterson Britton and Partners, 2008);
- *Review of Water Quality in the Tweed Estuary 2007-2011* (ABER, 2012);
- *Tweed Valley Floodplain Risk Management Study* (BMT WBM, 2014);
- *Tweed Riverbank Erosion Management Plan* (TSC, 2014);
- *Regional Boating Plan Tweed – Clarence Valley Region* (Transport for NSW, 2015);
- *NSW Maritime Infrastructure Plan 2019-2024* (TfNSW – Maritime, 2018);
- *Tweed Urban Stormwater Quality Management Plan* (AWC and Design Flow, 2016);
- *Tweed Sustainable Agriculture Strategy* (TSC, 2016); and
- *Tweed Scenic Landscape Strategy* (under development).

The *Tweed River Domestic Structures Strategy* in particular was developed by DPE– Crown Lands in conjunction with Tweed Shire Council, DPI Fisheries and DPE – Water. The Strategy provides a consistent and strategic approach for domestic foreshore infrastructure development on Crown land including domestic works on the riverbank and below mean high water mark. The Strategy is the first of its kind in NSW and provides a whole of estuary approach to foreshore management. The Strategy is being used by MEMA as a pilot strategy for the development of an additional eight strategies for rivers in northern NSW under the MEMS. Further information about the *Tweed River Domestic Structures Strategy* is provided in Appendix B.

A further three key actions from the MEMS are proposed for Tweed River floodplain and estuary:

- MEMS Action 2.4.2 - better alignment of existing government policy and resourcing for floodplain and drainage management through data collection and the development of strategic, evidence-based drainage management plans that will streamline and better integrate the existing regulatory framework. The Tweed floodplain is one of eight large coastal floodplains for which MEMA will develop drainage management plans as part of the MEMS;
- MEMS Actions 2.3.2 - development of marine vegetation management plans that maximise resilience, accommodate sea level rise, address key threats (clearing and drainage, cattle grazing, four-wheel driving on saltmarsh), facilitate rehabilitation opportunities and reduce red tape for low impact works. The Tweed is one of two locations in which estuary-wide strategies are proposed; and
- MEMS Action 2.3.3 will develop bank management strategies that aim to improve river health by identifying and requiring best management practices in riverbank remediation works while streamlining the development assessment process for those proposals that are in accordance with a bank management strategy. The Tweed River estuary is one of two locations in which estuary-wide bank management strategies are being implemented.

An assessment of the status of actions from both the 1991 and 1996 EMPs and the above listed initiatives is provided in Appendix B. Actions that were noted as complete or no longer required in these reviews have not been included in the audit. Actions relating to management of the Cobaki and Terranora Broadwater have also been excluded, as they are outside of the study area for the CMP, having been dealt with in the *Cobaki and Terranora Broadwater CZMP* (AWC, 2010).

1.8.4. State and Regional Plans and Policies

North Coast Regional Plan 2036

The *North Coast Regional Plan 2036* (NSW Government, 2017) will guide the NSW Government's land use planning priorities and decisions to 2036. The Plan recognises the spectacular environment and vibrant communities of the region. The plan also recognises the growing influence the increasing south east Queensland population will have on the North Coast. The plan includes a specific action to encourage ongoing cooperation and land use planning between the City of Gold Coast and TSC. Another action specific to the Tweed Shire and potentially the Tweed River estuary is to facilitate appropriate large-scale tourism developments in prime tourism development areas such as Tweed Heads, Tweed Coast, Ballina, Byron Bay, Coffs Harbour and Port Macquarie.

The regional priority identified in the plan specific to Tweed and potentially relevant to the Tweed River estuary is deliver housing in Kingscliff, Cobaki, Bilambil, Terranora and Kings Forest and explore additional Greenfield opportunities at Dunloe Park in Pottsville.

Far North Coast Regional Strategy 2006 – 2031

The purpose of the *Far North Coast Regional Strategy* (NSW Government, 2006) is to manage the region's expected high growth rate in a sustainable manner. The strategy aims to protect the unique environmental assets, cultural values and natural resources of the region while ensuring that future planning maintains the

character of the region and provides for economic opportunities. The plan also aims to manage future growth by preventing the spread of coastal development and encouraging the development of non-coastal centres. The strategy will inform future infrastructure investment priorities for the Far North Coast.

Tweed Local Strategic Planning Statement

The *Tweed Local Strategic Planning Statement* (TSC, 2020) sets out the 20-year vision for land-use planning in the Tweed. It outlines how future development and growth pressures will be managed in accordance with the community's desire to retain the area's high scenic quality, biological and ecological values, iconic natural landscapes, sense of community and relaxed lifestyle. The statement presents a number of planning priorities and associated action, several actions of which align with this CMP, including:

- Protect the Tweed's significant natural environment, resources and landscape qualities, while cultivating sustainable growth and development, which promotes the health and vitality of the community;
- Promote, protect, conserve and enhance the Tweed's high scenic quality, biological and ecological values for future generations and ecosystem health;
- Increase resilience and adapt to the impacts of natural hazards and climate change to ensure our future prosperity and wellbeing;
- Reduce carbon emissions and sustainably manage energy, water, waste and development impacts; and
- Safeguard the fragile coastal strip by protecting a green belt delineation between coastal settlements to limit urban sprawl and conserve natural landscapes.

Tweed Shire Urban Land Release Strategy

The *Tweed Shire Urban Land Release Strategy* (TUELRS) (GHD,2009) identifies a number of potential urban release lands within the Tweed Shire. Some of which are located wholly or partly within the Tweed River Catchment including North Arm, Kielvale and part of the Kings Forest West development. Potential impacts of increased urban areas on the Tweed river estuary are discussed in detail in Hydrosphere Consulting (2017b).

1.8.5. Integration with Council's Integrated Planning and Reporting Framework

The *Coastal Management Act 2016* requires local councils to embed coastal management within the Integrated Planning and Reporting (IP&R) framework established in the *Local Government Act 1993*. This approach will ensure that coastal management needs inform and are informed by, Councils' overall service delivery, financial and asset management planning responsibilities. The IP&R framework is the main mechanism by which councils comprehensively plan for and report on, their asset management and service delivery responsibilities. This will include performance auditing powers to ensure that programs are appropriately implemented and that identified coastal management activities are aligned with broader community strategic plans, reflect community priorities and are feasible, financially viable and able to be resourced.

Council is currently working within a ten-year Community Strategic Plan, 2017 – 2027 which sits above all other Council plans and policies in the planning hierarchy. The CSP identifies long term priorities, outcomes and aspirations for the future of the community and the local government area. Council uses this document to guide and inform their decision making and planning for at least the next ten years. The Delivery Program (four-year cycle) and Operational Plan (one year cycle) describe what parts of the CSP the Council is responsible for and identifies all key activities to be undertaken by Council during their elected term and

which year the activities are to be undertaken. The Delivery Program and Operational Plan are updated on a frequent (typically yearly) basis allowing for incorporation of management actions as required and as opportunities (e.g. funding availability) or emerging risks arise. Council is currently implementing the 2017-2021 four-year Delivery Plan and this is the Delivery Plan cycle within which the CMP will be certified and commenced.

The majority of CMP actions (refer Section 3.5) identified as being led by Council fall within the Natural Resource Management Service Stream of the 2017 – 2021 Delivery Plan. Council's key services that will deliver CMP actions are:

1.1.3 Coastal management;

1.1.4 Environmental sustainability;

1.1.5 Sustainable agriculture;

1.1.6 Waterways and catchment management;

1.2.1 Floodplain management;

1.4.1 Strategic land use planning; and

3.1.10 Pest management.

1.9. Community and Stakeholder Consultation

TSC is committed to open and transparent communication with the public and government agencies in order to ensure that the community's views are appropriately reflected in strategic planning for the Shire. Community and stakeholder consultation is also a key component of the CMP development process and was guided by a project specific communications plan and stakeholder engagement strategy (Hydrosphere Consulting, 2017e). The *Community Values Study* (Hydrosphere Consulting, 2017c) provides details of all activities undertaken from August to December 2016 as part of the initial community consultation phase of the CMP. Key findings of consultation include community values of the estuary, the current concerns and issues and the community's relative priorities for river management.

Consultation activities included the Tweed River Survey – a community phone survey and parallel 'opt-in' online/paper-based survey as well as targeted stakeholder consultation with key stakeholder groups and government agencies. Consultation was undertaken with:

- Community stakeholders:
    - The local Aboriginal community via the AAC and TBLALC;
    - Commercial and recreational fishermen, oyster farmers and seafood wholesalers;
    - Power boat users (Tweed River Ski Club, Tweed River Users Inc.), commercial boaters and river vessel operators (DPE – Crown Lands, Tweed River Users Group, houseboat hire and cruise operators) and recreational boaters (including local rowing clubs);
    - Cane industry representatives (Sunshine Sugar, cane farmers);
    - Environmental groups (Tweed Landcare, Caldera Environment Centre, Birdlife Northern Rivers); and
    - Destination Tweed (tourism).
- Government stakeholders:
    - Council – Councillors and Council staff;
    - DPE (regarding estuary health, National Parks, shorebirds, cultural heritage);

- NSW DPI (Fisheries);
- DPE – Crown Lands (regarding Crown Reserves, Crown land management and dredging licences);
- TfNSW – Maritime;
- LLS (catchment management);
- Marine Rescue; and
- Local Members of Parliament.

A project webpage was used to provide information, link to the on-line survey and allow community to provide feedback and information to the project team. Follow-up discussions with the relevant stakeholders were undertaken as necessary and are ongoing. The project is also being overseen by TCWC.

The Tweed River estuary and the development of the CMP has generated a significant amount of community interest with a high number of webpage visits as well as direct correspondence to TSC staff and the project team and articles appearing in the local newspapers. The Tweed River Survey received a huge response with a random sample of 405 residents providing input through a telephone survey, 814 respondents completing the online version and an additional 44 respondents completing printed copies. Results of the phone survey (i.e. random sampling of the total population) can be considered to generally reflect the views and behaviour of the wider community with a small margin of error whereas the non-random, i.e. “opt-in” nature of the online and paper-based surveys still provide an important snapshot of the views of active and regular river users (Jetty Research, 2017). Beliefs and attitudes represented by the online respondents were relatively similar to those of the “general population” telephone sample. In particular, there was next to no difference in the proportions considering particular types of river use as acceptable (Jetty Research, 2017).

1.9.1. Government Agency Feedback

Feedback from key government agencies involved in the CMP development included:

- DPI Fisheries provided guidance on fishery and habitat management. The CMP will need to detail any potential impacts on marine vegetation resulting from proposed management measures and approvals under the FM Act are likely to be required;
- DPE provided guidance on the NSW coastal management reforms and in particular the new CM SEPP and associated mapping and requirements of the CMP under current state government requirements;
- TfNSW – Maritime provided information regarding boating regulation and enforcement and the status of boating management planning in the Tweed; and
- DPE – Crown Lands stated that the project team will need to liaise with that Department regarding any proposed CMP management measures on Crown land and determine any approvals likely to be required.

1.9.2. Community Values

Key community values are discussed below and a snapshot of these is depicted in Figure 16:

- The Tweed River estuary is valued for its scenic beauty (Figure 17), biodiversity and ecological attributes, fisheries resources, recreational and sporting opportunities, conveyance of flood waters, drainage of the floodplain, agricultural uses and past and present Aboriginal cultural heritage values and traditional practices including cultural fishing;

- The ecological health of the river underpins everything else and supports the various uses and values enjoyed by the community;
- The river is generally considered to be healthy;
- This natural setting provides an important recreational opportunity and there is general support for a wide range of passive and active, water and shore-based pursuits; and
- Some activities are identified as less acceptable uses than others. For example, commercial fishing is ranked as having low acceptability and this is likely due to perceived conflict with highly popular recreational fishing and widely held concern about declining fish stocks due to overfishing. Similarly, jet ski use was also considered less acceptable due to potential for conflicts with other users and the amenity of the waterway. Generally, there is high acceptance for passive water-based recreation, river tours and motorised boating. Water skiing and wakeboarding were also considered acceptable uses by the majority of the community, although at lesser rates.

Figure 16: Community thoughts and ideas on estuary values

Source: Hydrosphere Consulting (2017c)

Figure 17: Tweed River scenic views looking upstream towards Murwillumbah with Mt Wollumbin in the upper catchment

Source: TSC (2016)

- Both motorised boating and passive recreational uses such as canoeing and kayaking are popular pursuits on the river and they are not always compatible (e.g. motorised boating with or without towing can generate noise and wake and passive craft users generally desire calm quiet conditions to enjoy natural surroundings). A key management challenge will be to equitably provide for competing uses.

1.9.3. Direct Community Feedback Regarding Management Concerns

Despite the majority of people believing the river is healthy, there are concerns about a number of issues that need to be managed to ensure the health and amenity of the river into the future. Issues raised during direct feedback from key stakeholder groups and the broader community via the project webpage, email, letters, phone calls or discussions included:

- The need for good water quality;
- Concern about wastewater discharges;
- Pollution from construction phase of development;
- Stormwater and Gold Coast Airport contamination;
- Acid sulfate soils (ASS);
- The increasing risk of flooding and sea level rise;
- Sedimentation affecting drainage of the floodplain and boat passage;
- Lack of foreshore vegetation;
- Bank erosion;
- Bank erosion and controls impacting Aboriginal sites (e.g. middens);
- The spread of rock walls for erosion protection;
- Specific types of boat wake-generating activities contributing to bank erosion;

- Litter and flood debris;
- On-river re-fuelling;
- Reduced fish stocks;
- Threats to shorebirds;
- Environmental impacts of commercial yabbie pumping tours;
- Siltation/sand build up;
- The need for assessment of the impacts of dredging;
- Dangers posed by speeding boats;
- Houseboats staying for extended periods;
- Illegal boat mooring;
- Difficulty accessing public foreshores and the river for recreation; and
- Recreational use conflicts.

1.9.4. Management Priorities

Management priorities raised by the community matched the main issues perceived by the community as listed below and depicted in Figure 18:

- Protection of the natural features of the waterway, addressing bank erosion and ensuring good water quality;
- Ensuring that usage of the waterway is able to be enjoyed without conflict by ensuring better policing of boating rules (e.g. speed limits and restricted areas), reducing anti-social behaviour (e.g. disregard for other river users, verbal abuse and excessive alcohol consumption) and exploring options to better manage competing uses;
- A preference for use of more eco-friendly and aesthetically pleasing options for erosion protection over the continued construction of rock walls; and
- Improving public accessibility to the waterway (including disabled access), improving facilities, planning for sea level rise and undertaking dredging for navigational safety and water exchange.

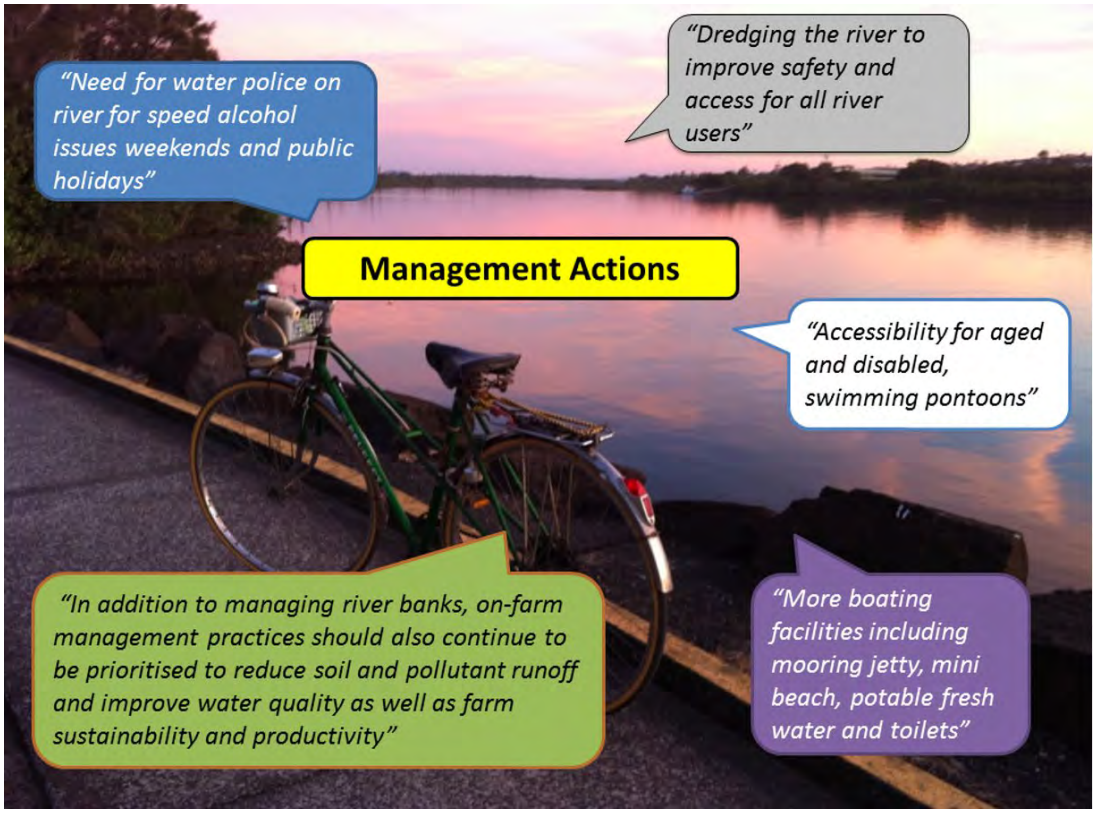

Figure 18 Community thoughts and ideas on management actions

Source: Hydrosphere Consulting (2017c)

In terms of future management there were a range of ideas and considerations put forward by the community and stakeholders including:

- Annual reporting of water quality to the community;
- Removing wastewater discharge from the river;
- Improved boating access and recreational fishing;
- Creation of more estuary beaches for boating and swimming access;
- Dredging to improve drainage of the floodplain, boating passage and flushing/water quality;
- Investigate and use alternative options to rock walls for erosion control;
- Support for the oyster growing industry;
- Habitat improvements;
- Riparian restoration;
- Involvement of Aboriginal community in implementation of on-ground actions;
- Raising the profile of Aboriginal history, values and cultural practices associated with the river;
- Education programs including school-based education;
- Shorebird management actions;
- Improved conditions for passive recreational uses;
- Investigate zoning for different recreational uses;
- More education and better enforcement of boating rules; and
- A proposal for an off-river water sports complex for power-boating activities (tow sports).

2. SNAPSHOT OF ISSUES

2.1. Study Area Characteristics

2.1.1. Cultural Heritage

The Tweed River estuary retains a significant cultural connection for local Aboriginal people. The Bundjalung people of the Tweed Valley have a long and deep association with the land in which their ancestors have lived for many generations. Evidence suggests that these lands have been occupied and settled by Aboriginal people for more than 40,000 years prior to the first European settlement in the area. Aboriginal cultural places and landscapes embed the cultural knowledge of the Aboriginal people, passed down the generations through oral tradition, embodying and preserving their relationship to the land. The protection of these places and landscapes is key to the long-term survival of these stories in Aboriginal culture (TSC, 2017b).

European settlement began in the 1840s when cedar getters first arrived by boat. The river was integral to the European settlers of the Tweed Valley and was the main transport medium for supplies and equipment from the cities and for cut timber and harvested crops to be sent back to the cities for sale. There is a history of dredging dating back to this era. Large scale dredging for navigational purposes and land reclamation activities, as well as sand extraction has occurred since the 1950s. Dredging of the entrance channel in association with the TRESBP and *ad hoc* maintenance dredging of the lower estuary has been undertaken in recent years. Dredging improves safety and navigational aspects of the river, supports a working port and marine based industries (e.g. tourism) and provides boating and fishing opportunities for users of the estuary. Targeted dredging may, in some circumstances, result in improved tidal flushing and water quality and improved flood mitigation. However, dredging has, in the past, been a significant influence on the estuary and large-scale dredging and reclamation projects have resulted in a range of changes to estuarine hydrodynamics (tidal volumes, peak flows, tidal lags etc.), sediment dynamics, bank morphology and impacts to ecology. Significant costs are associated with dredging and with any treatment, transportation and reuse of dredged material. Sediment won from contemporary dredging provides a valuable natural resource for use in erosion mitigation and beach nourishment projects (i.e. retaining the sand within the coastal sediment transport system) as well as for commercial use but needs to be undertake in a way that protects the environmental and social values of the estuary.

2.1.2. Estuary Processes

The Tweed River estuary is a mature, wave dominated barrier estuary with a permanently open, trained entrance. The key physical characteristics of the Tweed River estuary are outlined in Table 5.

Table 5: Key characteristics of the Tweed River estuary

Characteristic	Data	Notes
Study area	195 km^2	Refer Figure 8
Upper catchment area	767 km^2	Refer Figure 8
Estuary area	22.7 km^2	Includes areas mapped as open water, mangrove and saltmarsh areas (OEH, 2018a).
Estuary volume	56,954 ML	Based on areas at 0.6 m AHD (Roper *et al.,* 2011)
Average depth	2.6 m	Estimated by dividing the total volume at 0.6 m AHD by the total surface area of the estuary including mangrove areas but excluding saltmarsh (Roper *et al.*, 2011)

The dominant coastal processes involve a northward longshore drift of sand along Letitia Spit towards the southern breakwater at the Tweed River entrance. Historically, sand has accumulated on Letitia Spit as well

as continuing to deposit on the entrance bar. The TRESBP has been in operation since 2001 and seeks to maintain the natural flow of sand northwards, whilst maintaining a navigable entrance channel. As part of the TRESBP, sand is pumped from the Letitia Spit jetty to Duranbah and southern Gold Coast beaches. The pumping jetty does not intercept all northward-bound sand and hence there is continued deposition on the bar, natural bypass of the bar as well as marine sediment infeed to the estuary which leads to shoaling in the lower estuary. The condition of the lower estuary marine shoals is dependent on the relative balance of the ingress of marine sands through the entrance and the scouring potential of freshwater discharges from flood events.

The tide propagates to the upper extent of the study area, i.e. to Bray Park weir on the Tweed River. Prior to the construction of the weir, the estuary previously extended to at least Byangum based on parish maps and to approximately 1.4 km upstream of Boat Harbour bridge on the Rous River estuary. However, the most rapid attenuation occurs within the first 2-4 km of the river mouth and salinity in the upper reaches is greatly influenced by freshwater flows which are more frequent in the warmer months.

Tidal overtopping of the Bray Park weir occurs during certain combinations of climatic events and has been known to cause saltwater ingress to potable freshwater supply. Flood behaviour is dependent on the nature of rainfall events located in different parts of the catchment, but generally flood depths are higher in the upper estuary and become less influential in the lower estuary and the entrance.

The major in-stream structures that impact on flows in the Tweed River system are Clarrie Hall Dam (16,000 ML) and the Bray Park weir (520 ML). Extraction (primarily for town water supply but also for stock and irrigation purposes) occurs from the Bray Park weir pool which is supplied by both the Tweed and Oxley Rivers and releases from Clarrie Hall Dam. Both Council and private landholders own and manage significant drainage and floodplain infrastructure across the floodplain.

A previous study of water quality in the Tweed River estuary (ABER, 2012) divided the waterway into five functional zones based on morphology, sediment type, hydrodynamics, salinity regime and water residence times. Whilst the boundaries of each zone can vary considerably with seasonal changes in freshwater inflows, the broad functional zones as described below and depicted in Figure 19 are used throughout this CMP to describe the study area:

- Lower estuary – from the ocean entrance to Shallow Bay, upstream of Fingal Head (and for the purpose of the CMP study, with within the Terranora Inlet downstream of Barneys Point Bridge);
- Transition zone– from Shallow Bay/Tonys Island up to and including the Tweed Broadwater;
- Middle estuary – from the Tweed Broadwater to the village of Condong;
- Upper estuary – from Condong to Bray Park Weir; and
- Rous River estuary – the tidal extent of the Rous River from the confluence with the Tweed River at Tumbulgum to Numinbah Road bridge at Boat Harbour.

The Tweed River floodplain has been extensively modified through draining and levelling, construction of floodgates, levees and roads and the removal of most native vegetation, primarily for agricultural production. The predominant land uses comprise cropping for sugarcane production and grazing in the middle and upper estuary and on the Rous River estuary. Major urban areas are located in the lower estuary (Tweed Heads, Tweed Heads South, Fingal Head), transition zone (Banora Point, Chinderah) and in the upper estuary (Murwillumbah). These areas are serviced by wastewater treatment plants (WWTPs) which discharge to the estuary at Murwillumbah, Tumbulgum and Kingscliff contributing to the nutrient loading of the estuary.

Much of the floodplain has a high probability of occurrence of ASS. There is a significant history of disturbance of ASS (primarily through clearing and draining for sugarcane farming), identification of ASS areas and impacts and remediation of ASS priority areas and changes to farming practices with substantial improvements to soil health and water quality observed over the past twenty years.

Over 50% of the riparian vegetation on the estuary banks is considered highly or very highly disturbed, particularly in the Rous River estuary and upper estuary where there are large lengths of minimal riparian vegetation, predominately exotic vegetation and actively eroding banks. Bank erosion occurs as a result of both natural (flooding, wind waves, long term river meandering) and anthropogenic (riparian vegetation removal, stock access, boat wake, informal recreational access points) causes. Significant sections of the lower estuary and the transition zone are lined with protective infrastructure (e.g. rock walls) which historically made little accommodation for riparian or estuarine vegetation establishment and the associated features of aquatic habitat.

The influence of agriculture and urban development has resulted in increased nutrient and sediment runoff, faecal contamination of waterways and ASS impacts impacting on water quality and the environmental processes within the estuary.

The extensive hydraulic modification of the floodplain (e.g. drainage, levelling and installation of levees and floodgates) has resulted in a significant reduction of its natural connectivity with the estuary. The removal of the majority of coastal lowland vegetation and fish habitat such as former low lying backswamps, has compounded the hydraulic impacts. The modified floodplain is less ecologically diverse, has less available habitat and is less resilient to external pressures such as climate change. In the past two decades projects have been undertaken to re-establish hydrological connectivity and reduce impacts from historic drainage, including the modification of floodgate operating procedures, the installation of fish-gates in some floodgates and the increased uptake of best practice management of farms.

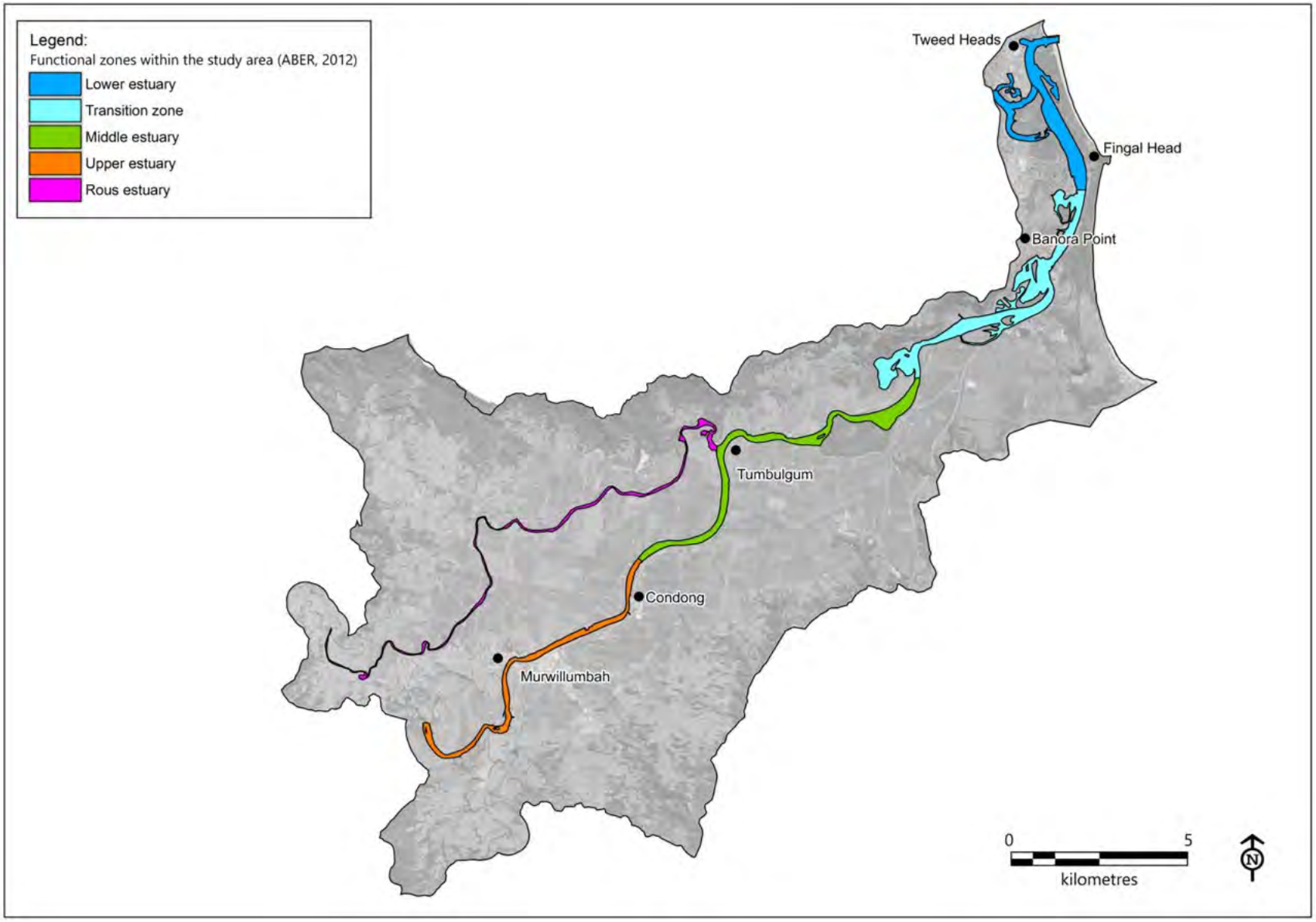

Figure 19: Tweed River functional zone boundaries within the CMP study area

2.1.3. Flora and Fauna

The Tweed River estuary has evolved into a diversity of habitats for a wide variety of flora and fauna. Important estuarine habitats include areas of seagrass and saltmarsh which are typically found downstream of Dodds Island and mangroves which occur up to and within the lower Rous River estuary (Figure 20). A large majority of these areas are classified as 'Key Fish Habitat' under the FM Act and are mapped as Coastal Wetlands under the CM SEPP. Estuarine macrophyte communities are essential nursery grounds for many fish and crustaceans. Coastal saltmarsh in particular is listed as a threatened ecological community under the *Biodiversity Conservation Act 2016* and is an important fish habitat with a valuable role in fish and prawn production. A significant decline in seagrass distribution has occurred since the 1930s with large scale losses associated with major dredging and reclamation projects. Recent changes in seagrass distribution were not uniform across the estuary with increases identified in some channel areas and declines noted in some inlets and bays. Seagrass was noted to be impacted by physical damage (e.g. trampling and propeller damage), undercutting and sedimentation.

Oyster reefs are another important and distinctive estuarine habitat and their presence is limited to colonisation on rock walls and pylons in the lower estuary. Two remnant Leaf Oyster reefs and several commercial oyster leases are located in the Terranora and Cobaki Broadwater systems upstream of Boyds Bay Bridge (outside of the study area of this CMP).

The study area encompasses approximately 15.3 km^2 of environmental conservation areas protected under the NPW Act (approximately 15% of the Tweed LGA). The conservation areas located adjacent to the Tweed River include Stotts Island Nature Reserve, Tweed Heads Historic Site and Ukerebagh Nature Reserve. Mooball National Park and Mount Nullum Nature Reserve are located in the upper catchment of the estuary. Stotts Island is considered a significant natural resource as it comprises the largest stand of lowland sub-tropical rainforest in NSW, an intact reminder of the once vast forests that grew on the flats. The island is critical habitat for the largest remaining population of the endangered Mitchell's rainforest snail (*Thersites mitchellae*) (NPWS, 2001).

Figure 20: Mangrove habitat in Ukerebagh Nature Reserve, left; *Zostera* spp. Seagrass exposed at low tide in the Ukerebagh Passage, right

Riparian vegetation and terrestrial remnant vegetation in the surrounding catchment, whilst patchy and fragmented, provides significant habitat for a range of species. Protected vegetation communities include two small areas of Littoral Rainforest in the lower estuary within the Coolangatta Tweed Heads Golf Club and opposite at Fingal Head. A large number of declared noxious and serious environmental weeds have been recorded in the study area, particularly in riparian areas, forest edges and bushland regrowth areas.

The estuary has been classified as priority habitat for threatened migratory shorebirds including Terek Sandpiper, Beach Stone Curlew and nesting Australian Pied Oystercatcher. Important roost sites for migratory birds and waders have been identified at Kerosene Inlet, Tonys Island and South Beach, Letitia Spit (the latter being outside of the study area). Two iconic species of raptors which are vulnerable to human pressures are known to inhabit the estuary, i.e. the Eastern Osprey and the White-bellied Sea-Eagle, along with the Brahminy Kite. Several species of dolphin inhabit or use the estuary including resident populations of Indo-Pacific Bottlenose Dolphin as well as the Australian humpback dolphin, the Common Bottlenose Dolphin and the migratory Indo-Pacific Humpback Dolphin. Marine turtles of endangered/vulnerable status that have been recorded or are likely to occur with the estuary include the Loggerhead Turtle, Leatherback Turtle, Green Turtle, Flatback Turtle and Hawksbill Turtle. Estuarine fish species of conservation concern known to or likely to inhabit the estuary include the threatened Grey Nurse Shark, Green Sawfish and vulnerable Black Rockcod (DPI, 2006). In addition, a nomination to list White's Seahorse (*Hippocampus whitei*) which is known to occur in the Tweed River is currently being considered by the NSW Fisheries Threatened Species Scientific Committee (DPI Fisheries, 2019). Whilst not threatened, several species of fish are classified as either "over fished" or "growth overfished" requiring continued monitoring and management through Fisheries Management Plans.

Mosquitos and sand-flies utilise the Tweed River estuary intertidal areas for breeding and have a significant impact on human health. Council implements control programs for these species in a number of locations. Hydrological modification of the floodplain, through either earthworks or due to climate change and sea level rise, has the potential to significantly affect available insect breeding habitat. Increased mosquito breeding habitat, particularly that of the saltmarsh mosquito, could have serious impacts for human health, due to their status as vectors of dangerous diseases such as Ross River Fever and Barmah Forest Virus.

2.1.4. Estuary Health Condition and Pressure Ratings

Previous assessments of ecosystem health have been undertaken for the Tweed River estuary as part of the *NSW Monitoring Evaluation and Reporting (MER) Strategy* (DECC, 2010a). The *2010 State of Catchment Report for the Northern Rivers Region* (Estuaries and Coastal Lakes) (DECC, 2010b) provided an overall condition rating of "Very Good" for the Tweed River estuary based on scores for Chlorophyll *a* ("Good"), macrophyte distribution ("Very good") and status of fish assemblages ("Fair"). The *State of the Environment (SOE) report* (EPA, 2015) which assigned a "Moderate" condition rating to the Tweed River, in keeping with the state-wide average, based on five component indexes: riparian vegetation cover, hydrological stress, biodiversity condition, geomorphic condition and catchment disturbance. These reports also identified key pressures to the estuary as sediment input, nutrient input, cleared land, agricultural runoff and fishing.

The condition of key ecological parameters for each functional zone has been assessed (Hydrosphere Consulting, 2019). The key ecological parameters comprise riparian condition and extent, bank condition, seagrass health and extent, estuarine water quality and quality of agricultural runoff (Table 6). Condition ratings are based on the definitions provided in the 2009 Report Card for the waterways and catchments of Cobaki and Terranora Broadwaters (International Water Centre, 2009) and based on the findings of the detailed studies undertaken for the CMP. The condition of the key ecological parameters for each functional zone are as follows:

- Lower estuary: "Very good" estuarine water quality, "Good" riparian vegetation condition, bank condition and seagrass communities (health and extent) and "Fair" riparian vegetation extent;
- Transition zone: "Very Good" riparian vegetation condition and estuarine water quality, "Good" coverage of riparian vegetation and "Good" health of seagrass communities and "Fair" bank condition;
- Middle estuary: "Good" estuarine water quality and riparian vegetation extent, "Fair" bank condition and riparian vegetation condition and "Fair to Poor" water quality in agricultural drains on the flood plain;

- Upper estuary: “Good to Fair” estuarine water quality and a “Poor” condition of health for all other key ecological indicators; and
- Rous River estuary: a “Poor” condition rating for all key ecological health indicators. A distinction can be made for a significant area of habitat comprising the lower 4km of the Rous River estuary, upstream of the confluence, in which the riparian vegetation condition is characterised as “Good” (north bank) to “Fair” (south bank).

Overall, the poorest ratings of estuary health identified were riparian vegetation (condition and extent), bank erosion and agricultural runoff in the Rous River estuary and upper estuary, estuarine water quality in the Rous River estuary and to a lesser degree, agricultural runoff in the middle estuary (in particular, the northern side of the McLeods Creek/Main Trust Canal priority ASS area).

Table 6: Condition rating for key ecological parameters of the Tweed River estuary

Functional zone	Riparian vegetation condition	Riparian vegetation extent	Bank condition	Seagrass health and extent	Estuarine water quality	Water quality in agricultural drains
Lower estuary						n/a
Transition zone						n/a
Middle estuary				n/a		
Upper estuary				n/a		
Rous River estuary				n/a		

Condition rating key (definitions based on the Report Card 2009 for the waterways and catchments of Cobaki and Terranora Broadwaters (IWC, 2009)):

- Very good – Conditions meet all characteristics of a healthy ecosystem; all essential ecological processes are present and habitats are in near pristine condition
- Good – Conditions meet all characteristics of a healthy ecosystem in most of the reporting region; most essential ecological processes are present and most habitats are intact
- Fair – Conditions meet some of the characteristics of a healthy ecosystem in most of the reporting region; some ecological processes are present and some habitats are impacted
- Poor – Conditions are unlikely to meet the characteristics of a healthy ecosystem in most of the reporting region; many essential ecological processes are not present and many habitats are impacted
- Fail – Conditions do not meet the characteristics of a healthy ecosystem; most essential ecological processes are not present and most habitats are severely impacted

2.1.5. Community Uses and Value

The estuary is a recreational area of great importance to the local community as well as users from the densely populated area of south-east Queensland. Community uses of the Tweed River estuary include both commercial and recreational fishing, tourism, motorised and non-motorised water based recreational activities and shore-based activities (e.g. walking, cycling, picnic etc.).


Figure 21: Recreational fishing at Tumbulgum and Jack Evans Boat Harbour


Figure 22: Jet skis at Fingal Head boat ramp; geotextile revetment at Clarrie Purnell Park, Condong enjoyed by jet ski, water skiers and paddle boarders


Figure 23: Recreational fishing boat and paddleboard accessing Tumbulgum Pontoon; passive water activities in Jack Evans Boat Harbour


Figure 24: Gas BBQs and picnic facilities at Tumbulgum; boardwalk at Jack Evans Boat Harbour

2.1.6. Population and Demographics

The Tweed Shire population has increased significantly in recent years. The resident Tweed Shire population in 2016 was approximately 91,000, an increase of approximately 22% since 2001 or 1.5% per year (.id, 2020). The estimated resident population in the Shire in 2020 is approximately 97,000. Seasonal population changes can be significant with the Shire population typically increasing by approximately 11% in the peak summer tourist season (Water Technology, 2020). The Tweed Shire population is expected to continue to grow into the future with the population expected to reach over 132,000 by 2041 (.id, 2020), an increase of approximately 3% per year over the 2020-2041 period.

Due to its proximity, the Tweed River is also heavily utilised by residents of the Gold Coast region which results in additional pressure on and user conflict within the estuary (Hydrosphere Consulting, 2021). The City of Gold Coast LGA population is forecast to increase by 50% from 580,000 in 2016 to 870,000 in 2036 (Water Technology, 2020), which will mean increasing pressure from this growing population centre on the Tweed River.

Population growth is expected to place further pressure on the Tweed River estuary including:

- Increasing visitor numbers affecting recreational amenity, water quality, fish stocks, increased habitat loss, biodiversity, and increased conflicts between river users.
- Increasing urban, commercial and industrial development, increasing stormwater and wastewater input to the estuary.

The CMP seeks to reduce the impacts from future population growth through a number of key actions including:

- Raising awareness and providing community education around the key threats to the estuary and how visitors and residents can reduce their impacts, for example:
    - Actions B1-B4 Stakeholder and community engagement.
    - Actions C1-C7 Estuary health monitoring and reporting program.
- Providing recreational facilities and access to the estuary that is sustainable and protects key habitats, for example:
    - Actions J1-J4 Protect significant estuarine vegetation – improve condition and extent.
    - Actions M1-M5 Support the protection of bird habitat.
    - Actions X1 – X5 Improvements to foreshore parks and recreational facilities.

  - Actions Z1-Z2 Maintain amenity of existing estuary beaches and create additional artificial sandy beaches.
  - Actions EE1-EE5 Maintain and improve boating infrastructure, access and ancillary facilities for boaters
  - Actions BB1-BB2 Continue to work with TfNSW to improve compliance with, and policing of boating rules, and recommend towing restrictions in conservation and restoration character zones.
- Managing bank erosion and rehabilitating riparian vegetation, for example:
  - Actions F1-F6 Rehabilitate and maintain priority bank erosion sites.
  - Actions G1-G2 Rehabilitate and maintain riparian vegetation.
- Addressing degraded estuarine water quality, for example:
  - Action O1 Stormwater controls.
  - Actions P1-P5 Reduce acid runoff.
  - Actions R1-R2 Improve wastewater and effluent management.

2.2. Threats to Estuary Values

2.2.1. Key Threats

Current key management issues facing the Tweed River estuary were identified and validated through previous plans (Appendix B) and studies (Hydrosphere Consulting, 2017a), community and stakeholder consultation (Hydrosphere Consulting, 2017c) and additional detailed studies undertaken as a component of this CMP. Consideration was also given to moderate and high priority state-wide threats to estuaries as identified in the *NSW Marine Estate Threat and Risk Assessment* (BMT WBM, 2017).

A discussion of the key threats affecting the Tweed River estuary, the causes/threatening processes contributing to these issues, the relevant CMAs and the affected estuary values is provided in Hydrosphere Consulting (2021) and summarised in Table 7 below. Nine key threats were identified comprising:

- Threat 1 - Bank erosion;
- Threat 2 - Habitat loss/barriers to habitat connectivity (waterway and riparian);
- Threat 3 - Degraded estuarine water quality;
- Threat 4 - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets (WWTP/sewer/stormwater, roads etc.);
- Threat 5 - Loss of or impacts to biodiversity;
- Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly, a lack of sandy beaches;
- Threat 7 - Conflict between river users;
- Threat 8 - Reduced stocks of target fish species; and
- Threat 9 - Restricted levels of boating infrastructure and facilities or reduced navigability.

Major Tweed River flood events are considered to be high consequence, low probability events with major impacts on the local community, the environment and the local economy. This threat has been considered in detail in Hydrosphere Consulting (2021) including discussion of the current and future flood risk. Flood risks

(incorporating catchment flooding in combination with tidal inundation) to the estuary have been assessed and planned for in the *Tweed Valley Flood Risk Management Study* (BMT WBM, 2014a) (FRMS) and *Flood Risk Management Plan* (BMT WBM, 2014b) (FRMP).

Table 7: Threats, primary causes and values affected

Threats	Primary causes	Coastal Management Area	Social and recreational values affected	Environmental values affected	Commercial values affected
Bank erosion	• Degraded riparian vegetation (clearing, exotic species) • Exacerbated flooding (upstream catchment clearing) • Boat wake • Land clearing • Agricultural practices (unfenced stock access and cropping to top of bank) • Inappropriate foreshore structures or structures not designed to cater for sea level rise • Poorly maintained foreshore protection works • Illegal vehicle access • Climate change and increased storminess	• CWLRA • CVA • CEA • CUA	• Public access to and use of the river and foreshore • Recreational fishing • Scenic quality and amenity • Aboriginal cultural heritage and practice	• Natural habitats and biodiversity • Stable riverbanks • Water quality	• Economic prosperity • Agricultural productivity
Habitat loss/barriers to habitat connectivity (waterway and riparian)	• Bank erosion • Degraded water quality • Tidal inundation and coincident flooding • Waterway barriers, e.g. floodgates, weirs, levees, ineffective fishway design • Private ownership of waterfront land • Agricultural practices (unfenced stock access and cropping to top of bank) • Climate change, sea level rise, “coastal squeeze” (i.e. inadequate planning/land use/buffer zone)	• CWLRA • CEA • CUA	• Recreational fishing • Scenic quality and amenity • Aboriginal cultural heritage and practice	• Natural habitats and biodiversity • Stable riverbanks • Water quality	• Economic prosperity • Agricultural productivity
Degraded estuarine water quality	• Bank erosion • Habitat loss (reduction of riparian buffer) • Disturbance of ASS through agricultural drainage and land management practices • Formation and flushing of MBO from drains • Runoff of nutrients and sediment from floodplain agriculture and upper catchment • Urban stormwater contributing sediment, organic debris, litter and pollutants • Ponding and formation of black water on low-lying lands after floods (poor drainage, inundation intolerant veg cover) • WWTP overflows (lower estuary) and illegal sewer connections • Industrial effluents • Water storage, extraction and freshwater releases • Sedimentation and shoaling • Dredging and sand extraction • Water pollution including marine debris, litter and illegal dumping • Climate change and increased storminess	• CWLRA • CEA • CUA	• Public access to and use of the river and foreshore • Recreational fishing • Scenic quality and amenity • Aboriginal cultural heritage and practice	• Natural habitats and biodiversity • • Water quality	• Economic prosperity • Agricultural productivity
Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets (WWTP/sewer/ stormwater, roads etc.)	• Inappropriate development on low-lying land • Exacerbation of floods (upstream catchment clearing) • Inappropriate crops/use of low-lying land • Tidal overtopping of Bray Park weir (incl. weir crest too low for current tidal anomalies and reduced catchment flows from impoundment/extraction) • Sea level rise, increased storminess • Ineffective drainage (design or maintenance) • Inadequate protection works (levees, etc.) • Increased risk of vector borne diseases associated with availability of insect breeding habitat	• CVA • CEA • CUA	• Public access to and use of the river and foreshore • Recreational fishing • Scenic quality and amenity • Aboriginal cultural heritage and practice	• Natural habitats and biodiversity • Stable riverbanks • Water quality	• Economic prosperity • Agricultural productivity

Threats	Primary causes	Coastal Management Area	Social and recreational values affected	Environmental values affected	Commercial values affected
Loss of or impacts to Biodiversity	• Weeds and feral animals • Roaming pets • Fragmentation/clearing • Physical damage (e.g. through four-wheel driving, boat beaching and trampling) • Habitat availability • Water quality • Litter and marine debris • Marine noise pollution • Climate change and sea level rise	• CWLRA • CVA • CEA • CUA	• Recreational fishing • Scenic quality and amenity • Aboriginal cultural heritage and practice	• Natural habitats and biodiversity • Stable riverbanks • Water quality	• Economic prosperity
Lack of access to water and foreshore for non-boat recreation, particularly lack of sandy beaches	• Extensive rock wall protection of foreshores and lack of embayments/access points • Private ownership of waterfront land • Erosion of access points/banks/beaches (see bank erosion) • Increasing user pressure (proximity to SEQ, increasing local population) • Lack of parking and ancillary facilities (showers, shade, etc.)	• CEA • CUA	• Public access to and use of the river and foreshore • Recreational fishing • Scenic quality and amenity • Aboriginal cultural heritage and practice	• Stable riverbanks • Water quality	• Economic prosperity
Conflict between river users	• Restricted levels of boating infrastructure and facilities • Lack of access for non-boat recreation • Geographical spread of boat ramps concentrates boat use • No separation of incompatible uses (e.g. PWC/towing vs nature appreciation, residential amenity) • Non-compliance with existing management (speed rules, use of waterways, separation distances, etc.)	• CWLRA • CEA • CUA	• Public access to and use of the river and foreshore • Recreational fishing • Scenic quality and amenity • Aboriginal cultural heritage and practice	• Natural habitats and biodiversity	• Economic prosperity
Reduced fish stocks	• Overfishing from combination of recreational and commercial fishing • Loss of habitat (e.g. riparian shading, backswamps) /degradation of habitat (e.g. dredging, trampling/shading/smothering/eutrophication of seagrass beds) • Reduced water quality (direct toxicity, reduced food resources, smothering of habitats, water pollution (marine litter, nutrient inputs) etc.) • Obstructions to fish passage/habitat connectivity (reduced habitat availability, barriers to life cycle events) • Climate change, increased storminess, changes in water temperatures, “coastal squeeze	• CWLRA • CEA	• Recreational fishing • Aboriginal cultural heritage and practice	• Natural habitats and biodiversity	• Economic prosperity
Restricted levels of boating infrastructure and facilities or reduced navigability	• Boat ramp capacity and parking not likely to be able to service future peak demand • On-river re-fuelling facilities not available for recreational vessels (i.e. increasing boat ramp usage and user conflicts) • Restricted number of mooring points • Restricted land availability and suitability for new boating facilities • Reductions to channel depth/width through sedimentation and shoaling	• CEA • CUA	• Public access to and use of the river and foreshore • Recreational fishing	• Stable riverbanks	• Economic prosperity

3. MANAGEMENT ACTIONS

3.1. Risk Assessment

Strategic responses to the identified threats have been developed using a risk assessment methodology adapted from the *Threat and Risk Assessment Framework for the NSW Marine Estate* (MEMA, 2015). The threats to the estuary values have been prioritised based on the residual risk (a combination of likelihood of a threat occurring and consequence of the threat) to estuary values under existing management conditions, so that future management efforts can focus on addressing the most important issues. This is designed to assess the adequacy of current management approaches and alternative options for addressing priority threats and implement the most cost-effective management actions to address the threats.

