

# Macleay River Estuary

## Estuary Management Study



# Macleay River Estuary Estuary Management Study

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# Executive Summary

Kempsey Shire Council, through its Coast & Estuary Management Committee has resolved to prepare an Estuary Management Plan (EMP) in accordance with States Estuary Program for the Macleay River estuary (the lower Macleay River, its tributaries and associated floodplain).

The purpose of an EMP is to provide a program of strategic actions and assist with funding for council, government authorities and other stakeholder groups to improve the Macleay River estuary through appropriate waterway, foreshore and catchment management initiatives.



The precursor to an EMP is preparation of an Estuary Management Study (EMS). The EMS is supported by a number of studies and assessments specific to Macleay River Estuary and includes:

- data compilation;
- tidal gauging;
- processes study; and
- ecology study.

The EMS identifies estuary values, uses, issues, management objectives and an initial set of management strategies with the aim of improving the health of the estuary and providing for the various uses of the estuary such as boating and fishing.

The study area for the Macleay River estuary covers the floodplain and includes the main regional town of Kempsey, in addition to the smaller towns of Frederickton, Smithtown, Kinchella, Jerseyville, Stuarts Point, Fishermans Reach and South West Rocks. The Macleay River estuary extends some 54 kilometres upstream from the ocean at South West Rocks to the tidal limit at Belgrave Falls about 10 km upstream of Kempsey. The study area also includes Back Creek (South West Rocks Creek). While the Macleay River is the dominant watercourse on the floodplain, significant tributaries include Christmas, Borrigalla and Clybucca Creeks, Macleay Arm to the north and Belmore River and Kinchella Creek to the south.

## **A Snapshot of the Estuary's Values and Issues**

The Macleay River estuary with a catchment of 11,000 km<sup>2</sup> is the regions second largest coastal river linking the tablelands of Armidale, gorge country and big valley to the ocean at South West Rocks.

The Macleay River estuary provides significant recreational boating opportunities that in turn form a vital component of the tourism sector of the lower Macleay River Valley and a significant lifestyle activity enjoyed by a large proportion of the community. Availability of suitable river access points and appropriate and complimentary marine infrastructure is critical to the enjoyment of recreation boating in the estuary.

There are also significant levels of commercial and recreational fishing activities and oyster farming in the Macleay River estuary. Outside the estuary, trawlers catch fish and prawns, many of which are

ecologically linked to the estuary. Recreational fishing is widespread and the Macleay River is acknowledged as providing important habitat for Australian Bass, a significant recreational species.

The floodplain of the Macleay River estuary includes large backswamps (or floodplain wetlands) that cover 60% of the floodplain and are intrinsically connected to estuarine health. The Macleay floodplain holds approximately 15% of the coastal floodplain wetlands in NSW (Kingsford et al. 2003). While the estuary contains significant environmental attributes, less than 5% of the Macleay River floodplain is under environmental protection or existing/proposed national parks estate zonings (Birch and GeoLINK 2010).

The entire floodplain is underlain by estuarine soils that include acid sulfate soils. Since the early 1900s the Macleay floodplain has been extensively modified with the construction of floodgates, drains and levees which has had a detrimental impact on floodplain wetlands, acid sulfate soil management and water quality. Kempsey Shire Council in association with individual landholders, community-based organisations and government agencies has been addressing floodgate and drain management issues since 2000. Projects have included actively managing floodgates with an opening protocol, floodgate modification or other methods to achieve multiple objectives of improving drain water quality, enhanced fish passage, maintaining agricultural production and flood mitigation functions.

### **The Main Issues and Focus Areas**

The EMS has examined the following key issues and values relating to the Macleay River estuary:

- Riparian corridor which contains some high value ecosystems that occur within the Macleay River estuary but are highly degraded and fragmented;
- Bank erosion: there is a high correlation between the presence/absence of bank erosion and absence/presence of structurally diverse native riparian vegetation outside the areas where rock bank protection works have been implemented;
- Floodplain wetlands which are intrinsically connected to estuarine ecology and health but have been significantly altered in the Macleay estuary due to land clearing, drainage and flood mitigation works;
- Acid sulfate soils – the entire floodplain is underlain by estuarine soils that include acid sulfate soils. Exposure of acid sulfate soils which has led to water quality issues, reduction in agricultural productivity, and loss of estuarine habitat. There is a history of fish kills that usually occur after heavy rains following prolonged dry periods.
- Drains and floodgate management which impacts on floodplain wetlands, acid sulfate soil management and water quality;
- Boating in respect to river access points and boating infrastructure;
- Sedimentation and dredging particularly in relation to boating navigation of waterways in the estuary;
- Tourism to identify opportunities in respect to the range of estuary values and uses;
- Protection of ecological habitats and wildlife such as remaining rainforest pockets, wetlands, black cod and migratory shorebirds;
- Fishery management to address key issues impacting on oyster farming and recreational and commercial fishing concerns;
- Water quality such as 'blackwater' discharges following floods and other pollution concerns;
- Climate change impacts on the estuary particularly in regard to sea level rise; and
- Heritage issues: Aboriginal and European heritage to ensure consistency between the EMP and heritage strategies in the region.

### **Estuary Management Priorities**

The table overleaf shows the ranked management objectives that have been developed following assessment of the above issues and values. The ranking relates to priority for management over the next five to ten years which is the expected planning timeframe for the Macleay River Estuary Management Plan before it undergoes review and adjustment. The ranked management objectives generally show that improved management of floodplain wetlands, floodgates and drains, and water quality improvements are

the key management objectives for the Macleay River estuary. Other objectives involve improved boating facilities, planning for sea level rise on the low-lying floodplain, implementing bank erosion works at key locations, and improving the condition of the riparian corridor.

### Ranked Estuary Management Objectives for 2011 to 2016

Ranking	Estuary Management Objective
1	Acknowledge sea level rise and climate change within the landuse planning framework
2	Improved export water quality from floodplain wetland areas
3	Coordinate and prioritise drainage projects
4	Pursue active water management of floodgates in non-flood periods
5	Conservation of representative areas of floodplain wetlands
6	Maximise opportunities for public access to the Macleay River from commercial areas and the public domain within riverside townships
7	Reduce the occurrence of black water discharge from floodplain wetlands
8	Investigate water management improvements in the Collombatti-Clybucca drainage scheme
9	Plan for appropriate landuse of floodplain and backswamps susceptible to sea level rise
10	Improved water retention in floodplain wetlands
11	Utilise best-practice erosion control, riparian management techniques and flood mit. works
12	Reconnect the built form and public domain of riverside townships with the Macleay River
13	Improve the fishery productivity of the Macleay River estuary system
14	Develop a clear floodgate management regime for flood and non-flood events
15	Manage Yarrahapinni floodgates in accordance with Yarrahapinni Wetlands National Park Plan of Management.
16	Protect and manage important habitat areas
17	Protect important riparian conservation areas where threatened by bank erosion, weed invasion, or land management practices
18	Manage recreational boat use in areas susceptible to boat wash erosion
19	Preparation of a strategic plan for the future management of floodplain wetlands
20	Improved boating access and infrastructure
21	Improve the condition and continuity of the riparian corridor
22	Reduce the incidence of fish kills and oyster mortality related to poor water quality from floodplain wetland areas
23	Clarify the protocol for oyster mortality events on the Macleay River
24	Improve the water quality in regard to chlorophyll a and suspended sediment
25	Reduce the sediment load from diffuse sources and erosion
26	Develop a water quality monitoring program in regard to estuary health
27	Identify high priority conservation value habitats
28	Protect existing public infrastructure threatened by bank erosion
29	Improved understanding of the connection between the floodplain wetlands and estuary health
30	Protect existing bank and riparian management works
31	Ensure EMS strategies do not conflict with heritage objectives
32	Consider commercial fisher needs in the planning approval process for boating infrastructure
33	Reduce nutrient loads from Sewage Treatment Plants and diffuse sources
34	Protect and manage migratory and threatened birds (particularly shorebirds).
35	Control of <i>Salvinia molesta</i> on wetlands and in drains;
36	Minimise sediment loads that impact upon estuarine habitat and reduce water quality
37	Improve community understanding of safety issues with crossing entrance bars
38	Increase the local population of black cod
39	Develop and implement a comprehensive monitoring and reporting program to improve the understanding of the ecological health of the Macleay River estuary;
40	Reduce the risk and eyesore associated with derelict oyster leases;
41	Continue sampling that contributes to the NSW MER reporting requirements;
42	Future pedestrian / cycle paths in the Macleay Arm area
43	Develop a maintenance dredging protocol to address boating navigation concerns in Macleay Arm and at Riverside Park at Kempsey
44	Develop an entrance management protocol for boating navigation at Back Creek entrance

## Introduction

The many estuaries of NSW are of great environmental, social and economic importance. Estuaries are calculated to contribute about \$400 million to the NSW economy through ecosystem services, food chain contributions and tourism and development (DWE, 2008).