The risk is a function of the 'likelihood' (i.e. rare to almost certain) and 'consequence' (i.e. insignificant to catastrophic) of a threat actually being realised under existing management conditions. The definitions and methodology of the risk assessment, along with a colour-coded threat consequence and risk assessment matrix specific to the Tweed River estuary is provided in Appendix C. The matrix shows:

- The risk each threat poses to each estuary value;
- The overall risk from each threat;
- The risk of each threat relative to other threats assessed (i.e. ranking of threats); and
- How the risk level is likely to change in the future (i.e. over 20, 50 and 100 years) in response to factors such as climate change, increasing development pressures and population increase.

Using the MEMA (2015) methodology, all threats are considered "high risk" other than conflict between river users, considered a moderate risk. The threats posing the highest relative risk to the estuary values, compared to the other key risks assessed are:

- Bank erosion;
- Habitat loss/barriers to connectivity;
- Degraded estuarine water quality;
- Flooding/tidal inundation; and
- Loss of or impacts to biodiversity.

A moderate level of risk is posed by:

- Lack of access to water and foreshore areas for non-boat recreation; and
- Conflict between river users and reduced fish stocks.

Relative to other values, the most threatened values are:

- Recreational fishing;
- Aboriginal cultural heritage and practice;
- Natural habitats and biodiversity; and
- Economic prosperity.

Bank erosion is predominantly a localised threat whereas degraded estuarine water quality and flooding/tidal inundation are considered estuary-wide threats. The remaining threats are experienced at a regional scale. All threats are current but are expected to be exacerbated by climate change and sea level rise in the future.

The results of the risk assessment have been used to identify strategic priorities for broad coastal management actions. More detailed assessments of risk and management priority were undertaken to assess and prioritise specific areas for bank rehabilitation, restoration of protective infrastructure, riparian restoration works, management of migration of estuarine vegetation and water quality improvements, as further detailed in Appendix C.

3.2. Developing Management Actions

Management strategies and actions were selected based on professional consideration of the legal, technical and engineering feasibility, the economic viability and acceptability of actions to the community and stakeholders as shown in Figure 25. Potential management options were identified to address the identified risks and threats and strategic priorities (Appendix C). This involved consideration of management solutions proposed and/or implemented as part of previous studies and plans of management as well as additional actions to address key pressures and threats identified. Community and stakeholder input through the TCWC, community survey and feedback and government agency consultation was also a key factor in developing management options.

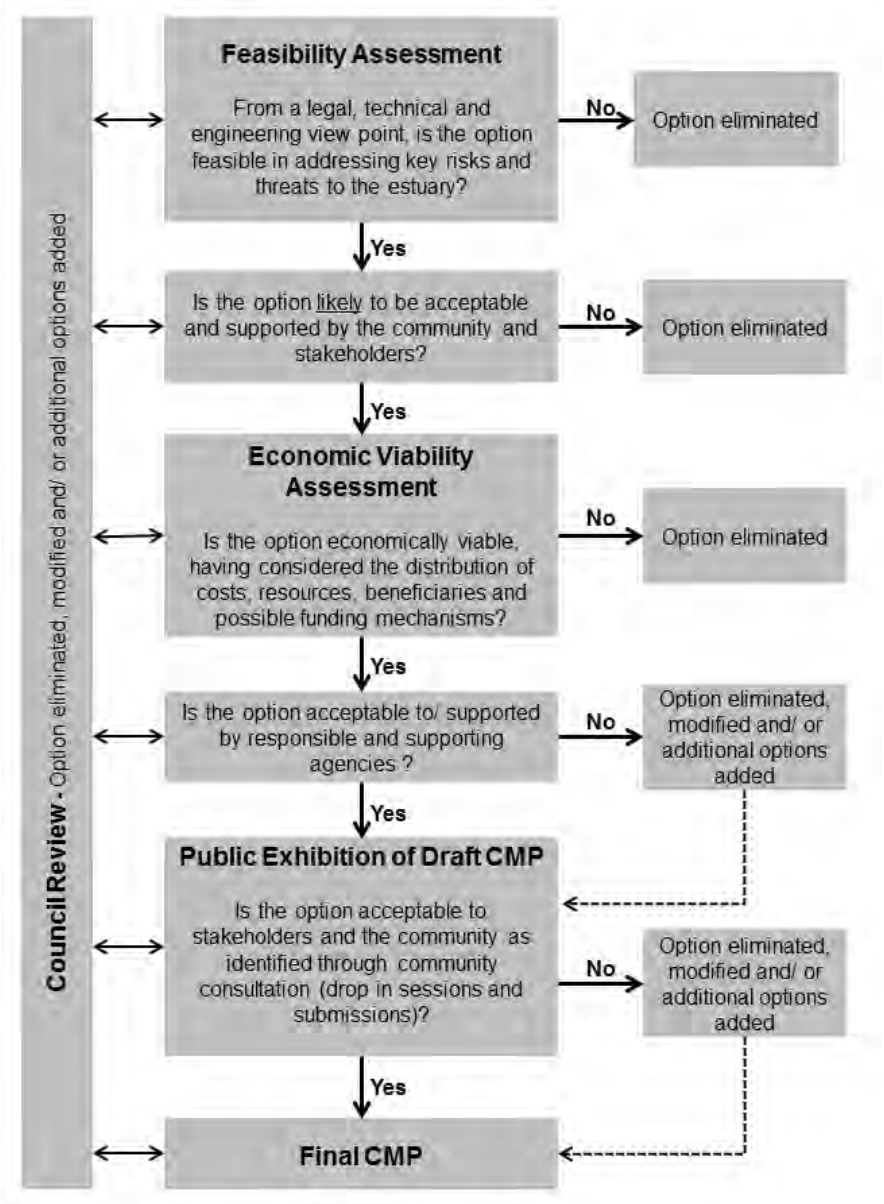

Figure 25: Options evaluation process

Coastal management options were selected where they addressed issues, reduce exposure to coastal hazards and took advantage of opportunities, consistent with provisions in Section 14 and 15 of the *Coastal Management Act, 2016*. This was achieved through examining the feasibility, viability and acceptability of coastal management options and considering the following factors:

- Promoting and achieving the objects of the *Coastal Management Act, 2016*;
- Meeting the coastal management objectives within the coastal management areas;
- The environmental, social, cultural and economic context and potential impacts;
- The feasibility of coastal management actions determined by effectiveness, technical viability, ecological sustainability and legal/approval risk of the management approach;
- Viability of implementation determined by anticipated cost, availability of resources, time and commitment and anticipated benefits; and
- The acceptability of the risks to Council, key stakeholders such as public authorities and the community, including willingness to contribute to the upfront and ongoing maintenance costs.

The potential management actions were further refined and defined through the CMP development process. Overarching strategies were developed including the Recreational Use Strategy (Section 3.3.2), Water Quality Improvement Strategy (Section 3.3.3) and Dredging Strategy Statement (Section 3.3.4) to guide, identify and refine specific management actions.

To guide and distinguish actions they were grouped into management categories/threats (Table 8). Some actions treat one threat, however, many actions treat more than one threat, directly or indirectly. A variety of management mechanisms that work on different levels or aspects of a threat are used to implement the actions. A summary of the proposed threat or management category, the relative overall risk from the threat, the relevant CMAs and the strategic management approach is provided in Table 8.

Table 8: Categorisation of management mechanisms for each key threat/management category

Management category/threat	Relative Overall Risk	Coastal Management Areas affected	Management mechanisms						
			Regulation/compliance/ incentives	Policy/program/planning	Education/awareness	Research/investigations/ design	Monitoring/mapping	On-ground works	Collaboration
Fundamental management actions	n/a	CWLRA, CVA, CEA, CUA							
Bank erosion	High	CWLRA, CVA, CEA, CUA							
Habitat loss and barriers to habitat connectivity	High	CWLRA, CEA, CUA							
Degraded estuarine water quality	High	CWLRA, CEA, CUA							
Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets	High	CVA, CEA, CUA							
Loss of or impacts to biodiversity	High	CWLRA, CEA, CUA							
Lack of access to water and foreshore for non-boat recreation, particularly lack of sandy beaches	Moderate	CEA, CUA							
Conflict between river users	Moderate	CWLRA, CEA, CUA							
Reduced stocks of target fish species	Moderate	CWLRA, CEA							
Restricted levels of boating infrastructure and facilities or reduced navigability	Low	CEA, CUA							

Source: Adapted from Marine Estate Management Authority (2017)

3.3. Strategies

3.3.1. Implementation Strategy

This CMP provides a management framework that is intended to guide coastal management and planning in the Tweed River estuary, consistent with the estuary vision and in response to the Coastal Management Area objectives (Section 1.7) and community values for the estuary (Table 4 and Hydrosphere Consulting, 2017c). The CMP recognises that the estuary has suffered impacts from past practices such as the construction of training walls, large-scale dredging and reclamation, the truncation of the estuary by Bray Park Weir and extensive drainage and floodplain modifications. Future pressures on the estuary have also been recognised including urban and agricultural land use, natural influences such as flooding and climate change and that the various recreational and commercial uses of the foreshores and waterways can result in conflicting uses and management priorities.

The estuary is managed by TSC and State government agencies (primarily DPE – Crown Lands, DPI Fisheries, NPWS and DPE), landholders and the community. The CMP provides an opportunity to implement a coordinated, sustainable and equitable management approach. The CMP includes a suite of coastal planning and management actions that aim to meet the objects of the *Coastal Management Act, 2016*, to protect and conserve estuarine and terrestrial ecosystems for the enjoyment of all stakeholders, whilst optimising the value of the floodplain and waterways for existing agricultural, commercial, recreational and cultural users, to protect and enhance natural coastal processes and to improve the resilience of coastal assets. The actions have been developed and prioritised based on the assessed risk of the threats to the estuary values, as presented in Hydrosphere Consulting (2021) and summarised in Section 2.2.

The CMP actions draw on existing programs and funding, with additional priority actions to be implemented as funding becomes available. The CMP actions target priority threats and seek to maximise benefits by addressing threats that affect multiple values. The availability of funding from TSC, NSW Government agencies and grant programs will strongly influence the success of the program. A key NSW Government initiative that will assist in implementing CMP actions is the MEMS (MEMA, 2018). In some cases, MEMS projects will be implemented by DPI Fisheries or LLS and will directly address CMP actions. Council will support these projects wherever possible and use information generated by MEMS projects to refine CMP implementation.

Longer-term pressures such as climate change and sea level rise have been considered in the formulation of management actions where either the emerging threat will be realised within the ten-year timeframe of the CMP (e.g. increased risk of overtopping of Bray Park Weir), or where actions need to be implemented within the ten-year timeframe to mitigate future risks (e.g. land use planning and development controls for tidal inundation in urban areas). Adaptive management measures have also been included in response to longer term threats such as sea level rise.

A significant concentration of high priority areas for management of bank erosion, riparian revegetation and water quality are located in the Rous River estuary and the upper and middle estuary, as evident on the figures presented in Appendix C. A focus on continuing to work with landowners in the upper and Rous River estuary to protect and rehabilitate riparian vegetation, stabilise banks and continue to improve agricultural best practices would potentially result in the greatest improvement to overall ecosystem value of the estuary.

3.3.2. Recreational Use Strategy

A guiding principle in the development of this CMP is the concept of river character zones, developed to promote complimentary waterway and foreshore uses for different areas of the estuary. The character zones were recommended in the *Recreational Use Study* (Hydrosphere Consulting, 2017d) to balance active and

passive recreational use, commercial use and environmental conservation and to manage the issues of bank erosion, usage conflicts and lack of waterway access and infrastructure.

The proposed character zones (Figure 26) are:

- Mixed Use Zone: Lower estuary to Tweed Broadwater – the management approach in the Mixed Use Zone should consider the provision of additional waterway access locations, formalisation and consolidation of access arrangements, upgrade of existing facilities, maintenance of navigation channels and mooring points to support commercial and recreational use. No vessels restrictions above existing TfNSW – Maritime regulations are advocated in this area.
- Conservation Zones: The proposed Stotts Island Conservation Zone extends from Tweed Broadwater to the upstream end of Stotts Channel, commensurate with the conservation value of the significant area of SEPP14 wetlands of the Broadwater and the rare and unique qualities of the Stotts Island Nature Reserve. There are existing wash and speed restrictions in the Stotts Channel. The proposed Ukerebagh Conservation Zone comprises the Ukerebagh Passage, complementing the natural and cultural heritage values and conservation status of coastal lowland vegetation in the adjacent Tweed Heads Historic Site and Ukerebagh Nature Reserve. There are existing power boat restrictions in the Ukerebagh Channel. The management approach in the Conservation Zones is designed to protect sensitive habitats by minimising bank erosion caused by large wake generating activities and encourage passive uses to increase the sense of tranquillity in the area. In addition to existing vessel restrictions, a “no towing or wake surfing” restriction has been recommended for the Stotts Island Conservation Zone.
- Active Use Zone: upstream end of Stotts Island to Commercial Road boat ramp, Murwillumbah – This reach is acknowledged as a high-speed towing area as it is sheltered from prevailing winds and has a generally flat water surface in most conditions. However, the reach is subject to severe erosion. Significant bank protection works will be required to ensure that continued wake generating boat use in this area is sustainable, however bank stabilisation works must be designed and constructed in a way that protects visual amenity and maximises ecological benefits. The creation of special locations for towing sports, in conjunction with protected banks, was supported by 70% of telephone respondents in the community survey. No vessels restrictions above existing TfNSW – Maritime regulations are advocated in this area.
- Restoration Zone: Commercial Road boat ramp, Murwillumbah to Bray Park Weir – This reach is shallow with dangerous rock and gravel bars. Bank erosion is a significant problem at Murwillumbah and therefore boat wash should be minimised to ensure a greater chance of success for bank restoration projects in this zone. Skiing/aquaplaning is currently prohibited upstream of Dunbible Creek to Bray Park Weir and there are restrictions on PWC usage between Dunbible Creek and the Commercial Road boat ramp. The management approach in the Restoration Zone is designed to prevent further bank erosion while providing fishing, swimming and canoe launching opportunities. In addition to existing restrictions from Bray Park Weir to Dunbible Creek, a “no towing or wake surfing” restriction has been recommended over the entire Restoration Zone.
- Rous Zone: Rous River estuary – This reach is a no-skiing/aquaplaning zone with low power craft usage. There is significant bank erosion along the river with limited riparian vegetation. The majority of banks are under private ownership. There is an opportunity to enhance the ecological recreation experience with fishing and canoeing facilities in the lower Rous River estuary near North Tumbulgum. No vessels restrictions above existing TfNSW – Maritime regulations are advocated in this area.

In implementing any of the actions recommended in this CMP, the concept of the character zones should be considered such that all actions support the intended outcomes for each zone. Specific management opportunities to enhance each zone are provided in Section 3.5.

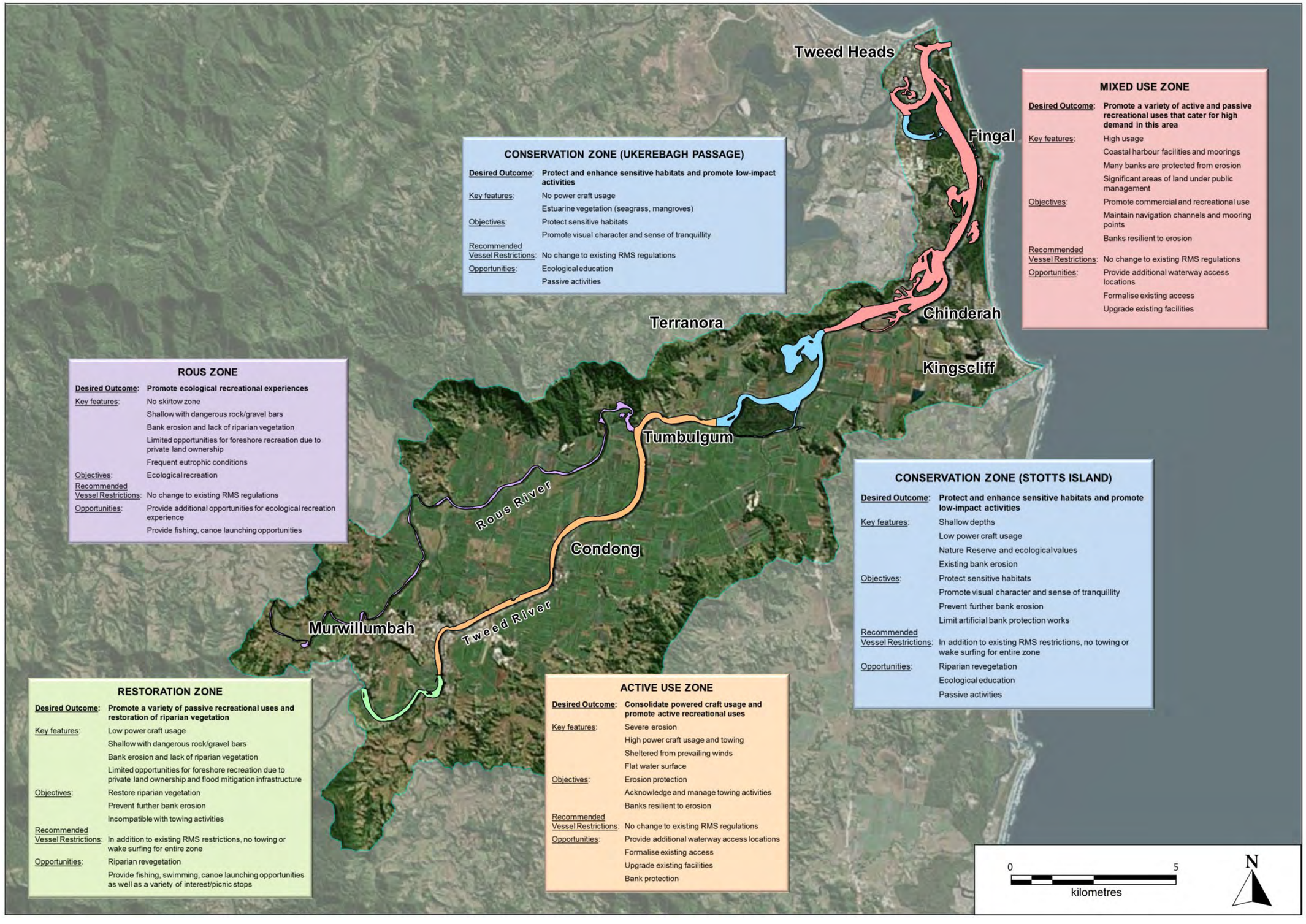

Figure 26: Suggested character zones for the Tweed River estuary

3.3.3. Water Quality Improvement Strategy

Based on the results of TSC water quality monitoring, key processes, problems and threats to water quality in the estuary have been identified (Hydrosphere Consulting (2018) and Section 2). The resulting water quality improvement strategy itemising priority issues and recommended management actions is provided in the table below. This strategy aims to achieve the detailed local objectives developed for this CMP for water quality including achieving greater compliance with Tweed River flow and water quality objectives.

Table 9: Tweed River Estuary Water Quality Improvement Strategy

Identified management issue	Functional zone	Recommended actions to be considered in CMP development
All issues	All zones	Application of the *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* (OEH, 2017) to inform decision making during Council's land use planning and assessment process.
Acid sulfate soil runoff – during and following moderate and high flow rainfall events	Upper estuary Middle estuary Rous River estuary	Continued management effort should focus on working with floodplain landholders to reduce acid runoff wherever possible. Management strategies include planning controls, drain shallowing, laser levelling, liming, tidal flushing, etc. This aligns with MEMS Action 2.4.2, i.e. better alignment of existing government policy and resourcing for floodplain and drainage management through data collection and the development of strategic, evidence-based drainage management plans that will streamline and better integrate the existing regulatory framework. The Tweed floodplain is one of eight large coastal floodplains for which MEMA will develop drainage management plans as part of the MEMS (MEMA, 2018).
Low dissolved oxygen – linked to high nutrient and Chlorophyll *a* levels indicating eutrophic conditions and a poorly functioning aquatic ecosystem	Middle estuary Rous River estuary	Reducing nutrient inputs to the middle estuary and Rous River through: • WWTP management during low-moderate flow; and • Catchment management during high flow. • Management of agricultural land and drains to minimise low DO floodwaters developing and reaching the estuary.
Elevated TN concentrations – particularly during high flow conditions, except for in the Rous River where high levels were more persistent throughout all flow conditions	Upper estuary Middle estuary Rous River estuary	Reducing nitrogen inputs to the system can best be achieved by reducing WWTP loading (particularly the Rous River) and catchment management throughout rural areas in the middle, upper and Rous River zones. Management strategies include soil conservation practices, addressing erosion, maintaining vegetative cover, minimising excess fertiliser use and establishing and maintaining vegetated riparian zones.
Elevated TP concentrations – associated with high flow conditions	Middle estuary Rous River estuary	Reduce catchment input of TP during rainfall events through catchment management (particularly soil conservation practices as phosphorus is strongly associated with sediment transport). Reduce WWTP loading (particularly important during low and moderate flows), with the Rous River estuary as a priority area.
Elevated bioavailable nitrogen (i.e. ammonium and NOx) – particularly during high flows and in all flow conditions in the Rous River estuary. Influences phytoplankton blooms	All zones	Management strategies should focus on reducing bioavailable nitrogen inputs to the system. This can best be achieved by reducing point source loading (e.g. WWTP discharge) during low and moderate flows and catchment management during high flows.

Identified management issue	Functional zone	Recommended actions to be considered in CMP development
Elevated dissolved organic nitrogen (DON) concentrations – during high flow conditions	Middle estuary	Reduce catchment input of DON during rainfall events through catchment management including soil conservation practices.
Results indicate the Tweed River estuary currently tends toward N limitation.	All zones	As nitrogen is the limiting nutrient, reducing nitrogen inputs to the estuary and particularly bioavailable forms (ammonium and NOx) is a key management action to reduce the risk of phytoplankton blooms and related impacts (e.g. increased turbidity, fluctuation in DO, disruption of chemical and biological processes etc.). However, reducing nitrogen only, may lead to a higher ratio of phosphorus and therefore a greater risk of blue green algae blooms (which are able to fix nitrogen from the atmosphere). Therefore, it is important that management effort focuses on reducing inputs of both nitrogen and phosphorus to the estuary.
Phytoplankton blooms (indicated by elevated Chlorophyll a) – in low and moderate flows	Upper estuary Middle estuary Rous River estuary	As discussed above, phytoplankton blooms are primarily controlled by bioavailable nitrogen and management efforts should focus on reducing DIN inputs and improving water clarity during moderate and high flow conditions. This can best be achieved by WWTP management during low and moderate flow and catchment management during high flow.
Elevated total dissolved solids (TSS) concentrations – particularly during high flows, estuary wide and during all flows in the Rous River estuary	Middle estuary Rous River estuary	Management strategies should focus on reducing TSS in catchment runoff during high and moderate flows. There are a number of soil conservation strategies that could be employed depending on site conditions, land use, slope etc. but in general involve maintenance of vegetative cover on land surfaces, vegetated riparian zones, employing erosion and sediment controls where vegetative cover cannot be maintained and stormwater treatment. Addressing bank erosion will also assist in reducing TSS loads. Strategies to reduce phytoplankton blooms will also significantly reduce TSS concentrations in the middle and upper reaches of the estuary. Stormwater controls in urban areas.
Elevated enterococci levels	All zones during high flow Rous River estuary during all flows	Community education advising that primary contact recreation (e.g. swimming) is not advisable for a certain period following significant rainfall (to be defined) throughout the estuary and not advisable in the Rous River most of the time. Investigate sources of pathogen inputs (i.e. human or animal sources and key locations) to better assess the risk to human health and to direct management effort to specific areas of the estuary. Stormwater controls in urban areas and education regarding pet droppings, illegal sewer connections etc. Restricting direct stock access to waterways.
Bray Park weir and fish ladders and environmental flow releases impacting on water quality (in particular, salinity) both upstream and downstream of the weir as well as fish passage	Upper estuary	It will be important for any future development in the catchment likely to impact freshwater flows to consider the existing effect of Bray Park weir. The potential raising of Clarrie Hall Dam and potential changes in upstream hydrology impacting the estuary will need to be assessed as part of the environmental impact assessment of the proposal. Appropriate measures such as environmental flow requirements will need to be adopted where necessary to mitigate potential adverse impacts on the estuary.

3.3.4. Dredging Strategy Statement

The *NSW Coastal Dredging Strategy 2019 – 2024* identifies that the "*NSW Government will continue to support dredging in other waterways that sustain significant boating activity through collaborative 'co-design' and co-funding opportunities that maximise commercial, economic and social benefits from greater coordination between relevant agencies and more effective engagement with industry and local government (via approved Coastal Management Programs) regarding maritime infrastructure investment*".

The *NSW Coastal Dredging Strategy 2019-2024* (DoL – Crown Lands, 2017) outlines waterway user benefits and other expected favourable outcomes, state-wide priority dredging preferences over the next five years, adopted sediment, environmental and statutory approvals, management principles and funding needed to maintain healthy and accessible waterways in NSW. In this strategy, the Lower Tweed River (Terranora Inlet boat harbour to the entrance) is specifically listed as a priority location with the State government being responsible for the dredging of this navigational channel. The *NSW Coastal Dredging Strategy* identifies that councils are responsible for maintaining other navigational channels (i.e. local waterways) with $6 million of funding committed through the Coastal Dredging Strategy and Boating Access Dredging Grants Program (50:50 funding). The lower Tweed River is listed as a key investment location in the strategy with state-owned assets located at the Southern Boat Harbour and significant sand bypassing infrastructure located in the vicinity of the entrance.

TSC manages several canal estates and various facilities to service local boating including most of the boat ramps. TSC is responsible for dredging associated with TSC managed infrastructure (e.g. boat ramp access channels) and for access to and within Council managed canals (i.e. Anchorage Island Estate and Oxley Cove) commensurate with the depth requirements relevant to the draft of vessels accessing that infrastructure i.e. relatively shallow in comparison to the depth requirements for maintaining navigational access to state-owned infrastructure. TSC is financially limited in managing the *ad hoc* maintenance dredging associated with Council managed assets and is not responsible for maintenance dredging of State-owned navigational channels in the estuary. However, TSC would consider co-contributions towards dredging projects where there is additional community benefit, e.g. such as the reuse of dredged material within the estuary.

3.4. Existing Management Programs

3.4.1. TSC Management Programs

This CMP is supported through the continuation of related TSC management programs including:

- Land use planning and development controls;
- On-site sewage management program;
- *Integrated Water Cycle Management Strategy* (Hydrosphere Consulting, 2016a) implementation;
- Asset management strategy and plans;
- Implementation of the *Tweed River Domestic Structures Strategy* (Department of Industry – Crown Lands *et al*., 2008);
- Waterways management program;
- Sustainable agriculture program;
- Environmental education program;
- Biodiversity program;
- Roads and stormwater program;

- Weed and pest management programs;
- Cultural program;
- Reserves conservation program;
- Council maintenance programs;
- Flood debris clean-up as required; and
- Algae and targeted water quality monitoring.

3.4.2. Agency Management Programs

Other government agency management programs may also contribute to achievement of the CMP objectives including:

- North Coast LLS extension officer and related projects;
- DPI regulation of NSW fisheries;
- DPI Food Authority oyster monitoring and management program;
- DPI Key Fish Habitat Protection programs;
- TfNSW - Maritime Coastal Dredging Strategy and Boating Access Dredging Grants Program;
- TfNSW – Maritime Boating Now Program;
- NSW Government Coastal and Estuary Grants Management Program; and
- NPWS management of National Parks and Nature Reserves.

In addition to the programs listed above, the *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* (OEH, 2017) was released to inform decision making in land use planning.

The MEMS sets the overarching framework for the NSW Government to coordinate the management of the marine estate over the next decade in accordance with the objects of the *Marine Estate Management Act 2014* and the NSW Government's vision for the marine estate. The Strategy balances economic growth, use and conservation of the marine estate by identifying evidence-based management priorities and setting policy directions for managing the marine estate as a single continuous system. Many of the investigations undertaken for this CMP and the resulting coastal management actions directly address the initiatives, objectives and/or actions in the MEMS, as detailed in Appendix E.

3.5. Actions to be Implemented by TSC or Other Public Authorities

The management of key threats in this CMP is grouped into 10 categories, one for each key threat as well as fundamental management actions that apply across all threats including Governance, Stakeholder and Community Engagement and Estuary Health Monitoring and Reporting. Management strategies and actions have been developed for a ten-year period.

The recommended Action Plan in Table 11 has been developed to address the key risks to the estuary values. The Action Plan specifies:

- ID – an alpha-numeric identification code provided for easy reference;
- Priority – each action has been assigned a priority according to importance and urgency for implementation (Table 10).

Table 10: Priority ranking

Priority	Description
Fundamental (F)	Actions that are critical for successful implementation of the CMP and important for long-term effective management
High (H)	Actions of high importance in addressing key threats and issues
Medium (M)	Actions considered of medium importance in addressing threats and issues
Low (L)	Actions considered of low importance in addressing threats and issues

- Action – A short descriptive name for the action is provided;
- Details – an outline of the scope of works required. Supporting detail on the development, design, coordination, or implementation of the action, relevant sites, associated management plans etc.;
- Responsible Organisation(s) – responsible for implementation of the action;
- Support Organisation(s) - may be required and/or requested to assist in implementation of the action, either through in-kind contributions or as a potential funding or information source. The Business Plan (Section 4) nominates potential funding sources and provides a description of funding ratios between the applicant and grant provider where available. This provides an indication of proposed cost-sharing arrangements between Responsible and Support Organisation(s) where applicable. In addition, support from various other local government and non-government organisations and groups including industry bodies, private landholders and community groups will be essential in the implementation of the plan to assist in implementation of the action, either through their regulatory role or land management function or as a potential funding or information source. Council will consult with other responsible parties to obtain acceptance of the actions prior to certification of this CMP by the Minister;
- Indicative Timeframe – indicative timeframe for implementation and alignment with Council's Delivery Program (DP). Based on the priorities developed in this CMP, timeframes for management actions have been estimated, pending funding availability. The assumed start date for CMP implementation is 1 July 2021, following Council adoption and certification of the Plan. The CMP has a planning timeframe of ten years therefore the duration of the Plan implementation period is from 1 July 2021 to 30 June 2031. Timing of the delivery of actions should be based on the priorities developed for this CMP but will also depend on the availability of funding.

The Business Plan (Section 4) provides a breakdown of action costs including capital, operational/ maintenance costs along with potential funding sources.

In accordance with the *Local Government Act 1993*, TSC will implement the management actions outlined in Table 11 as a part of Councils normal functions.

On-ground actions and overarching recommendations for each functional zone are shown on Figure 27 to Figure 32. The relevant CMAs addressed by the actions are identified in Section 3.2. Where specific local actions are proposed on land identified as coastal wetlands or littoral rainforest (or associated proximity areas), those actions are identified on these figures.

Relevant authorisations and appropriate tenure arrangements are to be obtained (by any works proponent) from public land managers for CMP actions on public land, including authorisations under the *Crown Land Management Act 2016* (refer Section 1.8.1).

Where actions are proposed on Crown land, consideration of Aboriginal Land Claims lodged under the *Aboriginal Land Rights Act 1983* (NSW) will need to be undertaken. Any works will need to be compliant with the *Native Title Act 1993* (Cth).

Table 11: Action Plan – CMP management actions

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
Fundamental Management Actions					
A	**Governance and administration**		The implementation of priority actions in this CMP will require continued collaboration between TSC, relevant State Government Agencies, Industry and affiliated community stakeholder groups. The TCWC meets every two months and brings these parties together to provide advice to Council on the management of the estuary.		
A1	F	Administration of the CMP through TSC Waterways Management Program overseen by TCWC.	Council will provide governance and administration services so that the CMP can be implemented effectively and efficiently, through both the TSC Waterways Management Program and through the ongoing resourcing and operation of the TCWC. The committee should continue integrated decision making between Council, community and state government agencies, such that all planning activities, contribute to the overall objectives of this CMP. The committee should promote open information exchange between all decision-making agencies, actively seek opportunities for improvement and continue to consider a balanced approach to management of the estuary. Key responsibilities of the TCWC include the review of CMP progress (yearly at a minimum) as detailed in Section 5. An external mid-term review of CMP progress to be undertaken at commencement of DP 2026-2029.	TSC, TCWC	Ongoing, mid-term review DP 2026-2029
A2	F	Support implementation of programs and strategies complimentary to the CMP.	Existing related strategies and management programs are listed in Sections 3.4 (TSC managed) and 3.4.2 (agency managed). TSC should ensure continuing implementation and support of existing strategies and programs where these are consistent with the aims of this CMP. In particular Council should adopt, implement or consider the following to inform decision making during Council's land use planning and assessment process: • *Tweed River Domestic Structures Strategy* (DoL *et al*., 2008); • Any bank management strategy(ies) developed for the estuary under Marine Estate Management (MEM) Strategy Action 2.3.3; and • *Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions* (OEH, 2017).	TSC	Ongoing
A3	H	Ensure future Crown land Plans of Management (PoM) are consistent with the CMP.	Several PoM are currently used for management of Crown land within the study area including for Stotts Island Nature Reserve (NPWS, 2001), the Tweed Heads Historic Site and Ukerebagh Nature Reserve (NPWS, 1999) and for the Tweed Coast Regional Crown Reserve. Under the *Crown Land Management Act 2016*, which commenced 1 July 2018, Council will also need to categorise and prepare PoM under the *Local Government Act 1993*, for Crown reserves for which Council is the Crown land manager. Amendments to existing PoM and any new PoM within the study area will need to be consistent with this CMP.	TSC NPWS, DPE – Crown Lands	Ongoing
A4	H	Periodic review of Coastal Management Areas (CMAs) to ensure accuracy and relevance.	During the lifecycle of the CMP, review the extent and efficacy of the Coastal Management Areas in view of the findings of the tidal inundation mapping and risk assessment (refer Action U), amendments to DPI mapping of marine vegetation and amendments made by DPE. This includes consideration of the: • Extension of the Coastal Environment Area to encompass the Coastal Wetlands Area; • Sufficiency of the Coastal Environment Area given the influence of the broader floodplain on estuary health and coastal values and the importance of appropriate zoning throughout whole hydrological units for effectively managing threats and risks to hydrology and inundation across coastal floodplains (DPI, 2019); and • Investigate why the lower end of McLeods Creek (a highly modified floodplain channel) is mapped as Coastal Environment Area CMA, when no other floodplain channels are included in the mapping. Linked to Action U5 re consideration of including a Coastal Vulnerability Area (tidal inundation) into the CM SEPP.	TSC DPE	Opportunistic
B	**Stakeholder and community engagement**				
B1	F	Develop and implement a Stakeholder Engagement Strategy.	Development and implementation of a Stakeholder Engagement Strategy to guide education, engagement and consultation activities and to coordinate relevant educational/engagement sub-actions in this CMP. Ongoing stakeholder and community involvement will be required to ensure successful implementation of the CMP and the overall satisfaction of stakeholders. This will include: • Ongoing consultation with interested and committed community groups, typically represented through the TCWC; • A high degree of engagement and collaboration with landholders; • On-ground participation in management actions, particularly local community groups such as Landcare and fishing groups; • Consultation and collaboration with local Aboriginal representatives and groups through the TBLALC and the AAC; and • Education programs. Achievement of the CMP objectives is reliant on stakeholder and community understanding and effective involvement in the management process. The strategy would be developed to ensure alignment with existing engagement activities such as TSC's environmental, cultural and sustainable agriculture programs.	TSC, TCWC	Ongoing
B2	F	Co-ordination and consultation with local Aboriginal community and NPWS.	Involve representatives of the Aboriginal community in the implementation of the CMP to ensure their values are prioritised appropriately. Feedback during the consultation process identified that the Aboriginal people are avid users of the estuary and the Aboriginal community wants to have a voice in rehabilitation projects, take ownership of actions and be involved in implementation of the CMP including on-ground actions.	TSC, AAC TBLALC	Ongoing

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
B3	F	Raise awareness of Aboriginal cultural heritage significance of the Tweed River estuary.	Work with representatives of the Aboriginal community and DPE(NPWS) to raise awareness of the Aboriginal cultural heritage significance of the Tweed Shire including history, values and cultural practices associated with the estuary, both historic and ongoing. Education and engagement activities should be cognisant with the Aboriginal people being "keepers" of their cultural heritage. TSC should provide educational material such as signage and interpretative boards at Aboriginal sites where appropriate. TBLALC has suggested the roll-out of school-based education campaigns such as that currently undertaken by TBLALC at Fingal Head Public School.	TSC, AAC TBLALC	Ongoing
B4	M	Provide additional nature-based educational opportunities including signage and information.	Recommended locations include: • The proposed Ukerebagh Passage Conservation Zone; • The proposed Stotts Island Conservation Zone (e.g. at Bruce Chick Park); • Bluey Hill Park, Tumbulgum (in conjunction with Action X4); • Pat Smith Park and off Rous River Way, Murwillumbah, Rous River estuary (in conjunction with Action X5); • Commercial Road Boat Ramp; and • Condong Boat Ramp. Additional education and engagement activities for specific key threats to the estuary are detailed under actions for the relevant threat below.	TSC DPE	Ongoing
C	**Estuary health monitoring and reporting program**				
C1	F	Annual estuary health report card.	Continue the production and annual release of an easy to understand, estuary health report card. The estuary health report card focuses on reporting the results of the Estuary Health Monitoring and Reporting Program (Action C2) and is also to incorporate results of other estuary health monitoring as it becomes available such as the riparian vegetation and bank condition monitoring (Action C3), monitoring of oyster banks and reefs (Action C4), avifauna monitoring (Action C5) and monitoring of other higher order predators such as dolphins and osprey (Action C6). The monitoring program and report card would be used to: • Track how well the estuary is being managed over time, • Inform the community of the current health of the estuaries; and • Provide TSC with an understanding of whether management approaches need to change.	TSC DPE	Ongoing – annual reporting
C2	F	Estuary Health Monitoring and Reporting Program.	Currently, estuary health is monitored through a series of disconnected monitoring programs at a variety of timescales and is rarely reported in a holistic and easily comprehensible manner. Feedback from the community and stakeholder consultation process indicated a desire for ongoing monitoring and an easy-to-read annual report card for the Tweed estuary (primarily on water quality). Continue routine and event-based water quality sampling at key sites within the Tweed River catchment. Report results to the community through an annual estuary health report card (see Action C1). Conduct comprehensive technical review of water quality data every five years to assess longer term trends, identify likely controlling process and any major changes in water quality over time including changes associated with implementation of the CMP. The last technical review was carried out in 2017 (Hydrosphere Consulting, 2018), therefore future technical reviews are recommended in 2022 and 2027.	TSC DPE	Ongoing
C3	F	Riparian vegetation and bank condition monitoring.	Undertake detailed riparian vegetation and bank condition monitoring and reporting for the whole estuary every three years and additionally following major flooding events. The assessment should build upon monitoring work carried out as part of this CMP (refer Hydrosphere Consulting, 2020) and be expanded to encompass the whole estuary including the Rous River estuary, natural banks in the lower estuary (e.g. Ukerebagh Island and areas of Chinderah foreshore) as well as bank erosion on private land. Whilst Council is not responsible for funding or initiating works to remediate bank erosion on private land, such erosion still has the ability to impact on the health of the estuary and Council plays a role in the approvals process for bank stabilisation works. The expanded assessment should include revegetation sites completed as part of this CMP and potential opportunities for future rehabilitation (i.e. Action F1). Results should be used to inform the Estuary Health Monitoring and Reporting Program (Action C2), reported in relevant estuary health report cards (Action C1) (when timing coincides with this reporting) and assist in interpretation of water quality data during technical data review (Action C2).	TSC DPE	Every 3 years
C4	H	Monitor oyster banks and reefs.	Establish a regular mapping and reporting program for remnant and restored oyster banks and reefs. Routine monitoring of oyster health and fish assemblages at existing remnant oyster banks and at proposed restoration sites is required to assess disease prevalence, disease risk to restoration projects and the success of restoration projects in terms of provision of additional fish habitat. Results of the monitoring should be reported in the annual estuary health report card (Action C1) and used to inform the Estuary Health Monitoring Program (Action C2). Also linked to Action L2.	DPI Fisheries TSC, DPE	Every 5 years
C5	H	Support monitoring of avifauna by volunteer groups.	TSC should continue to support existing monitoring and reporting activities undertaken by volunteer groups through in-kind support and through acknowledgement of these volunteer groups in any media reporting on the monitoring undertaken. Results of the monitoring should be reported in the annual estuary health report card (Action C1) and used to inform the Estuary Health Monitoring Program (Action C2).	TSC	Ongoing
C6	H	Support monitoring of other higher order predators.	TSC should provide in-kind support for any continuing dolphin monitoring program (e.g. by Dolphins Research Australia Inc. and Tweed Osprey Monitoring Group) for promotion etc. for example, via media announcements/web page information. Results of the monitoring should be reported in the annual estuary health report card (Action C1) and used to inform the Estuary Health Monitoring Program (Action C2).	TSC	Ongoing
C7	H	Increase training and resourcing for compliance monitoring staff.	Increase training and resourcing for compliance monitoring staff with a particular focus on collecting evidence of water pollution and vegetation clearing. The community expects Council to respond effectively to incidents of environmental pollution, acknowledging that compliance work has a high demand on resources and requires significant levels of staff expertise. It is recommended that Council allocate additional resources to the issue.	TSC	Ongoing

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
Threat 1 - Bank Erosion					
D	**Increased adoption of best management practices to mitigate pollution of surface and groundwater and enhance biodiversity**				
D1	H	Landholder communication and liaison.	Work with landholders to increase awareness of the impacts of both soil and riverbank erosion and to increase uptake of mitigation measures, including greater landholder adoption of best management practice, particularly in regard to water quality. Such measures may include: • Catchment revegetation to reduce flood peaks; • Soil conservation practices (phosphorus is strongly associated with sediment transport); • Maintaining vegetative cover; • Optimising dung beetle management in pastures; • Minimising excess fertiliser use; • Establishing and maintaining vegetation in riparian zones including suitable vegetation types/methods; • Retention of old and dead trees on farmland, riverbanks and riparian zones for provision of essential habitat for birds and small mammals; • Employing erosion and sediment controls where vegetative cover cannot be maintained; • Stormwater treatment; and • Management of agricultural land and drains to minimise low dissolved oxygen (DO) floodwaters developing and reaching the estuary, particularly in the middle estuary and Rous River estuary.	TSC Landcare, LLS	Ongoing
E	**Promotion of the diversity of river uses**				
E1	H	Liaison with TfNSW regarding *Tweed River Recreational Use Strategy* and character zones.	Recommend to TfNSW that the following measures be considered in any future revision of boating management measures applied to the Tweed River estuary: • Create a no-tow zone within the “Conservation Zone “ (Stotts Island) to prevent wake damaging sensitive environmental habitat, whilst increasing the areas suitability for tranquil and passive recreational uses; and • Extending the no ski/tow zone within the “Restoration Zone” (Bray Park Weir to Commercial Road Boat Ramp) to reduce the risk of further wake induced bank erosion and increase the likelihood of existing erosion being able to be stabilised with bioengineered works, whilst increasing the areas suitability for tranquil and passive recreational uses. The assignment of character zones (Section 3.3.2) and associated waterway usage restrictions would assist in the management of bank erosion, user conflicts, limited waterway and foreshore access and infrastructure restrictions, whilst also promoting the continuation of active and passive recreational use, commercial use and environmental restoration/conservation. To be successful, this approach needs to be supported by regulatory controls, signage, monitoring and enforcement and these measures would all depend upon TfNSW - Maritime supporting the towing restrictions advocated by Council in the Recreational Use Strategy and this CMP. In addition, the provision of sufficient infrastructure to cater for the needs of the recreational uses planned for each zone (refer Actions X to FF) must be considered. In particular, significant bank protection works (and associated maintenance requirements) will be required where wake generating boat use would be consolidated and banks subjected to repeated exposure to high energy, i.e. in the recommended Active Use Zone from Stotts Island to Commercial Road Boat Ramp, Murwillumbah. It is noted that for a large part of this zone, riverbank stabilisation works will be required to address existing severe bank erosion and protect roads, regardless of the ongoing presence of wake generating boating activities. The aims of each character/usage zone should be promoted through education in order to support compatible recreational use and environmental conservation in keeping with the long-term vision for the estuary.	TSC	DP 2023-2025
E2	H	Public promotion of *Tweed River Recreational Use Strategy*.	Promote and provide educational materials to encourage safe and sustainable boating and minimising wash.	TSC	DP 2023-2025 signage. Ongoing promotion
E3	H	Motorised Water Recreation Business Policy.	Develop a policy on Motorised Water Recreation Businesses and amend the Tweed LEP 2014 via addition of a clause, to allow for definition and assessment of Motorised Water Recreation Businesses, consistent with the environmental values and objectives of the Tweed River Estuary CMP. Such a policy would include non-commercial organised events including multiple participants using motorised vessels. In order to ensure that commercial vessel use of the river complies with the objectives of the CMP, Council needs to develop a guiding policy to confirm the threshold point at which commercial use will be classified as development and will require assessment. It is also considered that the impacts of certain high impact water sports are contrary to the objectives and intent of the Tweed Estuary CMP and as such activities that generate such impacts will be assessed through the development of objectives and assessment criteria, in an LEP clause. High impact water sports would be classified as those involving high levels of noise, wake, speed, risk or pollution.	TSC TfNSW - Maritime	DP 2023-2025

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
F	**Rehabilitate and maintain priority bank erosion sites**				
F1	F	Bank stabilisation works at high priority sites on public land including riparian vegetation rehabilitation.	High and moderate priority areas for bank rehabilitation, as identified in investigations undertaken for this CMP, are specified in Appendix C. Specific actions to address bank erosion are listed below. Related actions include Action D, Action G and Action Z1. Progressively carryout bank stabilisation works in accordance with prioritised sites identified in Appendix C. Works should be undertaken through a staged approach targeting grant funding programs as they become available. Works would be undertaken by TSC's Waterways Program focussing on sites that have environmental outcomes as a priority and by TSC's Roads Program, focussing on the protection of roads (and incorporating revegetation/habitat best practice where feasible). Cost estimates have been based on the estimates provided in the *Tweed Riverbank Erosion Management Plan* (TSC, 2014). Note that the sites prioritised for bank stabilisation in M2 do not generally include a detailed assessment of erosion affecting the Tweed Valley Way and Tumbulgum Road (exceptions include sites N1 and N2). See action F3. Alternatives to rock walls should be considered, taking into account benefit cost (including life cycle costs), project risks and funding availability. Design of bioengineering and structural works should include: • An allowance for sea level rise (e.g. the ability to add to the height of the rock fillets and revetments in the future); • Consideration of public foreshore access, use and aesthetic impact; • Consideration of the design principles specified in the guidelines for Environmentally Friendly Seawalls (DECC, 2009) and in the *Tweed Riverbank Erosion Management Plan* 2014 to maximise habitat diversity, complexity and surface area in the structure; • Consider the incorporation of instream vegetation structure for fish habitat; and • Allow for the establishment and maintenance of compensatory riparian habitat (e.g. revegetation/bioengineering designs) where full height structural works are required on either public or private land.	TSC DPE, DPI Fisheries	Ongoing
F2	H	Detailed design and restoration of lower estuary foreshore protection structures on Council managed land.	Undertake engineering investigations, design, cost estimation and carry out restoration for high and high-medium lower estuary foreshore protection structures on Council managed land (2.3 km) as identified in Appendix C when funding is available. Liaise with DPE - Crown Lands, TFNSW – Maritime and TBLALC as required where sites are wholly or partially outside of TSC managed land. Refer to details of Action F1 regarding consideration of alternatives to rock walls and the requirements for design of bioengineering and structural works. Consultation with DPE – Crown Lands should be undertaken in any instance of structures being located on Crown land (including submerged Crown Lands) to confirm management arrangements and any authorisations required.	TSC DPE - Crown Lands, TfNSW – Maritime, TBLALC	DP 2023-2025
F3	H	Detailed design and restoration of riverbank erosion adjacent to the Tweed Valley Way and Tumbulgum Road.	Undertake a detailed investigation of existing and predicted riverbank erosion sites adjacent to the Tweed Valley Way and Tumbulgum Road between Stott's Island and Murwillumbah (11.6 km). Prepare detailed designs, costs, priorities and timeframes for implementation of a ten-year program of works that will stabilise erosion, protect roads and enhance aquatic ecosystem service provision. Council will use the information generated to plan for investment in erosion stabilisation, particularly as it relates to road protection and to prepare and justify large scale grant applications for the implementation of future Tweed Riverbank stabilisation works. It is likely that engineered rock erosion stabilisation works will be required in a significant proportion of this reach, however Council and the community hold strong concerns about the cumulative impact of traditional rock revetment on the river environment, due to the already extensive scale of erosion present. Due to the close proximity of roads in this reach, a "no action" or "revegetation" approach to bank stabilisation will be impractical. Council's aim is to implement riverbank erosion stabilisation works that will protect road infrastructure while reducing the water quality and sedimentation impacts of erosion and optimise visual and ecological outcomes in the Tweed River Estuary. The study area will comprise both banks of the river from the upstream point of Stott's Island to the bridge in Murwillumbah.	TSC DPE, DPI Fisheries, DPE – Crown Lands	DP 2023-2025
F4	M	Monitor bank stabilisation works and improve/refine methods.	Carry out monitoring of erosion stabilisation techniques employed to increase the resilience of vulnerable riverbanks and update design advice for bank stabilisation works as required.	TSC DPE, DPI Fisheries	Ongoing
F5	H	Support MEMA reforms of development application process for bank stabilisation works.	Support MEMA reforms of development application process for best practice riverbank erosion stabilisation.	TSC	Ongoing
F6	L	Port infrastructure liaison with TfNSW - Maritime.	Continued liaison with TfNSW - Maritime on matters concerning port infrastructure including the condition of the lower estuary protective infrastructure (as identified in this CMP and from any ongoing monitoring). Bioengineered designs incorporating vegetation plantings and aquatic habitat should be incorporated into any future rock wall remediation works, where feasible.	TSC TfNSW - Maritime	

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
G	**Rehabilitate and maintain riparian vegetation**				
G1	H	Rous River Estuary Riparian Zone Management Plan.	Very high and high priority areas for riparian restoration works are identified in Appendix C. Specific actions are listed below. Related actions include Action D and Action F. Develop and implement a Riparian Zone Management Plan for the Rous River estuary to compliment the potential restoration sites identified in the *Tweed Riverbank Erosion Management Plan* (TSC, 2014). The Plan should include: • Identification of hotspots; • Identification of opportunities to revegetate; • The identification of stock access prevention, bank stabilisation, revegetation and riparian weed management techniques appropriate for the estuary and hotspots; • Consideration of shade and off-stream stock watering requirements where fencing is recommended to prevent stock access to the waterways; • Working with the cane industry, farmers and riparian landowners to identify potential bank stabilisation and revegetation projects; • Identify potential sources of funding for riparian rehabilitation projects including focused promotion and prioritisation of the Rous River estuary; • The promotion and implementation of bank stabilisation and revegetation projects; and Council should lead by example and ensure that all of its own infrastructure protection projects demonstrate BMP by minimising rock where practical and incorporating vegetation and fish habitat features.	TSC DPE, DPI Fisheries	DP 2023-2025
G2	H	Improve development application process to facilitate riparian rehabilitation projects on private land.	Ensure consistency in the application of rehabilitation planning in the development assessment and approvals process, including the use of conditions to require development impacts to be offset as directed by the Biodiversity DCP (TSC, 2017b). To facilitate and encourage private landholders to carry out riparian revegetation and rehabilitation projects on private land.	TSC	Ongoing
Threat 2 - Habitat loss and barriers to habitat connectivity					
H	**Restore natural drainage and reinstate tidal exchange**				
H1	M	Manage barriers to fish passage.	• Audit floodgate management practices (Council managed), status of floodgates and location of fish gates. • Identify priority fish passage barriers for removal/modification following on from previous work by DPI Fisheries, i.e. additional floodgates for upgrading and installation of fish gates. Work in conjunction with TSC's flood and sustainable agriculture programs, Floodgate Management Groups, DPI, Drainage Unions and landholders. • Review TSC's *Floodgate Management Protocol* and the floodgate management plans and agreements for management of modified floodgates both with and without volunteer operators. • Consider future tidal inundation.	TSC DPI Fisheries	DP 2023-2025
H2	M	Cost-benefit analysis and feasibility study(ies) of alternative floodplain land use options.	Undertake a cost-benefit analysis (CBA) and feasibility study(s) of alternative floodplain land use options to support decision making for land holders of low-lying agricultural land that, under current management practices, may become unviable in the face of rising sea levels and more frequent tidal inundation, i.e. identify: • Costs to protect agricultural land and the value of drained and flood protected landscapes for agricultural production; • Potential fisheries value from restoration of natural drainage, reinstatement of tidal exchange and rehabilitation of former wetland and backswamp areas in marginal/ low lying agricultural lands on the floodplain which would otherwise require increased protection against inundation events; • Potential for carbon storage in restored wetlands and backswamps as a future revenue source; and • Value of ecosystem services provided by accommodating landward retreat of estuarine vegetation communities. This action supports the ongoing and high value existing agricultural production on the floodplain where feasible and considers that other uses may be more viable in some locations in the future. A particular focus will be on identifying economically viable and socially acceptable strategies for implementation. The assessment should include broad consideration a range of factors including, but not limited to: • Land ownership scenarios; • Potential carbon sequestration benefits; • Potential impacts on farm viability and cash flow; and • Potential funding streams for farmers to undertake hydrological works, e.g. market-based approaches, public-private investment strategies and collective arrangements that promote cooperative action, financial incentives (e.g. grants, price signals and trading mechanisms, which are of particular importance where hydrological works are required to alter drainage patterns), non-financial measures (e.g. Government extension services) and regulatory frameworks (DEWHA, 2009).	TSC DPE, DPI Fisheries	DP 2026-2029
H3	H	Upgrade Bray Park Weir fishways.	Undertake upgrades to the existing fishways at Bray Park Weir to ensure adequate fish passage upstream and downstream of the weir under all conditions. Fishway design will be carried out as part of any Bray Park Weir upgrade works or funded as part of other projects (e.g. Clarrie Hall Dam upgrade). Include consideration of Clarrie Hall Dam raising and environmental flow requirements. Also linked to Action V.	TSC DPI Fisheries	DP 2023-2025

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
H4	L	Floodgate management investigation.	Assess which creeks and drains experience a build-up of silt and debris downstream of floodgates and investigate the management responsibilities for drain sections between the river and the first flood gate, streamlining of approval requirements and identifying opportunities for remediating these areas. The *Condong Creek Drainage Management Plan* has been developed to optimise flow in this system. Whilst most other creeks and drains draining to the estuary have floodgates only 50 to 80 m upstream of the confluence with the main rivers and management of these areas is undertaken by Council at an operational level, there are several creeks where the floodgates are located well upstream of the confluence that may require more formalised management arrangements (e.g. Dulguigan Creek and the outlet channel between Lake Kimberley and Shallow Bay). DPE - Crown Lands role would be focused on the investigation of management responsibilities (as opposed to on-ground assessments).	TSC Drainage Unions, DPE - Crown Lands, DPI Fisheries	DP2022-2025
H5	H	Support MEMA drainage management plan for the Tweed floodplain.	DPI Fisheries have stated that the Tweed floodplain is one of eight large coastal floodplains where, as part of the MEMS (Action 2.4), data will be collated to inform the development of strategic, evidence-based drainage management plans that streamline and better integrate the existing regulatory complexity. Drainage management plans will consider cumulative impacts, prioritise actions, investment planning and support decision making. Once developed the plans will also reduce red tape by permitting landholders to make informed and accountable decisions to mitigate and mange risks where the landscape and soil constraints are manageable and where threat and risk to use of the marine estate by other stakeholders is minimal. It will, however, take up to two years to develop the full legal framework to underpin the preparation of drainage management plans, given that no such plans exist and to consult on the complex nature of the issues involved like variations in land ownership and drainage unions.	TSC MEMA, DPI Fisheries	DP 2023-2025
I	**Investigate the potential for rehabilitation of former floodplain wetlands**				
I1	M	Identify sites for potential regeneration of floodplain wetlands.	The rehabilitation of former wetland or backswamp areas is a potential management action for maximising ecosystem benefits provided by the floodplain, whilst minimising the impact of agriculture on estuary ecosystems. This is particularly the case for former backswamps that were once important habitat areas or fish nurseries, or priority areas for riparian rehabilitation and/or acid sulfate soil (ASS) remediation. The best opportunities for rehabilitation are typically on waterlogged/tidally affected land of low agricultural value. Develop a methodology and undertake assessment (based on criteria such as elevation, tenure, soils, vegetation etc.) of areas of the floodplain that may have potential for regeneration of floodplain wetlands. To be developed in consultation with floodplain agricultural users including the NSW Sugar industry. Consult and work with cane and grazing industry representatives to find opportunities for improving ecosystem services in agriculturally marginal, low-lying/water-logged/tidally affected soils and identify potential outcomes that would benefit (improve farm efficiency or increase productivity) and motivate landholders. • Recommend suitable site(s) for pilot floodplain wetland rehabilitation site (see Action I3). Provide cost estimate for rehabilitation works. Linked with Actions H1-H6.	TSC DPI Fisheries, DPE, LLS, MEMA	DP 2023-2025
I2	M	Promote existing successful floodplain restoration projects.	Identify and promote successful examples of floodplain wetland rehabilitation projects (such as ponded pasture and reforestation projects). Promote through media, online, existing collaboration and education programs.	TSC DPI Fisheries, DPE, Landcare, Tweed Cane Growers Association, Sunshine Sugar	Ongoing
I3	M	Pilot floodplain wetland rehabilitation site.	Implement a pilot floodplain wetland rehabilitation project that has multiple benefits. Revegetate with lowland species with consideration given to species that would have been indigenous to the floodplain prior to clearing and appropriate for maximising ecological benefit.	TSC DPI Fisheries, DPE, LLS, MEMA	DP 2026-2029
J	**Protect significant estuarine vegetation - improve condition and extent**				
J1	H	Estuarine vegetation education program.	Design and deliver an education project to reduce boating impacts on seagrass beds, in particular from propeller tracking and trampling during boat beaching.	DPI Fisheries, TfNSW - Maritime DPE, TSC	DP 2023-2025 for signage/ brochure. Ongoing extra Fisheries Officer presence at boat ramps
J2	L	Protection of estuarine vegetation off Alf Rush Memorial Drive.	Protect estuarine vegetation along Alf Rush Memorial Drive through the management of vehicle access/ boat launching across the foreshore. Any rationalisation, formalisation and/or prevention of vehicle and boat launching access in this area would be undertaken in consultation with TfNSW – Maritime with regards to use of the foreshore to access the adjacent mooring field.	TSC DPI Fisheries, TfNSW, DPE	DP 2023-2025
J3	L	Letitia Spit Wetland Management.	The 1991 *Lower Tweed Estuary River Management Plan* identified that the spit was at threat from weed infestation, land degradation, habitat destruction, rubbish dumping and other problems associated with general neglect. Liaise with TBLALC to improve the management of degraded wetland and foreshore areas at Letitia Spit through the control and prevention of vehicular access and powered motorboat access and encouragement of recreational use away from fragile wetland areas. Tweed River Entrance Sand Bypassing Company (TRESBCo) has a land lease over parts of Letitia Spit for the Tweed Sand Bypass Project.	TSC TBLALC, DPI Fisheries, DPE	DP 2026-2029 for initial works and ongoing liaison.

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
J4	H	MEMA Tweed Intertidal Marine Vegetation Strategy.	Support MEMA development of an Intertidal Marine Vegetation Strategy for the estuary (MEMS Action 2.3.2). DPI Fisheries (2019) has indicated that as part of MEMS Action 2.3.2, that the Tweed is one of two locations in which an estuary-wide marine vegetation management strategy is to be developed as an evidence-based estuary-wide document that informs decision making about intertidal marine vegetation. These strategies aim to direct decision making toward maximise resilience, accommodate sea level rise, address key threats (clearing & drainage, cattle grazing, four-wheel drives on saltmarsh), facilitate rehabilitation opportunities and reduce red tape for low impact works (e.g. mangrove trimming for safe traffic sight lines).	MEMA TSC, DPI Fisheries	Ongoing
K	**Plan for and facilitate the migration of significant riparian and estuarine vegetation with sea level rise**				
K1	M	Review LEP zoning to incorporate areas for estuary vegetation migration.	Using tidal inundation maps, review LEP zoning in High and Moderate priority areas for mangrove and saltmarsh migration, as identified in Appendix C. Identify opportunities for incorporation of estuary vegetation migration areas into E or RU6 zones, particularly on public land. Identify these and appropriate additional areas that warrant detailed consideration under TSC's Development Control Plan (DCP) A19 clause C4, '*Bushland or Wetland Vegetation on the Coastal Floodplain'*	TSC	DP 2026-2029
K2	M	Provision of buffer zones to facilitate estuary vegetation migration.	Using incentive schemes and land holder agreements (e.g. TSC River Health Grants/Biodiversity Grants) continue to work with floodplain landholders to create buffer zones around existing waterways, wetlands and riparian areas, to accommodate dynamic changes to waterway, wetland and riparian vegetation boundaries, associated with sea level rise. Landholder agreements could involve restrictions on grazing or cropping.	TSC	DP 2026-2029
K3	M	Identify offsets for Stotts Island vegetation loss	Investigate a suitable location (s) for the establishment of lowland sub-tropical rainforest on the floodplain to offset the potential loss of this vegetation community from Stotts Island.	TSC	DP 2026-2029
L	**Support the conservation and recovery of shellfish ecosystems**				
L1	H	Shellfish ecosystem education.	Raise the profile of shellfish ecosystems by increasing education and communication on their function and value. There is growing recognition that in addition to policy tools for the protection of existing shellfish ecosystems, active repair and restoration is required to restore shellfish ecosystems and their ecological functions. Protection and re-establishment of shellfish ecosystems is likely to have positive implications for fish assemblages, water quality (as oysters filter the water), bank protection, overall ecosystem health, Aboriginal cultural heritage values and economic prosperity, fishing and tourism in particular. Specific actions as recommended by Gillies *et al*., (2018). This action aligns with actions within the MEMS Initiative 1 focused on developing a framework for oyster reef rehabilitation.	DPI Fisheries, TSC DPE	DP 2023-2025
L2	H	Baseline mapping of oyster reefs.	Undertake baseline mapping to determine the location, extent and vulnerability of any remaining oyster reefs and banks in the estuary and determine eligibility for protection of identified areas under Commonwealth and State Government laws subject to ecological community nomination determination. Linked to Action C4.	DPI Fisheries TSC, DPE	DP 2023-2025
L3	M	DPI Fisheries oyster reef collaboration.	Collaborate with DPI Fisheries to invest in and develop local restoration projects for native oyster species.	TSC, DPI Fisheries	DP 2023-2025
M	**Support the protection of bird habitat**				
M1	H	Support existing bird conservation projects.	Conserve and protect threatened shorebird and raptor habitat through continued support of projects at key habitat sites in and surrounding the Tweed River estuary.	TSC DPE, Landcare, volunteer groups (BirdLife Northern Rivers)	Ongoing
M2	H	Tony's Bar signage.	Install educational signage at Tonys Bar discouraging beaching of boats and providing information regarding the importance of the high tide roost to waders. Related to Action J1.	TSC TfNSW - Maritime	DP 2023-2025
M3	M	Mangrove maintenance.	Trim mangroves at observation points adjacent to key shorebird habitat to allow continued visibility for monitoring activities. Liaison with NSW Fisheries regarding permits and approvals (e.g. if a permit to harm marine vegetation will be required) and inclusion of mangrove trimming into TSC annual maintenance permit.	TSC DPI Fisheries	DP 2023-2025
M4	H	Osprey infrastructure maintenance.	Maintain Council managed Osprey infrastructure through periodic inspection and condition assessment to ensure continued provision of breeding sites and to address risks to public safety.	TSC	Ongoing
M5	H	Habitat tree plantings.	Incorporate plantings of large tree species suitable for raptor nesting habitat in riparian zones on Council managed land. For consideration as part of Actions F1 and G1.	TSC DPE – Crown Land	Ongoing
N	**Improve habitat and visual impact outcomes for riverbank erosion stabilisation works**				

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
N1	H	Encourage incorporation of bioengineering principles into private bank stabilisation works.	Where bank remediation is not wholly possible through revegetation alone, the criteria listed below should apply to protective infrastructure works. • Ensure design conditions for all bank stabilisation and coastal protection works incorporate bioengineering principles wherever feasible; • Use development consent conditions in facilitating this action; • In many cases, small scale works on private land involve creating or upgrading revetment walls on residential lots. In these cases, bioengineered approaches (e.g. incorporating estuarine/ riparian revegetation and/ or fish habitat) may be feasible; and • In all cases, where Council or NSW Agency approval is required, conditions should be applied which result in the establishment and maintenance of appropriate fish habitat, estuarine vegetation and/or native riparian plant species wherever feasible.	TSC DPE – Crown Lands, DPI Fisheries	Ongoing
Threat 3 - Degraded estuarine water quality					
O	**Ensure adequate development controls and compliance**				
O1	H	Stormwater controls in the coastal zone.	Ensure that requirements for stormwater detention and treatment are achieved for all future developments, including erosion and sediment control requirements during the construction phase.	TSC	Ongoing
P	**Reduce acid runoff**				
P1	H	Remediate priority ASS areas in the coastal zone.	Work with the sugar industry and floodplain landholders to reduce acid runoff wherever possible, primarily in the upper estuary, middle estuary and Rous River estuary and in particular, in amended priority ASS remediation areas (those which recorded low pH levels in drain waters during recent event sampling, i.e. upstream of Dulguigan Creek in the Rous River estuary, the northern side of the Main Trust Canal, Condong Creek, Blacks Drain and the floodplain between Bray Park and Murwillumbah). Existing management strategies include planning controls, drain shallowing, laser levelling, liming, tidal flushing etc.	TSC Sunshine Sugar, DPI Fisheries, DPE	Ongoing
P2	M	Audit of floodplain drain pH.	Follow-up audit of pH levels in key drains during or following a moderate-to-high flow event and where possible, additional sampling to isolate discrete problem areas for ASS export. Sampling should be undertaken close to the sampling trigger being reached, i.e. prior to full flushing of drains which may occur in large or continuing rainfall events.	TSC	DP 2023-2025
P3	M	Automatic pH loggers.	Deploy automatic pH loggers in agricultural drains in priority ASS remediation areas to monitor acidity levels and flushing behaviour during a variety of weather events. Coast estimation based on deployment of three pH loggers.	TSC	DP 2023-2025
P4	M	Identify sites for pilot ASS remediation projects in the coastal zone.	Identify opportunities for local, on-ground trials and monitoring of wet-acid containment projects. As per Action I2, identify a site where ASS rehabilitation can be undertaken with the dual aim of creating floodplain wetland(s) and improving floodplain ecosystem service delivery.	TSC DPI Fisheries, DPE	DP 2023-2025
P5	M	Sugar Industry self-regulation of ASS.	Work with the NSW sugar industry to continually improve the self-regulation of ASS with a view to improving the overall level of ecosystem services on the floodplain. This should include evaluation of the effectiveness of the self-regulation scheme in: • Addressing existing risks and new incidents in ASS areas; • Controlling the discharge of poor-quality water; • Improving connectivity between waterways and floodplain drains where appropriate (in conjunction with related Actions H1 and H2); • Providing for the revegetation of drains (allowing for drain maintenance requirements); • Controlling aquatic weeds; • Improving the public availability and transparency of reporting; and • Examining the consent requirements and extent of land to which Production Entitlement Areas (PAEs) apply.	TSC Sunshine Sugar	DP 2023-2025
Q	**Reduce catchment nutrient inputs to the estuary**		Management effort should focus on reducing inputs of both nitrogen and phosphorus to the estuary. Specific actions are listed below along with related actions, Action D to Action G.		
Q1	H	Green Banks Initiative.	Undertake revegetation of floodplain agricultural drain banks using *Lomandra* spp. and other native species through TSC Sustainable Agriculture Programs ‘Green Banks” initiative.	TSC DPE, DPI Fisheries	Ongoing
R	**Improve wastewater and effluent management**				
R1	H	Upgrade Murwillumbah WWTP.	Reduce the effect of WWTP discharges to the estuary by reducing point source loadings of bioavailable nitrogen in particular, by upgrading the Murwillumbah WWTP, focussed on reducing nutrient loads to the Rous River estuary during low-moderate flows. Options that could be investigated to achieve this may include: • Improving effluent quality; • Beneficial reuse of effluent; and • Discharge to less sensitive environments.	TSC	Unknown

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
R2	M	Investigate causes of high nutrient levels in Tweed River at Condong.	Work with Cape Byron Power to understand and identify opportunities to reduce nutrient levels in the estuary in the vicinity of Condong Sugar Mill. Particular aspects to investigate include potential nutrient loading from mill cooling water discharge (noting that this comes from Murwillumbah WWTP), as well as discharge from adjacent drains and stormwater outlets in the vicinity.	TSC	DP 2023-2025
S	**Reduce sediment inputs to the estuary**		Elevated levels of TSS, primarily of concern in the middle estuary and Rous River estuary, can be managed through specific related actions, Action D to Action G, Action O and Action R.		
T	**Reduce the human health risk of faecal contamination in the estuary**				
T1	L	Investigate sources of pathogens in Tweed River.	Investigate sources and relative loadings of pathogen inputs (i.e. human or animal sources and key locations) to better assess the risk to human health and to direct management effort to specific areas of the estuary.	TSC	DP 2026-2029
T2	M	Public health education regarding high-risk swimming periods.	Undertake community education regarding high-risk periods and locations for swimming throughout the estuary. Swimming is not advisable in the Rous River estuary most of the time. Include education measures to reduce faecal loading to the estuary (e.g. pet droppings, illegal sewer connections etc.).	TSC	Ongoing
Threat 4 - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets					
U	**Increase resilience of land, assets and people to impacts of sea level rise and increased tidal inundation**				
U1	M	Council asset vulnerability assessment.	Undertake a vulnerability assessment of Council assets, incorporating risk from coastal hazards, particularly sea level rise and tidal inundation. Incorporate risks into design, maintenance planning and replacement of existing and planned assets.	TSC DPE	DP 2023-2025
U2	M	Future development area vulnerability assessment.	Undertake a vulnerability assessment of existing and future development areas and LEP zonings, incorporating risk from coastal hazards, particularly sea level rise and tidal inundation. Incorporate sea level rise and tidal inundation risk into LEP and sub-division DCP review.	TSC DPE	DP 2023-2025
U3	M	Mosquito breeding habitat assessment	Undertake an assessment of potential changes in mosquito breeding habitat under future tidal inundation scenarios and determine potential health and wellbeing impacts on existing and future residential areas and populations. Likely to consist of a number of consultant engagements in addition to significant staff time commitment. Linked to Action U6.	TSC NSW Health	DP 2026-2029
U4	M	Develop sea level rise adaptation strategy.	Using the outcome of asset vulnerability assessments, develop long term adaptation strategies to manage the impacts of sea level rise, including the development of triggers that identify when strategies need to be implemented, modified or reviewed.	TSC DPE	DP 2026-2029
U5	H	Consider planning proposal for inclusion of Coastal Vulnerability Area in CM SEPP.	Consider preparation of a planning proposal to seek formal inclusion of a Coastal Vulnerability Area (tidal inundation) into the CM SEPP. Linked to and pending outcome of Action A4.	TSC DPE	DP 2023-2025
U6	H	Mosquito controls.	Continue to implement current controls regulating mosquito breeding in line with TSC's Pest Management Program, best management practice and developing science. Linked to Action U3.	TSC	Ongoing
U7	L	Coastal hazard education.	Develop and implement a communication strategy that ensures the impacts of sea level rise, future tidal inundation and adaptation responses are understood by the community and stakeholders.	TSC	Ongoing
U8	M	Liaison with DPI Agriculture re: alternative floodplain crops.	Recommend to DPI Agriculture that further research is required into the viability of alternative crops more suited to waterlogging and saline intrusion in response to increased flooding and predicted sea level rise impacts (e.g. trials of native tree food species and timber plantation species). DPI Agriculture or Research Australia Ltd (Rural R&D Corp) could potentially administer as a grant for post-graduate research.	TSC DPI Agriculture	DP 2030-2033
V	Address risk of overtopping of Bray Park Weir				
V1	H	Bray Park Weir Project Reference Group actions.	Project Reference Group to implement solutions including: • Review of Council operational procedure for monitoring and assessing the risk of overtopping at Bray Park Weir in light of findings from WRL (2017) and more recent Council investigations which identifies the probability of residual high tides in the estuary (i.e. a higher degree of sandbagging/concrete blocking during particular astronomical events may be required); • Concept design and environmental studies associated with any proposal to mitigate the risk of saltwater ingress into the water supply. Linked to Action H4; and • Evaluation of the current and likely future effectiveness of freshwater releases from Clarrie Hall Dam in preventing saline intrusion.	TSC	DP 2023-2025

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
Threat 5 - Loss of or impacts to biodiversity					
W	Conserve and rehabilitate key habitat and reduce conflicts between threatened species and estuary users				
W1	M	Threatened species education.	Support stakeholder and community education and engagement re conservation of existing populations of threatened fauna e.g. shorebird, raptor and dolphin populations in the Tweed River estuary. Minimising conflict between these populations and anthropogenic uses of the estuary (fishing, boating, port use etc.).	TSC DPE, Landcare, Dolphin Research Australia Inc., BirdLife Northern Rivers	Ongoing
W2	H	Marine debris hotspot mapping.	Undertake a mapping assessment to determine locations of marine and intertidal hotspots for accumulation of plastic litter and marine debris. It is likely that the majority of litter and marine debris is concentrated in specific locations such as in the vicinity of stormwater outlets, popular fishing locations and embayments. Mapping of the current hotspots will drive more time efficient and cost-effective future clean-up activities. Linked to Action O1 and W3.	TSC MEMA, DPE, DPI Fisheries, marine research and volunteer organisations	DP 2023-2025
W3	H	Monitoring and removal of marine debris.	Monitor accumulation and undertake periodic removal of marine debris from key locations. Linked to Action O1 and W2.	TSC MEMA, DPE, DPI Fisheries, marine research and volunteer organisations	Ongoing
Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly lack of sandy beaches					
X	Improvements to foreshore parks and recreational facilities		Related actions: Action E		
X1	L	Seating improvements Ebenezer Park and Keith Compton Drive foreshore.	Provide additional seating and vegetation at Ebenezer Park and Keith Compton Drive foreshore.	TSC DPE, TfNSW - Maritime	DP 2026-2029
X2	H	Upgrade facilities at Old Fingal Boat Harbour.	Provide and upgrade shore-based facilities on the upstream (southern) side of Old Fingal Boat Harbour. Improvements including erosion stabilisation, picnic tables, shelters, shower, pathway and access improvements would increase the amenity of this area.	TSC TfNSW - Maritime, DPE, DPE – Crown Lands, DPI Fisheries	DP 2023-2025
X3	L	Detailed design of Growers Market rest area at Tumbulgum upgrade.	Develop a detailed design and costing for upgrade of the Growers Market rest area at Tumbulgum. Upgrade to resemble a designated rest area to maximise the usage and safety of this popular location for all users e.g. by reducing the speed of drive-through traffic, enhancing foreshore vegetation, installing amenities and picnic facilities and improving the visibility of stalls to passing motorists.	TSC DPE – Crown Lands	DP 2030-2033
X4	L	Detailed design Bluey Hill Park upgrade.	Develop detailed design and costing for upgrade to Bluey Hill Park (North Tumbulgum). Upgrade to support passive recreational use of the lower Rous River estuary and middle estuary including provision of nature-based education opportunities, consideration of a canoe launching facility for canoes/kayaks/stand-up paddleboards (SUPs), native tree planting for shade, picnic facilities and vegetation restoration. A concept plan was included in the 1996 Management Plan.	TSC DPE, TfNSW - Maritime, DPE – Crown Lands	DP 2030-2033
X5	L	Enhance opportunities for nature-based education.	Provide nature-based education opportunities and consider installation of a canoe launching facilities for canoes/kayaks/SUPs. Suggested areas for consideration include Pat Smith Park (at the Dungay Creek confluence with Rous River estuary) and off Rous River Way, Murwillumbah. Upgrade to support passive recreational use of the Rous River estuary. A concept for a canoe/walking trail was included in the 1996 Management Plan	TSC DPE, TfNSW - Maritime	DP 2030-2033

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
Y	Maintain and improve facilities for connectivity of public access along the foreshore				
Y1	L	Investigate opportunities to increase connectivity with walking trails.	There is an extensive network of footpaths and cycleways in the lower estuary, but the opportunity to establish linkages between existing walkways and cycleways should be pursued to achieve a sense of completion, to enhance the value of investment already made and to maximise public recognition of the project. A specific opportunity to be investigated through development of a concept design and cost estimate is increasing connectivity with walking trails in the Tweed Heads historic site and Tweed Heads South levee.	TSC DPE, TBLALC, TfNSW - Maritime	DP 2026-2029
Z	Maintain amenity of existing estuary beaches and create additional artificial sandy beaches				
Z1	M	Maintain amenity of existing sandy beaches in the estuary.	Existing sandy beaches that would benefit from beach nourishment include: • Jack Evans Boat Harbour; • The northern side of the Terranora Inlet (Ebenezer Park); • New and Old Fingal Boat Harbours; • Chinderah; • Tumbulgum; • Condong; and • Murwillumbah Rowing Club. Beach nourishment of Jack Evans Boat Harbour should be in accordance with the existing engineering concept design (GHD, 2016) involving construction of a sill to retain nourished material. The design would provide for an all-tide sandy recreational beach, support seagrass growth in the area and reduce the frequency of current sand management works in the harbour. Design of any beach creation and beach nourishment works in the estuary should minimise impact on riparian vegetation and adjacent estuarine vegetation (e.g. seagrasses) including consideration of grain size suitability (for both amenity and seagrass vulnerability), beach slope and the potential for "slumping" of nourishment material. TfNSW - Maritime to include consideration of this action in the beneficial reuse of any maintenance dredged material from the bed of the estuary.	TSC, TfNSW – Maritime, DPE - Crown Lands	Opportunistic
Z2	H	Feasibility assessment for sandy beach creation.	Investigate the feasibility and document concept designs for the creation and maintenance of additional accessible sandy beaches for both non-boat recreation and for increased capacity for boat beaching (minimum recommended length = 30m). This action is suggested in conjunction with the investigation of additional boating infrastructure and ancillary features (Actions DD to GG). Suggested areas for consideration of additional sandy beaches include Fingal Peninsula, north of Wommin Lake Crescent and Tumbulgum. The optimal location(s) and feasibility of establishing additional artificial community beaches should consider beach longevity, recreational demand, environmental impacts (e.g. smothering of seagrass, disturbance to ASS), proximity to nourishment sand sources, ongoing maintenance requirements and associated costs.	TSC TfNSW - Maritime	DP 2021-2025
AA	Reduce river user conflict through provision of adequate access and infrastructure and through sufficient separation of incompatible uses		The mitigation of conflict between users of the estuary is achieved through related actions: Action E, Action X to Action Z and Actions DD to FF.		
BB	Continue to work with TfNSW to improve compliance with and policing of boating rules and recommend towing restrictions in conservation and restoration character zones. TfNSW - Maritime is responsible for boating and navigation infrastructure in the Tweed Estuary.				
BB1	H	Boating safety education and enforcement.	Continue educational campaigns (such as talking to boat ramp users) and enforcement to: • Inform the community of boating rules; • Increase compliance with and policing of existing rules; • Raise awareness of environmental impacts of boating and safety risks to other waterway users; and • Encourage consideration of other users of waterways, foreshore and nearby residents.	TfNSW – Maritime TSC	Ongoing
BB2	M	Vessel number surveys.	TfNSW - Maritime undertakes surveys of vessel numbers using the river.	TfNSW - Maritime TSC	DP 2021- 2025
Threat 8 - Reduced stocks of target fish species					
CC	Improve the status of fish assemblages in the estuary				
CC1	H	DPI Fisheries education program.	Collaborate with DPI Fisheries on an education/engagement program to improve community understanding of commercial fishing impacts and benefits and the science-based management of the industry. This action aligns with actions under MEMS Initiative 6 which includes actions to foster the industry to develop its social licence (MEMS Action 6.8).	DPI Fisheries, TSC	Ongoing
Threat 9 - Restricted levels of boating infrastructure and facilities or reduced navigability					
DD	Continue to liaise with stakeholders regarding the upgrade and expansion of Tweed Port in line with Council and community requirements				

ID	Priority	Action	Details	Responsible organisation(s) Support organisation(s)	Indicative timeframe
DD1	M	Consultation regarding port development.	TSC should continue to liaise with the above stakeholders to ensure that the requirements of Council and the community are considered in all port development activities. Any proposal to upgrade the Tweed Boat Harbor precinct area would involve key stakeholders including Council and the community. TfNSW – Maritime convenes a Tweed Harbour User Group. DPE – Crown Lands are also important stakeholders.	TSC TfNSW – Maritime, DPE-Crown Lands.	Ongoing
EE	Maintain and improve boating infrastructure, access and ancillary facilities for boaters		The majority of actions revolve around the formalisation and consolidation of existing facilities and access arrangements to optimise facility performance and reduce user conflict in the estuary. Related actions: Action E, Action X to Action Z.		
EE1	H	Increase funding to TSC's Boating Facilities Management program.	Increase funding to TSC's Boating Facilities Management program, primarily for the pro-active maintenance of TSC's waterways infrastructure.	TSC TfNSW - Maritime, DPE	Ongoing
EE2	M	Improve boat ramp facilities.	Improve the facility layout at existing boat ramps and identify opportunities to increase efficiency and reduce congestion. Consultation will be undertaken with the key user groups of each ramp to ensure consideration of priority needs. Considerations include the provision of direct access between ramps and pontoons and the installation of mooring bollards in the vicinity of popular locations with limited mooring and beaching access (e.g. Tumbulgum). There are five ramps at which efficiency improvement projects could be undertaken.	TSC TfNSW - Maritime, DPE	DP 2026-2029
EE3	L	Assist private sector to undertake feasibility assessment for on-water re-fuelling facilities.	Investigate the feasibility (site availability, commercial viability, environmental risk/benefit) of establishing on-water re-fuelling facilities in the estuary. Comments raised during stakeholder consultation indicate at least some demand for on-water re-fuelling facilities although no detailed evaluation has been undertaken. Responsibility for providing a fuel facility for boating would need to be considered in accordance with the NSW Maritime Infrastructure Plan 2019-2024 along with funding opportunities through the TfNSW - Maritime Boating Now Program. Council staff would support private sector led investigations. DPE - Crown Lands role would be limited to providing appropriate authorisations under the *Crown Land Management Act 2016*, if / when required.	TSC TfNSW - Maritime , DPE - Crown Lands, DPE	DP 2030-3031
EE4	M	Boat ramp improvements at John Oxley Park, Chinderah.	Maintenance dredging at John Oxley Park boat ramp is planned however there is limited space available to significantly upgrade this boat ramp to accommodate additional lanes or trailer parking spaces. Note that the role of DPE - Crown Lands in this action would be limited to providing appropriate authorisations under the *Crown Land Management Act 2016* if required	TSC TfNSW - Maritime, DPE - Crown Lands, DPE	DP 2023-2025
EE5	L	Boat ramp improvements at Condong Road Boat Ramp.	Upgrade car parking facilities at Condong Road Boat ramp (Clarrie Purnell Park) including asphalting and line markings.	TSC TfNSW - Maritime, DPE	DP 2026-2029
FF	Ensure adequate planning, assessment and control of dredging and sand extraction in the estuary				
FF1	L	Minor dredging associated with TSC managed infrastructure and canals.	Continue maintenance dredging activities associated with Council managed infrastructure (e.g. boat ramp access channels) and Council managed canals (i.e. Anchorage Island Estate and Oxley Cove) as needed to maintain function, access and safety. The depth of maintenance dredging is to be sufficient to accommodate shallow draft vessels consistent with current use. TSC to consider co-contributions towards dredging projects where there is additional community benefit e.g. the reuse of dredged material within the estuary. The need for a local dredging strategy and implementation plan for the estuary will be considered in consultation with relevant stakeholders.	TSC TfNSW - Maritime	Opportunistic (as required)
FF2	M	TRESBP Environmental Monitoring System data review.	Undertake a review of existing data collected thus far through the TRESBP Environmental Monitoring System to determine the net direction of sediment movement in the estuary, the threshold for exportation of sand from the system via dredging and sand extraction under existing conditions and the impact of climate change on that regime. It is important to understand whether the flood tide infeed of marine sands to the estuary is generally greater than or less than the ebb tide transport of sand, i.e. whether shoals will continue to grow or whether they will erode with a net export of sediment and how this regime will progress into the future in response to dredging and sand extraction activities and to emerging risks such as sea level rise TfNSW - Maritime and the TRESBP team to clarify the scope of such an investigation.	TfNSW - Maritime TSC	DP 2023-2025

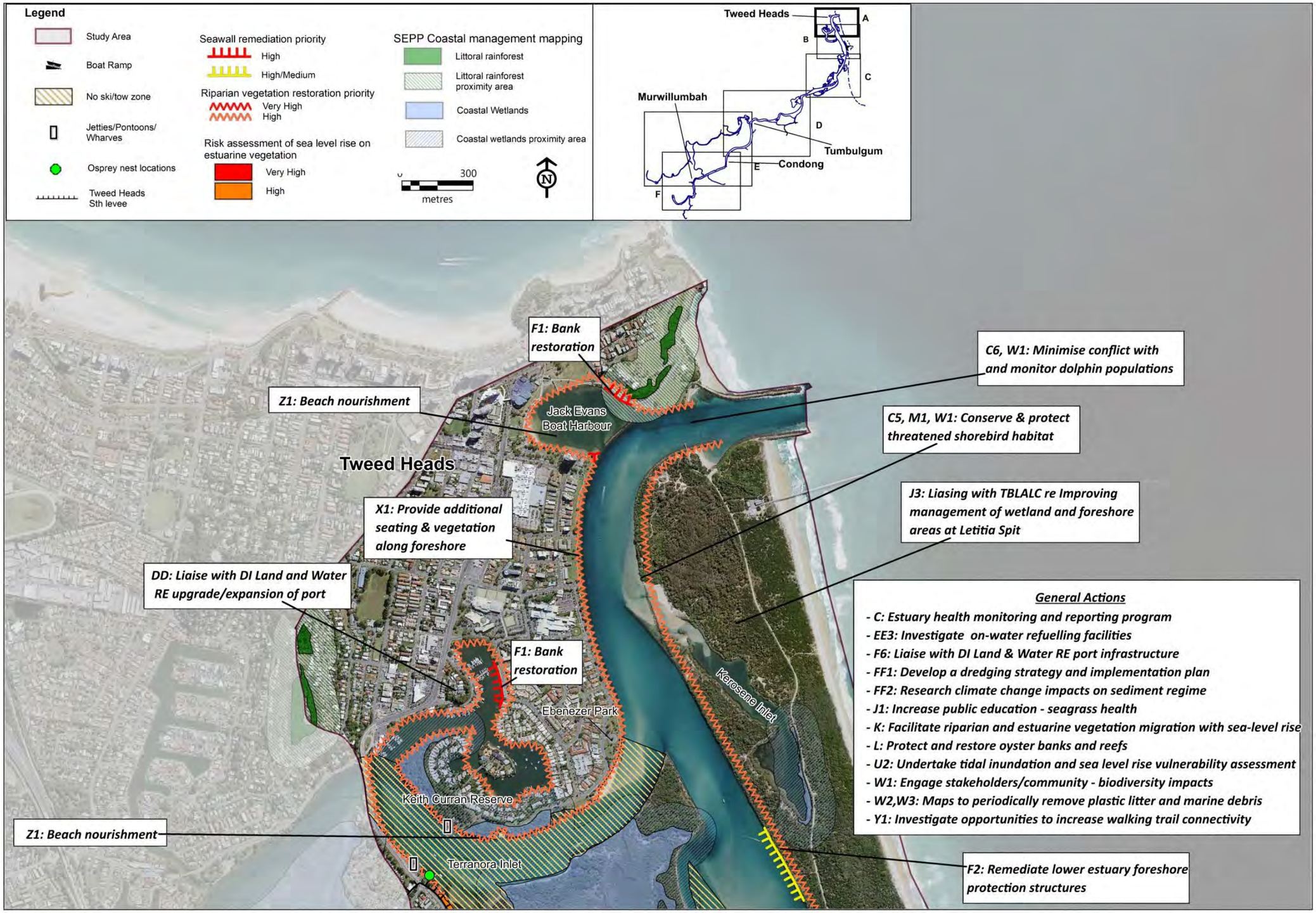

Figure 27: Tweed River estuary CMP on-ground actions – lower estuary - entrance reach, Terranora Inlet and Southern Boat Harbour

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendices M2 to M5, respectively.

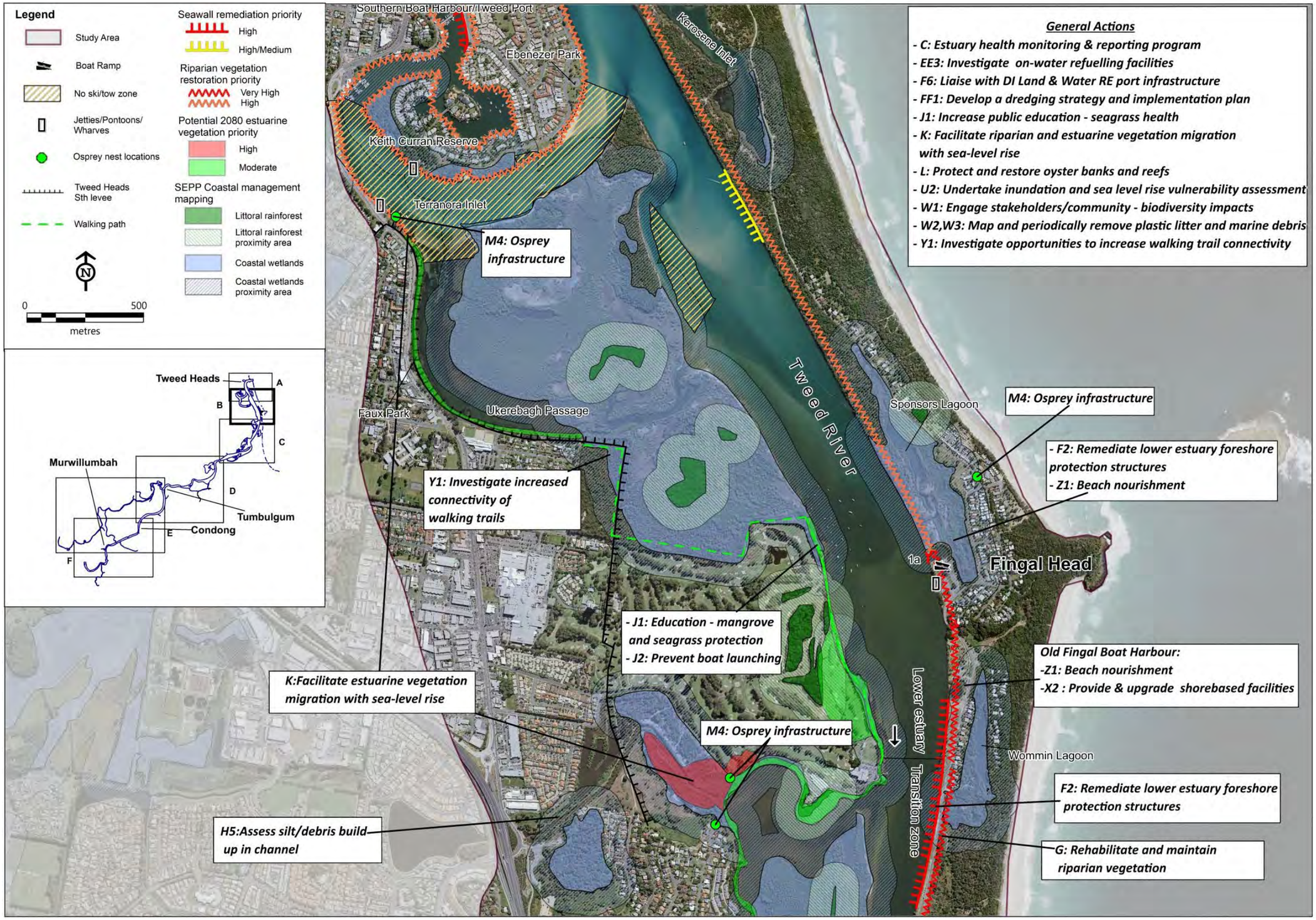

Figure 28: Tweed River estuary CMP on-ground actions – lower estuary – Ukerebagh Island to Fingal Head

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendices M2 to M5, respectively.