The management of estuaries has developed in line with the increasing pressures on estuaries and coastal areas in general. Habitat degradation, water quality issues, loss of amenity and access restrictions are some of the estuary related issues confronting coastal communities and their councils.

Because of its commercial and recreational value, the Macleay River estuary (Macleay estuary) is a principal feature of the NSW mid north coast region. Past flood mitigation works combined with increases in population, tourism, commercial and recreational activities are placing pressures on the natural processes, health and integrity of this estuary, its coastal floodplain and its foreshores.

In recognition of the above, Kempsey Shire Council, through its Coast & Estuary Management Committee has resolved to prepare an Estuary Management Plan (EMP) for the Macleay estuary. The procedure for developing an EMP as set under the NSW Government Estuary Management Program involves the following eight step process:



1. Form an Estuary Management Committee
2. Identify issues and set goals
3. Assemble existing data
4. Carry out an Estuary Process Study
- 5. Carry out an Estuary Management Study**
- 6. Prepare and review the Estuary Management Plan**
7. Adopt and implement the Estuary Management Plan
8. Monitor and review the management process

Kempsey Shire Council has met the requirements of steps 1 through 4 of this process. This study, the Macleay River Estuary Management Study addresses step 5. It will precede the development of an Estuary Management Plan. The final Estuary Management Plan is expected to remain current for a 5 year planning timeframe before requiring review.

The study area includes the Macleay River estuary and its coastal floodplain. This includes the waterways and all tributaries up to the tidal limit, the entrance, foreshores, floodplain and adjacent land including towns, and the coastline. The study area also includes Back Creek (South West Rocks Creek). The extent of the Macleay estuary study area is shown in **Illustration 1.1**.



LEGEND

-  Study area
-  Watercourse / waterbody



## 1.1 Aims of the Macleay River Estuary Management Study

The main aims of the Macleay River Estuary Management Study are to:

- identify estuary values, uses, issues and management objectives based on community and stakeholder consultation and review of the findings of the Data Compilation study and Processes Study and other relevant literature, strategies and policies;
- identify critical processes and threats to the estuary;
- identify and describe the management issues affecting the Macleay estuary including those identified through the previous estuary process steps and through community and stakeholder consultations; and
- develop a prioritised list of the estuary management issues including the identification of potential management strategies for consideration and further refinement during the formulation of the Macleay River Estuary Management Plan.

## 1.2 Report Structure

This report is structured in the following manner:

Section 1	<b><i>Introduction</i></b> Describes the study area and outlines the statutory framework for estuary management in NSW including the various legislative, policy, and planning instruments that apply to the Macleay River Estuary Management Plan
Section 2	<b><i>Estuary Values</i></b> Presents a summary of the outcomes of community and stakeholder consultations and an overview of estuary values, uses of the estuary, and issues derived from the consultation and literature review
Sections 3 to 16	<b><i>Estuary Issues</i></b> These sections address each of the identified issue topics for the Macleay estuary including an overview of the current status of the topic, and associated management issues, objectives and proposed management strategies. The issue topics comprise: riparian management and erosion; floodplain wetlands management; acid sulfate soils; floodgates and drain management; boating; sedimentation and dredging; tourism; habitat protection; fishery management; threatened species; water quality; climate change; heritage; and estuary health.
Section 17	<b><i>Summary of Management Strategies</i></b> Summaries the proposed management strategies from the previous sections

## 1.3 Background

The Coast and Estuary Management Committee was established by Kempsey Shire Council in 1997 to prepare management plans for the estuaries and coastal lands within Kempsey Shire local government area. Estuary Management Plans are prepared under the guidance of the NSW Coastal Policy 1997, the Estuary Management Manual (1992), and the North Coast Rivers Healthy Rivers Commission Report (HRC 2003). The process to date has been jointly funded by Council with assistance from States Estuary Program administered by DECCW.