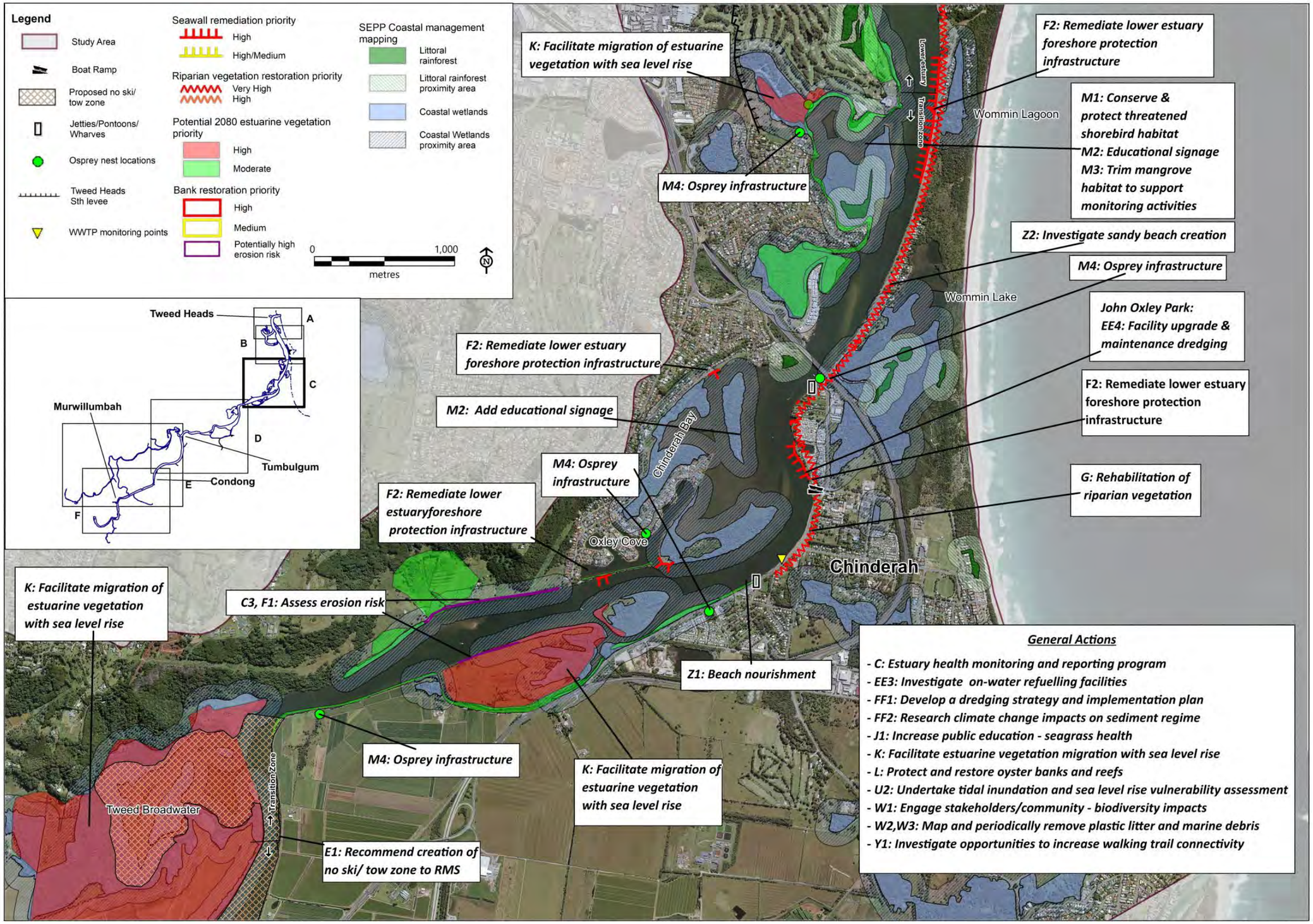

Figure 29: Tweed River estuary CMP on-ground actions – transition zone

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

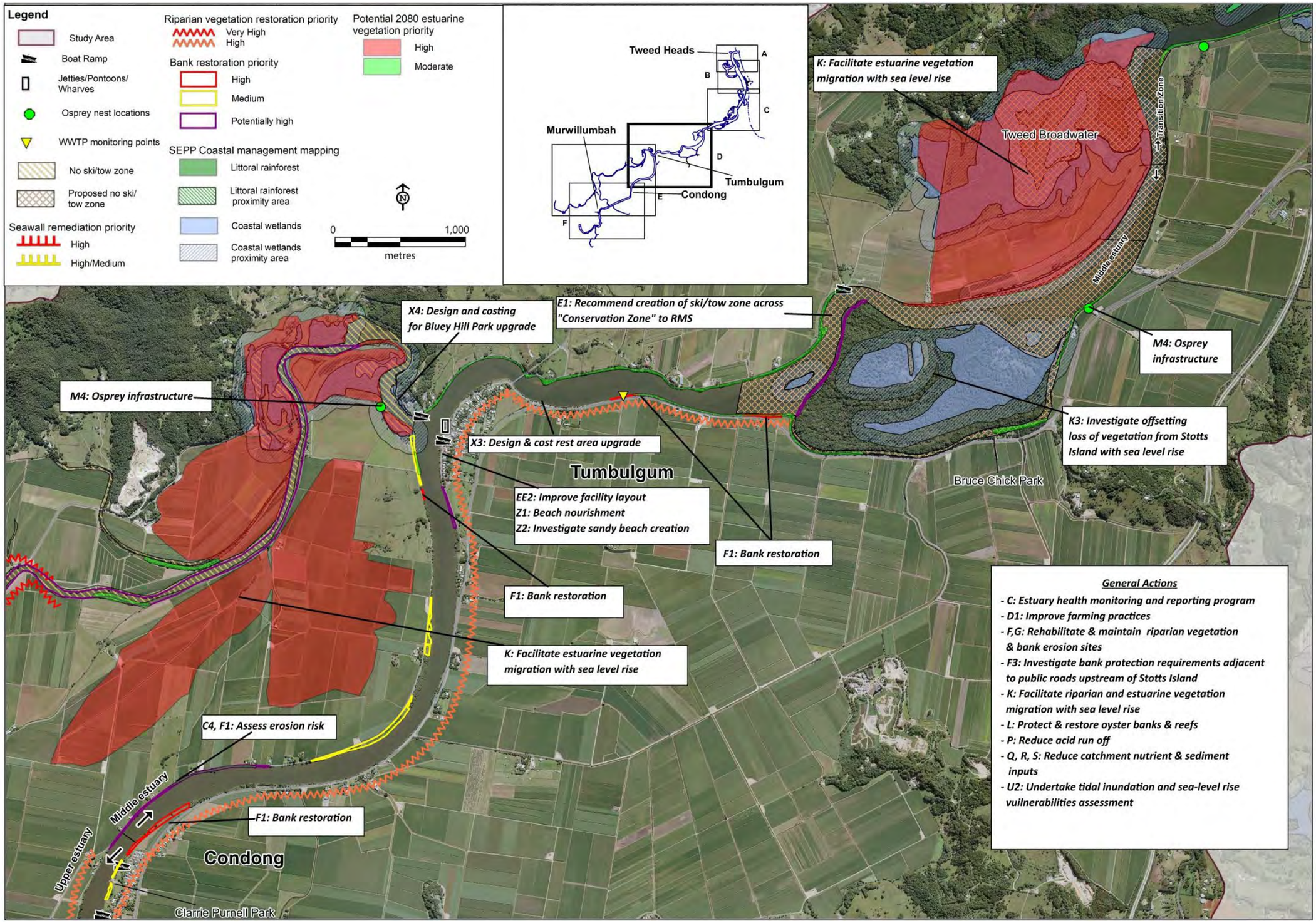

Figure 30: Tweed River estuary CMP on-ground actions – middle estuary

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

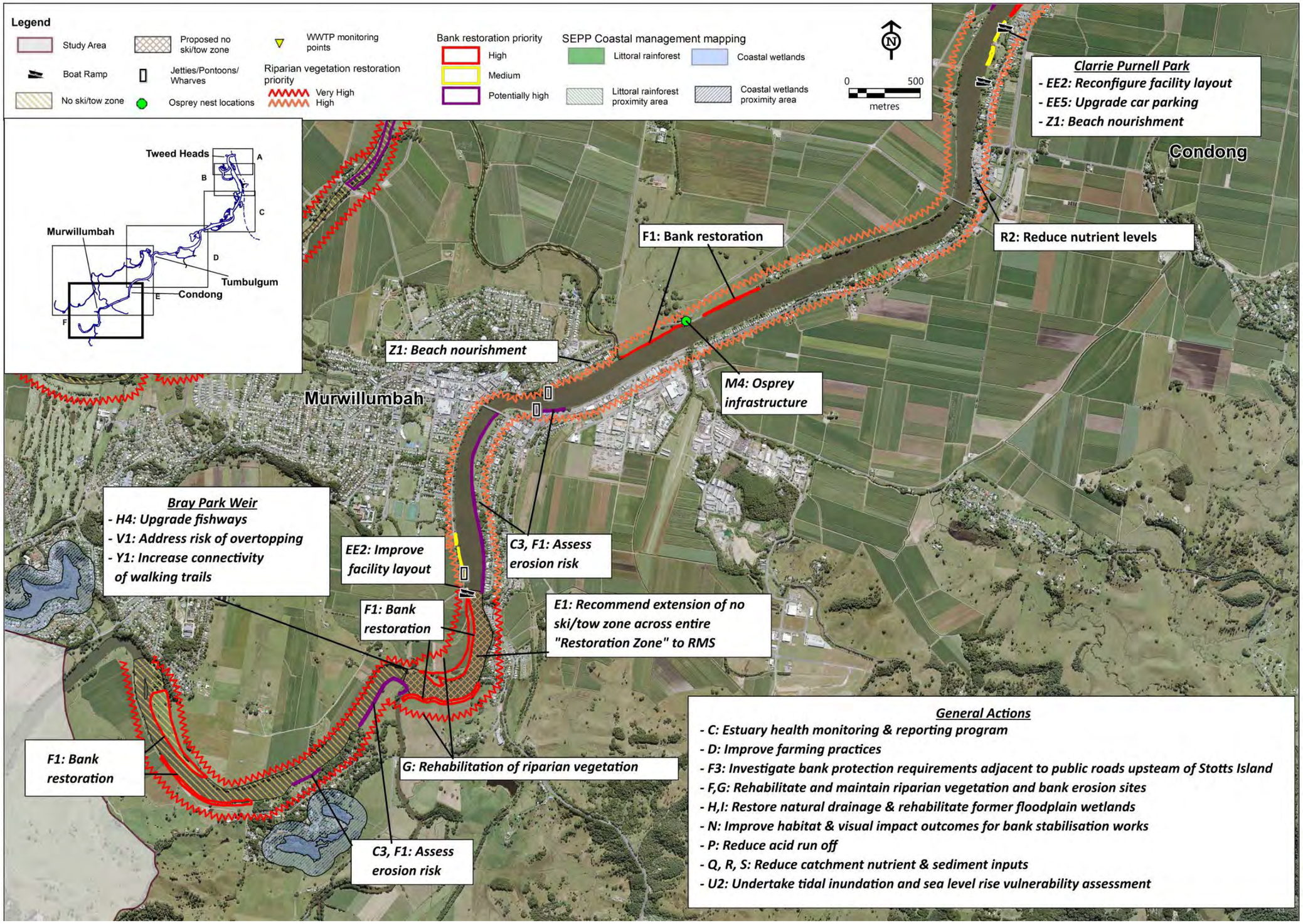

Figure 31: Tweed River estuary CMP on-ground actions – upper estuary

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

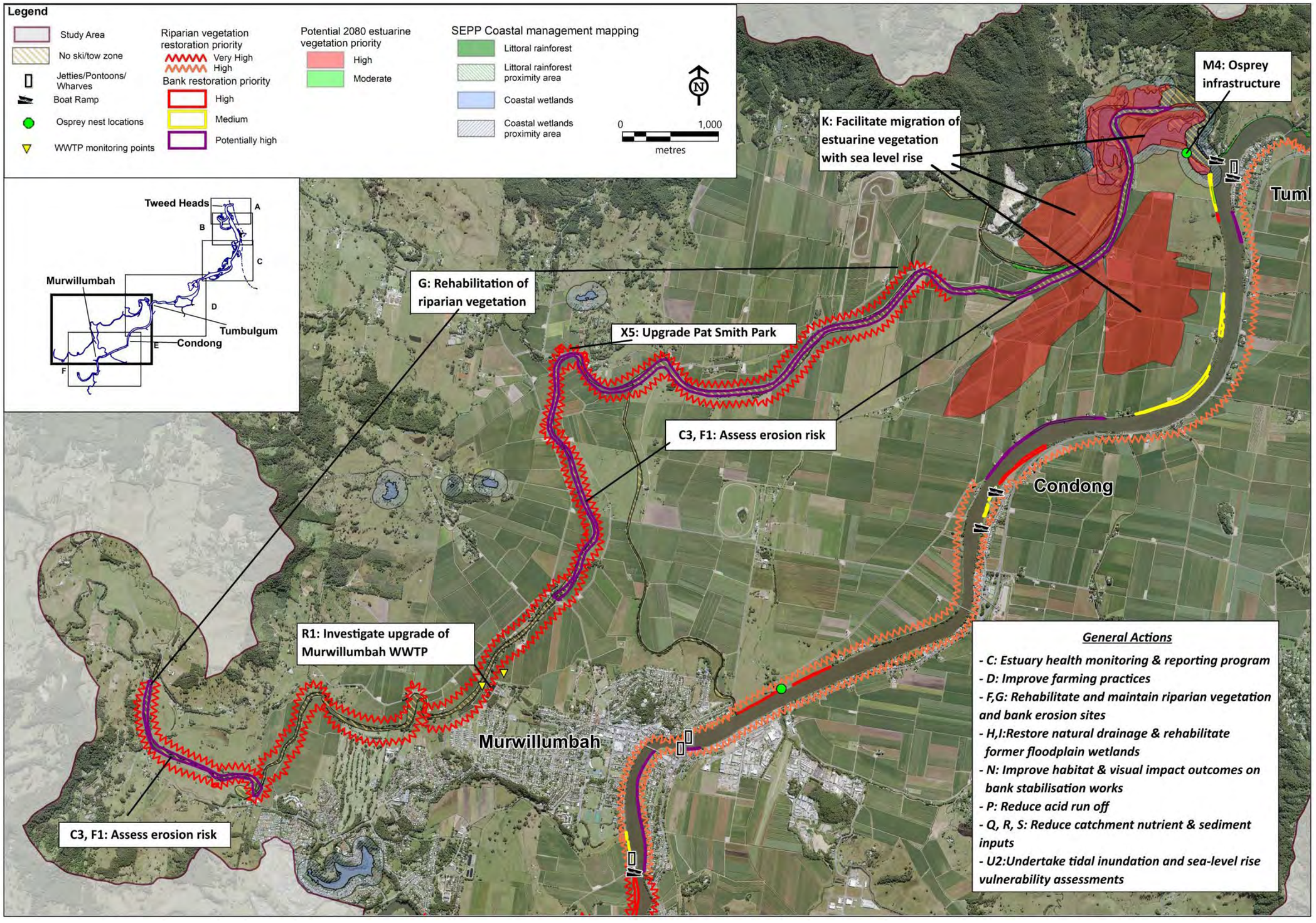

Figure 32: Tweed River estuary CMP on-ground actions – Rous River estuary

Note: only very high and high priority rehabilitation sites are shown for bank restoration, restoration of protective infrastructure, riparian revegetation and coastal squeeze of significant estuarine vegetation. Individual mapping of each of these priorities can be found in Appendix C.

3.6. Whether the CMP Identifies Recommended Changes to the Relevant Planning Controls, Including any Proposed Maps

Mapping of coastal management areas has been completed by DPE (2017) and is shown in Figure 13 (Section 1.6). This CMP encompasses the coastal management areas mapped within the CM SEPP (CWLRA, CEA and CUA). Although the CVA is not mapped in the CM SEPP, the study area is subject to coastal hazards and these have also been addressed in this CMP where relevant to the estuary. This CMP provides a management framework to guide coastal management and planning for the Tweed River Estuary, in response to the relevant objectives for each coastal management area from the *Coastal Management Act, 2016*. No changes to the current coastal management areas are proposed as part of this CMP however Action A4 (refer Action Plan Section 3.5) has been included to review the coastal management areas to ensure accuracy and relevance and determine whether changes are required. A number of actions to be carried out as part of this CMP (e.g. tidal inundation assessment) will provide further information to allow for assessment of the adequacy of current coastal management areas and recommend changes as needed.

4. BUSINESS PLAN

The Business Plan (Table 12) outlines the key components of the funding strategy for the CMP, including the cost of proposed actions, potential funding sources and timing and alignment with Council's Delivery Program under the IP&R Framework.

The Business Plan specifies:

- ID, priority and action name from Table 11;
- Indicative Cost – an estimate of total costs for implementation over the ten-year life of the plan is provided (2021$). A breakdown of action costs in accordance with Council's Delivery Program periods including an estimate of total capital, operational/ maintenance costs is also provided. Where actions require Council staff resources, actual costs have only been applied where it is expected that implementation will exceed current resourcing levels and additional funding is required. Cost estimates cover the tasks listed in the actions (including preliminary investigations, environmental assessment, approvals and implementation) unless otherwise stated. Cost estimates provided in the action descriptions are preliminary only and are based on the best available information. Where the cost of on-ground works is not known, this has not been included in the CMP.

  Many of the actions operate in conjunction with, or are linked with other actions, i.e. resulting in a collective set of actions that address each threat. Where actions are implemented through an existing program, additional expenditure and funding have not been included. Similarly, where a study/review is required to determine the appropriate level of expenditure, the cost of the review has been estimated in the action planning. Implementation costs should be confirmed by the results of the review;
- Potential Funding Source – A summary of funding sources is provided in Section 4.1;
- Cost benefit distribution – A key driver in meeting these objectives is the protection and improvement of estuary health bringing about subsequent public benefits (e.g. through improved recreational potential and amenity). None of the recommended actions aim to benefit private interests although they may do so indirectly as a consequence of improved estuary health (e.g. to commercial fishers in association with health of fish stocks or to private landholders in association with improved riverbank stability and improved understanding of best management practices). No cost-sharing with private parties has been proposed; and
- Business Plan category – three categories are provided as follows:
  - Category 1 – economic analysis complete, action funded under normal operating budget or existing programs and grants and not expected to impact on current resourcing levels;
  - Category 2 – economic analysis complete, action subject to funding; and
  - Category 3 – no economic analysis, action subject to detailed costing, economic analysis and funding.

4.1. Funding and Resources

Delivery of the Tweed River Estuary CMP is estimated to cost $26,215,000 over ten-years. The CMP actions are expected to be funded through TSC and state government contributions, monetary grants and volunteer works by community members and organisations. Some actions are funded under Council's normal operating budgets or through existing programs and grants. It will not be possible for TSC to implement all actions identified in this CMP without additional sources of funding. As such, identification of grants and the submission of successful funding applications is an important component of this CMP. A list of current possible sources of external federal, state and local funding is provided below. However, it is important to note that many grants and funding sources change year to year, are only available up to a limited budget, or

require significant co-funding commitment. The description of potential funding sources below provides the current funding ratios between the applicant and grant provider where available, giving an indication of proposed cost-sharing arrangements between Responsible and Support Organisation(s) where applicable. Accurate estimates of project costs, particularly for on-ground works cannot be developed until survey and design tasks have been completed, with these tasks often incurring significant costs. It will be necessary to remain informed of current funding availability throughout the implementation of the CMP and take advantage of funding opportunities as they arise. In each case, the precise amount of funding available will not be known until it has been awarded.

Agencies other than TSC with responsibility for delivery of actions in this CMP have provided written confirmation of their agreement to the actions stated within the CMP that would be carried out by/or related to land or assets owned and/or managed by that public authority as either a 'responsible' or 'supporting' agency. All public authorities have provided formal agreement to the CMP under section 15(4)(b) of the CM Act. Delivery of the actions will depend on the availability of funding and resources which is yet to be confirmed. The timeframe of implementation will be influenced by the availability of resources and funding.

Council operates an annual budget primarily through rates and charges (e.g. water, sewer and waste) as well as fees, contributions and loans. Funds from charges are spent on providing and maintaining those specific services. Occasionally, special rates are applied to new developments to fund the provision of facilities and services and the long-term maintenance and management of environmental and built assets in particular areas. Council's funds are also extended through grants as they become available. Certification of this CMP will facilitate eligibility for funding of key actions through the DPE– Coast and Estuaries Grants program. Actions will be prioritised for future applications for external funding with matching contributions from the budgets of relevant Council programs.

Key sources of funding identified for the CMP actions are:

- TSC ordinary rates – collected from ratepayers to fund general community services and facilities;
- TSC water access charge – collected from relevant ratepayers to fund the maintenance of dams and weirs, reservoirs, pumping stations, mains and water treatment plants;
- An On-Site Sewerage Management Fee provides for the inspection and monitoring of health and environmental risks of these systems on relevant properties;
- A portion of fees collected by Council for water and sewerage are made available to TSC's Waterways Program for funding works that improve water quality in the upper catchment and estuary;
- Works undertaken on private land can be funded through TSC grant programs including River Health Grants and Biodiversity Grants;
- NSW Coastal and Estuary Grants Program - certification of this CMP will facilitate eligibility for funding of key actions through the NSW Coastal and Estuary Grants Program. Currently the State Government will provide $2 for every $1 provided by the applicant (2:1 ratio) for eligible actions in a certified CMP.

  Funding is provided by the NSW Government and administered by DPE to support local government work to improve the health of NSW coasts and estuaries under two streams:

  - Planning stream – for planning and studies including investigation, design and cost-benefit analyses for infrastructure works recommended in a certified CMP; and

    - Implementation stream for each of the four coastal management areas with priority given to projects that reduce risk from coastal hazards and projects that enhance environmental resilience and the natural environment.

- Increasing Resilience to Climate Change program – a partnership program between Local Government NSW (LGNSW) and DPE to encourage:
    - Implementation of actions to address identified climate risks;
    - Regional consideration of climate change impacts in decision making;
    - Implementation of climate change adaptation actions beyond business-as-usual projects and programs; and
    - Enhanced adaptive capacity.
- Crown Reserves Improvement Fund Program – administered by DPE – Crown Lands for development and maintenance projects and to improve land and facilities on Crown Land. Funding under this program is subject to a competitive grant application process and eligibility requirements which may change from year to year and in accordance with departmental priorities.
- Clean Coastal Catchments On-Farm Grants Program - administered by LLS as part of the MEMS. Commencing in November 2020 grants are available for horticulture farms (blueberry, blackberry, raspberry and greenhouse vegetables) to keep nutrients on-farm and to make operations more productive, profitable and environmentally sustainable. Local farmers can apply for grants of up to $10,000 for on-farm infrastructure;
- The NSW Environment Trust – administered by DPE to fund a broad range of projects which enhance the environment of NSW. Relevant streams include environmental education, protecting our places (for the sharing and protection of Aboriginal Cultural knowledge and the protection, restoration and enhancement of culturally significant Aboriginal Land), education, research, restoration and rehabilitation projects and waste avoidance and resource recovery;
- The NSW Community Building Partnership program – administered by the NSW Department of Premier and Cabinet for infrastructure projects that deliver positive social, environmental and recreational outcomes that promote community participation, inclusion and cohesion. This program supports projects involving the construction of new community infrastructure, the refurbishment, repair and maintenance of existing community infrastructure and the purchase of capital equipment with a minimum individual asset value of more than $2,500;
- NSW EPA Waste Less, Recycle More initiative - a set of programs including “Council Litter Prevention Grants”, managed by the NSW Environment Protection Authority and NSW Environmental Trust. The initiative includes programs for local government, business, industry and the community;
- Commonwealth Community Led Grants - Indigenous Advancement Strategy grant funding for Aboriginal people and communities to devise strategies that will support their community and the people living in it and to carry out projects that address an emerging need or opportunity;
- Recreational Fishing Trust – administered by DPI Fisheries, provides support to support a wide range of projects including those which support recreational fishing enhancement, aquatic habitat rehabilitation, fishing education and research on fish and recreational fishing;
- NSW Boating Now Program – administered by TfNSW;
- Coastal Dredging Strategy and Boating Access Dredging Grants Program – administered by TfNSW-Maritime, provides funding for dredging projects which improve the accessibility of waterways for recreational and commercial waterway boaters and other users. Currently the State Government will

provide $1 for every $1 provided by the applicant (1:1 ratio) for successful applications under the Program;

- Walking and Cycling program – administered by TfNSW, provides funding for projects that encourage people to walk or cycle as part of their everyday travel;
- Regional roads funding assistance is available to Local Government through several grant programs;
- The Emissions Reduction Fund – administered by the Australian Government Clean Energy Regulator. The scheme provides incentives to reduce carbon emissions by providing opportunities to wan Australian Carbon Credit Units. Types of projects which can participate include those which increase soil carbon, reduce livestock emissions or expand opportunities for environmental carbon sink plantings and reforestation;
- Landcare Grants - Landcare Australia works with governments, corporate and philanthropic organisations and donors to facilitate funding for good quality, hands on projects and programs that will improve environmental outcomes for the Landcare community; and
- Land for Wildlife - a voluntary property registration scheme that aims to assist landholders to maintain wildlife habitats on their land. Land for Wildlife in NSW is co-ordinated by non-government organisations, community groups and local councils. These regional arrangements are co-ordinated state-wide by the Community Environment Network (CEN) in partnership with DPE. The CEN works with interested local organisations who run local Land for Wildlife Programs. Tweed Shire Council is the local provider, operating throughout the Tweed River catchment area. Delivery includes site assessments, advice on suggested management strategies and actions for the property support and encouragement for landholders to carry out nature conservation on their land. Registration is free and non-binding. The good faith agreement between the CEN and landholders does not change the legal status of the properties and information is confidential.

Human resources and in-kind contributions are also required from:

- TSC;
- DPE – Crown Lands, DPE, TfNSW - Maritime, Landcare, LLS;
- TBLALC;
- Landholders;
- Tweed Cane Growers;
- Volunteer groups;
- Educational and research institutions; and
- Recreational groups (such as fishing clubs).

Where actions are being implemented through an ongoing concurrent program (Section 3.4), additional expenditure has not been included. Enhancement of funding, where required, is specified in the Business Plan.

The actions detailed in Table 12 (the Business Plan) will be implemented by Council, or where indicated in Table 12 by other relevant public authorities, in accordance with the *Local Government Act 1993*; environmental planning instruments, development control plans under the *Environmental Planning and Assessment Act 1979*; and/or other relevant legislation.

Table 12: Business Plan – CMP management actions

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
Fundamental Management Actions												
A	Governance and administration											
A1	F	Administration of the CMP through TSC Waterways Management Program overseen by TCWC	20	20				20		100% public	a, b	2
A2	F	Support implementation of programs and strategies complimentary to the CMP	To be implemented under TSC DP operating budget							100% public	a	1
A3	H	Ensure future Crown land Plans of Management are consistent with the CMP	To be implemented under TSC DP operating budget							100% public	a	1
A4	H	Periodic review of Coastal Management Areas to ensure accuracy and relevance	To be implemented under TSC DP operating budget							100% public	a, b	1
B	Stakeholder and community engagement											
B1	F	Develop and implement a Stakeholder Engagement Strategy	To be implemented under TSC DP operating budget							100% public	a	1
B2	F	Co-ordination and consultation with local Aboriginal community and NPWS	To be implemented under TSC DP operating budget							100% public	a, h, p	1
B3	F	Raise awareness of Aboriginal cultural heritage significance of the Tweed River estuary	15	15			15			100% public	a, b, h, p	2
B4	M	Provide additional nature based educational opportunities including signage and information	30	30			10	10	10	100% public	a, b, p	2
C	Estuary health monitoring and reporting program											
C1	F	Annual estuary health report card	To be implemented under TSC DP operating budget							100% public	a, b	1
C2	F	Estuary Health Monitoring and Reporting Program	120	120			40	40	40	100% public	a, b	1
C3	F	Riparian vegetation and bank condition monitoring	75	75			25	25	25	100% public	a, b, d	2
C4	H	Monitor oyster banks and reefs	40	40			20		20	100% public	a, b, i	2
C5	H	Support monitoring of avifauna by volunteer groups	To be implemented under TSC DP operating budget							100% public	a	1
C6	H	Support monitoring of other higher order predators	To be implemented under TSC DP operating budget							100% public	a	1
C7	H	Increase training and resourcing for compliance monitoring staff	440		440		160	160	120	100% public	a, b	3
Threat 1 - Bank Erosion												
D	Increased adoption of best management practices to mitigate pollution of surface and groundwater and enhance biodiversity											
D1	H	Landholder communication and liaison	To be implemented under TSC DP operating budget							100% public	a, b, q	1
E	Promotion of the diversity of river uses											
E1	H	Liaison with TfNSW regarding Tweed River Recreational Use Strategy	To be implemented under TSC DP operating budget							100% public	a	1
E2	H	Public promotion of Tweed River Recreational Use Strategy	20	20			20			100% public	a, b	2
E3	H	Motorised Water Recreation Business Policy	To be implemented under TSC DP operating budget							100% public	a	1
F	Rehabilitate and maintain priority bank erosion sites											
F1	F	Bank stabilisation works at high priority sites on public land including riparian vegetation rehabilitation	8500	8,200		300	3,500	2,500	2,500	100% public	a, b, d, l, n, p, q, r	2
F2	H	Detailed design and restoration of lower estuary foreshore protection structures on TSC managed land	3560	3,440		120	1,060	1,500	1,000	100% public	a, b, d	3
F3	H	Detailed design and restoration of river banks adjacent to the Tweed Valley Way and Tumbulgum Road	9150	8,800		350	1,950	5,400	1,800	100% public.	a, b, d, m, i	3
F4	M	Monitor bank stabilisation works and improve/refine methods	To be implemented under TSC DP operating budget							100% public	a,b	1
F5	H	Support MEMA reforms of development application process for bank stabilisation works	To be implemented under TSC DP operating budget							100% public	a	1

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
F6	L	Port infrastructure liaison with DPIE - Crown Lands	To be implemented under TSC DP operating budget							100% public	a	1
G	Rehabilitate and maintain riparian vegetation											
G1	H	Rous Estuary Riparian Zone Management Plan	Cost of implementation provided in F1.							100% public	a, b, d	2
G2	H	Improve development application process to facilitate riparian rehabilitation projects on private land.	To be implemented under TSC DP operating budget							100% public	a,b	1
Threat 2 - Habitat loss and barriers to habitat connectivity												
H	Restore natural drainage and reinstate tidal exchange											
H1	M	Manage barriers to fish passage	30	30			30			100% public	a, b, i	2
H2	M	Cost-benefit analysis and feasibility study(ies) of alternative floodplain land use options	50	50				50		100% public	a, b, c, i, o	2
H3	H	Upgrade Bray Park Weir fishways	1650	1600		50	100	1,500	50	100% public	a,b	3
H4	L	Floodgate management investigation	100	100			100			100% public	a,b	1
H5	H	Support MEMA drainage management plan for the Tweed floodplain	To be implemented under TSC DP operating budget							100% public	a,b	1
I	Investigate the potential for rehabilitation of former floodplain wetland											
I1	M	Identify sites for potential regeneration of floodplain wetlands	50	50			50			100% public	a, b, c, i, o, s	2
I2	M	Promote existing successful floodplain restoration projects	To be implemented under TSC DP operating budget							100% public	a,b	1
I3	M	Pilot floodplain wetland rehabilitation site	310	300		10	100	200	10	100% public	a, b, c, i, o, s	3
J	Protect significant estuarine vegetation - improve condition and extent											
J1	H	Estuarine vegetation education program	65	15	50		35	20	10	100% public	a, b, i	2
J2	L	Protection of estuarine vegetation off Alf Rush Memorial Drive	5	5			5			100% public	a, b, i	2
J3	L	Letitia Spit Wetland Management	46	40		6		40	6	100% public	a, b, i	2
J4	H	MEMA Tweed Intertidal Marine Vegetation Strategy	To be funded under MEMS							100% public	s	1
K	Plan for and facilitate the migration of significant riparian and estuarine vegetation with sea level rise											
K1	M	Review LEP zoning to incorporate areas for estuary vegetation migration	To be implemented under TSC DP operating budget							100% public	a,b	1
K2	M	Provision of buffer zones to facilitate estuary vegetation migration	To be implemented under TSC DP operating budget							100% public	a,b	3
K3	M	Identify offsets for Stotts Island vegetation loss	To be implemented under TSC DP operating budget							100% public	a,b	1
L	Support the conservation and recovery of shellfish ecosystems											
L1	H	Shellfish ecosystem education	To be implemented under TSC DP operating budget							100% public	a, b, i	1
L2	H	Baseline mapping of oyster reefs	20	20			20			100% public	a, b, i	2
L3	M	DPI Fisheries oyster reef collaboration	To be implemented under TSC DP operating budget							100% public	a, b, i	1
M	Support the protection of bird habitat											
M1	H	Support existing bird conservation projects	To be implemented under TSC DP operating budget							100% public	a,b	1
M2	H	Tony's Bar signage	Costs included in J1							100% public	a	2
M3	M	Mangrove maintenance	To be implemented under TSC DP operating budget							100% public	a,b	1
M4	H	Osprey infrastructure maintenance	30			30	10	10	10	100% public	a, b	2
M5	H	Habitat tree plantings	30	27		3	10	10	10	100% public	a, b, d	2

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
N	Improve habitat and visual impact outcomes for river bank erosion stabilisation works											
N1	H	Encourage incorporation of bioengineering principles into private bank stabilisation works	To be implemented under TSC DP operating budget							100% public	a,b	1
Threat 3 - Degraded estuarine water quality												
O	Ensure adequate development controls and compliance											
O1	H	Stormwater controls	To be implemented under TSC DP operating budget							100% public	a,b	1
P	Reduce acid runoff											
P1	H	Remediate priority ASS areas	450	435		15	150	150	150	100% public	a,b	1
P2	M	Audit of floodplain drain pH	To be implemented under TSC DP operating budget							100% public	a,b	1
P3	M	Automatic pH loggers	15	15			15			100% public	a,b	1
P4	M	Identify sites for pilot ASS remediation projects	50	50			50			100% public	a,b	1
P5	M	Sugar Industry self-regulation of ASS	To be implemented by sugar industry							100% public	a	1
Q	Reduce catchment nutrient inputs to the estuary											
Q1	H	Green Banks Initiative	240	225		15	80	80	80	100% public	a, b, d, i	2
R	Improve waste water and effluent management											
R1	H	Upgrade Murwillumbah WWTP	To be implemented under TSC DP operating budget							100% public	a	3
R2	M	Investigate sources of high nutrient levels in Tweed River at Condong	To be implemented under TSC DP operating budget							100% public	a, b	1
S	Reduce sediment inputs to the estuary Elevated levels of TSS, primarily of concern in the middle estuary and Rous estuary, can be managed through specific related actions. Refer Action D to Action G, Action O and Action R.											
T	Reduce the human health risk of faecal contamination in the estuary											
T1	L	Investigate causes of pathogens to Tweed River	60	60				60		100% public	a, b	2
T2	M	Public health education re: high-risk swimming periods.	To be implemented under TSC DP operating budget							100% public	a	1
Threat 4 - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets												
U	Increase resilience of land, assets and people to impacts of sea level rise and increased tidal inundation.											
U1	M	Council asset vulnerability assessment	100	100			100			100% public	a, b, c	2
U2	M	Future development area vulnerability assessment	100	100			100			100% public	a, b, c	2
U3	M	Mosquito breeding habitat assessment	50	50				50		100% public	a, b, c	2
U4	M	Develop sea level rise adaptation strategy	50	50				50		100% public	a, b, c	1
U5	H	Consider planning proposal for inclusion of Coastal Vulnerability Area in CM SEPP.	To be implemented under TSC DP operating budget							100% public	a, b	1
U6	H	Mosquito controls	To be implemented under TSC DP operating budget							100% public	a	1
U7	L	Coastal hazard education	To be implemented under TSC DP operating budget							100% public	a, b	1
U8	M	Liaison with DPI Agriculture re: alternative floodplain crops	To be implemented under TSC DP operating budget							100% public	a, b	1
V	Address risk of overtopping of Bray Park Weir											
V1	H	Bray Park Weir Project Reference Group actions	To be implemented under TSC DP operating budget							100% public	a, b, c	1
Threat 5 - Loss of or impacts to biodiversity												
W	Conserve and rehabilitate key habitat and reduce conflicts between threatened species and estuary users											

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
W1	M	Threatened species education	To be implemented under TSC DP operating budget							100% public	a, b	1
W2	H	Marine debris hotspot mapping	20	20			20			100% public	a, b, e, i	2
W3	H	Monitoring and removal of marine debris	30	30			10	10	10	100% public	a, b, e, i	2
Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly lack of sandy beaches												
X	Improvements to foreshore parks and recreational facilities											
X1	L	Seating improvements Ebenezer Park and Keith Compton Drive foreshore	50	48		2		50		100% public	a, b, j	2
X2	H	Upgrade facilities at Old Fingal Boat Harbour	300	280		20		290	10	100% public	a, b, c, d, f, j, i	2
X3	L	Detailed design Growers Market rest area at Tumbulgum upgrade	140	135		5			140	100% public	a, b, c, d, f, j, i	2
X4	L	Detailed design Bluey Hill Park upgrade	140	135		5			140	100% public	a, b, c, d, f, j, i	2
X5	L	Enhance opportunities for nature-based education	50	47		3			50	100% public	a, b, c, d, f, j, i	2
Y	Maintain and improve facilities for connectivity of public access along the foreshore											
Y1	L	Investigate opportunities to increase connectivity with walking trails	20	20				20		100% public	a, b, l	2
Z	Maintain amenity of existing estuary beaches and create additional artificial sandy beaches											
Z1	M	Maintain amenity of existing sandy beaches in the estuary	500	450		50	200	200	100	100% public	a, b, k	3
Z2	H	Feasibility assessment for sandy beach creation	50	50				50		100% public	a, b, k	2
Threat 7 - Conflict between river users												
BB	Continue to work with TfNSW to improve compliance with, and policing of boating rules, and recommend towing restrictions in conservation and restoration character zones											
BB1	H	Boating safety education and enforcement	Included in J1							100% public	a, b, i, j	2
BB2	M	Vessel number survey	To be implemented by TfNSW - Maritime							100% public	a, j	1
Threat 8 - Reduced stocks of target fish species												
CC	Improve the status of fish assemblages in the estuary											
CC1	H	DPI Fisheries education program	To be implemented under TSC DP operating budget							100% public	a, b, i	1
Threat 9 - Restricted levels of boating infrastructure and facilities or reduced navigability												
DD1	M	Consultation regarding port development	To be implemented under TSC DP operating budget							100% public	a	1
EE	Maintain and improve boating infrastructure, access and ancillary facilities for boaters											
EE1	H	Increase funding to TSC's Boating Facilities Management program	600	600			240	240	120	100% public	a, b, f, j	2
EE2	M	Improve boat ramp facilities	300	280		20		280	20	100% public	a, b, f, j	2
EE3	L	Feasibility assessment for on-water re-fuelling facilities	30	30					30	100% public	a, b, f, j	2
EE4	M	Boat ramp improvements at John Oxley Park, Chinderah.	100	95		5	95	3	2	100% public	a, b, f, j	2
EE5	L	Boat ramp improvements at Condong Rd Boat Ramp	100	95		5		95	5	100% public	a, b, f, j	2

ID	Priority	Action/Costs ($'000)	Total 10 yr cost	Total capital cost	Total operational cost	Total maintenance cost	[1]DP 2023-2025	DP 2026-2029	DP 2030-2033	Cost-benefit distribution (private vs public benefit)	[2]Potential funding source(s)	[3]Business plan category
FF	Ensure adequate planning, assessment and control of dredging and sand extraction in the estuary											
FF1	L	Minor dredging associated with TSC managed infrastructure and canals	To be implemented under TSC DP operating budget							100% public	a, b, j, k	1
FF2	M	TRESBP Environmental Monitoring System data review	To be implemented under TSC DP operating budget							100% public	a,b	1
		TOTALS	**27,901**	**26,397**	**490**	**1,014**	**8,320**	**13,113**	**6,468**			

Business Plan Notes:

1. DP - Delivery Program within Council's IP&R framework. Years correspond to end of financial year i.e. DP 2023 - 2025 is the 1st four-year Delivery Program (start 1st July 2022, end 30th June 2025) etc. Timing may be dependent on certification of CMP and approval of funding where applicable.

2. Potential Funding Sources:

a. TSC funds (including River Health Grants, Biodiversity Grants, Land for Wildlife etc.) and staff time – TSC

b. NSW Coastal and Estuary Grants Program -DPE (2:1 funding)

c. Increasing Resilience to Climate Change program -DPE

d. Crown Reserves Improvement Fund Program- DPE-Crown Lands

e. The NSW Environment Trust -DPE

f. The NSW Community Building Partnership program - NSW Department of Premier and Cabinet

g. NSW EPA Waste Less, Recycle More initiative - EPA

h. Commonwealth Community Led Grants – Commonwealth of Australia

i. Habitat Action Grants funded from Recreational Fishing Trusts – DPI Fisheries

j. NSW Boating Now Program – TfNSW - Maritime

k. Coastal Dredging Strategy and Boating Access Dredging Grants Program – TfNSW - Maritime (1:1 funding)

l. Walking and Cycling program - TfNSW

m. Regional Roads Funding Assistance – NSW Local Government

n. The Emissions Reduction Fund – Australian Government Clean Energy Regulator

o. Clean Coastal Catchments On-Farm Grants Program – LLS (MEMA)

p. NPWS funds – DPE-NPWS

q. Landcare – Landcare Australia

r. Coastcare - Coastcare Australia

s. Marine Estate Management Strategy - MEMA

Funding is subject to grant availability and approval.

3. Business Plan Categories:

Category 1 – economic analysis complete, action funded under normal operating budget or existing programs and grants and not expected to impact on current resourcing levels.

Category 2 – economic analysis complete, action subject to funding.

Category 3 – no economic analysis, action subject to detailed costing, economic analysis and funding.

5. MONITORING, EVALUATION AND REPORTING PROGRAM

5.1. Monitoring and Reporting on CMP Progress

This CMP and the progress of action implementation will be monitored continually to ensure the actions are effective, remain relevant and the objectives of the plan are being achieved. Monitoring will allow for identification of any emerging threats within the ten-year timeframe for implementation. The following reporting will be undertaken throughout CMP implementation:

- Project updates will be presented at each TCWC meeting (held every 2 months), with the meeting minutes provided to Council, so that CMP implementation progress is regularly and publicly reported;
- Progress in the delivery of funded (i.e. Category 1) CMP actions and the success of these actions, where the responsibility of Council, will be reported through TSC's IP&R process. Council will report on the implementation of the CMP through the IP&R framework on an annual, four yearly and ten-yearly basis. Progress of implementation will be documented for each action with reference to the timeframe for implementation provided in Table 11. Category 2 and 3 actions will not be included and reported within the IP&R Framework unless funding has been obtained. The yearly CMP IP&R progress report will be presented to the TCWC for review prior to submission to Council; and
- Where actions are the responsibility of a public authority(s) other than Council, Council will work closely with that authority and will seek input from those authorities on the status of implementation of actions for inclusion in project updates to the TCWC and IP&R reports.

5.2. Review of the CMP

In addition to the ongoing and annual review of implementation of the CMP actions, Council is required to undertake a detailed review of the CMP at least once every ten years or sooner if significant new circumstances arise. A mid-term review will be undertaken at five years post-certification of the CMP to consider and identify:

- The effectiveness of the CMP in managing key threats and risks (i.e. have CMP actions made a difference? has the level of risk for threats been reduced?);
- Any changes to the level of risk from threats to the core values of the estuary;
- Any new circumstances or emerging threats to be considered;
- Changes to the prioritisation of actions, if required;
- Identification of any new management strategies and actions to address new threats in conjunction with responsible agencies;
- Requirements for ongoing commitments or long-term actions beyond the ten year timeframe of the CMP; and
- Any requirements to amalgamate management plans for the Cobaki and Terranora Broadwaters estuaries with the Tweed River CMP in the future.

The mid-term review will provide recommendations for any necessary changes to the CMP, including modifications to existing actions or additional actions to more effectively manage risks and updates to the Business Plan (i.e. costs, timing, funding sources etc.). Any such changes to the CMP would need to be endorsed by the stakeholders and relevant government agencies as well as the community.

In the event that it is identified that actions have not been sufficiently implemented, the cause of delay/ failure will be documented and solutions or alternatives identified in conjunction with any other agencies responsible

for implementation (e.g. identification of alternative funding streams or additional stakeholder assistance, or postponement to a more achievable timeframe) where feasible.

A ten-year review at the end of the CMP implementation period will be undertaken to pre-empt the preparation of an updated CMP. The ten-year review is to consider:

- Results of the mid-term review;
- Results of IP&R reporting since the mid-term review;
- Review of status of CMP actions including overall success and any barriers to the effective implementation;
- Data provided by the estuary health monitoring (e.g. Water Quality Monitoring Program);
- Any new or updated scientific knowledge; and
- Prevailing community attitudes, government policy and strategic planning status.

5.3. Estuary Health Monitoring and Reporting Program

A CMP requires a monitoring of estuary health to assist in determining whether the desired outcomes of CMP implementation are being realised. One of the key objectives for the Tweed River Estuary CMP is protection and improvement in water quality and estuary health. The Tweed River Estuary Health Monitoring and Reporting Program (Action C2) provides a means of tracking key estuary health indicators and may assist in detecting changes associated with implementation of the CMP.

TSC monitors water quality at a number of sites in the Tweed River Estuary to assess estuary health. Samples are collected routinely on a monthly basis and opportunistically following rainfall events. Water samples are analysed for a broad range of environmental indicators and reported to the community via an annual report card (Action C1). Comprehensive technical review of water quality is carried out every five years to assess longer term trends, identify likely controlling process and any major changes in water quality over time. The TSC water quality monitoring program is discussed further in the *Tweed Estuary Water Quality Assessment and Improvement Strategy* (Hydrosphere Consulting, 2018).

In addition, Action C3 (riparian vegetation and bank condition monitoring) will be undertaken by TSC every three years, to assess changes to riparian condition and bank stability and to determine any changes in response to actions implemented as part of this CMP (i.e. Action F1). Action F4 (Monitor bank stabilisation works and improve/refine methods) will also be undertaken by TSC as bank stabilisation works progress to provide a process for continual improvement of methods employed.

Results from monitoring Actions C2, C3 and F4 will be reported in relevant annual estuary health report cards (Action C1, when timing coincides) and will assist in interpretation of water quality data during technical data review (Action C2).

6. MAPS

Table 13: Index of maps occurring within this CMP

Map	Location
Figure 1: Tweed River functional zone boundaries within the CMP study area	Executive Summary
Figure 2: Tweed River estuary CMP on-ground actions – lower estuary - entrance reach, Terranora Inlet and Southern Boat Harbour	Executive Summary
Figure 3: Tweed River estuary CMP on-ground actions – lower estuary – Ukerebagh Island to Fingal Head	Executive Summary
Figure 4: Tweed River estuary CMP on-ground actions – transition zone	Executive Summary
Figure 5: Tweed River estuary CMP on-ground actions – middle estuary	Executive Summary
Figure 6: Tweed River estuary CMP on-ground actions – upper estuary	Executive Summary
Figure 7: Tweed River estuary CMP on-ground actions – Rous River estuary	Executive Summary
Figure 8: Tweed River catchment, major waterways and study area for the Tweed River estuary CMP	Section 1.1 - The Study Area
Figure 13: Coastal Management Areas within Tweed Shire and the CMP study area	Section 1.6 - Coastal Management Areas
Figure 19: Tweed River functional zone boundaries within the CMP study area	Section 2.1.2 – Estuary Processes
Figure 26: Suggested character zones for the Tweed River estuary	Section 3.3.2 – Recreational Use Strategy
Figure 27: Tweed River estuary CMP on-ground actions – lower estuary - entrance reach, Terranora Inlet and Southern Boat Harbour	Section 3.5 – Actions to be Implemented by TSC or Other Public Authorities
Figure 28: Tweed River estuary CMP on-ground actions – lower estuary – Ukerebagh Island to Fingal Head	Section 3.5 – Actions to be Implemented by TSC or Other Public Authorities
Figure 29: Tweed River estuary CMP on-ground actions – transition zone	Section 3.5 – Actions to be Implemented by TSC or Other Public Authorities
Figure 29: Tweed River estuary CMP on-ground actions – transition zone	Section 3.5 – Actions to be Implemented by TSC or Other Public Authorities
Figure 30: Tweed River estuary CMP on-ground actions – middle estuary	Section 3.5 – Actions to be Implemented by TSC or Other Public Authorities
Figure 31: Tweed River estuary CMP on-ground actions – upper estuary	Section 3.5 – Actions to be Implemented by TSC or Other Public Authorities
Figure 32: Tweed River estuary CMP on-ground actions – Rous River estuary	Section 3.5 – Actions to be Implemented by TSC or Other Public Authorities
Figure 33: Management priority of bank erosion hotspot areas in the middle and upper estuary and the Rous River estuary (Site A, B, C, E, H1&2, L2, N1&2 and potentially severe erosion areas)	Appendix C – Risk Assessment
Figure 34: Priority rating for restoration of protective infrastructure in the lower estuary	Appendix C – Risk Assessment

Map	Location
Figure 35: Overview of bank segments and level of disturbance of riparian vegetation	Appendix C – Risk Assessment
Figure 36 Management priority areas and anthropogenic constraints for migration of significant estuarine vegetation	Appendix C – Risk Assessment
Figure 37: Overall compliance scores at each estuarine water quality monitoring site in the Tweed River estuary	Appendix C – Risk Assessment

ABBREVIATIONS

AAC	Aboriginal Advisory Committee
ASS	Acid sulfate soil
CBA	Cost-benefit analysis
CEA	Coastal Environment Area
CM SEPP	State Environmental Planning Policy (Coastal Management) 2018
CMA	Coastal Management Area
CMP	Coastal Management Program
CUA	Coastal Use Area
CVA	Coastal Vulnerability Area
CWLRA	Coastal Wetlands and Littoral Rainforest Area
CZMP	Coastal Zone Management Plan
DCP	Development Control Plan
DIN	Dissolved Inorganic Nitrogen
DO	Dissolved Oxygen
DON	Dissolved Organic Nitrogen
DP&E	Department of Planning and Environment
DPI Fisheries	Department of Primary Industries – Fisheries
DPE - Crown Lands	Department of Planning and Environment – Crown Lands
DPE	Department of Planning and Environment
EMP	Estuary Management Plan
EPA	Environment Protection Authority
FM Act	*Fisheries Management Act 1994*
FRMP	Floodplain Risk Management Plan
FRMS	Floodplain Risk Management Study
IP&R	Integrated Planning and Reporting (Framework)
IWCM	Integrated Water Cycle Management
LEP	Local Environmental Plan
LGA	Local government area
LLS	(North Coast) Local Land Service
MEMA	Marine Estate Management Authority
MEMS	Marine Estate Management Strategy
MER	Monitoring, evaluation and reporting
NOx	Oxidised Nitrogen
NPW Act	*National Parks and Wildlife Act 1974*
NPWS	National Parks and Wildlife Service
NSW	New South Wales
OEH	Office of Environment and Heritage
PAE	Production Area Entitlement
PoM	Plan of Management
Qld	Queensland
SOE	State of Environment
SUP	Stand Up Paddleboard
TARA	Threat and Risk Assessment
TBLALC	Tweed-Byron Local Aboriginal Land Council
TCWC	Tweed Coast and Waterways Committee
TfNSW	Transport of NSW
TfNSW – Maritime	Transport for NSW - Maritime

TN	Total nitrogen
TP	Total phosphorous
TRESBP	Tweed River Sand Bypassing Project
TSC	Tweed Shire Council
TSS	Total suspended solids
WQ	Water quality
WWTP	Wastewater treatment plant

REFERENCES

.id (2020) *Tweed Shire Council community profile*. Webpage. https://profile.id.com.au/tweed/population?EndYear=2001&DataType=UR. Accessed December 2020.

ABER (2012) *Review of water quality in the Tweed Estuary 2007-2011*. Report prepared for Tweed Shire Council.

Australian Wetlands (2008). *Chinderah Pontoon Seagrass Mapping and Health Assessment*. Prepared for Tweed Shire Council.

Australian Wetlands Consulting and Design Flow (2016) *Tweed Urban Stormwater Quality Management Plan*. Prepared for Tweed Shire Council.

AWC (2010) *Cobaki and Terranora Broadwater Coastal Zone Management Plan.* Prepared for Tweed Shire Council.

BMT WBM (2014) *Tweed Valley Floodplain Risk Management Plan*. Prepared for Tweed Shire Council.

BMT WBM (2014b) *Tweed Valley Floodplain Risk Management Study*. Prepared for Tweed Shire Council.

BMT WBM (2017) *NSW Marine Estate Threat and Risk Assessment Report*. Available at: https://www.marine.nsw.gov.au/__data/assets/pdf_file/0010/736921/NSW-Marine-Estate-Threat-and-Risk-Assessment-Final-Report.pdf. Accessed 31/1/2018.

BMT WBM (2019) *Tweed Estuary Tidal Inundation Assessment and Mapping*

CARE Engineering (2001) *Tweed River Estuary Management Plan Review*. Prepared for Tweed Shire Council and TRMPAC.

Centre for Coastal Management UNE (1992) *Recreational Management Plan for the Upper Tweed Estuary*.

CSIRO and BoM (2015) *Climate Change in Australia Projections for Australia's Natural Resource Management Regions: Technical Report*, CSIRO and Bureau of Meteorology, Australia. Available at https://www.climatechangeinaustralia.gov.au/en/publications-library/technical-report/. Accessed 12/3/19.

DECC (2009) Environmentally Friendly Seawalls - A Guide to Improving the Environmental Value of Seawalls and Seawall-lined Foreshores in Estuaries. Department of Environment and Climate Change NSW on behalf of Sydney Metropolitan Catchment Management Authority.

DECC (2010a) *New South Wales Natural Resources Monitoring, Evaluation and Reporting Strategy 2010 – 2015*.

DECC (2010b) *State of Catchments – Estuaries and Coastal Lakes – Northern Rivers Region*. http://www.environment.nsw.gov.au/resources/soc/northernrivers/10426NRIVERSestuarine.pdf. Accessed 2/2/2018.

DEWHA (2009) *Ecosystem Services: Key Concepts and Applications*, Occasional Paper No 1, Department of the Environment, Water, Heritage and the Arts, Canberra.

DoL – Crown Lands (2017) *NSW Coastal Dredging Strategy 2019 - 2024*. Available at: http://www.crownland.nsw.gov.au/__data/assets/pdf_file/0008/708776/nsw-coastal-dredging-strategy.pdf. Viewed 1/8/17.

DoL, TSC, DPI, DWE, NSW Maritime (2008) *Tweed River Domestic Structures Strategy*.

DPI (2005a) *Reducing the Impact of Road Crossings on Aquatic Habitat - Tweed Shire*.

DPI Fisheries (2019) *NSW Fisheries Threatened Species Scientific Committee White's Seahorse (Hippocampus whitei) Final Determination*.

Dwyer, P (2011) *Successful fish habitat protection and rehabilitation projects: case studies without a funding application in sight*. 20th NSW Coastal Conference, Tweed Heads 2011.

Ecograph (2004) *Tweed Vegetation Management Strategy 2004*. Prepared for Tweed Shire Council.

EPA (2016) State of Environment 2015 – River Health. Available from: https://www.epa.nsw.gov.au/publications/soe/20150817soe-2015 (refer 17. River Health). Accessed 31/8/2018.

Eyre B. and Pepperell P. (1997) *Spatially Intensive Approach to Water Quality Monitoring in the Rous River Catchment*.

GHD (2009). *Tweed Shire Urban Land Release Strategy*. GIS layers were supplied by TSC.

GHD (2016) *Jack Evans Boat Harbour Foreshore Management Options Assessment*. Prepared for Tweed Shire Council.

Gillies, C.L., McLeod, I.M., Alleway, H.K., Cook, P., Crawford, C. and Creighton, C. (2018) Australian shellfish ecosystems: Past distribution, current status and future direction. PLoS ONE 13(2): e0190914. Available at: https://doi.org/10.1371/journal.pone.0190914 (accessed 26/2/2018).

Hossain, Md. M. K. (2005) *An examination of seagrass monitoring protocols applied to two New South Wales estuarine settings* (Unpublished doctoral thesis). Australian catholic University, Fitzroy, Victoria, Australia.

Hydrosphere Consulting (2016a) *Tweed Shire Council Integrated Water Cycle Management Strategy*. Prepared for Tweed Shire Council.

Hydrosphere Consulting (2017a) *Coastal Management Program for the Tweed River Estuary: Literature Review*. Prepared on behalf of Tweed Shire Council.

Hydrosphere Consulting (2017b) *Coastal Management Program for the Tweed River Estuary: Assessing the Impact of Potential Future Catchment Development.* Prepared for Tweed Shire Council.

Hydrosphere Consulting (2017c) *Coastal Management Program for the Tweed River Estuary: Community Values Study*. Prepared on behalf of Tweed Shire Council.

Hydrosphere Consulting (2017d) *Coastal Management Program for the Tweed River Estuary: Recreational Use Study*. Prepared for Tweed Shire Council.

Hydrosphere Consulting (2017e) *Tweed River Estuary Coastal Management Program: Community Engagement Strategy*. Prepared on behalf of Tweed Shire Council

Hydrosphere Consulting (2018) *Coastal Management Program for the Tweed River Estuary: Water Quality Assessment and Improvement Strategy*. Prepared for Tweed Shire Council.

Hydrosphere Consulting (2019) *Coastal Management Program for the Tweed River Estuary: Ecological Assessment.* Prepared for Tweed Shire Council.

Hydrosphere Consulting (2020a) *Coastal Management Program for the Tweed River Estuary: Coastal Hazards and Risk Identification and Assessment.* Prepared for Tweed Shire Council.

Hydrosphere Consulting (2020b) *Tweed River Estuary CMP: Public Exhibition Submissions Report*. Prepared on behalf of Tweed Shire Council.

Hydrosphere Consulting (2021) *Coastal Management Program for the Tweed River Estuary: Key Management Issues and Threats.* Prepared on behalf of Tweed Shire Council

International Water Centre (2009) Report Card 2009 for the waterways and catchments of Cobaki and Terranora Broadwaters. Prepared for Tweed Shire Council.

Jetty Research (2017) *Measuring use and perception of the Tweed River estuary and support for potential actions*. Prepared on behalf of Tweed Shire Council.

Land and Property Management Authority (2005) *Tweed Coast Regional Crown Reserve Plan of Management.* Prepared on behalf of Land and Property Management Authority (now DPE – Crown Lands).

Marine Estate Management Authority (2015) *Threat and Risk Assessment Framework for the NSW Marine Estate*.

Marine Estate Management Authority (2018) *Marine Estate Management Strategy 2018 – 2028*.

NSW DP&E (2018) NSW Coastal Management State Environmental Planning Policy Maps, Geocortex viewer.

NSW Government (2006) *Far North Coast Regional Strategy 2006-31*

NSW Government (2017) *North Coast Regional Plan 2036*

NSW Maritime (2006) *Tweed Estuary Boating Plan 2006-2010*.

NSW NPWS (1999) *Tweed Heads Historic Site and Ukerebagh Nature Reserve Plan of Management*.

NSW NPWS (2001) *Stotts Island Nature Reserve Plan of Management*.

OEH (2016) *NSW Water quality and River Flow Objectives – Tweed River. Available at: http://www.environment.nsw.gov.au/ieo/tweed/report-03.htm#P307_25850. Accessed 31/1/2018.*

OEH (2017*) Risk-based Framework for Considering Waterway Health Outcomes in Strategic Land-use Planning Decisions.* Available at: https://www.epa.nsw.gov.au/publications/water/risk-based-framework-waterway-health-strategic-land-use-planning-170205. Accessed 6/3/19.

OEH (2018a) Estuaries of NSW – Tweed River – Physical Characteristics .http://www.environment.nsw.gov.au/estuaries/stats/TweedRiver.htm accessed 31/1/2018. Accessed 31/1/2018.

OEH (2018b) *NSW Coastal Management Manual*.

Pacific Wetlands (2012) *Tweed River Estuary Estuarine Vegetation Monitoring Program*. Prepared for NSW Department of Trade and Investment, Crown Lands and Queensland Department of Science, Information Technology, Innovation and the Arts.

Patterson Britton & Partners (1998) *Tweed River Estuary Bank Management Plan*. Prepared or Tweed River Management Plan Advisory Committee.

Patterson Britton & Partners (2008) Tweed River *Estuary Recreational Boating Facilities Study*, Tweed Shire Council.

PWD (1991) *Lower Tweed Estuary River Management Plan.*

Riches, M. and Huegill, J (2001) *Sustainable Land Management of Coastal Floodplains in Northern NSW: - Tweed River Catchment Final Report*. Natural Heritage Trust, NR1008.98. NSW Fisheries Office of Conservation, Ballina.

Roper T., Creese B., Scanes P., Stephens K., Williams R., Dela-Cruz J., Coade G. and Coates B. (2011) Assessing the condition of estuaries and coastal lake ecosystems in NSW, Monitoring, evaluation and reporting program. Technical Report Series, Office of Environment and Heritage, Sydney.

Russell, K. (2005). *NSW Northern Rivers Estuary Habitat Mapping - Final Analysis Report*. NSW Department of Primary Industries, Port Stephens.

Short, F., Carruthers, T., Dennison, W. and Waycott, M. (2007) Global seagrass distribution and diversity: A bioregional model. *Journal of Experimental Marine Biology and Ecology, 350 3–20*.

Transport for NSW (2015) *Regional Boating Plan: Tweed – Clarence Valley Region*.

TfNSW – Maritime (2018) *NSW Maritime Infrastructure Plan 2019-2024*.

TRMPAC (1996) *Upper Tweed Estuary Management Plan.*

TSC (2008a) *Tweed River Murwillumbah Reach Bank Enhancement Master Plan*.

TSC (2008b) *Tweed Development Control Plan. Available at: http://www.tweed.nsw.gov.au/PlanningPolicies. Accessed 31/1/2018.*

TSC (2014) *Tweed Riverbank Erosion Management Plan 2014*.

TSC (2016) *Tweed Sustainable Agriculture Strategy*.

TSC (2017a) draft Biodiversity Development Control Plan. Draft for consultation. Available at: file:///C:/Users/Orla/Downloads/TSC08382_Draft_Biodiversity_Development_Control_Plan%20(2).pdf. Accessed 28/2/2018.

TSC (2017b) *Draft Aboriginal Cultural Heritage Management Plan*.

TSC (2018) *Tweed River Estuary Coastal Management Program Scoping Study Report*.

Water Technology (2020) *Tweed Coastal Management Program Stage 1 Scoping Study*. Final Report. Prepared for Tweed Shire Council

WBM (2000) *Tweed River and Catchment Interim Water Quality Management Plan*. Prepared for Tweed Shire Council

APPENDIX A. MANDATORY REQUIREMENTS OF THE NSW COASTAL MANAGEMENT MANUAL

This appendix lists the mandatory requirements for the preparation of a coastal management program (Stages 1 to 4, NSW Coastal Management Manual (OEH, 2018b) and how they have been addressed in this CMP).

Table 14: Addressing the mandatory requirements of the *NSW Coastal Management Manual*

Mandatory Requirements		Where addressed in this CMP
Purpose of a coastal management program		
2.	A CMP is to consider a range of timeframes and planning horizons including immediate, 20 years, 50 years, 100 years and (if council considers it relevant based on expert advice) beyond.	The timeframe of risks assessed are discussed in Appendix C Risk Assessment.
3.	A CMP is to consider a broad range of coastal management issues and management actions with a focus on achieving the objects and objectives of the CM Act.	The range of coastal management issues are discussed in detail in the Hydrosphere Consulting (2021) and summarised in Section 2. Management actions are suggested in the above appendices and refined in Section 3.
Where and when a coastal management program is prepared		
4	A CMP must include the rationale for selecting the area to be covered by a CMP and identify whether it applies to: i) all or part of the coastal zone of one local government area; or ii) all or part of the coastal zone of adjoining local government areas that share a coastal sediment compartment or estuary (where adjoining local government areas share a coastal sediment compartment or estuary - refer to Schedule 1 of the CM Act - a CMP that addresses an area comprising that coastal sediment compartment or estuary must reflect this regional context)	The rationale for selecting the CMP study area is provided in Section 1.1.
5.	A CMP must identify: i) any proposed amendments to mapping of the relevant coastal management areas; ii) evidence to support any proposed amendments or additions to the area of the four coastal management areas in the relevant area; and iii) information about these proposed amendments that can support the preparation of a planning proposal and, in particular, that could be forwarded along with a planning proposal to the Greater Sydney Commission (if the planning proposal relates to the Greater Sydney Region) or the Minister (for elsewhere) to inform a Gateway determination under section 3.34 of the EP&A Act.	Discussion of the suitability of the mapped Coastal Management Areas is provided in Section 1.6 and Figure 13. No changes to the mapped CMAs are recommended at this time (refer Section 3.6), however Action A4 (Section 3.5) involves periodic review of Coastal Management Areas to ensure accuracy and relevance, particularly as additional information is gathered as part of other CMP actions that may affect CMAs.

Mandatory Requirements		Where addressed in this CMP
How a coastal management program is prepared		
6.	During preparation of a CMP, a council is to: i) identify the scope of the CMP; ii) determine and assess coastal risks, vulnerabilities and opportunities (including without limitation risks to environmental, social and economic values and benefits); and iii) evaluate and select coastal management options.	The scope of the CMP was identified in the Brief to Consultants and in the subsequent preparation of a Scoping Study. The range of coastal management issues are discussed in detail in the Hydrosphere Consulting (2021) and summarised in Section 2. Management actions are suggested in the above appendices and refined in Section 3.
7.	A council may choose not to repeat steps (or parts of steps) in subparagraphs (ii) or (iii) of mandatory requirement 6 for the area the subject of the proposed CMP (or parts of that area) if those tasks have already been undertaken for the coastal management of that area, provided that council first considers: i) whether the existing assessment of coastal risks, vulnerabilities and opportunities, or the existing evaluation of coastal management options, that council proposes to rely on enables council to prepare the CMP in accordance with mandatory requirement 8 below and sections 14 and 15 of the CM Act; ii) the effectiveness of the existing coastal management of that area; and iii) whether any circumstances concerning the coastal management of that area have changed.	N/A
Matters to be dealt with in a coastal management program		
8.	A CMP must: i) provide a description of how the objects of the CM Act have been considered and promoted in preparing the CMP;	The objects of the CM Act are reflected in the specific local objectives developed for this CMP (Section 1.7). The alignment of the objects of the CM Act and the MEM Act with the specific local objectives of the CMP is shown in Appendix D.
	ii) provide a description of how the objectives of the coastal management areas covered by the CMP have been given effect to in preparing the CMP;	The management objectives for each coastal management areas have been used to guide the development of specific local objectives developed for this CMP (Section 1.7)
	iii) identify the key coastal management issues affecting the areas to which the CMP is to apply and how these have been considered;	The range of coastal management issues are discussed in detail in the Hydrosphere Consulting (2021) and summarised in Section 2.
	iv) identify any coastal management actions required to address those key coastal management issues in an integrated and strategic manner;	Management actions are provided in the Action Plan in Section 3.5.

Mandatory Requirements		Where addressed in this CMP
	v) identify how the coastal management actions in (iv) have been considered and evaluated (including, without limitation, how council has evaluated the coastal management actions in light of the functions and responsibilities council has under legislation other than the CM Act);	A description of how management options were evaluated and selected is provided in Sections 2.2.1, 3.1 and 3.2.
	vi) identify any environmental protection works, on land identified as 'coastal wetlands' or 'littoral rainforests' on the Coastal Wetlands and Littoral Rainforests Area Map under the CM SEPP, that are proposed to be carried out by or on behalf of a public authority;	Specific local actions and their location in proximity to Coastal Wetlands and Littoral Rainforest areas are identified on the action maps (Figures 27 to 32).
	vii) identify any coastal protection works that are proposed to be carried out by or on behalf of a public authority;	Beach nourishment: Refer Actions Z1, Z2 and FF1 of the Action Plan (Section 3.5) Seawalls, revetments and groynes and bank treatments: Refer Actions F1 – F6 of the Action Plan (Section 3.5) and Appendix C.
	viii) set out the recommended timing for the proposed coastal management actions;	The proposed timing (i.e. in which Delivery Program(s) of Council's IP&R Framework) of action is specified in the Business Plan (Section 3.6).
	ix) identify a proposed monitoring, evaluation and reporting program in relation to the CMP, including by identifying key indicators, trigger points and thresholds relevant to the CMP; and	An MER program is provided in Section 5.
	x) include a business plan.	A Business Plan is provided in Section 4.
9.	The business plan included in the CMP must identify: i) all proposed coastal management actions identified elsewhere in the CMP; ii) the full proposed capital, operational and maintenance costs and recommended timing, of proposed coastal management actions; iii) any proposed cost-sharing arrangements and any other viable funding mechanisms for the proposed coastal management actions to ensure delivery of those actions is consistent with the timing for their implementation under the CMP; and iv) the distribution of costs and benefits of all proposed coastal management actions.	A Business Plan including these requirements is provided in Section 4.
10.	Where coastal hazards have been identified in a coastal management area, a CMP must identify proposed coastal management actions for those hazards.	This CMP identifies that the coastal hazards affecting the estuary include bank erosion and tidal inundation. Actions to address these hazards include Actions A4, C3, E1-E3, F1-F6, G1- G2, K1-K3, U1-U8, V1, FF1 and FF2 of the Action Plan (Section 3.5).

Mandatory Requirements		Where addressed in this CMP
11.	If the CM Act requires that a coastal zone emergency action subplan be prepared, it must identify any requirements for how emergency coastal protection works, within the meaning of the CM SEPP, are to be carried out.	N/A No beach erosion, coastal inundation or cliff slope instability has been identified as occurring within the estuary. As such, a coastal zone emergency action subplan is not required.
12.	A CMP must demonstrate how a council has considered: i) projected population growth and demographic changes; and ii) projected use of coastal land for infrastructure, housing, commercial, recreational and conservation purposes	Projected growth and landuse changes are considered in detail in Hydrosphere Consulting (2017b) and the associated risks and threats discussed in Section 2.
13.	A CMP must demonstrate how a council has considered: i) current and future risks, at timeframes of immediate, 20 years, 50 years, 100 years and (if council considers it relevant based on expert advice) beyond; ii) (if council considers it relevant) current and future risks of potentially high consequence, low probability events that may affect the relevant area; iii) the effects of projected climate change and how it may affect the relevant area; iv) the local and regional scale effects of coastal processes; and v) the ambulatory and dynamic nature of the shoreline and how it may affect the relevant area.	The timeframe of risks assessed are discussed further in: Section 1.2 (CMP Timeframe); Appendix C (Risk Assessment); Hydrosphere Consulting (2019) (re tidal inundation); Hydrosphere Consulting (2020a) (re: migration of estuarine vegetation with sea level rise); and Hydrosphere Consulting (2021) (summarising the key management issues and threats).

Mandatory Requirements		Where addressed in this CMP
14.	A CMP is to include the following sections: i) Executive summary ii) Introduction iii) A snapshot of issues iv) Actions to be implemented by the council or by public authorities v) Whether the CMP identifies recommended changes to the relevant planning controls, including any proposed maps vi) A business plan vii) Coastal zone emergency action subplan if the CM Act requires that subplan to be prepared viii) Monitoring, evaluation and reporting program ix) Maps x) Reference list	The CMP has been formatted, generally in Mandatory Requirement 14. The CM Act does not require a coastal zone emergency action subplan to be prepared as part of this CMP for the Tweed River Estuary.
Consultation on the coastal management program		
15.	A draft CMP must be exhibited for public inspection at the main offices of the councils of all local government areas within the area to which the CMP applies, during the ordinary hours of those offices, for a period of not less than 28 calendar days before it is adopted. This mandatory requirement does not prevent community consultation, or other consultation, in other ways.	Public exhibition of the CMP was undertaken in accordance with the Community and Stakeholder Engagement Strategy. Submissions are provided in Hydrosphere Consulting (2020b).
Review, amendment and replacement of a coastal management program		
16.	When implementing a CMP, a council must: i) carry out the monitoring, evaluation and reporting program in the CMP (MER); and ii) monitor key indicators, trigger points and thresholds identified in the MER.	An MER program is provided in Section 5 with indicators provided in the Action Plan.
17.	Councils must report on the implementation of a CMP through the IP&R framework on an annual, four yearly and ten-yearly basis.	Alignment of the CMP with Council's IP&R Framework is discussed in Section 1.8.5 and demonstrated in Section 4 Business Plan.

Mandatory Requirements		Where addressed in this CMP
Implementation of a coastal management program		
18.	When an adjoining council or a public authority is affected, or is likely to be affected, by implementation of some aspect of a CMP, a council must liaise with that authority when implementing that aspect of the CMP.	N/A Section 1.1discusses the bounds of the study area being wholly within the Tweed LGA.
19.	Councils must maintain sufficient information and records about its management of the relevant parts of the coastal zone that will enable it to demonstrate: i) how the CMP has been implemented ii) what has been achieved in connection with the CMP, including whether coastal management actions have been carried out within the timeframes identified in the CMP.	Monitoring, evaluation and reporting of implementation is discussed in Section 5.

APPENDIX B. STATUS OF PREVIOUS RELATED MANAGEMENT PLANS AND PROGRAMS

This Appendix summarises the relevant guidelines and management plans developed or updated from the 1991 Lower Tweed River Management Plan to present.

Table 15: Summary of status of management actions from previous management plans and programs

Plan	Objective	Key actions relevant to management of the Tweed River	Current Status (October 2016)	Potential Considerations for CMP
Lower Tweed Estuary River Management Plan (PWD, 1991) Document includes technical reports on: ecology, influent, hydro-dynamics, recreation, archaeology and visual assessment.	Detailed objectives have been set for: • Fisheries • Ecology • Visual amenity • Recreation • Navigation • Heritage • Discharge • Public involvement *(Maintain a civic liaison committee to overview the impact of progress and development pressures on river wellbeing.)* All objectives encompass a maintain and improve approach - delivering the plans aim of, "maintain a healthy river". Specific recommendations/actions have been set for 18 different areas within the river	There are approximately 70 actions listed in the plan under main objectives and each 'specific area' has a number of short and long-term actions recommended for it. A separate process will need to be undertaken to document and assess the status of all actions.	Audit completed separately (see Table 15).	see Table 15
Lower Tweed Estuary River Management Plan Formal Review (CARE Engineering, 2001)	Objectives of the plan should reflect the nine primary goals of the State's Coastal Policy at the time of review: • To protect, rehabilitate and improve the natural environment. • To recognise and accommodate coastal processes and hazards. • To seek protection and enhancement of aesthetic qualities. • To seek protection and enhancement of cultural heritage. • To ensure that development and use of resources is ecologically sustainable. • To ensure that new human settlement is ecologically sustainable. • To facilitate appropriate public access and use. • To support provision of information to enable effective management. • To encourage integrated planning and management	Recommendations: 1. Establish linkages between existing walkways and cycleways wherever reasonably possible to achieve a sense of completion, to enhance the value of investment already made and to maximise public recognition of the project. 2. With the exception of 1 above, over the next three years, direct remaining funds as much as possible towards upper estuary improvements, including works in Murwillumbah itself, to provide river 'destination' attractions. 3. In the short term, consistent with 2 above, satisfy outstanding lower estuary project completion commitments only where necessary. 4. Establish a priority schedule for boating related works between Barneys Point Bridge and Murwillumbah in liaison with the Waterways Authority. Such works should include heritage wharfage in Murwillumbah as an upstream target destination for recreational craft, sewage pump outs, minor en-route wharves, sandy beaches and walking trails. (Where possible 100% funding should be sought from the Waterways Authority.) 5. Continue expenditure on data, monitoring and education including positive pursuit of the annual Tweed River Festival concept.		

Plan	Objective	Key actions relevant to management of the Tweed River	Current Status (October 2016)	Potential Considerations for CMP
Upper Tweed Estuary Management Plan (TRMPAC, 1996) Note: supporting studies included detailed volumes on ecology, hydrodynamics and water quality, archaeology, recreation, riparian vegetation corridors and foreshore visual quality.	To provide an integrated program of works that will: • Identify, enhance and protect significant habitat, particularly tidal wetlands and riparian corridors • Protect heritage • Provide recreation facilities, • Encourage boating activities • Increase awareness • Address riverbank erosion • Improve water quality, particularly in Rous • Minimise ASS impacts • Conserve scenic qualities of river	Summary of key actions: 1. Address LEP as required to ensure protection of valuable habitats, incl. Osprey nests and flying fox camps 2. Prioritise revegetation of riparian corridors 3. Support volunteer groups 4. Set up demonstration sites 5. Develop rehab guidelines 6. Support ASS research and mitigation 7. Disseminate knowledge of ASS management 8. Develop catchment based water quality plan 9. Monitor water quality 10. Set and review water quality objectives 11. Develop WQ education program 12. Develop natural resource education centre 13. Construct regional boat ramp at Condong 14. Upgrade facilities at Commercial Road 15. Upgrade Tumbulgum foreshore 16. Construct sandy beaches in river 17. Remove sandbars in Stotts Channel 18. Construct small craft launching facility in Bruce Chick Park 19. Dock facility at Budd Park to support rainforest centre 20. Canoe trail in Rous River 21. Upgrade park facilities, Pat Smith and weir, Bluey Hill, Bullamakanka etc. 22. Prioritise and design structures for bank stabilisation 23. Implement mozzie and midge control 24. Develop a dredge policy	Majority of actions complete. Exceptions include: 13, 16, 17, 18, 20, 21 13. Site not suitable due to bank erosion issues nearby. 16. Sandy beaches not pursued due to mostly private land tenure. Also ongoing works required to maintain sandy beaches in the upper estuary prohibitive. 17. The area was dredged historically but has not been for a while. Some calls from Cane farmers to do this to improve drainage. 18. Not pursued. Work is underway in October 2016 to upgrade facilities at Bruce Chick Conservation Park in line with the management plan adopted by TSC in Sep 2015. An ageing toilet block and shelter is being removed. Two new shelters will be installed later in 2016 with interpretive signage and serve as a short-term visitor rest area. Overnight and longer-term camping is being discouraged as it is considered in conflict with the park's environmental values. 20. Not completed to date but Council is currently looking at this option. 21. Not pursued	CMP to consider re-evaluation of sites for upgrade of foreshore at Tumbulgum. Council is currently looking at a potential Canoe trail in the Rous River. Potential for a launching facility at Pat Smith Park. CMP to consider option and work underway.

Plan	Objective	Key actions relevant to management of the Tweed River	Current Status (October 2016)	Potential Considerations for CMP
Recreational Management Plan for the Upper Tweed Estuary (Centre for Coastal Management UNE, 1992)		1. Upgrade facilities at foreshore parks and reserves (e.g. picnic tables, boat ramps, parking lots, upgrade signage, toilets, rubbish bins, bench seating, shade trees, water taps/bubblers, fish cleaning facilities, jetties, pontoons, walking/bike trails, weirs /weir access, flood resistant toilet facilities, demolition of unused facilities, vegetation, playgrounds, stairs/ramps, roads) 2. Restrict and police boating speed (particularly the narrow stretch of river adjacent to the Condong Sugar Mill) 3. Cease continued erosion of the foreshore adjacent to the Tumbulgum Bridge. 4. Mechanical methods of weed eradication along riverbanks be implemented by Tweed Shire Council 5. Dredging of entrance channel to boat ramp at John Oxley Park 6. Construction and provision of small sandy beaches at the site of the unofficial boat ramp at Condong 7. Construction and provision of small sandy beaches downstream of Tumbulgum Village on Riverside Drive 8. Construction and provision of small sandy beaches on the west bank of Tweed Estuary downstream of Tumbulgum Bridge. 9. Construction of new jetties/pontoons 10. Tumbulgum Village boating speed revised to 8 knots 11. Improved channel marking in Estuary adjacent to Commercial Road boat ramp to identify gravel shoal 12. Increase presence of Maritime Services staff during peak holiday periods. 13. Encourage schools to make more use of the Estuary for educational purposes 14. A database of all foreshore parks, reserves and access points, public boat ramps, jetties, wharves, boat hiring facilities and an up to date list of community recreation clubs and contact persons should be prepared and updated on a regular basis. 15. New brochure and map should be prepared detailing speed limits, restrictions to water skiing and jet skiing, navigation markers and dangerous areas for boating on the Upper Tweed Estuary and tributaries 16. Construction and provision of small sandy beaches immediately downstream of the Commercial Road boat ramp 17. Construction and provision of small sandy beaches at the east bank of the Tweed Estuary in area zoned 3(c) (location of Tweed River Motel, supermarket and liquor shop – Pacific Highway); 18. Construction and provision of small sandy beaches at the existing site of the dredging stockpile and treatment area upstream of the village of Tumbulgum. 19. Investigate declining fish stocks in the upper reaches 20. A brochure outlining the interpretive walking /cycling trails	Tumbulgum jetty upgraded to pontoon. Boating map says 'no wash' zones at Tumbulgum, however, water-skiing is allowed after 8am. "*Note: Bank erosion is a serious problem at Tumbulgum. Do not create wash and keep to speed limits*." 2. According to the most recent TfNSW – Maritime boating map there have been no boating speed restrictions put in place. Unknown whether there has been policing of boat speeding in the Condong area. 3. No-wash zone put in place (TfNSW -Maritime boating map), however, water skiing in the area is allowed after 8am (refer to potential considerations for CMP).	Consider status of actions in the development of the Recreational Use Study are preferred management strategy.

Plan	Objective	Key actions relevant to management of the Tweed River	Current Status (October 2016)	Potential Considerations for CMP
Tweed River Estuary Bank Management Plan (PBP, 1998)	Provide an integrated program of works that will: • Identify current areas of bank erosion and prioritise them in order of severity and impact on the community • Identify the main causes of bank erosion at those sites • Provide solutions to the main bank erosion problems identified on the river	• Recommendations made for stabilisation at all major identified erosion locations, with prioritisation of key sites of public land. • Recommendation for monitoring program at erosion sites • Recommendation on public awareness raising	Works completed at most high priority locations. Information used to guide erosion stabilisation works on private land. Management plan reviewed in 2012 wake and bank stability study, new priorities to be set out in 2012 Riverbank Management Plan	Superseded by 2014 plan
Sustainable Land Management of Coastal Floodplains-Tweed River (Riches and Huegill, 2001)	• Achieve sustainable land management of coastal flood plains through improved flood gate management. • Document status of 250 flood gates in the Tweed • Actively manage /modify 47 high priority flood gates in Tweed	• Recommendations made to address multiple aspects of many floodgates. • Includes template floodgate management plans and agreements between TSC and drainage unions.	• All high priority ASS remediation floodgates modified (28). • 100s of hectares laser levelling and drain infilling • ASS scald remediation • Green banks, Lomandra and trees approx. 30 km.	Audit of floodplain drains as part of CMP studies to assess ASS impacts from major floodplain drains. Based on results of audit, consider further management in consultation with cane industry.
Reducing the Impact of Road Crossings on Aquatic Habitat - Tweed Shire (DPI, 2005a)	• Locate and prioritise road crossings that form barriers to fish passage • Provide remediation recommendations for individual barriers	• Recommendations provided to remove 23 high priority structures	Largely driven by DPI Fisheries. 7 structures removed, ranging from a major project ($100k plus) on Oxley River to smaller projects on Rous, Duroby, Rowlands and some small tributaries. All sites mapped on TSC GIS layer. Projects are generally very expensive and best approached through incorporation into road upgrades or compensatory measures. All upper catchment sites	None in estuary. Fisheries program to put fish gates on floodgates completed (discussed below).
Tweed Estuary Boating Plan 2006-2010 (NSW Maritime, 2006)	• 5 year plan to identify and protect the recreational and environmental values of the Tweed River Estuary, ensure that boating practices maximise user safety • Compliment Estuary Management plan	• Range of actions and restrictions including introduction of minimal wash zones, 4 knot zones and other boating safety educational programs.	• Actions implemented by TfNSW - Maritime. • Superseded by NSW Maritime Infrastructure Plan 2019-2024.	Consider status of actions in the development of the Recreational Use Study are preferred management strategy.
Bring Back the Fish – DPI Fisheries 2006-2009 (DPI, 2009)	• enhance aquatic ecosystems by restoring stream connectivity and rehabilitating key aquatic habitats	• Improve fish passage by modification of floodgates in the Tweed Floodplain	Cooperative project between DPI Fisheries, Drainage Union, Council and landholders. 22 auto-tidal fish gates installed on priority floodgates to allow some tidal exchange and fish passage. Fish gates still operational and seen as a success by all parties.	All priority floodgates have fish gates. Discuss as successful management approach.
Tweed River Estuary Recreational Boating Facilities Study (PBP, 2008)	• identification of current and future infrastructure requirements for recreational boating generated from within the region; • assessment of the potential to develop a marine precinct to foster the growth of marine services in accordance with recognised best practice principles; • identification of the order of costs in implementing individual strategic options; and • identification of staging for individual options. • assessment of river carrying capacity carrying capacity.	• Upgrade, expand and plan for the following to cater to unfulfilled demand for recreational boating facilities: o boat ramps/trailer parking facilities; o wharves/jetties/servicing; and o moorings/marinas/storage.	• Ongoing maintenance and improvement of recreational boating facilities is undertaken by TSC Waterways program with funding from TfNSW - Maritime Boating Now Program. • Pontoon at Chinderah now complete. • Commercial Rd boat ramp (Murwillumbah) has been upgraded. • Council currently has no plans to development any marine/boating precincts, or any new facilities/servicing locations. **The plan has not been formally adopted or funded by TSC*	CMP Recreational Use Strategy to provide current assessment of boating access adequacy

Plan	Objective	Key actions relevant to management of the Tweed River	Current Status (October 2016)	Potential Considerations for CMP
Tweed River Murwillumbah Reach Bank Enhancement Master Plan (TSC, 2008a)	• Guide management and rehabilitation of riverbanks in urban and residential areas of Murwillumbah • Increase profile of the river in the community, by increasing visibility, accessibility and amenity. • Leverage on improvements above to gain environmental and river related social gains in other parts of the catchment	• The master plan makes recommendations based on improving connections between people and river, within three themes: o Visual connections o Green connections o Pedestrian connections	• Budd Park riverbank stabilisation and amenity improvement project is the only initiative from the plan now completed. • Improve riparian veg from YHA to MBah boat ramp has been discussed and has had some interest from the community. • Nothing else being pursued at present. Remaining actions are very costly. Not many actions for foreshore recreation are identified based on the isolation of the river by roads. **The plan has not been formally adopted or funded by TSC*	Consider riparian vegetation improvement from YHA to MBah boat ramp as a potential site for works.
Tweed River Domestic Structures Strategy (DoL *et al*., 2008)	• To provide a consistent and strategic approach for domestic foreshore infrastructure development. • To consolidate and streamline the development assessment process for foreshore infrastructure proposals. • To provide greater security for landholders adjoining the river with an interest in domestic foreshore structures. • To identify: o areas where public facilities may be required; o where shared facilities are more appropriate; o more opportunities for community use of foreshore public lands. • To assist in the removal of unauthorised structures.	This Strategy incorporates waterways, both natural and man-made, within the navigable reaches of the Tweed River and its tributaries. Foreshore infrastructure covered by the strategy includes domestic structures in the waterway below mean high water mark (MHWM) as well as works on the riverbank. The strategy covers private infrastructure such as jetties, pontoons and boat ramps, however, no change is proposed regarding the management of foreshore structures in the existing canal estates where the land tenure is other than Crown land. The strategy does not apply to marina developments or other commercial infrastructure which would be assessed under a separate process.	Council has adopted the Strategy for use in decision making in Council's development assessment and approvals process.	Ensure ongoing implementation of the Strategy as an action in the CMP.
Tweed Riverbank Erosion Management Plan (TSC, 2014)	• Environmental values of the aquatic and riparian environment will be protected and enhanced. • High value public infrastructure and public open space will be protected. • The visual and recreational amenity of the river environment will be protected and enhanced.	Outline strategic approach to riverbank erosion management - prioritising TSC investment and guiding works on private land. Provides preferred design options and a schedule for high priority riverbank stabilisation works focussing on revegetation and bio-engineered designs that maximise ecological and amenity values and structural protection works as necessary including a list of prioritised sites for each of the following 3 categories of works: • Revegetation 15,863m • Pre-emptive bioengineered stabilisation works 4,668m. • Structural protection - up to 5,754m	High priority works between Stotts Island and M'Bah underway, some completed. Done as funding is available through roads dept. • Need to ensure that impacts of works are mitigated. • Sites where revegetation should occur. • Browns Lane Murwillumbah – rock lined with reef balls and large woody debris OEH funded trial. • Chinderah Many projects happening. Mbah boat ramps, geotextile bags at Condong.	CMP to review Erosion Plan and update if necessary. Look at funding the program. CMP to include action to fund works. Emphasis on pre-emptive work required in places.

Plan	Objective	Key actions relevant to management of the Tweed River	Current Status (October 2016)	Potential Considerations for CMP
Regional Boating Plan Tweed – Clarence Valley Region (Transport for NSW, 2015)	• The plan examines physical characteristics of the waterways, water users, safety issues, waterway access and vessel storage across the waterways and recommends improvement projects.	• Identified 6 priority regional infrastructure projects within the study areas supported by funding from the *NSW Boating Now* program: o Condong Boat ramp improvements and toilet facilities, Clarrie Purnell Park; o Relocate and upgrade pontoon at Budd Park, Murwillumbah; o Car park and riverbank stability improvements at Murwillumbah boat ramp (Commercial Road); o Replace pontoon and provide disabled access at Fingal boat harbour (Lighthouse Parade); o Boat ramp improvements at Oxley Park, Chinderah; and o Replace timber jetty with pontoon at Tumbulgum. • A range of safety, access and storage actions to be implemented by TfNSW – Maritime.	• All projects underway or being planned by Council. Most will be complete in 2017. • Maintenance dredging of silt from the Chinderah Boat Ramp (i.e. facilities management dredging) is planned. o Tumbulgum jetty upgraded to pontoon. • Superseded by NSW Maritime Infrastructure Plan 2019-2024.	Document work underway Discuss with TfNSW – Maritime: boating and bank erosion management work underway in NSW.
Cobaki and Terranora Broadwater Catchment Management Plan (IWC, 2010)	• Improve water quality and ecosystem health. • Improve rural stormwater discharge quality. • Improve urban stormwater discharge quality. • Restore riparian habitat. • Protect and enhance shorebird habitat. • Increase and enhance public access. • Protect commercial and recreation fishing. • Stabilise degraded creek banks. • Increase awareness and protection of Aboriginal cultural heritage	There are a large number of actions within 11 different strategic areas. Priority works include rural riparian restoration, bird habitat enhancement and improving stormwater quality discharge from the western drainage scheme.	All priority actions have been commenced and are at varying stages of implementation. Many actions, for example riparian zone restoration, will be ongoing.	Outside the study area. CMP to refer to the Plan for relevant information as needed.
Tweed Urban Stormwater Quality Management Plan (AWC and Design Flow, 2016)	Confirm council's stormwater management objectives Provide ambient and stormwater quality management objectives. Provide specific guidance for monitoring and management of stormwater quality improvement devices.	• Provides policy guidance for consideration in assessment of new developments and in council accepting stormwater management assets for maintenance. • Establish stormwater group (TSC internal) to meet regularly and coordinate approach • Build skills in assessment and management of built assets. • Monitor performance of existing SQIDS. • Develop budget estimates to deliver SQID maintenance programs	• Adopted by TSC 2016 • Stormwater group not established to date. • Council is conducting condition assessment of existing assets. This work is ongoing.	CMP to consider funding of upgrades to existing stormwater assets where auditing shows need for improvements to improve river health.
Tweed Valley Floodplain Risk Management Study (BMT WBM, 2014b)	Directed towards providing solutions to existing flooding problems in developed areas and ensuring that new development is compatible with the flood hazard and does not create additional flooding problems in other areas.	• Studies and investigations including local drainage studies (Murwillumbah, Lower Tweed), levee investigations (Murwillumbah, Tweed Heads), evacuation planning study. • Flood warning and evacuation planning and management; • Community engagement and education; and • Climate change planning, development controls and strategic planning recommendations.	• Actions are being implemented by Council and are ongoing	CMP to consider flood risk mapping and implications for the estuary in Coastal Hazards Assessment as part of detailed studies

Plan	Objective	Key actions relevant to management of the Tweed River	Current Status (October 2016)	Potential Considerations for CMP
Tweed Coast Regional Crown Reserve Plan of Management (Land and Property Management Authority, 2005)	Consolidates information about the reserve, its values, current and proposed future use and management issues. The vision for the plan is "Publicly accessible Crown land with enhanced and sustainable environmental, social, cultural and economic values for the benefit of the community". Objectives include: • identify and enable multiple purpose and sustainable land and waterway use. • preserve significant visual amenity. • improve social and recreational opportunities. • enhance and encourage public use and access.	22 mostly high-level strategies. No implementation costs or timeframes given. Most sites outside the study area.	• Jack Evans Boat Harbour site improvement works completed by TSC.	CMP to liaise with Lands to determine status of: • redevelopment & upgrade of Southern Boat Harbour, Boyds Bay Marina. • Site improvement plans at Old Fingal Boat Harbour
Review of Water Quality in the Tweed Estuary 2007-2012 (ABER, 2012)	Analysis of temporal and spatial trends in water quality, identifies likely controlling processes and discusses. ecological implications and management actions	• Reduce catchment fine grained TSS exports during median and high flows. • Reduce phytoplankton blooms during low to median flows through STP management. • Reduce DIN in STP effluent • STP Discharge during median to high flow • Reuse during low flow • Reduce N and P in tandem to achieve effluent ratio of 16:1. • Reinstate backswamp flood reserves. • Introduce wet pasture management. • Reduce ponding in cane land	• Sustainable agriculture strategy implementation ongoing including measures for soil conservation and erosion management. • Laser levelling of cane land mostly complete for ponded sites. • WWTP upgrades undertaken at Banora Point and MBah.	• Water Quality review as part of CMP to assess current WQ status. • CMP to evaluate effluent impacts from WWTPs. • CMP to consider opportunities for potential floodplain connectivity/changes in land use/management.
A Spatially Intensive Approach to Water Quality Monitoring in the Rous River Catchment (Eyre and Pepperell, 1997)	Investigate the relative magnitude of sources of sediment and nutrients on WQ in whole of catchment, including fresh reaches.	• Control N from point sources at Mbah STP, dairy and stables. • Control diffuse runoff from cane, banana and grazing land.	• Mbah STP was upgraded in 2007 to tertiary treatment facility with reuse of wastewater at Condong Sugar Mill. • No action on diary to date (though Council did investigate and attempt discussion with landholders). • Extensive work with Cane Industry to improve environmental outcomes. • Ongoing effort to engage riparian landowners and fence cattle out of creeks.	• CMP Water Quality review to assess any current evidence of Mbah WWTP and dairy impacts. • Consider re-evaluating potential management actions at dairy • Continue work with Cane Industry to further riparian restoration work and commitment.
Tweed Vegetation Management Strategy (Ecograph, 2004)	Aims to provide a coordinated approach to the management of vegetation in the Tweed Shire.	1) the recovery existing bushland areas; 2) restoration of previously cleared areas; 3) Threatened species recovery, 4) management of threatening processes and 5) education, monitoring, planning and research.	The strategy informed zoning of LEP	High level doc. No actions relevant to CMP
Tweed Sustainable Agriculture Strategy (TSC, 2016)	Provides a strategic direction for sustainable agriculture in the Shire	27 actions relating to sustainable land management, monitoring, education, promotion of best practice etc.	Ongoing implementation.	CMP to support relevant actions including potential for funding of actions where benefits for the estuary can be realised
Tweed Scenic Landscape Strategy (under development)	Assess scenic quality and management options for the Tweed.	Actions not complete, but likely to be overlap with Tweed River sites	Under development, expected completed end of 2017	CMP process to work alongside Scenic Strategy and data share results.

Table 16: Summary of status of management actions from the 1991 Lower Tweed River Estuary Management Plan

1991 Lower River EMP Actions	Actions undertaken and status (October 2016)	Potential Considerations for CMP
High Priority Actions-1 (as assessed by 1997 review)		
Fish Habitat Action (i) Construct wetlands on Letitia Spit and retain these new areas as Aquatic Reserves.	• Regeneration of coastal wetlands on Fingal Peninsula • 1997 Review noted the aboriginal community were keen to ban commercial fishing in all enclosed waters of Fingal peninsula. The Recreational Fishing Haven now covers these areas meaning no commercial fishing is now permitted in these areas. Netting is also prohibited in Wommin Lake and Wommin Lagoon. • Sponsors Lagoon saltmarsh revegetation works ten years ago successful • Attempt to control vehicle access at Kerosene Inlet was not successful	• Defer to TBLALC for status/management of issues.
Fish Habitat Action (iv) Monitor seagrass and mangrove distributions in the Lower Estuary.	• Russell (2005) analysed estuarine habitat mapping data from estuaries across the northern rivers including the Tweed River estuary. Estuarine vegetation (mangroves, seagrass, saltmarsh) was mapped using aerial photographs from the 1940s to 2000. • Hossain (2005) assessed changes in seagrass distribution based on aerial photography within the lower Tweed River estuary including Terranora Inlet from 1997-2001. • DPI Fisheries conducted estuarine vegetation mapping in the Tweed River in 2006 as part of a state-wide mapping project • Baseline ecological assessment at Kerosene Inlet (Australian Wetlands, 2010) including seagrass mapping and assessment. • Pacific Wetlands (2012) examined changes in estuarine vegetation (mangroves, seagrass and saltmarsh) within Terranora Inlet and small area of the lower Tweed River estuary between 2000 and 2012. • Australian Wetlands (2008) completed mapping and health assessment of seagrass at Chinderah Pontoon.	• Estuarine vegetation distribution to be considered by CMP including potential impacts due to sea level rise.
Ecological Action (xii) Oversight a monitoring program formulated to detect and report on ecosystem vitality.	• There have been a number of ecosystem health assessments throughout the Tweed River including: Ecosystem Health Monitoring Program Scoping Study and implementation in the Cobaki Terranora Broadwaters; ongoing water quality sampling and analysis; targeted (short-term) water quality investigations (e.g. Rous River assessment Eyre, 1997); shorebird monitoring; baseline ecological assessment at Kerosene Inlet (Australian Wetlands, 2010); Ecosystem health assessment (Uni of Qld, 2003)	• CMP Detailed studies include ecological assessment to be conducted as part of the CMP
Discharge Action (ii) Invite interested organisations to comment on water quality targets suggested.	• Consultation with relevant stakeholders undertaken and Tweed River water quality objectives adopted by TSC in 2000, see WBM (2000).	• Water Quality Assessment to consider Tweed WQ objectives
Discharge Action (iii) Continue water quality monitoring with a view to identifying any potentially damaging constituents as well as constituents for which opportunities for removal are available and practical.	• Routine water quality monitoring is undertaken in the Tweed Estuary. • Results are analysed and reported and management recommendations provided. Most recent report was ABER (2012). • Management actions e.g. catchment management, WWTP upgrades etc. are undertaken as part of Council operations and other stakeholder actions.	• Detailed studies as part of the CMP to include a Water Quality Assessment since 2007 and development of a Water Quality Improvement Plan
Discharge Action (v) Produce public education material to alert the public to the problems caused by providing nutrients to stormwater and the problems arising from the use of fertilisers, carwash soaps, animal excreta, grass clippings, paints, oils and chemicals.	• Stormwater Pollution Guide (NSW DEC, 2000) available on Council website. • Tweed Urban Stormwater Quality Management Plan (TSC, 2016). • Council has an Environmental Education Program and a dedicated Environmental Education Officer and ongoing initiatives.	• Opportunity for further public education as part of CMP
Implementation Action (i) Disseminate results of river monitoring to the broader community.	• Results are analysed and reported and management recommendations provide. Most recent report was ABER (2012) available on Council website along with other water quality reporting. All licensed discharges under the *Protection of the Environment Act 1997* are required to publish pollution monitoring data from March 2012 onwards. TSC publishes all their data on the Council website.	• Detailed studies as part of the CMP to include a Water Quality Assessment since 2007 and development of a Water Quality Improvement Plan • Potential for annual report on water quality
Implementation Action (iii) Ensure all new stormwater systems connected to the river incorporate trash racks and siltation pits/ponds.	• Tweed Urban Stormwater Quality Management Plan (TSC, 2016) and TSC's Development Design Specification D7 – Stormwater Quality provide guidance on required stormwater treatment devices. The design of stormwater systems has evolved since the 1991 EMP and there are other options for stormwater management than just trash racks and siltation ponds. • TSC auditing of existing stormwater improvement devices is underway. • 2000 stormwater plan had huge list of actions and some delivered.	• CMP to discuss current stormwater management and identify issues/gaps. • CMP to consider funding of upgrades to existing stormwater assets where auditing shows need for improvements to improve river health.

1991 Lower River EMP Actions	Actions undertaken and status (October 2016)	Potential Considerations for CMP
Implementation Action (iv) Monitor water quality within specific areas against agreed area targets and report annually on departures.	• Routine water quality monitoring is undertaken in the Tweed Estuary. • Reporting is completed on longer time scales than annual.	• Detailed studies as part of the CMP to include a Water Quality Assessment. Reporting timeframes to be reviewed as part of assessment.
Implementation Action (v) Establish a centralised system for recording and analysing water quality within the Tweed River.	• Tweed Laboratory Centre conducts water quality sampling and recording on behalf of Council. Council maintains a central database of water quality results.	none
Implementation Action (xi) Conduct annual reviews of progress and achievements.	• Reviews have been completed on longer time scales than annual. • Review of the EMP were conducted in 1997 and 2001	• This audit provides a review of current status of EMP actions. • CMP to set review timeframes
High Priority Action - 2 (as assessed by 1997 review)		
Fish Habitat Action (ii) Incorporate habitat diversity in the design of the Lower Estuary Dredge Program.	• DPI Lands currently conducts dredging of entrance and lower river as required for maintenance of navigation channels. • All dredging campaigns are required to assess environmental impacts of proposal (including impacts on habitat) under EP&A Act and other relevant legislation (Fisheries Management Act, POEO Act etc.).	• The CMP will document all current dredging activities to ensure that appropriate levels of dredging are recognised in the long-term management of the estuary.
Fish Habitat Action (vi) Construct carefully designed waterway ventilation improvements to Wommin Lake & Wommin Lagoon.	• Pipes were upgraded to culverts in 2008 (Wommin Lagoon) and 2016 (Wommin Lake). Done mainly to shore up structure of road. Careful work undertaken to make sure changes in hydraulics do not impact wetland zonation. Adaptive management with rock work to adjust water level and flow. TSC is aware of shoaling occurring at inlet to lake. • Wommin Lagoon saw some increases in seagrass after works.	• TSC to monitor this with regard to potential impacts
Fish Habitat Action (vii) Produce maps showing changes in distribution of seagrass & mangroves at intervals of 3 years or thereabouts.	See Fish Habitat Action (iv)	• Estuarine vegetation distribution to be considered including potential impacts due to sea level rise
Fish Habitat Action (xiii) Regularly update influent auditing of wastes directed to the Tweed River. Monitor discharges of sewage effluent, industrial wastewater and stormwater to appraise the effect of such discharges on fish production.	• Discharges of sewage effluent and industrial wastewater are licensed by the NSW EPA and monitored according to licence requirements. • Stormwater discharges not monitored at every outlet. • Tweed River Water Quality Monitoring Program assesses overall water quality. • Effect on fish production not assessed	• Detailed studies as part of the CMP to include a Water Quality Assessment
Ecological Action (ii) Ascertain which types of river habitat are in need of extension in association with proposed future river dredging works.	• All dredging campaigns are required to assess environmental impacts of proposal (including impacts on habitat) under EP&A Act and other relevant legislation (Fisheries Management Act, POEO Act etc.). This may include provision for compensatory habitat if impacts occur.	• The CMP will document all current dredging activities to ensure that appropriate levels of dredging are recognised in the long-term management of the estuary.
Ecological Action (iii) Identify opportunities for general habitat improvements within the estuary and foreshore areas.	• A number of habitat improvement works have been undertaken. • Fish Unlimited was an on-ground project repairing mangrove and saltmarsh in Sponsors Lagoon, a collaboration between TSC, Fisheries, Wetland Care Australia and TBLALC	• Opportunity for further work as part of CMP
Ecological Action (iv) Identify measures to improve habitat security for the Little Tern, Osprey, Brahminy Kite and other endangered birds.	• Permanent Osprey nesting poles provided in the lower estuary. 21 artificial nest structures in Tweed Estuary. Was cooperatively managed by NPWS and Essential Energy and Council. Council is now taking over responsibility. • Tweed Osprey Monitoring Group – keeping records on this. • Most shorebird habitat conditions met. The key factor at risk is spring tide roost sites, especially considering sea level rise impacts. • TSC proposed to do clearing of Mangroves on Tonys Bar and Kerosene Inlet where they are taking over important roost areas. Application made to Fisheries was not supported.	• Action in CMP to manage Osprey Poles. • Action in CMP to review roost requirements Tonys Bar/Kerosene Inlet and consider re-application to clear mangroves.
Ecological Action (vii) Investigate options to provide/extend formal security over important habitat areas whether through zoning, fencing or statutory controls.	• SEPP14 and SEPP26 mapped areas in lower estuary, Estuarine habitat (mangrove, seagrass, saltmarsh) protected under the Fisheries Management Act. National Parks and Nature Reserves in the study area include Ukerebagh Nature Reserve and Historical Site, Stotts Island Nature Reserve, Environmental Protection Zoning under Tweed LEP 2000 for much of the Fingal Peninsula including enclosed waters of the (Kerosene Inlet, Wommin Lake and Lagoon, Sponsors Lagoon); Ukerebagh Passage etc.	• CMP to assess level of protection of existing habitat areas and identify areas for improvement.

1991 Lower River EMP Actions	Actions undertaken and status (October 2016)	Potential Considerations for CMP
Ecological Action (ix) Formulate a future works program that identifies site specific habitat creation and habitat enhancement possibilities.	• Riparian zone management undertaken where landholder willingness	• CMP to include habitat creation aims with actions such as bank erosion management, riparian reveg works etc.
Ecological Action (x) Produce information sheets highlighting the importance of foreshore and river habitats.	• Community consultation materials produced as part of the EMP. • Since then, TSC and other agencies have produced a number of materials providing this information e.g. estuarine habitat brochures, fisheries resources etc.	• Opportunity for further education as part of CMP
Recreational Action (i) Produce a Waterway Recreation Strategy.	• Recreation Management Plan for the Upper Tweed Estuary (UNE, 1992) • Tweed River Estuary Recreational Boating Facilities Study (Patterson Britton & Partners, 2008) • Tweed Estuary Boating Plan (NSW Maritime, 2006) • Regional Boating Plan Tweed – Clarence Valley Region (Transport for NSW Maritime Management Centre, 2014) – this covers boating safety, access and infrastructure actions but does not address bank erosion issues or other types of recreational use. • NSW Maritime Infrastructure Plan 2019-2024 (TfNSW – Maritime, 2018).	• Recreational Use Strategy to be developed as part of this CMP. • Check status of planning for boating.
Recreational Action (iv) Assess whether any existing important habitat is under threat from existing recreational activity.	• Bank erosion assessed. • DPI Fisheries estuarine habitat assessments and mapping	• Seagrass assessment to be conducted as part of this CMP. • Recreational Use Strategy to be developed as part of this CMP
Discharge Action (i) Prepare annual reviews providing details of all authorised discharges and any significant unauthorised discharges that reach the Tweed River.	• Discharges of sewage effluent and industrial wastewater are licensed by the NSW EPA and monitored according to licence requirements. • Stormwater discharges not monitored at every outlet. • Tweed River Water Quality Monitoring Program assesses overall water quality	• Detailed studies as part of the CMP to include a Water Quality Assessment since 2007 and development of a Water Quality Improvement Plan
Discharge Action (iv) Examine all stormwater networks with a view to installing sediment trapping devices and, where nutrient infeed is known to be a problem, consider denitrification measures such as wetlands.	• Tweed Urban Stormwater Quality Management Plan (TSC, 2016) and TSC's Development Design Specification D7 – Stormwater Quality provide guidance on required stormwater treatment devices. • TSC auditing of existing stormwater improvement devices is underway.	• CMP to discuss current stormwater management and identify issues/gaps. • CMP to consider funding of upgrades to existing stormwater assets where auditing shows need for improvements to improve river health.
Discharge Action (vi) Encourage operators of licenced discharges to comply with licence conditions.	• Discharges of sewage effluent and industrial wastewater are licensed by the NSW EPA and monitored according to licence requirements. Upgrades of WWTPs have occurred to improve treatment performance and increase capacity	• CMP to discuss existing compliance and enforcement, any outstanding issues and areas for improvement.
Discharge Action (vii) Disseminate knowledge regarding development problems that can arise in areas of acid sulphate soils	• Over the last 20 years there has been a large effort in the field of Acid Sulphate Soil research and education. Tweed Council have worked collaborated with state agencies, key industries, landholders and the broader community to better manage ASS on the Tweed floodplain. All ASS are mapped and incorporated into planning and development processes.	• Further work to be conducted as part of the CMP: • Audit of floodplain drains and assessment of floodplain connectivity
Implementation Action (ii) Ensure all future discharges to the Tweed River are sited with reference to likely ecological and water quality impacts.	• Planning provisions incorporate requirements for environmental impact assessment for any new development/activities.	• Managed by existing DA process
Implementation Action (vii) Produce publicity brochures detailing the need for community and individual co-operation in sustaining the vitality of the Tweed River.	• Various public education campaigns have been undertaken by Council and other agencies and are ongoing • General community awareness of environmental issues has increases in the last 20 years	• Opportunity for further public education as part of this CMP and continuing
Implementation Action (viii) Produce project material for Tweed Shire Schools (and further afield) to promote understanding in the community as to the fragility of river ecosystems.	• Council has an Environmental Education Program covers topics relating to sustainability, waste, water and biodiversity. It links to the current NSW primary school curriculum and can also be adapted to High School. Council has a dedicated Environmental Education Officer.	• Opportunity to incorporate CMP findings into education program

1991 Lower River EMP Actions	Actions undertaken and status (October 2016)	Potential Considerations for CMP
Implementation Action (x) The Lead Agency, when identified, to develop a strategy to review the changing priority of river problems.	• Reviews completed in 1997 and 2001 involved assessment of changing priorities	• This CMP will prioritise actions for implementation
Maintenance and Improvement Action (i) Prepare and execute a program of high priority works.	• A detailed program of works, timing, costs and priority was not completed	• This CMP will document a detailed implementation program including priority, timing, responsibility, cost.
Maintenance and Improvement Action (ii) Prepare and oversight the execution of a long-term works program of river improvements	• As above	• As above
Maintenance and Improvement Action (iv) Liaise with river Committees and the community generally concerning proposed lower estuary improvement work.	• The Tweed River Committee meets regularly to discuss river management	• TCWC overseeing this CMP
Maintenance and Improvement Action (v) Maintain full and open liaison with all community sectors interested or concerned with proposed river improvements.	• Council has consulted with the community, interested groups and key government agencies through the TRC and community consultation activities	• Community and stakeholder engagement undertaken throughout the CMP
Medium Priority Action - 3 (as assessed by 1997 review)		
Fish Habitat Action (iii) Monitor changes in water level throughout the Lower Estuary including Cobaki and Terranora Broadwaters.	• Tide gauges installed throughout lower estuary. • Water levels monitored closely by Tweed River Sand Bypass Project	• none
Fish Habitat Action (v) Examine the merit of closing Sponsors Lagoon to professional fishing.	• Now closed to commercial fishing and forms part of the recreation fishing haven	• none
Fish Habitat Action (xi) Monitor changes in average water levels within the estuary with emphasis given to linking detected changes with causes.	• Tide gauges installed throughout lower estuary. • Water levels monitored closely by Tweed River Sand Bypass Project • Sea Level Rise is now accepted as occurring and TSC has adopted benchmarks for sea level rise.	• CMP to consider climate change impacts including sea level rise on estuarine vegetation communities.
Ecological Action (i) Conduct ecological assessments of the relative importance of any major near-river undeveloped lands not considered in studies to date	• All future development areas in the study area have been developed	• CMP will look at future development impacts
Ecological Action (vi) Compile a strategy for linking dependant habitats.	• NPWS Key Habitats and Corridor Mapping Project • Filling the Biodiversity Gaps Connecting Tweed Coast to Border Ranges (project partners are Tweed Shire Council, North Coast Local Land Services and the Office of Environment and Heritage).	• Managed by NPWS
Ecological Action (viii) Seek to ensure all development proposals are assessed with reference to the need for habitat preservation	• Development applications must comply with ecological requirements under the LEP and other relevant legislation e.g. Fisheries Management Act, EPA Act, EPBC Act etc.	• Managed by existing DA process
Visual Amenity Action (iii) Ensure visual impacts of riverside development proposals are fully assessed as development applications are formalised.	• Development applications must comply with visual amenity requirements	• Managed by existing DA process
Visual Amenity Action (v) Identify major sites of negative visual impact and where practical recommend options to improve the viewscape.	• Current work ongoing on landscape character by TSC.	• CMP to Support study and recommendations. • Consider in bank stabilisation works.
Recreational Action (ii) Seek to encourage recreation in 'preferred zones' to minimise disruption to other river systems.	• No recreational ‘zones’ have been established to date on the river. • Would happen with review of boating plan. Suggest passive recreation zone around Stotts Island? • Submission to TfNSW - Maritime for consideration in review of the boating plan regarding preferred recreational “Character Zones” to minimise recreational use conflict.	• CMP Recreational Strategy to consider potential for zones
Recreational Action (iii) Monitor implementation of the Waterway Recreation Strategy for compatibility with existing ecosystems.	• Waterway Recreation Strategy (1992) out of date	• Recreational Use Strategy to be developed as part of this CMP
Recreational Action (vii) Confirm the need for further land areas for waterfront recreation and establish a priority list for possible future acquisitions.	• Sandy beaches limited in lower estuary. Some calls for beach creation from the public.	• Recreational Use Strategy to consider areas for acquisition and use for foreshore recreation area.
Navigation Action (i) Prepare a works program to extend and improve navigable waterways in the Tweed Estuary identifying needs, priorities and castings.	• Dredging undertaken in lower estuary. Kingscliff Beach and Fingal Head beach nourishment.	• Lower estuary dredging programs

1991 Lower River EMP Actions	Actions undertaken and status (October 2016)	Potential Considerations for CMP
Navigation Action (ii) Prepare a map for public use describing the location of existing and proposed navigation waterways.	• Not completed	• Recreational Use Strategy to consider public use and access
Navigation Action (iii) Confer with existing River Committees to ensure changes in navigation needs are identified and accommodated where feasible in updates to the RMP.	• Not completed	• Recreational Use Strategy to consider public use and access
Heritage Action (ii) Take expert advice as to how to risk least damage to unrecorded sites during development works.	• Tweed Shire and NPWS AHIMS mapping of sites is required to be considered in any development proposal. Recent mapping effort have created a comprehensive database of sites.	• Managed by existing DA process
Implementation Action (vi) Examine the practicality of organising a network of voluntary water quality analysts to collect data on turbidity, pH, BOD and other quality indicators.	• Not completed • TSC Water Quality Monitoring is ongoing	• none
Implementation Action (xii) Organise a fully independent assessment of river condition on a three-year basis. The assessment to examine achievements won and reference progress being made in other river systems where alternative management systems operate.	• Water quality assessment is ongoing. Other ecological assessment at specific sites is undertaken.	• Detailed studies as part of the CMP to include a Water Quality Assessment. Reporting timeframes to be reviewed as part of assessment.
Area 1: Jack Evans Boat Harbour • Continue to monitor water quality and sediments to detect the presence of contaminants. • Search for opportunities to control stormwater related problems.	• TSC's ongoing water quality monitoring program includes a site in Jack Evans Boat Harbour • Major foreshore improvement and recreational amenity works completed 2011 incorporating extensive stormwater control and treatment works to ensure removal of pollutants prior to river discharge.	Detailed studies as part of the CMP to include a Water Quality Assessment
Area 2 Kerosene Inlet Wetland Area • Partition endangered bird roost areas • Continue ecological monitoring program. • Develop a traffic management plan. • Seek to rehabilitate natural vegetation systems in the areas surrounding Kerosene Inlet.	• TSC proposed to do clearing of Mangroves at Kerosene Inlet where they are taking over important roost areas. Application made to Fisheries was not supported. • Baseline ecological assessment at Kerosene Inlet (Australian Wetlands, 2010). Follow up survey done by TSC. • 4wds still a problem. Australian Wetlands (2010) mention unauthorised access by 4wd as a 'pressure' on the system, particularly at northern end. • Compensatory works for highway, increase flushing by lowering rock wall. Algae on seagrass.	Action in CMP to review roost requirements Tonys Bar/Kerosene Inlet and consider re-application to clear mangroves. TBLALC manages this area
Area 3 Sponsors Reach • Develop management plan to control vehicular traffic. • Continue ecological monitoring program in Sponsors Lagoon. • Integrate immediate improvement proposals into a larger term rolling program for water related recreation and habitat improvements.	• Vehicles managed successfully. Action Completed. • Management Plan developed • New boat ramp constructed at Fingal Head. • Parkland near old boat harbour including children's playground recently completed.	Considered self-sustaining
Area 4: Wommin Reach • Prepare designs for new aquatic/wetland centre areas between Wommin Lake and Wommin Lagoon. • Prepare designs for improved ventilation of Wommin Lake and Wommin Lagoon. • Integrate immediate improvement proposals into a longer-term rolling program for water related recreation and habitat improvements. • Examine options for routing urban stormwater away from Wommin Lagoon or seek methods to remove nutrients from the stormwater. • Examine the need for a higher standard of protection over wetland/aquatic areas.	• Wetland centre not pursued. • Stormwater not considered a current issue. • Recent drain/culverts installed 2008/2016	• TSC is aware of shoaling occurring at inlet to lake and there is a need to monitor this with regard to potential impacts
Area 5: Tonys Island Reach • Finalise designs for shoal removal and mitigation of midge problem at Tonys Bar. • Create additional secure bird habitat on Tonys Bar for the Little Tern and other vulnerable birds. • Seek high level of protection for vulnerable bird habitats. • Monitor benefits arising from bird and fish habitat enhancement works.	• TSC proposed to do clearing of Mangroves at Tonys Island where they are taking over important roost areas. Application made to Fisheries was not supported.	• Action in CMP to review roost requirements Tonys Bar/Kerosene Inlet and consider re-application to clear mangroves.

1991 Lower River EMP Actions	Actions undertaken and status (October 2016)	Potential Considerations for CMP
Area 6: Rocky Point Reach • Closely monitor the impacts of any maintenance dredging and other enhancement works. • Seek a high level of protection for bird habitats	• Bird habitats not considered at risk in this section.	• none
Area 7: Ukerebagh Passage – • To prevent access by feral and domestic dogs, reduce the trafficability of the existing causeway remnants at the eastern end of Ukerebagh Passage. • Install trash racks on all stormwater discharges into Ukerebagh Passage. • Establish a program to monitor key ecological indicators and a program to quantify and describe influent pollutants discharging into the waterway. • Examine the need for a plan of minor selective maintenance dredging to revitalise inlet channels shoaled by urban sedimentation and to maintain the passage of a protective buffer for the island.	• Ukerebagh Island Plan of Management (NPWS, 1999) lists elimination of pest species as a priority. The Plan discusses that fencing to restrict feral animals is not practical but limiting access points and installing signage and through public education which explains the reasons for excluding domestic animals is recommended. • TSC's ongoing water quality monitoring program includes a site in Ukerebagh Passage. • No dredging works in Ukerebagh Passage have been undertaken and are not supported by NPWS unless impacts of estuarine fauna and birds are adequately assessed and found to have minimal impact.	• Discuss environmental values, issues as raised through consultation
Area 8: Terranora Inlet • Allocate a high ranking for ongoing maintenance of Terranora Inlet waterways within any proposed program of river improvement works. • Undertake regular monitoring of navigable depths in Terranora Inlet.	• Terranora Inlet has been dredged a number of times to maintain the navigational channel at suitable and safe depths. The most recent dredging campaign was undertaken by Department of Industry - Crown Lands (now DPE – Crown Lands) in 2015. • Hydrographic survey is undertaken routinely as part of OEH monitoring and for specific dredging campaigns.	• Discuss dredging campaigns
Area 9: Boyds Bay • Identify all stormwater inflows to the area and design suitable treatment measures (e.g. GPT) • Determine a suitable site to establish a future sullage pump out facility. Changed to educate and encourage use of sullage pump out facility and increase regulation • Maintain acceptable water quality in authorised discharges. • Investigate methods of improving the quality of stormwater discharges.	• Stormwater issues in Tweed marina. Stormwater drains • Sewage Pump out facility located at the Tweed Heads Marina, owned and maintained by TSC. • The entire Tweed Estuary is a no discharge zone for both treated and untreated sewage from vessels (NSW Maritime, 2010).	• Consider options in CMP for stormwater improvements. Cross-ref with Council staff undertaken audits of existing stormwater assets
Area 11: Entrance Reach • Recognise the necessity for a long-term commitment to navigability.	• Since 2001, the Tweed River entrance has been actively managed by the NSW and QLD governments to maintain a safe entrance.	• none

APPENDIX C. RISK ASSESSMENT

This Appendix provides detailed information on the risk assessment methodology and findings.

Strategic priorities

The risk is a function of the 'likelihood' (i.e. rare to almost certain) and 'consequence' (i.e. insignificant to catastrophic) of a threat actually being realised under existing management conditions. The definitions of 'likelihood' (i.e. rare to almost certain) and 'consequence' (i.e. insignificant to catastrophic), adapted for the CMP timeframe and study area and the framework for the risk assessment matrix, are provided in Table 16 and Table 17 respectively.

In accordance with the *Coastal Management Manual* (OEH, 2018) the risk assessment evaluates the current day risk and also considers how the risk level likely to change in the future (i.e. over 20, 50 and 100 years). This includes assessment of it how factors such as climate change, increasing development pressures and population increase will impact these risks. Where available, future risk levels have been assigned based on the projected data for these risks. In other cases, a qualitative assessment has been undertaken considering the expected future changes.

Table 17: Definition of likelihood and consequence

Likelihood	
Rare	Not expected to impact on the value within the next 20 years. Management actions for any possible future threats not likely to require implementation within a 20-year timeframe
Unlikely	Not expected to impact on the value within the next ten-years but expected within 20 years. Alternatively, management actions to be implemented within this timeframe if impacts are expected to worsen (e.g. as a result of climate change and sea level rise)
Possible	Not expected to impact on the value every year but expected within ten-years. Alternatively, management actions to be implemented within this timeframe if impacts are expected to worsen (e.g. as a result of climate change and sea level rise)
Likely	Not expected to impact on the value continuously but expected every year. Alternatively, management actions to be implemented within this timeframe if impacts are expected to worsen (e.g. as a result of climate change and sea level rise)
Almost certain	Expected to impact on the value frequently or continuously
Consequence	
Insignificant	No impact or only to the extent that it has no discernible effect on the value
Minor	Small or temporary impact on the overall condition of the value
Moderate	Significant effect on the value at an estuary-wide level. Recovery period of 2-3 years likely
Major	Value is substantially impacted at a wider level with an extended recovery period (5-ten-years) likely
Catastrophic	Value is impacted permanently and irreversibly

Source: Adapted from Marine Estate Management Authority (2015)

Table 18: Risk assessment matrix

Likelihood	**Level of Risk**				
Almost certain	Minimal	Low	Moderate	High	High
Likely	Minimal	Low	Moderate	High	High
Possible	Minimal	Minimal	Low	Moderate	High
Unlikely	Minimal	Minimal	Minimal	Low	Moderate
Rare	Minimal	Minimal	Minimal	Low	Low
Consequence level	**Insignificant**	**Minor**	**Moderate**	**Major**	**Catastrophic**

The colour-coded threat consequence and risk assessment matrix specific to the Tweed River estuary is provided in Table 18 and shows the risk each threat poses to the values, with an overall current day risk from each threat and the likely projected risk level in the future (i.e. at 20, 50 and 100 years).

The following method, as recommended by MEMA (2015) was used in determining the overall current day risk from each threat:

- All values were considered to be equal for purposes of the risk assessment;
- If a threat posed a high risk to even one value, the threat was rated overall as a **high risk**;
- If a threat posed a moderate risk to at least two values, but it was not a high risk to any values, it was rated as a **moderate risk overall**;
- If a threat posed a low or moderate risk to at least two benefits and was not considered to be a high risk to any benefit, or moderate risk to more than one benefit, it was rated as a **low overall risk**; and
- A threat that was no more than a low risk to one benefit was rated as a minimal overall threat.

In addition, the following weighted method was applied in deriving the relative risk from each threat, relative to each other threat assessed:

- All values were considered to be equal for purposes of the risk assessment;
- Risk levels were assigned a score, i.e. Minimal = 1; Low = 2; Moderate = 3; and High = 4;
- The sum of scores for each threat were calculated; and
- The spread of the “sum of scores” (0 to max) for all threats was assessed and the range of values divided equally into four overall relative risk levels, i.e. Minimal, Low, Moderate and High.

The above weighted method was also used to determine the risk to each estuary value relative to each other value assessed and was used to understand threat to values from cumulative risks.

Caveats

Consideration of impacts to Aboriginal Cultural Heritage and Practice use a different method of evaluation, taking into account the Aboriginal community’s "whole of landscape” interpretation of impacts which may otherwise be seen as an individual or small-scale threat and considers impacts to both tangible and intangible (e.g. sense of place) values. Therefore, a moderate to high impact from one threat may result in a moderate to high impact on the whole of the value.

Any deficiencies in existing management conditions have not been considered “threats” for the purpose of the risk assessment but are discussed in consideration of threats (Hydrosphere Consulting, 2021 and summarised in Section 2.2) and prioritisation of management actions (Section 3.2).

Whilst key locally specific coastal management values as determined in Section 1.7 are considered in the risk assessment, the values “Coastal risk and adaption to climate change” and “Education, engagement and public opinion” are considered over-riding principles in the consideration of each threat and have not been assessed individually in the risk assessment and threat prioritisation matrix (Table 18).

Table 19: Risk assessment – Tweed River estuary threats and values

Threats	Primary causes	Coastal Management Areas affected	Threatened Social and Recreational Values				Threatened Environmental Values			Threatened Commercial Values		Overall Current Risk	Overall current risk relative to other key threats	20 yr Risk	50 yr Risk	100 yr Risk
			Public access to and use of the river and foreshore	Recreational fishing	Scenic quality and amenity	Aboriginal cultural heritage and practice	Natural habitats and biodiversity	Stable riverbanks	Water quality	Economic prosperity	Agricultural productivity					
Bank erosion	- Degraded riparian vegetation (clearing, exotic species) - Exacerbated flooding (upstream catchment clearing) - Boat wake - Land clearing - Agricultural practices (unfenced stock access and cropping to top of bank) - Inappropriate foreshore structures or structures not designed to cater for sea level rise - Poorly maintained foreshore protection works - Illegal vehicle access - Climate change and increased storminess	CWLRA, CVA, CEA, CUA	Low	Mod	High	High	High	High	High	Mod	Low	**High**	High	High	High	High
Habitat loss/barriers to habitat connectivity	- Linked to Bank erosion; Degraded water quality; Tidal inundation and coincident flooding - Waterway barriers, e.g. floodgates, weirs, levees, ineffective fishway design - Private ownership of waterfront land - Agricultural practices (unfenced stock access and cropping to top of bank) - Climate change, sea level rise, “coastal squeeze” (i.e. inadequate planning/land use/buffer zone)	CWLRA, CEA, CUA	N/A	High	Mod	High	High	High	Mod	High	Low	**High**	High	High	High	High
Degraded estuarine water quality	- Linked to Bank erosion; Habitat loss (reduction of riparian buffer) - Disturbance of ASS through agricultural drainage and land management practices - Formation and flushing of MBO from drains - Runoff of nutrients and sediment from floodplain agriculture and upper catchment - Urban stormwater contributing sediment, organic debris, litter and pollutants - Ponding and formation of black water on low-lying lands after floods (poor drainage, inundation intolerant veg cover) - WWTP overflows (lower estuary) and illegal sewer connections - Industrial effluents - Water storage, extraction and freshwater releases - Sedimentation and shoaling - Dredging and sand extraction - Water pollution including marine debris, litter and illegal dumping - Climate change and increased storminess	CWLRA, CEA, CUA	Mod	High	Mod	High	High	an	High	Mod	Low	**High**	High	High	High	High
Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets	- Inappropriate development on low-lying land - Exacerbation of floods (upstream catchment clearing) - Inappropriate crops/use of low-lying land - Tidal overtopping of Bray Park Weir (incl. weir crest too low for current tidal anomalies and reduced catchment flows from impoundment/extraction) - sea level rise, increased storminess - Ineffective drainage (design or maintenance) - Inadequate protection works (levees, etc.) - Increased risk of vector borne diseases associated with availability of insect breeding habitat	CVA, CEA, CUA	Low	Low	Low	Mod	Mod	High	Mod	Low	High	**High**	High	High	High	High

Threats	Primary causes	Coastal Management Areas affected	Threatened Social and Recreational Values				Threatened Environmental Values			Threatened Commercial Values		Overall Current Risk	Overall current risk relative to other key threats	20 yr Risk	50 yr Risk	100 yr Risk
			Public access to and use of the river and foreshore	Recreational fishing	Scenic quality and amenity	Aboriginal cultural heritage and practice	Natural habitats and biodiversity	Stable riverbanks	Water quality	Economic prosperity	Agricultural productivity					
Loss of or impacts to Biodiversity	- Weeds and feral animals - Roaming pets - Fragmentation/clearing - Physical damage (e.g. through four wheel driving, boat beaching and trampling) - Habitat availability - Water quality - Litter and marine debris - Marine noise pollution - Climate change and sea level rise	CWLRA, CEA, CUA	N/A	Mod	Low	High	High	High	Low	Mod	N/A	**High**	High	High	High	High
Lack of access to water and foreshore for non-boat recreation, particularly lack of sandy beaches	- Extensive rock wall protection of foreshores and lack of embayments/access points - Private ownership of waterfront land - Erosion of access points/banks/beaches (see bank erosion) - Increasing user pressure (proximity to SEQ, increasing local population) - Lack of parking and ancillary facilities (showers, shade, etc.)	CEA, CUA	High	Mod	Mod	Mod	N/A	Min	Min	Mod	N/A	**High**	Mod	Mod	High	High
Conflict between river users	- Linked to Restricted levels of boating infrastructure and facilities; Lack of access for non-boat recreation - Geographical spread of boat ramps concentrates boat use - No separation of incompatible uses (e.g. PWC/towing vs nature appreciation, residential amenity) - Non-compliance with existing management (speed rules, use of waterways, separation distances, etc.)	CWLRA, CEA, CUA	Mod	Mod	Mod	Mod	Mod	N/A	N/A	Low	N/A	Mod	Mod	High	High	High
Reduced stocks of target fish species	- Overfishing from combination of recreational and commercial fishing - Loss of habitat (e.g. riparian shading, backswamps) /degradation of habitat (e.g. dredging, trampling/shading/smothering/eutrophication of seagrass beds) - Reduced water quality (direct toxicity, reduced food resources, smothering of habitats, water pollution (marine litter, nutrient inputs) etc.) - Obstructions to fish passage/habitat connectivity (reduced habitat availability, barriers to life cycle events) - Climate change, increased storminess, changes in water temperatures, “coastal squeeze”	CWLRA, CEA, CUA	N/A	High	N/A	Mod	Mod	N/A	N/A	High	N/A	**High**	Mod	Mod	Mod	High
Restricted levels of boating infrastructure and facilities or reduced navigability	- Boat ramp capacity and parking not likely to be able to service future peak demand - On-river re-fuelling facilities not available for recreational vessels (i.e. increasing boat ramp usage and user conflicts) - Restricted number of mooring points - Restricted land availability and suitability for new boating facilities - Reductions to channel depth/width through sedimentation and shoaling	CEA, CUA	High	High	N/A	N/A	N/A	Min	N/A	High	N/A	**High**	**Low**	Mod	Mod	High
		Overall risk to value relative to other values	Mod	High	Mod	High	High	Mod	Mod	High	Low					

The likely timing and the geographic extent of the threats (temporal and spatial extent) is shown in Table 19. All threats are current but in many cases are expected to be exacerbated by added pressures from climate change and sea level rise in the future.

Table 20: Temporal and spatial extent of the threats

Timeframe				Spatial extent
Current threat	**20 years**	**50 years**	**100 years**	
• Habitat loss/barriers to habitat connectivity • Lack of access to water and foreshore for non-boat recreation • Conflict between river users • Reduced fish stocks • Loss of, or impacts to biodiversity • Restricted levels of boating infrastructure and facilities or reduced navigability	Some management actions (planning/ zoning considerations) to be implemented to minimise impacts to habitat loss/connectivity and biodiversity from climate change and sea level rise.	Exacerbation of risks due to added pressure from climate change, sea level rise and increasing population.	Continued exacerbation of risks due to added pressure from climate change, sea level rise and likely increasing population.	**Regional**
• Degraded estuarine water quality • Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets	Some management actions (planning/ zoning considerations) to be implemented to minimise impacts from tidal inundation and coincident flooding as a result of climate change and sea level rise	Exacerbation of risks due to added pressure from climate change and sea level rise.	Continued exacerbation of risks due to added pressure from climate change and sea level rise.	**Estuary-wide**
• Bank erosion		Exacerbation of risks due to added pressure from climate change and sea level rise	Continued exacerbation of risks due to added pressure from climate change and sea level rise.	**Localised**

Source: Adapted from MEMA (2015)

Prioritisation of bank rehabilitation sites

A list of priority bank rehabilitation sites was provided in the *Tweed Riverbank Erosion Management Plan* (TSC, 2014). The erosion risk and rehabilitation priority of "High priority" sites as identified in the 2014 Plan were reassessed in May 2017 during detailed studies for this CMP as provided in Hydrosphere Consulting (2020a).

The assessment identified areas of severe erosion risk along the riverbank predominantly located between Bray Park Weir and Condong (i.e. Sites B, C, H2 (downstream end) and I1). The most critical high priority sites for stabilisation (N1 and N2) are located between Tumbulgum and Stotts Island due to their proximity to key public road infrastructure. Sites N1 and the upstream section of N2 would require stabilisation primarily using structural protection due to the narrow confines of the riparian area between the river and Tweed Valley Way (typically <7m), with a bioengineering design (incorporating rock toe/revetment and revegetation areas) possible in the downstream area of N2. The next most pressing high priority sites are H1 and downstream end of H2 (on the north bank, downstream of Murwillumbah), I2 (immediately downstream of Condong) and L2 (opposite Tumbulgum) due to their proximity road infrastructure and the prevalence of boat wake induced erosion on this straight. These sites should be stabilised using bioengineered designs where possible. High priority stabilisation sites of less urgency for bank stabilisation but a major priority for riparian revegetation are located upstream of Murwillumbah's Commercial Road boat ramp (sites A, B, C and E) and are suitable for revegetation, preferably with the instigation of a no-towing zone upstream of Murwillumbah Bridge. In summary, areas identified at high priority for remediation of erosion risk are provided in Table 20 below.

All priority bank rehabilitation sites identified are located within Crown Waterway Reserve. Whilst in some cases the land affected is privately owned, the intention of prioritising and rehabilitating sites is for the improvement of estuary health and the protection of public assets as opposed to protecting private interests.

In addition to the erosion hotspot assessment, it was also noted that there were a number of potentially severe erosion risk areas (coloured purple in Figure 33) that could be classified as high priority for rehabilitation that were not included a high priority sites in the *Tweed Riverbank Erosion Management Plan* (TSC, 2014). These areas include the majority of the Rous River estuary due to lack of riparian vegetation (particularly sections of bank in the upper 2 km of the Rous River estuary within the study area (adjacent to grazing land and downstream of Kynumboon), significant sections of bank in the Murwillumbah area (both public and private ownership), sections of the north bank downstream of Condong, small sections of the southern bank upstream and downstream of Tumbulgum; the western side of Stotts Island and on Dodds Island.

Further detail on prioritisation of bank erosion sites is provided in Hydrosphere Consulting (2020a). While this CMP recommends rehabilitation of all sites identified in the 2014 Plan, funding should initially target areas mapped as the highest priority.

Table 21: High priority sites within the middle and upper estuary for bank stabilisation works

Site	Length	Proposed stabilisation method	% public/ private beneficiaries	Land tenure
A	750 m	Revegetation	100% public, i.e. for the improvement of estuary health.	Crown land (waterway)
B	765 m	Revegetation with some sections potentially requiring battering and installation of a rock toe	100% public, i.e. for the improvement of estuary health.	Road Reserve and Crown land (waterway)
C	1,000 m	Revegetation with some sections potentially requiring battering	100% public, i.e. for the improvement of estuary health.	Crown land (waterway) and small area of TSC Crown Land
E	600 m	Revegetation with some sections potentially requiring battering	100% public, i.e. for the improvement of estuary health.	Road Reserve
H1	~1,425 m	Rock toe revetment and revegetation (i.e. a “bioengineered approach”) with potential for rock fillets in conjunction with toe armouring	100% public, i.e. for the improvement of estuary health.	Crown land (waterway) (private land affected)
H2			100% public, i.e. for the improvement of estuary health.	Crown land (waterway) (private land affected)
I2	~600 m	Toe revetment and rock fillets combined with revegetation	100% public, i.e. for the improvement of estuary health and protection of public road infrastructure.	TSC Crown Land (Public Recreation Reserve) and Crown Land (waterway)
L2	~100 m	Revegetation	100% public, i.e. for the improvement of estuary health and protection of public road infrastructure.	Road Reserve and Crown land (waterway)
N1	400 m	Rock revetment or fillet combined with revegetation	100% public, i.e. for the protection of public road infrastructure and improvement of estuary health.	Road Reserve and Crown land (waterway)
N2			100% public, i.e. for the protection of public road infrastructure and improvement of estuary health.	Road Reserve and Crown land (waterway)
Potentially high-risk erosion areas	~35,600 m	Further investigations required	TBC	TBC
Total length of high priority sites (A to N2)	**5,640 m**			

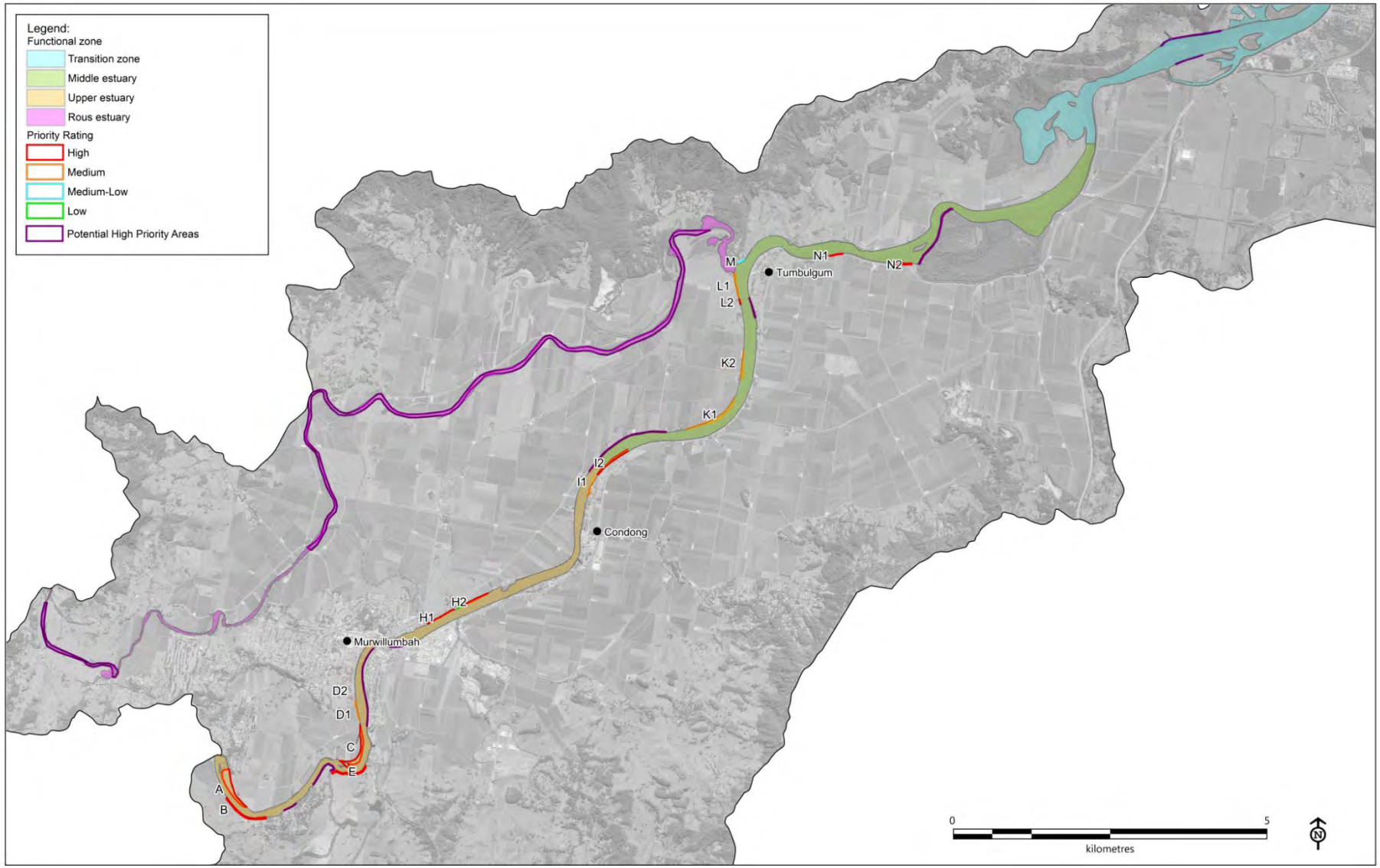

Figure 33: Management priority of bank erosion hotspot areas in the middle and upper estuary and the Rous River estuary (Site A, B, C, E, H1&2, L2, N1&2 and potentially severe erosion areas)

Source: Base layer mapping provided by TSC

Prioritisation of protective infrastructure restoration works

A preliminary inspection of the foreshore retaining, revetments, rock walls and other protective infrastructure in the lower estuary (downstream of Dodds Island) was completed in May 2017 to document the condition and obvious signs of deterioration of the structures.

The assessment identified the priority areas for rock revetment restoration works, as specified in Table 21 and shown on Figure 34 and including approximately:

- 2 km of high priority areas displaying clear evidence of deterioration resulting in extensive erosion of rock revetments and estuary banks; and
- 345 m of high -medium priority banks showing serious deterioration of the rock revetment and erosion risk.

Table 22: High and high-medium priority sites within the lower estuary for protective infrastructure restoration works

Site	Length	Priority	% public/ private beneficiary	Land tenure
1a	~34m	High	100% public	Public (TSC)
1b	~345 m	High - medium	100% public	Public (DI-Lands). Consultation with adjacent Private landowner may be required to access the land
2a	~174 m	High (Public safety risk due to footpath collapse).	100% public	Public (TSC and DI-Lands). TSC is the predominant landowner.
5a	~198 m	High	100% public	Public (TSC)
7a	~895 m	High	100% public	Public (DI-Lands)
7c	~416 m	High	100% public	Public (TSC and DI-Lands). TSC is the predominant landowner.
9a	~132 m	High	100% public	Public (TSC and DI-Lands). TSC is the predominant landowner.
9b	~96 m	High	100% public	Public (TSC)
10a	~79 m	High		Public (TSC)

All priority protective infrastructure restoration sites identified are located wholly within public land, the intention of restoration being to maintain and protect public assets (river training walls, roads, footpaths etc.) and to improve estuary health.

Further detail on prioritisation of protective infrastructure restoration works in the lower estuary is provided in Hydrosphere Consulting (2020a).

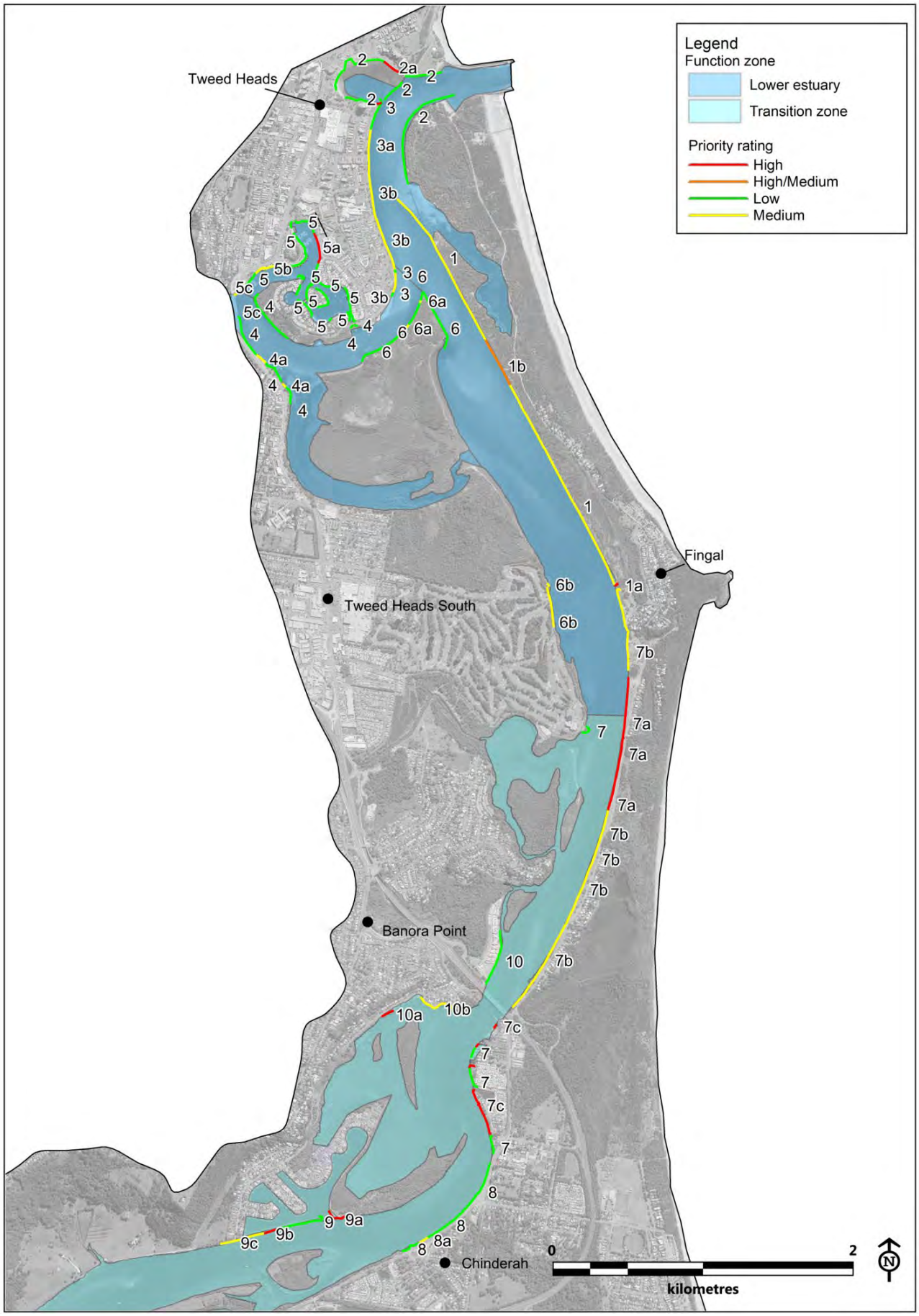

Figure 34: Priority rating for restoration of protective infrastructure in the lower estuary

Source: Base layer mapping provided by TSC

Prioritisation of riparian restoration works

A desktop inspection of riparian vegetation connectivity and an in-field inspection of riparian coverage and composition undertaken in July 2017 (as a component of the detailed studies for this CMP.

The assessment identified that over 50% of the estuary's banks were considered to be highly to very highly disturbed, primarily in the Rous River estuary and the upper and middle estuary functional zones, as identified in red and yellow in Figure 35 below. Prioritisation should be given to restoration of riparian vegetation in very highly and highly disturbed areas and in conjunction with any bank rehabilitation works or being undertaken as a component of TSC's Roads Program. In particular, large scale riparian restoration is recommended for areas 13 and 14 in the upper estuary, upstream of the Commercial Road Boat ramp (i.e. identified as the "Restoration Zone" in the Recreational Use Study (Hydrosphere Consulting, 2017d). The importance of this reach for riparian rehabilitation has underpinned it being identified as a "Restoration Zone" in the character zones component of the Recreational Use Strategy (Section 3.3.2). This reach of the upper estuary provides the only opportunity for riparian revegetation of a significant scale in the upper Tweed Estuary and as such is a project that should be implemented and promoted as a flagship or icon initiative of the CMP implementation phase.

The north bank (left bank) of the lower 4km of the Rous River estuary (area 15 on Figure 35) is characterised as having "Good" riparian vegetation condition (low to moderately disturbed) and is considered a significant area of habitat within the middle, upper and Rous River estuary areas which are otherwise characterised by moderately to very highly disturbed riparian zones. Prioritisation should be given to the protection of the habitat in the lower Rous River estuary.

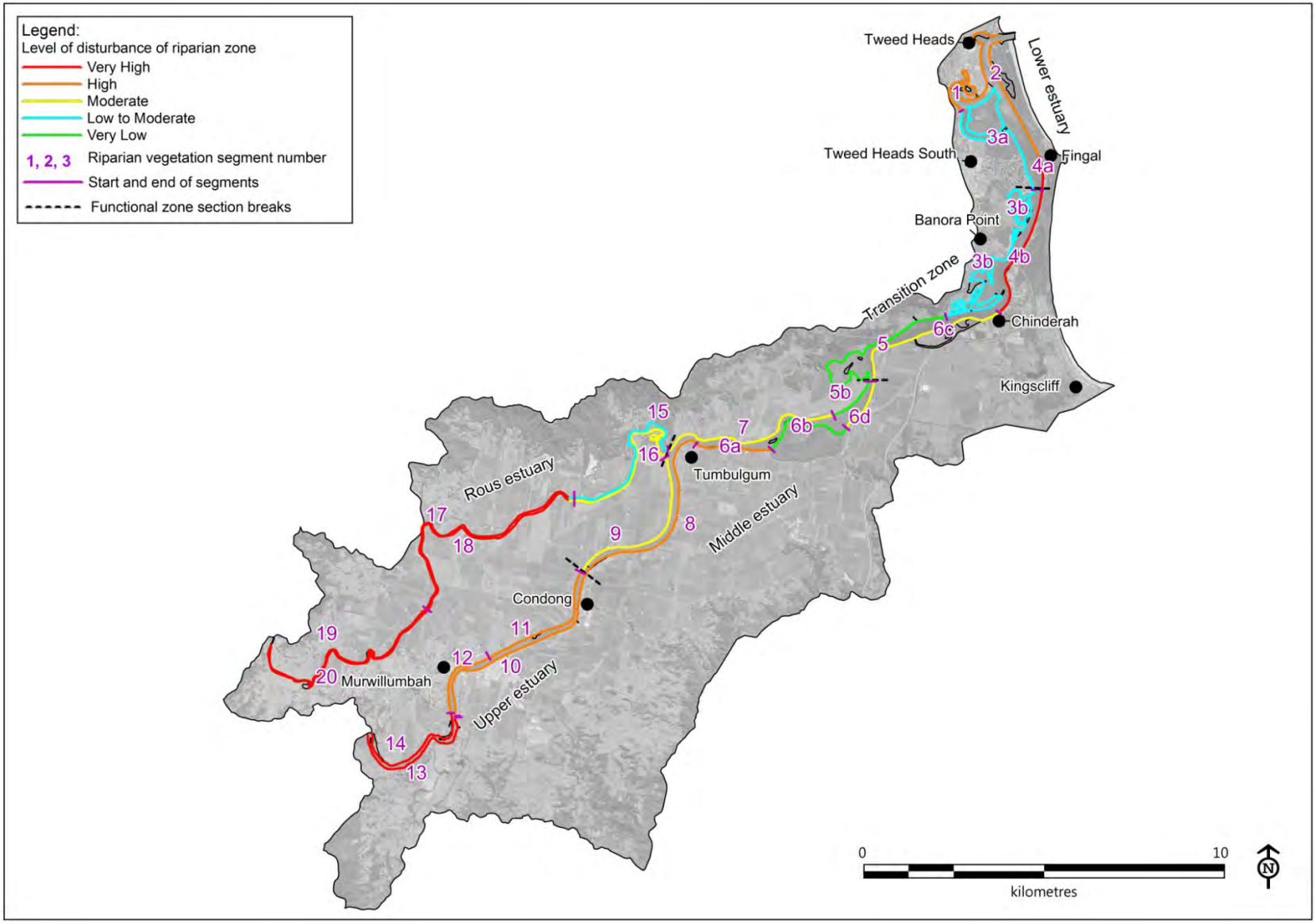

Figure 35: Overview of bank segments and level of disturbance of riparian vegetation

Source: Base layer mapping provided by TSC

Prioritisation of significant estuarine vegetation areas at risk of coastal squeeze

Mapping of sea level rise impacts to estuarine vegetation was undertaken (Hydrosphere Consulting, 2019) as a component of the detailed studies for this CMP. The assessment was undertaken based on intertidal estuarine vegetation types, topography, land use, land tenure, aerial photography and a 2080 tidal inundation scenario as modelled by BMT WBM (2019). The scenario adopted for this activity was the 2080 Mean High Water Springs (MHWS) upper tidal inundation scenario which represents frequent (fortnightly) inundation under an upper inundation scenario conservatively chosen to represent the largest foreseeable change in tidal inundation by 2080 (refer Hydrosphere Consulting, 2019).

Substantial sections of estuarine vegetation are bordered by relatively low-lying land classified as either residential or primary production and/or are located on moderately steep banks structures bordered by roads. These barriers and constraints have the potential to impact landward migration of intertidal estuarine vegetation as a result of the modelled 2080 sea level rise scenario.

Inundation areas, as mapped by BMT WBM (2019) were allocated a management priority classification (High, Moderate or Low) indicating the level of further investigation or human intervention and consultation required in order to minimise the potential impacts of sea level rise on intertidal estuarine vegetation migration at each location due to current anthropogenic barriers or land use constraints (Figure 36). The priority classifications take into account the maximum potential for expansion under conservative 2080 sea level rise scenario, as well as opportunities such as existing vegetation classification for environmental protection and conservation areas (e.g. CM SEPP Coastal wetland mapping) and the potential for intervention to minimise the impacts on migration due to current anthropogenic barriers or land use constraints.

The assessment identified seven distinct areas as HIGH priority for further investigation or management due to their potential to be substantially impacted by sea level rise, anthropogenic barriers and land use constraints. These areas are summarised in Table 22.

Table 23: High priority areas for further investigation or management of vegetation migration - 2080 MHWS upper inundation sea level rise scenario

Area ID	Location and Site Description	2080 Sea-level Rise Impact
Area 20	Privately owned primary production land (>150 Ha approx.) at Tygalgah bordered by a flood levee with flood gates around much of the peninsula and road reserve on its northern side.	Area 20 has a large area with potential for providing suitable estuarine vegetation migration habitat. This area will likely experience tidal inundation and impeded drainage causing impacts on agricultural productivity. Physical constraints to estuarine vegetation migration include the flood levees and flood gates.
Area 19	Privately owned primary production land (>50 Ha approx.) bordered by a road reserve on its southern edge. The land has some existing internal roads and drainage modifications.	Area 19 has a large area with potential for providing suitable estuarine vegetation migration habitat. This area will likely experience tidal inundation and impeded drainage, causing impacts on agricultural productivity. This could provide an opportunity for migration of estuarine vegetation. Physical constraints to estuarine vegetation migration are limited in this area. This could enable unhindered estuarine vegetation migration to the low-lying inland areas.
Area 18	The land is predominantly privately owned and zoned Rural Landscape with an area zoned E Zone and a small area of community owned land. Significant areas of existing mangroves and Bushland conservation. Entirely mapped as CM SEPP Coastal wetlands.	Area 18 has potential for providing suitable estuarine vegetation migration habitat. This area will likely experience tidal inundation and impeded drainage, causing impacts on agricultural productivity. This could provide an opportunity for migration of estuarine vegetation.
Area 17	Privately owned area largely mapped as CM SEPP Coastal wetlands and zoned as E Zone and Primary Production. This area has a moderate area of existing mangroves.	Area 17 has the most extensive areas of mapped mangroves in the upper parts of the estuary. It is low lying (0.5-1.0 metres AHD) and will likely be periodically inundated in the 2080 sea level rise scenario. These areas present an opportunity for foreshore mangrove and saltmarsh migration. Internal physical barriers include a raised farm access road. Adjacent barriers (levee and floodgates) could prevent estuarine vegetation migration further southwards along the peninsula.
Area 15	Tweed Broadwater - Predominantly private land zoned as Primary Production land with areas of E Zoning and small areas of Crown land (State managed). Significant existing mangroves and saltmarsh on north eastern foreshore. Extensively mapped as CM SEPP Coastal wetlands.	Area 15 has extensive areas of mangrove with some saltmarsh on the north eastern edge. It is low lying (0.5-1.0 metres AHD) and will likely be periodically inundated in the 2080 sea level rise scenario. These areas present an opportunity for foreshore mangrove and saltmarsh migration. Barriers to migration include a levee, floodgates and a road between the areas populated by mangroves and the adjoining low-lying areas to the west. Unmapped drainage modifications (e.g. drains and levees) may also be present within the area however the area is likely to present a significant opportunity for migration of estuarine vegetation.

Area ID	Location and Site Description	2080 Sea-level Rise Impact
Area 12	Dodds Island - Mangrove areas on land zoned Primary production and small areas of E Zoning. Partially mapped as SEPP Coastal wetlands.	This area is predominantly used for agricultural purposes. The 2080 sea level rise scenario will likely result in substantial migration of existing estuarine vegetation across the island. However, landuse practices have the potential to create a 'coastal squeeze' effect on saltmarsh and mangrove habitats. The 2080 scenario will likely result in substantial inundation of Dodds Island due to the majority of the island having an average elevation of~1 m (AHD) leaving most of the island periodically inundated. The majority of this land will become optimal habitat for estuarine vegetation unless impacted by surrounding agricultural practices or future land use practices.
Area 8	Shallow Bay inlet channel - Area 8 is CM SEPP Coastal wetlands and E Zone. The area contains both saltmarsh and mangroves.	Sea level rise will likely result in estuarine vegetation migration where banks are less steep. Of note the area has been previously disturbed through clearing activities. Mangroves currently only populate some areas but could migrate to a larger area within the CM SEPP area assisted by the 2080 sea level rise scenario.

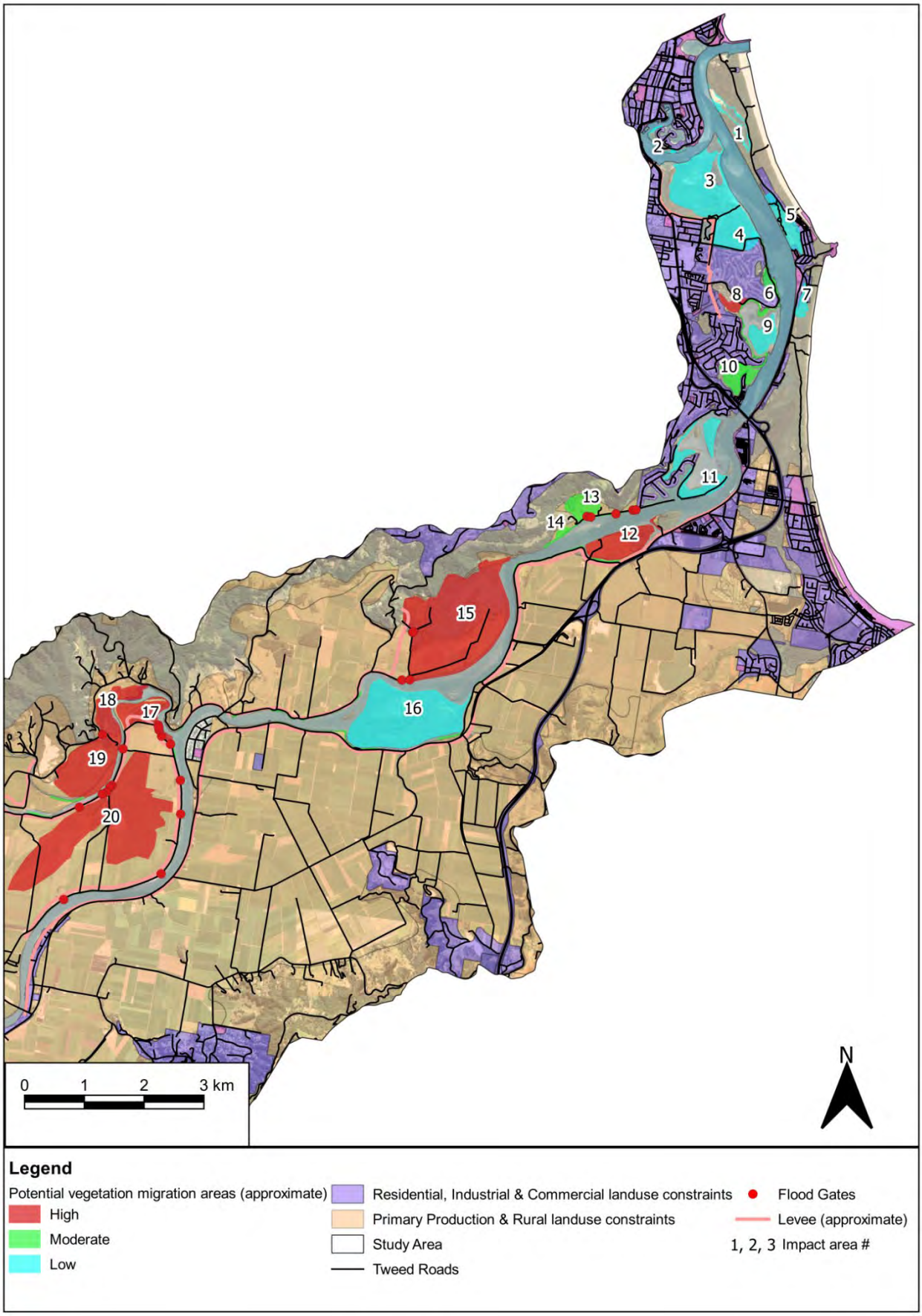

Figure 36: Management priority areas and anthropogenic constraints for migration of significant estuarine vegetation

Source: Base layer mapping provided by TSC

Prioritisation of areas to focus water quality improvements

Estuarine water quality compliance was measured against water quality objectives for the Tweed River (estuaries) (OEH, 2016) for aquatic ecosystem and human health (Hydrosphere Consulting, 2018). The Tweed River Flow and Water Quality Objectives provide well established direction for improved water quality sought by the community over many years. Compliance was assessed for a key range of indicators against the objectives for aquatic ecosystem health (pH, dissolved oxygen, total suspended solids, total nitrogen, total phosphorus and Chlorophyll *a*) and human health (enterococci).

The percentage compliance for each functional zone, i.e. the percentage of samples that achieved the guideline value over the measurement period (2012-2016) is shown in Figure 37. The highest compliance score, “A” applies to sites achieving over 76% compliance with the guideline values and makes allowance for variability in water quality with rainfall runoff, i.e. a percentage of samples will not meet guideline values, even in very natural systems.

Results indicated that compliance was greatest in the lower estuary (i.e. an “A” score) and generally deteriorated with distance upstream. All sites in the middle and upper estuary received a “B” grade (i.e. between 66-75% overall compliance) with the exception of the site located adjacent to the village of Condong and the Condong Sugar Mill effluent discharge location. The lower Rous River estuary received a “C” grade, deteriorating to a D grade (<50% compliance) at the upper most sites on the Rous River estuary.

Analysis of potential sources of water quality issues was undertaken by examining compliance in relation to adjacent and upstream catchment characteristics such as land use, vegetation coverage and potential point and non-point sources. Results indicated that management of:

- nutrients and sediment loading to the estuary from diffuse source land management practices should be focussed on the upper catchment, the Rous River estuary and the middle and upper estuary;
- ASS and acid runoff should be focussed on the Rous River estuary and the upper and middle estuary;
- point source nutrient loading should be focussed on the Rous River estuary (Murwillumbah WWTP) and middle estuary (Tumbulgum WWTP) and in the upper estuary (Condong Sugar Mill); and
- faecal contamination should be undertaken catchment wide but focussed on the Rous River estuary which is impacted during all flows.

In summary, high priority areas for carrying out actions for the improvement of estuarine water quality compliance are the Rous River estuary, the upper and middle estuary (as indicated by B-D scores in Figure 37) and the upper catchment.

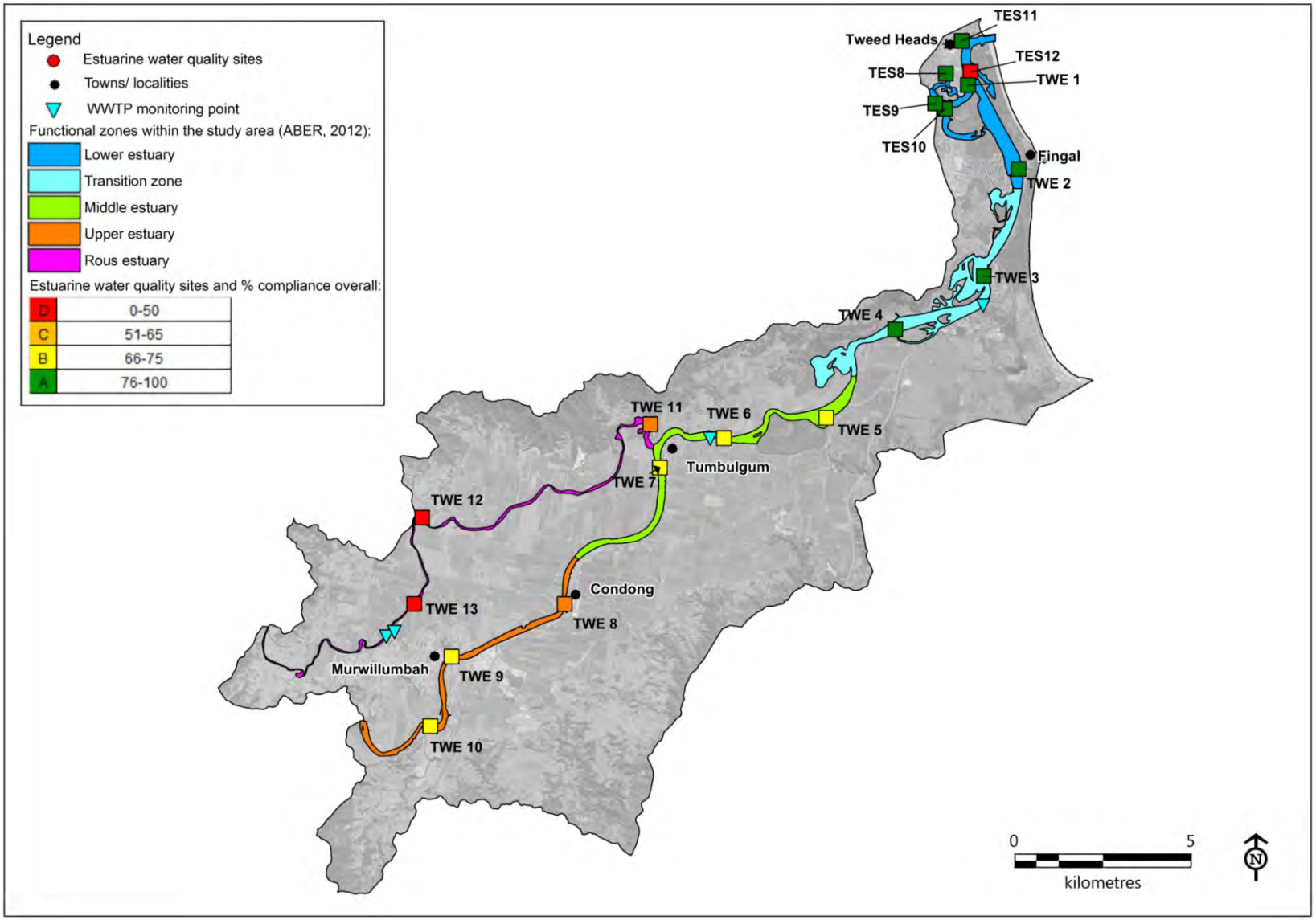

Figure 37: Overall compliance scores at each estuarine water quality monitoring site in the Tweed River estuary

Source: Base layer mapping provided by TSC

APPENDIX D. LINKS TO THE OBJECTS OF THE *COASTAL MANAGEMENT ACT 2016* AND THE *MARINE ESTATE MANAGEMENT ACT 2014*

The focus of this CMP is to achieve the 13 objects of the *Coastal Management Act 2016* through the development of a long-term management strategy. Table 23 identifies linkages between the locally specific objectives developed for the CMP (refer Section 1.7). The objects of the *Coastal Management Act 2016* are:

(a) to protect and enhance natural coastal processes and coastal environmental values including natural character, scenic value, biological diversity and ecosystem integrity and resilience, and

(b) to support the social and cultural values of the coastal zone and maintain public access, amenity, use and safety, and

(c) to acknowledge Aboriginal peoples' spiritual, social, customary and economic use of the coastal zone, and

(d) to recognise the coastal zone as a vital economic zone and to support sustainable coastal economies, and

(e) to facilitate ecologically sustainable development in the coastal zone and promote sustainable land use planning decision-making, and

(f) to mitigate current and future risks from coastal hazards, taking into account the effects of climate change, and

(g) to recognise that the local and regional scale effects of coastal processes, and the inherently ambulatory and dynamic nature of the shoreline, may result in the loss of coastal land to the sea (including estuaries and other arms of the sea), and to manage coastal use and development accordingly, and

(h) to promote integrated and co-ordinated coastal planning, management and reporting, and

(i) to encourage and promote plans and strategies to improve the resilience of coastal assets to the impacts of an uncertain climate future including impacts of extreme storm events, and

(j) to ensure co-ordination of the policies and activities of government and public authorities relating to the coastal zone and to facilitate the proper integration of their management activities, and

(k) to support public participation in coastal management and planning and greater public awareness, education and understanding of coastal processes and management actions, and

(l) to facilitate the identification of land in the coastal zone for acquisition by public or local authorities in order to promote the protection, enhancement, maintenance and restoration of the environment of the coastal zone, and

(m) to support the objects of the Marine Estate Management Act 2014."

Similarly, the *Marine Estate Management Act 2014* provides several objects, as identified below, for which linkages with the locally specific objectives of this CMP are identified in Table 23:

- *(a) to provide for the management of the marine estate of New South Wales consistent with the principles of ecologically sustainable development in a manner that:*
    - *(i) promotes a biologically diverse, healthy and productive marine estate, and*
    - *(ii) facilitates:*
        1. *economic opportunities for the people of New South Wales, including opportunities for regional communities, and*

2) the cultural, social and recreational use of the marine estate, an

3) the maintenance of ecosystem integrity, and

4) the use of the marine estate for scientific research and education,

(b) (b) to promote the co-ordination of the exercise, by public authorities, of functions in relation to the marine estate,

(c) (c) to provide for the declaration and management of a comprehensive system of marine parks and aquatic reserves.

The *2018-2028 Marine Estate Management Strategy* (MEMA, 2018) details how the Marine Estate Management Authority will achieve the vision for the NSW Marine Estate over the next ten years. The Strategy recognises that effective coastal and marine management needs to be holistic, coordinated and evidence-based. The Strategy:

- sets the policy directions for managing the marine estate as a single continuous system;
- identifies management priorities based on the findings of the NSW marine estate threat and risk assessment; and
- balances economic growth, use and conservation of the marine estate.

The Strategy coordinates all aspects of marine estate management under one framework. This involves all relevant NSW Government agencies, integration with local government, industry, stakeholders and communities. The final Strategy will be released in 2018, supported by a detailed implementation plan and Marine Integrated Monitoring Program that will monitor the progress of the Strategy's actions and address key knowledge gaps.

Many of the Strategy initiatives and actions are relevant to the management of the Tweed River estuary and have been addressed during the development of this CMP as shown Table 23.

Table 24 to Table 27 list the full management objectives for the coastal management areas and how this CMP gives effect to each of them.

Table 24: Alignment of the locally specific coastal management values and objectives with the objects of the *Coastal Management Act 2016* and the *Marine Estate Management Act 2014*

Values of the CMP Study Area	Locally Specific CMP Objectives	Alignment with objects of the CM Act 2016													Alignment with objects of the MEM Act 2014						
		(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(a)(i)	(a)(ii)1	(a)(ii)2	(a)(ii)3	(a)(ii)4	(b)	(c)
Environmental Values																					
Natural habitats and biodiversity	Protect, restore and enhance natural habitats and their connectivity, including littoral rainforests, coastal wetlands, riverbanks, riparian vegetation and fish habitat. Improve the capacity of the estuary to withstand and recover from intense weather events and adapt to future increases in tidal inundation, by allowing for migration of fringing habitats with sea level rise.	✓				✓	✓	✓	✓		✓		✓		✓			✓		✓	
Stable riverbanks	Increase resilience of riverbanks to erosion. Stabilise eroding banks using techniques that increase habitat value and enhance amenity. Manage riverbank erosion by bank rehabilitation and through encouraging compatible use of the waterway and riparian zone.	✓	✓			✓	✓	✓	✓	✓	✓				✓			✓		✓	
Water quality	Improve water quality by reducing the inflow of nutrients, acid runoff, sediments, faecal contamination and treated effluent. Achieve greater compliance with Tweed River Flow Objectives and Water Quality Objectives and ensure that river water is clean and safe and can support abundant native aquatic life and safe recreational uses.	✓				✓			✓		✓				✓		✓	✓		✓	
Social and Recreational Values																					
Public access to and use of the river and foreshore	Improve public access to the river and foreshore for both land and water based activities. Provide and maintain a diverse range of user appropriate, well connected and easily accessed open space and facilities. Reduce user conflicts.		✓		✓	✓	✓	✓	✓	✓	✓					✓	✓			✓	
Coastal risk and adaption to climate change	Identify coastal hazard risks and develop actions that increase the adaptive capacity of Council, the community and natural systems to the predicted impacts of climate change, including increased storm intensity and sea level rise.	✓				✓	✓	✓	✓	✓	✓	✓	✓		✓			✓	✓	✓	
Recreational fishing	Improve recreational fishing opportunities by protecting fish habitat, improving fish passage and increasing water quality. Enhance foreshore fishing opportunities and promote sustainable fishing practices.	✓	✓		✓				✓		✓				✓	✓	✓	✓		✓	
Scenic quality and amenity	Protect and enhance the quality of views to and from waterways and foreshores through appropriate designs and measures to mitigate visual impacts of development and other uses.	✓	✓		✓		✓	✓	✓		✓					✓	✓			✓	
Education, engagement and public opinion	Increase engagement with the community and other stakeholders to improve understanding of the river ecosystem, its condition and key threats and benefits associated with appropriate use of the waterways.		✓	✓	✓		✓	✓	✓	✓	✓	✓			✓		✓		✓	✓	
Aboriginal cultural heritage and practice	Protect cultural sites and promote Aboriginal cultural values of the estuary through education and sustainable use of the estuary.	✓	✓	✓					✓		✓	✓					✓		✓	✓	
Commercial Values																					
Economic prosperity	Protect and increase the economic prosperity and sustainability of industries supported by the estuary.		✓		✓		✓		✓	✓	✓				✓	✓		✓		✓	
Agricultural productivity	Encourage and promote sustainable agricultural activities and enhance productivity through education, adoption of best management practices and adaption to social, economic and environmental changes.		✓		✓		✓		✓		✓	✓			✓	✓		✓	✓	✓	

Table 25: Management objectives for the coastal wetlands and littoral rainforests area (Section 6 CM Act)

Management Objective	Issue	Where documented in CMP / Additional notes
a)	to protect coastal wetlands and littoral rainforests in their natural state, including their biological diversity and ecosystem integrity	Section 1.7 of the CMP states – "The Tweed River estuary CMP provides a management framework to guide coastal management and planning for the Tweed River estuary, in response to the relevant objectives for each coastal management area from the Coastal Management Act, 2016 (Table 3). The CMP also focuses on the protection of specific local objectives (Table 3), based on the community values for the estuary." Specific local CMP objectives are described in Table 4, several of which align with this management objective. For example, CMP Objective 1 is to "Protect restore and enhance natural habitats and their connectivity, including littoral rainforests, coastal wetlands, riverbanks, riparian vegetation and fish habitat…" Refer to the Recreational Use Strategy (3.3.2), Hydrosphere Consulting (2019) (Ecological Assessment), Hydrosphere Consulting (2021) (Key Management Issues and Threats), Appendix C (Risk Assessment), particularly "Prioritisation of significant estuarine vegetation areas at risk of coastal squeeze" which includes consideration of lands that may be suitable for upslope migration of coastal wetlands and littoral rainforest. Several management actions generally promote CM Act Management Objective 6(2)(a) including (but not limited to): Fundamental Management Actions (A3, A4; B4; C3) Actions under Threat 1 - Bank Erosion (E1–E3; F1-F5; G1) Actions under Threat 2 - Habitat loss and barriers to habitat connectivity (H3, H6; I1, I2, I3; J3, J4).
b)	to promote the rehabilitation and restoration of degraded coastal wetlands and littoral rainforests	Section 1.7 of the CMP states – "The Tweed River estuary CMP provides a management framework to guide coastal management and planning for the Tweed River estuary, in response to the relevant objectives for each coastal management area from the Coastal Management Act, 2016 (Table 3). The CMP also focuses on the protection of specific local objectives (Table 3), based on the community values for the estuary." CMP Specific local CMP objectives are described in Table 4, several of which align with this management objective. Refer to Recreational Use Strategy (3.3.2), Hydrosphere Consulting (2019) (Ecological Assessment), Hydrosphere Consulting (2021) (Key Management Issues and Threats), Appendix C (Risk Assessment), particularly prioritisation of significant estuarine vegetation areas at risk of coastal squeeze which includes consideration of lands that may be suitable for upslope migration of coastal wetlands and littoral rainforest. Several management actions generally promote Management Objective 6(2)(b) including (but not limited to): Management Actions Under B – Stakeholder and community engagement Actions under C – Estuary health monitoring and reporting program. Actions under Threat 1 Bank Erosion Actions under Threat 2 Habitat loss and barriers to habitat connectivity etc. Specific management actions that generally promote this management objective are for example: Management Action I1 – "Identify sites for potential regeneration of floodplain wetlands." Management Action K1 – "Review LEP zoning to incorporate areas for estuary vegetation migration."; Management Action K2 – "Using incentive schemes and land holder agreements (e.g. TSC River Health Grants/Biodiversity Grants) continue to work with floodplain landholders to create buffer zones around existing waterways, wetlands and riparian areas, to accommodate dynamic changes to waterway, wetland and riparian vegetation boundaries, associated with sea-level rise."
c)	to improve the resilience of coastal wetlands and littoral rainforests to the impacts of climate change, including opportunities for migration	Section 1.7 of the CMP states – "The Tweed River estuary CMP provides a management framework to guide coastal management and planning for the Tweed River estuary, in response to the relevant objectives for each coastal management area from the Coastal Management Act, 2016 (Table 3). The CMP also focuses on the protection of specific local objectives (Table 3), based on the community values for the estuary." CMP Specific local CMP objectives are described in Table 4, several of which align with this management objective. Refer to Recreational Use Strategy (3.3.2), Hydrosphere Consulting (2019) (Ecological Assessment), Hydrosphere Consulting (2021) (Key Management Issues and Threats), Appendix C (Risk Assessment), particularly prioritisation of significant estuarine vegetation areas at risk of coastal squeeze which includes consideration of lands that may be suitable for upslope migration of coastal wetlands and littoral rainforest. Several management actions generally promote Management Objective 6(2)(c) including (but not limited to): Management Actions Under B – Stakeholder and community engagement Actions under C – Estuary health monitoring and reporting program. Actions under Threat 1 Bank Erosion Actions under Threat 2 Habitat loss and barriers to habitat connectivity etc. Specific management actions that generally promote this management objective are for example: Management Action I1 – "Identify sites for potential regeneration of floodplain wetlands." Management Action K1 – "Review LEP zoning to incorporate areas for estuary vegetation migration."; Management Action K2 – "Using incentive schemes and land holder agreements (e.g. TSC River Health Grants/Biodiversity Grants) continue to work with floodplain landholders to create buffer zones around existing waterways, wetlands and riparian areas, to accommodate dynamic changes to waterway, wetland and riparian vegetation boundaries, associated with sea-level rise."

Management Objective	Issue	Where documented in CMP / Additional notes
d)	to support the social and cultural values of coastal wetlands and littoral rainforests	Section 1.7 of the CMP states – "The Tweed River estuary CMP provides a management framework to guide coastal management and planning for the Tweed River estuary, in response to the relevant objectives for each coastal management area from the Coastal Management Act, 2016 (Table 3). The CMP also focuses on the protection of specific local objectives (Table 3), based on the community values for the estuary." CMP Specific local CMP objectives are described in Table 4, several of which promote this management objective. Refer to Recreational Use Strategy (3.3.2), Hydrosphere Consulting (2019) (Ecological Assessment), Hydrosphere Consulting (2021) (Key Management Issues and Threats), Appendix C (Risk Assessment). Several management actions generally promote Management Objective 6(2)(d) including (but not limited to): Management Actions Under B – Stakeholder and community engagement Actions under C – Estuary health monitoring and reporting program. Actions under Threat 1 - Bank Erosion Actions under Threat 2 - Habitat loss and barriers to habitat connectivity etc. Specific management actions that generally promote this management objective are, for example: Management Action B4 – "Provide additional nature based educational opportunities including signage and information". Management Action E1 – "Recommend to TfNSW that the following measures be considered in any future revision of boating management measures applied to the Tweed River estuary: create a no-tow zone within the "Conservation Zone "(Stotts Island) to prevent wake damaging sensitive environmental habitat, whilst increasing the areas suitability for tranquil and passive recreational uses; and…" Management Action J3 – "Liaise with TBLALC to improve the management of degraded wetland and foreshore areas at Letitia Spit through the control and prevention of vehicular access and powered motorboat access, and encouragement of recreational use away from fragile wetland areas".
e)	to promote the objectives of State policies and programs for wetlands or littoral rainforest management	Section 1.7 of the CMP states – "The Tweed River estuary CMP provides a management framework to guide coastal management and planning for the Tweed River estuary, in response to the relevant objectives for each coastal management area from the Coastal Management Act, 2016 (Table 3). The CMP also focuses on the protection of specific local objectives (Table 3), based on the community values for the estuary." CMP Specific local CMP objectives are described in Table 4, several of which generally promote this management objective. Section 2.1.3 (Flora and Fauna) discusses the vegetative context and key features throughout the estuary management area including for example; " Important estuarine habitats include areas of seagrass and saltmarsh which are typically found downstream of Dodds Island, and mangroves which occur up to and within the lower Rous River estuary. A large majority of these areas are classified as 'Key Fish Habitat' under the Fisheries Management Act 1994 and are mapped as Coastal Wetlands under the Coastal Management SEPP. Estuarine macrophyte communities are essential nursery grounds for many fish and crustaceans. Coastal saltmarsh in particular is listed as a threatened ecological community under the Biodiversity Conservation Act 2016 and is an important fish habitat with a very valuable role in fish and prawn production" Appendix E describes the CMP links to the Marine Estate Threat and Risk Assessment and the Marine Estate Management Strategy. This is a good assessment of linkages and is relevant to wetlands and littoral rainforest management (in-part). Additional relevant sections in the CMP include: Description of the Coastal Management Areas (Section 1.6) The CMP vision and Coastal Management Objectives adopted from the Coastal Management Act Identification of roles and responsibilities (Section 1.8) Alignment of policy and programs (Section 1.8.5, and Actions A2 and A3) Hydrosphere Consulting (2021) discusses habitat loss and barriers to habitat connectivity Actions related to Crown Land management (Action A3, F6) Actions related to research, monitoring and mapping (Actions A4, C3-C6; F6; G2; L2; W2) Actions related to communication and education (Actions B1, B3, B4, E1, E2, E3, I2, M2, W1, BB1) Actions related to compliance, enforcement and reporting (Actions C7; E1). The CMP is considered to generally promote the intentions (where relevant) of: SEPP (Coastal Management) 2018; *The NSW Wetlands Policy (2010); Biodiversity Offsets Policy* (refer CMP Management Action G2) NPWS park management policies; MEMS (i.e. CMP Management Action H6 which may improve hydrological conditions for wetlands; Action J4).

Table 26: Management objectives for coastal vulnerability area (Section 7 CM Act)

Management Objective	Issue	Where documented in CMP / Additional notes
a)	to ensure public safety and prevent risks to human life	The CVA is not mapped in the CMP. Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the CMP objectives generally promote this management objective (i.e. stable riverbanks, public access to and use of the river and foreshore, coastal risk and adaptation to climate change). CMP Section 2 describes threats to estuary values. Specifically, relevant threats include: Threat 1 (bank erosion); Threat 4 – Tidal inundation and coincident flooding damaging agricultural land, private property public facilities and assets. Hydrosphere Consulting (2020a) is the "Coastal Hazards and Risk Identification and Assessment Report" Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which also prioritises bank rehabilitation and stabilisation sites and protective infrastructure restoration works. Relevant Management Actions: Action under F – Rehabilitate and maintain priority bank erosion sites (F1 – F6). Actions under U - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets (U1, U2, U4, U7).
b)	to mitigate current and future risk from coastal hazards by taking into account the effects of coastal processes and climate change	The CVA is not mapped in the CMP. Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the objectives directly align with this management objective (i.e. stable riverbanks, public access to and use of the river and foreshore, coastal risk and adaptation to climate change). CMP Section 2.1.2 describes estuary (coastal) processes. CMP Section 2 describes threats to estuary values. Specifically, relevant threats include: Threat 1 - Bank erosion; Threat 4 – Tidal inundation and coincident flooding damaging agricultural land, private property public facilities and assets. Hydrosphere Consulting (2020a) comprises the "Coastal Hazards and Risk Identification and Assessment Report". This report looks at entrance instability, tidal inundation (only briefly but notes the tidal inundation study which was later completed and included in Appendix P), and bank erosion. Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which assesses bank erosion risk and tidal inundation and coincident flooding risks including consideration of coastal processes and climate change. *Tweed Estuary Tidal Inundation Assessment and Mapping* (BMT WBM (2019) is a tidal inundation study that maps various design water level events out to 2120 under sea level rise scenarios. Relevant Management Actions include: Actions under F – Rehabilitate and maintain priority bank erosion sites (F1 – F6). Actions under U - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets (U1, U2, U4, U7).
c)	to maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place	The CVA is not mapped in the CMP. Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the CMP objectives generally promote this management objective (Stable river banks, public access to and use of the river and foreshore, coastal risk and adaptation to climate change). CMP Section 2.1.2 describes estuary (coastal) processes. CMP Section 2 describes threats to estuary values. Specifically, relevant threats include: Threat 1 – Bank erosion; Threat 4 – Tidal inundation and coincident flooding damaging agricultural land, private property public facilities and assets. Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly, a lack of sandy beaches. Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which assesses (in-part) the risks to maintaining the presence of beaches and the natural features of foreshores. Relevant Management Actions include: Actions under E - Promotion of the diversity of river uses (E1 – E3). Actions under F - Rehabilitate and maintain priority bank erosion sites. Actions under Z - Maintain amenity of existing estuary beaches and create additional artificial sandy beaches (Z1, Z2). Actions under FF - Ensure adequate planning, assessment and control of dredging and sand extraction in the estuary (FF1, FF2).

Management Objective	Issue	Where documented in CMP / Additional notes
d)	to maintain public access, amenity and use of beaches and foreshores	The CVA is not mapped in the CMP. Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the CMP objectives generally promote this management objective (i.e. stable river banks; water quality; public access to and use of the river and foreshore; recreational fishing; coastal risk and adaptation to climate change; scenic quality and amenity; education, engagement and public opinion; Aboriginal cultural heritage and practice). CMP Section 2 describes threats to estuary values. Several of the threats relate to the maintenance of public access, amenity and use of beaches and foreshores, in particular: Threat 1 – Bank erosion Threat 5 – Loss of or impacts to biodiversity Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly, a lack of sandy beaches. Threat 7 – Conflict between river users Threat 9 – Restricted levels of boating infrastructure and facilities or reduced navigability. Section 3.3.2 of the CMP is the Recreational Use Strategy which strategically considers recreational use of and access to the Tweed River estuary. Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which assesses (in-part) the risks to maintaining public access, amenity and use of beaches and foreshores. Relevant Management Actions include: Actions under Fundamental Management Actions; Actions under E – Promotion of the diversity of river uses (E1 – E3) Actions under X - Improvements to foreshore parks and recreational facilities Actions under Y - Maintain and improve facilities for connectivity of public access along the foreshore Actions under Z - Maintain amenity of existing estuary beaches and create additional artificial sandy beaches (Z1, Z2) Actions under EE - Maintain and improve boating infrastructure, access and ancillary facilities for boaters Actions under FF - Ensure adequate planning, assessment and control of dredging and sand extraction in the estuary (FF1, FF2).
e)	to encourage land use that reduces exposure to risks from coastal hazards, including through siting, design, construction and operational decisions	The CVA is not mapped in the CMP. Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the CMP objectives generally promote this management objective (Coastal risk and adaptation to climate change; education, engagement and public opinion; agricultural productivity). CMP Section 2 describes threats to estuary values. The threats that relate to encouraging land use that reduces exposure to risks from coastal hazards, including through siting, design, construction and operational decisions include: Threat 4 - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets (WWTP/sewer/stormwater, roads etc.). Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which assesses (in-part) the risks from coastal hazards. Relevant Management Actions include: Action H3 Actions under U– Increase resilience of land, assets and people to impacts of sea level rise and increased tidal inundation (U1, U2, U4, U5, U7). Management Action U2 states – "Undertake a vulnerability assessment of existing and future development areas and LEP zonings, incorporating risk from coastal hazards, particularly sea level rise and tidal inundation. Incorporate sea level rise and tidal inundation risk into LEP and Sub-division DCP review." Management Action U4 states – "Using the outcome of asset vulnerability assessments, develop long term adaptation strategies to manage the impacts of sea level rise, including the development of triggers that identify when strategies need to be implemented, modified or reviewed." Management Action U5 states – "Consider preparation of a planning proposal to seek formal inclusion of a Coastal Vulnerability Area (tidal inundation) into the Coastal Management SEPP".

Management Objective	Issue	Where documented in CMP / Additional notes
f)	to adopt coastal management strategies that reduce exposure to coastal hazards: (i) in the first instance and wherever possible, by restoring or enhancing natural defences including coastal dunes, vegetation and wetlands, and (ii) if that is not sufficient, by taking other action to reduce exposure to those coastal hazards	The CVA is not mapped in the CMP. Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the CMP objectives generally promote this management objective (Natural habitats and biodiversity; stable river banks; coastal risk and adaptation to climate change; education, engagement and public opinion; economic prosperity; agricultural productivity). Section 4 of the CMP identifies key threats specifically relating to current and future risks from coastal hazards including: Threat 1- Bank erosion. Threat 2 - Habitat loss/barriers to habitat connectivity (waterway and riparian) Threat 4 - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets (WWTP/sewer/stormwater, roads etc.) Threat 5 - Loss of or impacts to Biodiversity (Tweed River entrance), tidal inundation, bank/foreshore erosion. Several CMP management actions seek to mitigate current and future risks from coastal hazards, taking into account the effects of climate change. Relevant Management Actions that reduce exposure to coastal hazards by restoring or enhancing natural defences, or other action to reduce exposure to hazards include: Fundamental Management Actions (A4, C3) All Actions under E - Promotion of the diversity of river uses All Actions under F – Rehabilitate and maintain priority bank erosion sites All Actions Under G – Rehabilitate and maintain riparian vegetation Actions under H - Restore natural drainage and reinstate tidal exchange (H3, H4, H6) All Actions under I - Investigate the potential for rehabilitation of former floodplain wetlands All Actions under J - Protect significant estuarine vegetation - improve condition and extent All Actions under K - Plan for and facilitate the migration of significant riparian and estuarine vegetation with sea level rise All Actions under U - Increase resilience of land, assets and people to impacts of sea level rise and increased tidal inundation. Actions under V - Address risk of overtopping of Bray Park Weir
g)	if taking that other action to reduce exposure to coastal hazards: (i) to avoid significant degradation of biological diversity and ecosystem integrity, and (ii) to avoid significant degradation of or disruption to ecological, biophysical, geological and geomorphological coastal processes, and (iii)to avoid significant degradation of or disruption to beach and foreshore amenity and social and cultural values, and (iv) to avoid adverse impacts on adjoining land, resources or assets, and (v) to provide for the restoration of a beach, or land adjacent to the beach, if any increased erosion of the beach or adjacent land is caused by actions to reduce exposure to coastal hazards	The CVA is not mapped in the CMP. As noted for f(i) and f(ii) above, several CMP Management Actions align with restoring or enhancing natural defences, to reduce exposure to coastal hazards (erosion and inundation of foreshores, and tidal inundation). With regard to 'taking other action', CMP Management Actions F1 to F5 specifically relate to rehabilitating and maintaining priority bank erosion sites. With regard to riverbank stabilisation, the second Specific local CMP Objective described in Table 4 is: "Increase resilience of riverbanks to erosion. Stabilise eroding banks using techniques that increase habitat value and enhance amenity. Manage riverbank erosion by bank rehabilitation and through encouraging compatible use of the waterway and riparian zone." This CMP objective generally promotes objective (g). Bank stabilisation or protective infrastructure restoration works for many of the identified sites (as prioritised in Appendix C) may involve coastal protection works as defined in the CM Act.

Management Objective	Issue	Where documented in CMP / Additional notes
h)	to prioritise actions that support the continued functionality of essential infrastructure during and immediately after a coastal hazard emergency	The CVA is not mapped in the CMP. Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the CMP objectives generally promote this management objective (Stable river banks, coastal risk and adaptation to climate change, economic prosperity). CMP Section 2 describes threats to estuary values. Specifically, relevant threats include: Threat 1 - Bank erosion; Threat 4 – Tidal inundation and coincident flooding damaging agricultural land, private property public facilities and assets. Hydrosphere Consulting (2020a) is the "Coastal Hazards and Risk Identification and Assessment Report" Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which also prioritises bank rehabilitation and stabilisation sites and protective infrastructure restoration works. Relevant Management Actions include: Actions under F – Rehabilitate and maintain priority bank erosion sites (F1 – F6). Actions under U - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets (U1, U2, U4, U5, U7).
i)	to improve the resilience of coastal development and communities by improving adaptive capacity and reducing reliance on emergency responses	The CVA is not mapped in the CMP. Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the CMP objectives generally promote this management objective (i.e. stable riverbanks, coastal risk and adaptation to climate change, economic prosperity, agricultural productivity). CMP Section 2 describes threats to estuary values. Specifically, relevant threats include: Threat 1 - Bank erosion; Threat 4 – Tidal inundation and coincident flooding damaging agricultural land, private property public facilities and assets. Hydrosphere Consulting (2020a) is the "Coastal Hazards and Risk Identification and Assessment Report" Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which also prioritises bank rehabilitation and stabilisation sites and protective infrastructure restoration works. Relevant Management Actions include: Actions under F – Rehabilitate and maintain priority bank erosion sites (F1 – F6). Actions under G - Rehabilitate and maintain riparian vegetation (G1, G2) Action H3 and H6 Action J3 and J4 Actions Under K - Plan for and facilitate the migration of significant riparian and estuarine vegetation with sea level rise Actions under U - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets (U1, U2, U4, U5, U7). Actions under V - Address risk of overtopping of Bray Park Weir.

Table 27: Management objectives for coastal environment area (Section 8 CM Act)

Management Objective	Issue	Where documented in CMP / Additional notes
a)	to protect and enhance the coastal environmental values and natural processes of coastal waters, estuaries, coastal lakes and coastal lagoons, and enhance natural character, scenic value, biological diversity and ecosystem integrity	Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). This object is generally promoted by several of the specific local objectives developed for the CMP (Table 4, Section 1.7). The alignment of the objects of the CM Act with the specific local objectives of the CMP is shown in Appendix D. Section 2 of the CMP describes the threats to estuary values. The CMP states; "Current key management issues facing the Tweed River estuary were identified and validated through previous plans and studies, community and stakeholder consultation (Hydrosphere Consulting (2017c) and additional detailed studies undertaken as a component of this CMP. Consideration was also given to moderate and high priority threats to estuaries State-wide as identified in the NSW Marine Estate Threat and Risk Assessment Report (BMT WBM, 2017), as listed in Appendix E. A discussion of the key threats affecting the Tweed River estuary, the causes/threatening processes contributing to these issues, the relevant CMAs, and the affected estuary values is provided in Hydrosphere Consulting (2021), and summarised in Table 7…" The threats, their primary causes, and the social and recreational, environmental, and commercial values affected are described in Table 7. The identified threats are indeed a threat to achieving management objective (a). The CMP includes an Implementation Strategy (section 3.3.1), a Recreational Use Strategy (section 3.3.2), a Water Quality Improvement Strategy (section 3.3.3) and a Dredging Strategy Statement (section 3.3.4). These strategies generally promote this management objective. These strategies form the baseline for relevant CMP Management Actions. Hydrosphere Consulting (2018) is the Water Quality Assessment and Improvement Strategy. Hydrosphere Consulting (2017b) assesses the impacts of future catchment development. Hydrosphere Consulting (2019) comprises the Ecological Assessment. Section 3 of the CMP describes the coastal management actions. The management actions are listed under categories including "Fundamental" and "Threat 1 to Threat 9". Management action headings in Section 3 include: Fundamental Management Actions Threat 1 – Bank Erosion Threat 2 – Habitat loss and barriers to habitat connectivity Threat 3 – Degraded estuarine water quality Threat 4 – Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets Threat 5 – Loss of or impacts to biodiversity Threat 6 – Lack of access to water and foreshore for non-boat recreation, particularly lack of sandy beaches Threat 7 – Conflict between river users Threat 8 – Reduced stocks of target fish species Threat 9 – Restricted levels of boating infrastructure and facilities or reduced navigability. Management actions that generally promote this management objective include: Actions under C - Estuary health monitoring and reporting program Action D1 – Increased adoption of best management practices to mitigate pollution of surface and groundwater and enhance biodiversity Actions under E - Promotion of the diversity of river uses. Actions under F - Rehabilitate and maintain priority bank erosion sites Actions under G - Rehabilitate and maintain riparian vegetation Actions under H - Restore natural drainage and reinstate tidal exchange Actions under I to W

Management Objective	Issue	Where documented in CMP / Additional notes
b)	to reduce threats to and improve the resilience of coastal waters, estuaries, coastal lakes and coastal lagoons, including in response to climate change	As above for (a). Multiple CMP management actions generally promote this management objective. Hydrosphere Consulting (2018) is the Water Quality Assessment and Improvement Strategy. Hydrosphere Consulting (2017b) assesses the impacts of future catchment development. Hydrosphere Consulting (2020a) comprises the Coastal Hazards and Risk Identification and assessment report. Hydrosphere Consulting (2019) comprises the Ecological Assessment. Hydrosphere Consulting (2021) describes the key management issues and threats. Reduction of threats to, and improvement of resilience of the Tweed River Estuary (including in response to climate change) is a key focus of this CMP. Management actions that generally promote this management objective include: Actions under C - Estuary health monitoring and reporting program Action D1 – Increased adoption of best management practices to mitigate pollution of surface and groundwater and enhance biodiversity Actions under E - Promotion of the diversity of river uses. Actions under F - Rehabilitate and maintain priority bank erosion sites Actions under G - Rehabilitate and maintain riparian vegetation Actions under H - Restore natural drainage and reinstate tidal exchange Actions under I to W. Two good examples of aligned management actions are for example: Management Action K1 – “Using tidal inundation maps, review LEP zoning in High and Moderate priority areas for mangrove and saltmarsh migration, as identified in Appendix C. Identify opportunities for incorporation of estuary vegetation migration areas into E or RU6 zones, particularly on public land. Identify these and appropriate additional areas that warrant detailed consideration under TSC’s DCP A19 clause C4, ‘Bushland or Wetland Vegetation on the coastal Floodplain’”. Management Action L3 – “Collaborate with DPI Fisheries to invest in and develop local restoration projects for native oyster species”.
c)	to maintain and improve water quality and estuary health	As above for (a) and (b).
d)	to support the social and cultural values of coastal waters, estuaries, coastal lakes and coastal lagoons	This management objective is generally promoted by several of the specific local objectives developed for the CMP (Table 4, Section 1.7). The alignment of the objects of the CM Act with the specific local objectives of the CMP is described in Appendix D. The CMP includes an Implementation Strategy (section 3.3.1), a Recreational Use Strategy (Section 3.3.2), a Water Quality Improvement Strategy (Section 3.3.3) and a Dredging Strategy Statement (section 3.3.4). These strategies fundamentally align with Management Objective (d). These strategies form the baseline for relevant CMP Management Actions. The CMP Management actions are described in Section 3. Some specific examples of management actions that generally promote this management objective include actions under: Threat 1 (E) - Promotion of the diversity of river uses. Threat 2 (N) - Improve habitat and visual impact outcomes for riverbank erosion stabilisation works Threat 4 (U) - Increase resilience of land, assets and people to impacts of sea level rise and increased tidal inundation Threat 6 (X) - Improvements to foreshore parks and recreational facilities Threat 6 (Y) - Maintain and improve facilities for connectivity of public access along the foreshore Threat 6 (Z) - Maintain amenity of existing estuary beaches and create additional artificial sandy beaches Threat 7 (AA) - Reduce river user conflict through provision of adequate access and infrastructure and through sufficient separation of incompatible uses Threat 7 (BB) - Continue to work with TfNSW - Maritime to improve compliance with, and policing of boating rules, and recommend towing restrictions in conservation and restoration character zones Threat 9 (EE) - Maintain and improve boating infrastructure, access and ancillary facilities for boaters. Two good examples of aligned management actions are for example: Management Action B2 – “Involve representatives of the Aboriginal community in the implementation of the CMP to ensure their values are prioritised appropriately”. Management Action E2 – “Promote the character zones and their aims and provide educational materials to encourage vessel operators undertaking high impact activities (skiing, wakeboarding, wake surfing, PWC) to avoid the conservation and restoration zones for high wake, noise and amenity disturbing activities.”

Management Objective	Issue	Where documented in CMP / Additional notes
e)	to maintain the presence of beaches, dunes and the natural features of foreshores, taking into account the beach system operating at the relevant place	Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the objectives generally promote this management objective (i.e. stable river banks, public access to and use of the river and foreshore, coastal risk and adaptation to climate change). CMP Section 2.1.2 describes estuary (coastal) processes. CMP Section 2 describes threats to estuary values. Specifically, relevant threats include: Threat 1 – Bank erosion; Threat 4 – Tidal inundation and coincident flooding damaging agricultural land, private property public facilities and assets; Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly, a lack of sandy beaches. Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which assesses (in-part) the risks to maintaining the presence of beaches and the natural features of foreshores. Relevant Management Actions include: Actions under E – Promotion of the diversity of river uses (E1 – E3). Actions under F - Rehabilitate and maintain priority bank erosion sites. Actions under Z - Maintain amenity of existing estuary beaches and create additional artificial sandy beaches (Z1, Z2). Actions under FF - Ensure adequate planning, assessment and control of dredging and sand extraction in the estuary (FF1, FF2).
f)	to maintain and, where practicable, improve public access, amenity and use of beaches, foreshores, headlands and rock platforms	Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the objectives generally promote this management objective (i.e. stable river banks, public access to and use of the river and foreshore, coastal risk and adaptation to climate change). CMP Section 2.1.2 describes estuary (coastal) processes. CMP Section 2 describes threats to estuary values. Specifically, relevant threats include: Threat 1 – Bank erosion; Threat 4 – Tidal inundation and coincident flooding damaging agricultural land, private property public facilities and assets; Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly, a lack of sandy beaches. Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which assesses (in-part) the risks to public access, amenity and use of beaches (within the estuary management area). Relevant Management Actions include: Actions under E – Promotion of the diversity of river uses (E1 – E3). Actions under F - Rehabilitate and maintain priority bank erosion sites. Actions under Z - Maintain amenity of existing estuary beaches and create additional artificial sandy beaches (Z1, Z2). Actions under FF - Ensure adequate planning, assessment and control of dredging and sand extraction in the estuary (FF1, FF2).

Table 28: Management objectives for coastal use area (Section 9 CM Act)

Management Objective	Issue	Where documented in CMP / Additional notes
a)	to protect and enhance the scenic, social and cultural values of the coast by ensuring that: (i) the type, bulk, scale and size of development is appropriate for the location and natural scenic quality of the coast, and (ii) adverse impacts of development on cultural and built environment heritage are avoided or mitigated, and (iii) urban design, including water sensitive urban design, is supported and incorporated into development activities, and (iv) adequate public open space is provided, including for recreational activities and associated infrastructure, and (v) the use of the surf zone is considered	Section 3.4.1 of the CMP identifies related TSC management programs including: - Land use planning and development controls. - On-site sewage management program. - Integrated Water Cycle Management Strategy (Hydrosphere Consulting, 2016b) implementation... etc. General observations: (i) The CMP does not specifically address the type, bulk, scale and size of development. However, it does include the following relevant Management Actions: Action N1 – "Ensure DA conditions reflect the objectives of the CMP to achieve the mitigation of harmful impacts on riparian vegetation, aquatic habitat and visual amenity when full height structural works (i.e. to the top of bank) are required to stabilise erosion on either public or private land". Action U2 - "Undertake a vulnerability assessment of existing and future development areas and LEP zonings, incorporating risk from coastal hazards, particularly sea level rise and tidal inundation. Incorporate sea level rise and tidal inundation risk into LEP and Sub-division DCP review." Action U4 – "Using the outcome of asset vulnerability assessments, develop long term adaptation strategies to manage the impacts of sea level rise, including the development of triggers that identify when strategies need to be implemented, modified or reviewed." (ii) The CMP does not focus on this level of detail as it relates to development. However, relevant CMP local specific objectives include: "Protect and enhance the quality of views to and from waterways and foreshores through appropriate designs and measures to mitigate visual impacts of development and other uses.", and; Protect cultural sites and promote Aboriginal cultural values of the estuary through education and sustainable use of the estuary". (iii) Hydrosphere Consulting (2018) is the 'Water Quality Assessment and Improvement Strategy'. This Hydrosphere Consulting (2020a) includes consideration of water quality issues as they relate to land use and storm water. Hydrosphere Consulting (2017b) is 'Assessing the Impact of Future Catchment Development' which considers: -potential future scenarios for changes to the dominant agricultural crop (sugarcane) on the floodplain; -potential for expansion of urban and rural development and anticipated impacts; and -the influence of water resource development and water extraction on the estuary. Hydrosphere Consulting (2017b) also considers the CERAT Model (OEH 2012). Hydrosphere Consulting (2017b) concludes (in-part) with the statement – "Catchment modelling has shown that the planned future urban development within the Tweed River estuary is predicted to have relatively minor impacts on the total catchment load of nutrient and sediment. However, on a local scale, immediately downstream of development areas, there is potential for increases in nutrient and sediment loads to have significant local effects on aquatic ecosystem function, particularly during known high risk periods following rainfall/runoff events and during construction phases. Potential management actions for consideration by the Tweed River estuary CMP include: -Ensure Council requirements for stormwater detention and treatment are achieved for all future developments including requirements for construction phase of developments." Relevant CMP Management Actions include: Action C2 - Implement recommended changes to the water quality monitoring and reporting program and continue monitoring. Action G2 - Ensure consistency in the application of rehabilitation planning in the development assessment and approvals process, including the use of conditions to require development impacts to be offset as directed by the Biodiversity DCP. Action O1 - Ensure that requirements for stormwater detention and treatment are achieved for all future developments, including erosion and sediment control requirements during the construction phase. (iv) Specific local CMP objectives are described in Table 4 against the 'values' of the study area that were determined through the Community Values Study (Hydrosphere Consulting (2017c). Several of the objectives generally promote this management objective (public access to and use of the river and foreshore; recreational fishing; coastal risk and adaptation to climate change; scenic quality and amenity; education, engagement and public opinion; Aboriginal cultural heritage and practice). CMP Section 2 describes threats to estuary values. Several of the threats relate to the provision of public open space and recreational activities and associated infrastructure in particular: Threat 1 – Bank erosion Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly, a lack of sandy beaches. Threat 7 – Conflict between river users Threat 9 – Restricted levels of boating infrastructure and facilities or reduced navigability. Section 3.2.3 of the CMP is the Recreational Use Strategy which strategically considers recreational use of and access to the Tweed River estuary. Hydrosphere Consulting (2021) assesses and describes the "Key Management Issues and Threats". Appendix C is the "Risk Assessment" which assesses (in-part) the risks to maintaining public access, amenity and use of beaches and foreshores. Relevant Management Actions include: Actions under Fundamental Management Actions Actions under E – Promote of the diversity of river uses (E1 – E3) Actions under X - Improvements to foreshore parks and recreational facilities

Management Objective	Issue	Where documented in CMP / Additional notes
a)	continued	Actions under Y - Maintain and improve facilities for connectivity of public access along the foreshore Actions under Z - Maintain amenity of existing estuary beaches and create additional artificial sandy beaches (Z1, Z2) Actions under EE - Maintain and improve boating infrastructure, access and ancillary facilities for boaters Actions under FF - Ensure adequate planning, assessment and control of dredging and sand extraction in the estuary (FF1, FF2). (v) Not Applicable as the CMP management area does not include the surf zone.
b)	to accommodate both urbanised and natural stretches of coastline	This CMP does not cover the coastline areas.

APPENDIX E. LINKS TO THE MARINE ESTATE THREAT AND RISK ASSESSMENT AND TO THE MARINE ESTATE MANAGEMENT STRATEGY

This Appendix provides more information on the linkages between the CMP with the:

- Ranked Moderate and high priority threats to the Marine Estate as identified in the NSW Marine Estate Threat and Risk Assessment Report (BMT WBM, 2017); and
- The initiatives, objectives and actions of the *2018-2028 Marine Estate Management Strategy* (MEMA, 2018).

Table 29: Consideration of MEMA TARA ranked moderate and high priority state-wide threats to estuaries

MEMA TARA ranked moderate to high priority threats to estuaries State-wide	Relevant key threat category in Tweed River estuary CMP (i.e. may be listed as a stressor against under key threats)										Specific locations within the Tweed River estuary
	Threat 1 – Bank Erosion	Threat 2 - Habitat loss and barriers to habitat connectivity	Threat 3 - Degraded estuarine water quality	Threat 4 - Tidal inundation and coincident flooding damaging agricultural land, private property, public facilities and assets	Threat 5 - Loss of or impacts to biodiversity	Threat 6 - Lack of access to water and foreshore for non-boat recreation, particularly a lack of sandy beaches	Threat 7 - Conflict between river users	Threat 8 - Reduced stocks of target fish species	Threat 9 - Restricted levels of boating infrastructure and facilities or reduced navigability	Other management issues – Entrance Management; Aboriginal Cultural Heritage and Practice	
Agricultural diffuse source runoff	✓	✓	✓	✓	✓			✓			Upper estuary; Rous River estuary; middle estuary (Tumbulgum); transition zone
Urban stormwater discharge			✓								Whole estuary
Estuary entrance modifications + breakwaters										✓	Lower estuary
Clearing riparian and adjacent habitat including wetland drainage	✓	✓			✓						Whole estuary
Modified freshwater flows		✓	✓	✓							Whole estuary; Bray Park Weir
Recreation - boating and boating infrastructure	✓	✓			✓	✓	✓	✓			Whole estuary; Active Zone (Murwillumbah to Condong); and lower estuary
Navigation & entrance management and modification, harbour maintenance etc.	✓	✓	✓		✓			✓	✓		Lower estuary
Foreshore development	✓	✓	✓	✓	✓	✓	✓			✓	Whole estuary
Sewage effluent and septic runoff		✓	✓		✓			✓			Rous River estuary (Murwillumbah WWTP); Middle estuary (Tumbulgum WWTP)
Stock grazing of riparian and marine vegetation	✓	✓	✓		✓						Rous River estuary; upper estuary
Climate Change 20 years	✓	✓	✓	✓	✓			✓			Whole estuary
Four wheel driving					✓						Tweed Broadwater saltmarsh; Alf Rush Memorial Drive; wetlands on Leticia Spit
Shipping - Large commercial vessels and associated port activities and industries (trade ships, cruise ships, etc.)	N/A										
Commercial fishing - estuary general							✓	✓			Upstream of the lower estuary
Oyster aquaculture	N/A There is no oyster aquaculture within the Tweed River estuary. However, Oyster reefs and banks are discussed in “Habitat loss and barriers to habitat connectivity”										
Passive recreational use					✓	✓	✓		✓	✓	
Beach nourishment and grooming						✓			✓		
Recreational fishing - shore-based line and trap fishing								✓		✓	Whole estuary including recreational fishing havens of the lower estuary and enclosed waters of the Fingal Peninsula
Recreational boat-based line and trap fishing								✓		✓	Whole estuary including recreational fishing havens of the lower estuary
Deliberate introduction of plants and animals (e.g. foxes, bitou bush)					✓						Whole estuary
Pipelines, cables, trenching and boring											
Shipping -small commercial vessels (ferries, charter boats etc.)	✓				✓		✓		✓		Whole estuary other than the Rous River estuary
Recreational fishing- hand gathering								✓		✓	Whole estuary including recreational fishing havens of the lower estuary and enclosed waters of the Fingal Peninsula
Whale and dolphin watching											Lower estuary
Oil, gas, minerals, sand, aggregate, coal mining	✓	✓			✓			✓	✓		Transition zone (commercial sand extraction)
Commercial fishing – estuary prawn trawl	N/A										

Table 30: Linkages between the Tweed River Estuary CMP and relevant actions in the Marine Estate Management Strategy (MEMA 2018)

Marine Estate Management Strategy			Link to Tweed River Estuary CMP
Management Initiative	**State-wide priority threats relevant to Tweed River Estuary**	**Actions**	
1. Improving water quality and reducing litter	• Water pollution was identified as the number one threat to both the environmental assets and the social, cultural and economic benefits derived from the marine estate • Agricultural diffuse source runoff • Clearing riparian vegetation and adjacent habitat including wetland drainage • Stock grazing of riparian and marine vegetation • Urban stormwater discharge • Sewage effluent and septic runoff • Climate change (20 years) • Modified freshwater flows, hydrology, hydraulics and flow regimes • Water pollution including from litter, solid waste, marine debris and microplastics • Seafood contamination • Inadequate, inefficient regulation and/ or over regulation (agencies) • Reduction in abundance of species and trophic levels • Habitat disturbance • Lack of community awareness of the marine estate and associated threats and benefits • Inadequate social and economic information	1.1 Improve water quality in agricultural and urban catchments using a pilot-based implementation of the *Risk-based Framework.*	This CMP supports the ongoing adoption, implementation and consideration of relevant strategies, plans and frameworks for use in Council's land use planning and assessment process (refer Action A2).
		1.2 Improve the management of diffuse-source water pollution [including stormwater] by: • clarifying NSW Government and local government roles and responsibilities • building capacity to implement the Risk-based framework • using mechanisms within existing policy, planning and legislative frameworks to improve outcomes • improving minimum requirements for industry standards and ensuring compliance with regulations and best-practice through social research, education campaigns and compliance programs.	Section 3.3.3 of the CMP provides a Water Quality Improvement Strategy which aims to achieve the detailed local objectives developed for this CMP including achieving greater compliance with Tweed River Flow Objectives and Water Quality Objectives. Components of the Water Quality Improvement Strategy, as detailed in the Water Quality Assessment (Hydrosphere Consulting, 2018) and the Ecological Assessment (Hydrosphere Consulting, 2019) are recommended in the CMP. CMP actions relate to bank protection and rehabilitation (Action D – G), development controls, reduction in acid runoff, catchment nutrient inputs, sediment inputs and human health risk and improvements to wastewater and effluent management (Actions O to T). In particular, Action D1 is focused on improving landholder awareness and uptake of best management practice in regard to water quality.
		1.3 Facilitate and deliver on-ground activities that reduce diffuse-source water pollution through investigation and provision of funding programs and financial incentives.	
		1.4 Implement a targeted marine litter campaign and establish a Marine Litter Working Group.	Marine litter and debris is an identified threat to estuarine water quality, fish stocks and biodiversity as identified in Section 2. Action W2 and W3 involve determining mapping of and periodic removal of plastic litter and marine debris from key locations in the estuary.
		1.5 Develop monitoring, reporting and performance indicators for water quality actions and fill key knowledge gaps. This action is integrated into the Monitoring Program.	The Tweed River Estuary Health Monitoring and Reporting Program (Action C) includes the continuation or establishment of monitoring programs for water quality, bank condition, oyster banks and reefs, avifauna and dolphins to provide a good assessment of ecosystem health throughout the estuary, as well as development and annual release of an easy-to-understand estuary health report card.
2 - Delivering healthy coastal habitats with sustainable use and development	• Dredging • Hydrological modifications • Modified freshwater flows • Foreshore development • Clearing of riparian vegetation • Beach nourishment and grooming • Four-wheel driving • Governance • Lack of access	2.1 Assess and manage cumulative and legacy impacts for estuary entrance modification and dredging by: • strategically dredging trained entrances to minimise the impact of interruptions to sand movement caused by entrance infrastructure and redeploying sand at erosion and sediment deprived locations • developing and incorporating practical design features that maximise marine habitat and recreational values into existing training walls during maintenance and upgrade works • auditing commercial dredging in estuaries.	The Tweed River Entrance Sand Bypassing Project (TRESBP) has been in operation since 2001 and seeks to maintain the natural flow of sand northwards, whilst maintaining a navigable entrance channel (Hydrosphere Consulting, 2020a). Continuation of longshore sand movement is provided through operation of the TRESBP and associated monitoring and maintenance programs. No additional management responses were identified regarding entrance management in this CMP. A significant discussion on historic and recent estuarine dredging is provided in Hydrosphere Consulting (2020a), summarised in Section 3.1.3. Actions FF1 and FF2 recommend the consideration of preparing a local dredging strategy and the review of review of TRESBP monitoring data, respectively.
		2.2 Assess and manage cumulative and legacy impacts on foreshore development and land-use change in the coastal zone by: • reviewing and updating existing coastal design guidelines to promote best-practice designs in coastal urban environments. • implementing policy changes to enable adequate assessment of and response to the impact of existing infrastructure that modifies freshwater flows or drains wetlands when rezoning or when land-use change is considered to remediate the legacy impacts of older infrastructure.	The Tweed DCP (TSC, 2008b) Section 3 contains development standards and other provisions in respect of floodplain management in Tweed Shire and relates to Tweed Local Environmental Plan which is the principal planning instrument governing development in the Shire. The Tweed LEP undergoes periodic review.

Marine Estate Management Strategy			Link to Tweed River Estuary CMP
Management Initiative	**State-wide priority threats relevant to Tweed River Estuary**	**Actions**	
		2.3 - Develop and implement a state-wide policy for the management of coastal Crown lands (including submerged lands) in collaboration with local government Coastal Management Programs in priority areas to: • develop estuary-wide strategies that reduce red tape and inform the assessment of foreshore structures strategies for private works spanning the intertidal foreshore (such as pontoons and boat ramps); • develop marine vegetation management plans that maximise resilience, accommodate sea level rise (see Initiative 3), address key threats (clearing and drainage, cattle grazing, four-wheel driving on saltmarsh), facilitate rehabilitation opportunities (see Initiative 1) and reduce red tape for low impact works (e.g. mangrove trimming for safety traffic sightlines) • investigate estuary-wide bank protection options to inform the assessment of bank protection work proposals (including beach nourishment and grooming) and facilitate rehabilitation opportunities (see Initiative 1) • facilitate greater coordination between State and local government in the assessment of foreshore and intertidal zone development proposals • maximise State and local government responses for noncompliant development and activities.	Tweed River Domestic Structures Strategy (DoI – Crown Lands *et al*., 2008) has been adopted by Council and is the basis for the development of further strategies across the northern region under the MEMS. Refer Action A2: Ensure the ongoing implementation of related Council management programs and strategies and support of related agency plans and strategies. The Ecological Assessment () identifies priority areas for action with regards to the migration of estuarine vegetation with sea level rise with relevant sub-actions provided under Action K: “Plan for and facilitate the migration of significant riparian and estuarine vegetation with sea level rise”. Action G includes the development and implementation of a detailed Riparian Zone Management Plan for highly disturbed segments including in the upper catchment and on private land in the Rous River. Voluntary land management agreements with private land holders will be used to rehabilitate and maintain existing riparian vegetation on private land for environmental/conservation purposes, TSC will encourage private landholders to carry out riparian revegetation and rehabilitation projects on private land. The management of anthropogenic impacts on seagrass extent and conditions is addressed through sub-actions under Action J: Protect significant estuarine vegetation - improve condition and extent. TSC is currently addressing high priority erosion risks on public land as funding becomes available. Re-prioritised high and moderate priority areas for bank rehabilitation were identified in investigations undertaken for this CMP (Action F: Rehabilitate and maintain priority bank erosion sites). Specific actions also include engineering investigations and design for high and high-medium priority rock wall remediation sites; monitoring of erosion stabilisation techniques; support for MEMA reforms of the DA process for best practice riverbank erosion stabilisation; and investigation of options for bank protection to accommodate wake-generating recreational activities in the proposed “Active Use Zone”. Action F5: Support MEMA reforms of DA process for best practice riverbank erosion stabilisation. Action N: Improve habitat and visual impact outcomes for riverbank erosion stabilisation works allowing for the establishment of riparian habitat.
		2.4 Re-establish resilient coastal floodplains and connectivity within coastal catchments by: • better aligning existing government policy and resourcing for floodplain and drainage management • providing fish passage at priority weir and road crossing barrier sites in coastal catchments.	Several successful projects have been undertaken and management procedures modified in the Tweed which have contributed to re-establishing hydrological connectivity and mitigation of some of the more severe impacts that agricultural drainage once had on the Tweed River estuary. These have included the removal of obsolete structures (weirs), modification of floodgates and management practices and the increased uptake of best practice management on farms. The continued restoration of natural drainage and reinstatement of tidal exchange, where appropriate, to assist in addressing habitat loss and further optimise the ecological value of the floodplain is proposed through Action H. Investigating the rehabilitation of former floodplain wetlands is a management action with the potential for maximising ecosystem benefits provided by the floodplain, whilst minimising the impact of agriculture on estuary ecosystems. Refer Action I.
		2.5 Undertake research and monitoring to address key knowledge gaps, such as techniques to minimise the impact of trained estuary entrances and methods for determining marine vegetation resilience and assess the effectiveness of the management actions within this initiative. This action is integrated into the Monitoring Program.	Several detailed studies were undertaken in the development of this CMP to address knowledge gaps on Water Quality (Hydrosphere Consulting, 2018), Future Development (Hydrosphere Consulting, 2017b), Coastal Hazards (Hydrosphere Consulting, 2020a), Ecology (Hydrosphere Consulting, 2019), Recreational Use (Hydrosphere Consulting, 2017d) and Tidal inundation (BMT WBM, 2019). These detailed studies have been used to inform the continuation of existing monitoring parameters and the establishment of new monitoring programs (Action C).

Marine Estate Management Strategy			Link to Tweed River Estuary CMP
Management Initiative	**State-wide priority threats relevant to Tweed River Estuary**	**Actions**	
3. Planning for a changing climate	• Sea level rise on saltmarsh, mangroves, beaches and mudflats, rocky shores and species and communities protected under the FM Act and BC Act • Ocean acidification on all environmental assets • Altered storm and cyclone activity on water, saltmarsh, seagrass, reefs and species and communities protected under the FM Act and BC Act • Climate change and sea temperature rise on all environmental assets • Environmental climate change stressors (20 years) on public participation in the marine estate; food ad business viability; and spiritual connectivity. •	3.1 Enhance mapping of estuarine communities (such as saltmarsh and mangroves) to identify those communities most at threat from sea level rise under expected climate change scenarios and use this information to model areas of land suitable for retreat and those that should be prioritised for protection. Apply this information in decision making.	The CMP Identifies coastal hazard risks and develops actions that increase the adaptive capacity of Council, the community and natural systems to the predicted impacts of climate change, including increased storm intensity and sea level rise. Improving the capacity of the estuary to withstand and recover from intense weather events and adapt to future increases in tidal inundation, by allowing for migration of fringing habitats with sea level rise is a key objective of the CMP. A detailed localised tidal inundation assessment is provided in BMT WBM (2019) with relevant actions regarding vulnerability assessments and development of adaptive strategies provided in Actions U1-U8. The impacts of climate change and sea level rise on ecosystems was investigated in the Ecological Assessment (Hydrosphere Consulting, 2019) and included in the Risk Assessment (Appendix C) along with impacts from of sea level rise and tidal inundation on Aboriginal cultural heritage (sites and places of significance. Relevant actions: Action B3: re raising the profile of Aboriginal cultural heritage significance of the Tweed Shire. Action G1 - Riparian zone management planning. Action H3 - Cost-benefit analysis and feasibility studies of alternative land use options including restoration of natural drainage, reinstatement of tidal exchange, rehabilitation of former wetland and backswamp areas and accommodating landward retreat of estuarine vegetation communities. Action K – Facilitating the migration of significant riparian and estuarine vegetation with sea level rise. Action L – Supporting the conservation and recovery of shellfish ecosystems. Action U1 – U8 involving a variety of actions to increase resilience of land, assets and people to impacts of sea level rise and increased tidal inundation such as vulnerability assessment, development of long-term adaptation strategies, consideration of inclusion of a CVA and communication strategies re sea level rise and tidal inundation.
		3.3 Build the knowledge and capacity of coastal and marine managers and the community to increase resilience to climate change in the marine estate through strategic adaptation planning and management.	
		3.4 Investigate the impacts of climate change on Aboriginal cultural heritage values in the marine estate and implement strategies to reduce or adapt to this risk. This action is linked to Initiative 4.	
4. Protecting the Aboriginal cultural values of the marine estate	• Resource-use conflict • Environmental degradation from water pollution, habitat disturbance, pests and disease or climate change • Governance of the marine estate and critical knowledge gaps • Public safety from contaminated shellfish • Lack of access availability	4.1 Work with Aboriginal communities to evaluate current arrangements for Aboriginal involvement in Sea Country management and decision-making and establish and implement a framework to ensure the involvement of Aboriginal people is effective and appropriate	Tweed Council acknowledges and respects the Tweed Aboriginal community's right to speak for its country and to care for its traditional country in accordance with its laws, customs and traditions and welcomes the Aboriginal people's contribution to protecting, strengthening and enriching the heritage of all Australians within the wider community. A key objective of the CMP (refer Section 1.7) is to "*Protect cultural sites and promote Aboriginal cultural values of the estuary through education and sustainable use of the estuary*". Feedback during the consultation process identified that the Aboriginal people are avid users of the estuary and the Aboriginal community wants to have a voice in rehabilitation projects, take ownership of actions and be involved in implementation of the CMP including on-ground actions and this is reflected through management actions B2 and B3 to works with Aboriginal community representatives to ensure their values are prioritised and to raise the profile of Aboriginal cultural heritage in the estuary.
		4.2 Work with Aboriginal communities to identify the cultural values of Sea Country to improve the incorporation of values into decision-making on the marine estate	
		4.3 Implement an integrated Aboriginal engagement model to increase Aboriginal participation in Sea Country management, planning and monitoring through employment and training of Aboriginal people at a regional and local level.	
		4.4 Explore and assist Aboriginal communities to implement opportunities for economic development in the NSW marine estate and improved representation of Aboriginal cultural values in NSW marine parks.	
		4.5 Integrate research and monitoring into the Monitoring Program to address key knowledge gaps and to assess management effectiveness in reducing threats and risks to Aboriginal cultural heritage.	

Marine Estate Management Strategy			Link to Tweed River Estuary CMP
Management Initiative	**State-wide priority threats relevant to Tweed River Estuary**	**Actions**	
5. Reducing impacts on threatened and protected species	• Climate change • Estuary entrance modifications • Point discharges, • Introduction of animals and plants, • Agricultural diffuse-source runoff • Clearing riparian and adjacent habitat including wetland drainage • Foreshore development • Urban stormwater discharge • Modified freshwater flows • Passive recreational use – swimming, surfing, walking and dog walking. • Four-wheel driving • Charter activities – whale and dolphin watching • Boating and boating infrastructure • Small commercial vessels (e.g. ferries, charter boats) • Habitat disturbance • Wildlife disturbance and impacts on species	5.3 Improve the awareness of threats to threatened and protected species and compliance with regulations to reduce impacts through education campaigns, social research (see Initiative 8) and increased compliance.	Education campaigns or opportunities associated with shellfish ecosystems, faecal contamination, threatened species, nature based recreational opportunities, boating impacts (especially to seagrasses and high tide roosts), aboriginal cultural heritage and values, sea level rise impacts and commercial fishing impacts and benefits are recommended within or supported through Actions B1, B3, B4, E1, E2, J1, L1, M2, T2, U7, V1, BB1 and CC1.
		5.4 Improve reporting and data sharing on protected species threats to support evidence-based decision-making, including linking and enhancing existing databases, raising awareness of reporting pathways, actively analysing and communicating data more regularly and integrating research and data into the Monitoring Program.	Monitoring of oyster banks and reefs, avifauna, raptors and dolphins is a component of the Estuary Health Monitoring and Reporting Program (Action C) and will be disseminated in an annual estuary health report card.
		5.6 Understand and reduce impacts of threatened and protected species habitat modification through mapping of key habitat areas, embedding rehabilitation and conservations actions in planning processes and collaborating with landowners and the community to protect species and habitats.	Detailed information is provided in the Ecological Assessment (Hydrosphere Consulting, 2019) and summarised in Section 2 with relevant actions as follows: Action C – including regular mapping and reporting program for oyster banks and reefs. Actions F and G - bank restoration and rehabilitation of riparian vegetation (i.e. provision of shade and in-water habitat structures. Action J: preventing physical damage to seagrass, raising awareness of the physical damage to seagrass from boating activities and improved management of sensitive wetland areas of Letitia Spit. Action K: planning for and facilitating the migration of estuarine vegetation with sea level rise.
		5.7 Develop and implement research programs to address key knowledge gaps associated with cumulative threats to threatened and protected species and the effectiveness of management interventions. This action will be integrated into Modified freshwater flows the Monitoring Program	Action C - including regular mapping and reporting program for several threatened and protected species including continued support of dolphin population monitoring.
6. Ensuring sustainable fishing and aquaculture	• Estuary general fishery impacts on fish assemblages • Shore and boat-based line and trap fishing (estuaries and offshore) impacts on fish assemblages • Boat-based line and trap fishing (offshore) impacts on species and protected communities • Hand gathering (coast) impacts on fish assemblages • Oyster aquaculture	6.1 Introduce harvest strategies and evaluate ecological risk in partnership with stakeholders and shareholders to address the priority threats associated with the reduction in abundance of fish species and trophic levels	Management of the commercial and recreational fisheries in the Tweed River estuary is governed and regulated by DPI Fisheries. TSC will collaborate with DPI Fisheries on an education/engagement program to improve community understanding of commercial fishing impacts and benefits and the science-based management of the industry (Action CC1). There are no aquaculture leases in the CMP study area.
		6.2 Conduct an environmental assessment of recreational fishing, periodically review current rules and take action to improve fish stocks and to address threats associated with harvest, bycatch and illegal sale of fish	
	• Resource use conflict • Environmental • Governance • Critical knowledge gaps • Lack of access	6.7 Partner with fishing and aquaculture sectors to deliver information and training to fishers in NSW to improve self-compliance and sustainable fishing practices and develop economic opportunities	
		6.8 Work with fishing sectors and tourism authorities to investigate and implement opportunities to promote fishing and NSW wild caught seafood and build social licence.	

Marine Estate Management Strategy			Link to Tweed River Estuary CMP
Management Initiative	**State-wide priority threats relevant to Tweed River Estuary**	**Actions**	
7. Enabling safe and sustainable boating	• Boating and boating infrastructure – affects water, seagrass, beaches and mudflats, shallow soft sediment and species and communities protected under the FMA and BCA • Small commercial vessels (e.g. ferries, charter boats, commercial fishing, whale watching) on species protected under the BCA	7.1 Reduce the threats to seagrass from vessels through improved regulation, administration, education, new mooring technologies and delivery mechanisms.	Relevant actions include: • the delivery of an Annual Estuary Health Report Card (Action C) • education project to reduce boating impacts on seagrass beds (Action J1) • protection of estuarine vegetation from vehicle access/ boat launching in susceptible areas (Action J2) • ensuring design of beach creation and beach nourishment projects consider impacts to seagrass beds including grainsize suitability and slope of placement to reduce impacts from slumping (Actions Z1 and Z2) In addition, the Recreational Use Strategy (Hydrosphere Consulting, 2017d) will be used to guide Council and other relevant agencies in planning for future recreational use of the estuary. The Strategy aims to provide for the various recreational activities that are valued by users of the estuary, address conflicts between users and minimise impacts on environmental, cultural and amenity values. The Strategy includes constraints on access to the waterway and impacts such as estuarine vegetation damage.
		7.2 Establish a framework to manage increased mooring demand through the Moorings Review program.	TSC will continue to liaise with relevant stakeholders regarding the upgrade and expansion of Tweed Port in line with Council and community requirements (Action DD). Specific actions are also recommended for the maintenance and improvement of infrastructure and facilities (Action EE).
		7.4 Partner with industry to investigate a pilot program at marinas in NSW to design and install sump drain runoff handling systems with sediment traps.	
		7.5 Improve awareness of threats to threatened and protected species and compliance with regulations, through data sharing, education, social research and compliance planning to reduce impacts of boating. This links to actions in Initiatives 5, 8 and 9.	Refer response to MEMS Actions 5.3 and 7.1.
	• A Lack of access • Governance	7.7 Continue improving environmentally sustainable boating and resolve conflicting uses and waterway access to the marine estate through the NSW Boating Now Program.	The CMP aims to reduce conflict between river users and deliver infrastructure through: • Recommendation of a character zone approach for boating restrictions to TfNSW - Maritime (Action E1); • Provision of adequate access and infrastructure and through sufficient separation of incompatible uses (Action AA); and • Continuing to work with TfNSW - Maritime to improve compliance with and policing of boating rules and recommend towing restrictions in conservation and restoration character zones (Action BB).
		7.8 Deliver waterways infrastructure in accordance with the Maritime Safety Plan to enhance social, cultural and economic benefits through an interagency approach (also see Initiative 8).	
8. Enhancing social, cultural and economic benefits	• Governance of the marine estate • Critical knowledge gaps • Lack of access availability • Resource-use conflict	8.1 Increase stakeholder and community awareness of marine estate values, management arrangements and promote safe and ecologically sustainable use of the marine estate by: • building on existing school and community education programs to encourage environmental stewardship, enhance self-compliance and promote physical and mental health benefits associated with nature • developing and promoting best practice guidance / codes of practice to reduce resource use conflicts (also see action 8.4) • developing online information resources and expansion of digital technologies.	Refer response to MEMS Action 1.2, 5.3 and 7.7.
		8.3 Establish and deliver the Marine Integrated Monitoring Programs social, cultural and economic components, to: • develop a shared understanding of the NSW community's attitudes, values, perceptions, experiences, knowledge, aspirations, patterns of use to support evidence-based decision-making and adaptive management • communicate data / results publicly through appropriate information portals.	Refer response to MEMS Action 1.5.

Marine Estate Management Strategy			Link to Tweed River Estuary CMP
Management Initiative	**State-wide priority threats relevant to Tweed River Estuary**	**Actions**	
		8.4 Develop a baseline of current and future use of the marine estate, initially at a pilot scale, to support effective management, address resource use conflicts and access to the marine estate by: • carrying out a comprehensive analysis of human use activities, supporting infrastructure and facilities, activity trends, management issues • spatially mapping on a public facing digital platform • identifying hotspots and developing specific management responses to address issues in partnership with agencies and stakeholders • linking outcomes to education and awareness programs to promote best practice (also see action 8.1).	The Recreational Use Strategy (Hydrosphere Consulting, 2017d) will be used to guide Council and other relevant agencies in planning for future recreational use of the estuary. The Strategy aims to provide for the various recreational activities that are valued by users of the estuary, address conflicts between users and minimise impacts on environmental, cultural and amenity values. The Strategy includes constraints on access to the waterway and impacts such as estuarine vegetation damage.
9. Delivering effective governance	• Governance of the marine estate	9.1 Improved co-ordination and integration across all levels of government (including cross-border and the land–sea interface) by developing a governance framework piloted at a catchment scale (see Initiative 1) to: • identify overlapping jurisdictional boundaries • clarify roles and responsibilities • align policies and programs • Identify opportunities for: - data management and sharing - research, monitoring and mapping - compliance and reporting - communication and engagement.	This CMP aims to improve coordination and integration across state and local government as relevant to the management of the Tweed River estuary and includes: • identification of roles and responsibilities (Section 1.8; and within each action in the Action Plan); • alignment of policy and programs (Section 1.8.3 and Actions A2 and A3); • actions related to research, monitoring and mapping (Actions A4, C3-C6; L2; U8; W2; FF1 and FF2); • actions related to communication and education (Actions B1, B3, B4, E1, E2, E3, I2, J1, L1, M2, T2, U7, W1, BB1 and CC1); and • actions related to compliance, enforcement and reporting (Actions C7; E1; O1; P6; Z1 and Z2)
		9.2 Increased stakeholder and community participation by building capacity and awareness of coastal and marine management, piloted at a catchment scale (see Initiative 1) and locally via marine park management planning pilots.	Achievement of the management plan objectives is reliant on stakeholder and community understanding and effective involvement in the management process. Specific actions include (Action B): • Development of a Stakeholder Engagement Strategy to guide education, engagement and consultation activities and to coordinate relevant educational/engagement sub-actions in this CMP; • Work with representatives of the Aboriginal community and DPE to raise the profile of the Aboriginal cultural heritage significance of the Tweed Shire including history, values and cultural practices associated with the estuary, both historic and ongoing; and • Provide additional nature based educational opportunities including signage and information.
		9.4 Improve co-ordination and effectiveness of compliance across government by: • investigating tools to support proactive compliance by users through use of new technologies and education programs (see Initiative 8) • collaborate across multiple government agencies to co-ordinate enforcement, education and data sharing.	Refer response to MEMS Action 9.1.