Previous studies and surveys commissioned for the Macleay estuary as part of the estuary planning process include:

- Data compilation study (GECO 2005);
- Full Hydrographical Survey (Dept Commerce May 2003);
- Tidal Gauging Hydrosurvey (MHL Sept 2003);
- Macleay River Estuary Processes Study (WMAWater Jan 2009);
- Coastal Lake Assessment and Management (CLAM) Back Creek South West Rocks Sustainability Assessment Report (Jun 2007);
- Macleay River Estuary Ecological Study (Birch and GeoLINK, study in progress); and
- Macleay River Marine Infrastructure Assessment (GeoLINK, study in progress)

## 1.4 Macleay River Estuary Study Area

The Macleay River is located approximately 340 km north of Sydney on the Mid North Coast of NSW and has a catchment area of 11,435 km<sup>2</sup>. The catchment extends to the tablelands of Armidale, gorge country and big valley to the ocean at South West Rocks. The Macleay River estuary covers an area of 739km<sup>2</sup> including the main regional town of Kempsey, in addition to the smaller towns of Frederickton, Smithtown, Kinchella, Jerseyville and South West Rocks. The Macleay River estuary extends some 54 kilometres upstream from the ocean at South West Rocks to the tidal limit at Belgrave Falls about 10km upstream of Kempsey.

The coastal floodplain has an area of 400 km<sup>2</sup> and includes well defined levees up to seven metres above mean sea level along the rivers and creeks below Kempsey, grading to large semi permanent backswamps often less than one metre above mean sea level (M.Tulau & S. Naylor 1999). These swamps cover some 240 km<sup>2</sup> representing 60% of the floodplain. The Macleay floodplain holds approximately 15% of the coastal floodplain wetlands in NSW (Kingsford et al. 2003).

The entire floodplain from Kempsey to South West Rocks is underlain by extensive estuarine deposits that include potential and actual Acid Sulfate Soil (ASS). It is estimated that some 310 km<sup>2</sup> of floodplain downstream of Kempsey is underlain by high risk ASS that is either at or near the surface.

Extensive flood mitigation works initiated after the 1949 and 1950 floods have significantly modified the coastal floodplain with some 210 floodgates in 47 separate structures servicing some 116km of excavated drains, 180km of levees. A large proportion of the Macleay River banks downstream of Kempsey are lined with rock protection works (M. Tulau & S. Naylor 1999).

While the Macleay River is the dominant watercourse on the floodplain, significant tributaries include Christmas, Borrigalla and Clybucca Creeks, Macleay Arm, Andersons Inlet to the north and Belmore River and Kinchella Creek to the south. The Macleay River enters the ocean through a trained river entrance located approximately 1.6 km north of South West Rocks. Previously the river entered the ocean at Grassy Head. The change in entrance location occurred during a large flood in 1893 when floodwaters broke through to the ocean at the present entrance location. The new entrance channel was dredged and training walls were constructed by 1897. The old river channel between South West Rocks and Grassy Head is now a backwater known as the Macleay Arm.

The mangroves area on the Macleay cover an area of about 5 km<sup>2</sup> representing 5% of the State's estuarine remaining total mangrove forest total area, while seagrass and saltmarsh areas cover 1.1 km<sup>2</sup> and 3.7 km<sup>2</sup> respectively of the estuary (West, *et al*, 1985). The majority (>80%) of the seagrass in the Macleay is found in the Macleay Arm between Shark Island and Grassy Head. The majority (>60%) of the saltmarsh occurs as extensive fields of marine rush and salt couch in the Clybucca Creek / Andersons Inlet area.

While the Macleay River estuary contains significant environmental attributes, less than 5% of the Macleay River floodplain is under environmental protection or existing/proposed national parks estate zonings (Birch and GeoLINK 2010).

The Macleay River “riparian corridor” is highly degraded due to the extent of clearing and the scarcity of remnant pockets along the riparian margin and across the floodplain. Weed infestation is extensive (ID Landscape Management 2005). Extensive backswamp areas now have little productivity as many of the water tolerant species are now replaced by less tolerant pasture species. There is a history of fish kills that usually occur after heavy rains following prolonged dry periods. (S. Naylor 1996)

The Lower Macleay provides significant recreational boating opportunities with abundant diversity of waterways fronting the New Entrance area of South West Rocks.

There are significant levels of commercial and recreational fishing activities and oyster farming in the lower Macleay. Outside the estuary, trawlers catch fish and prawns, many of which are ecologically linked to the estuary. Recreational fishing is widespread with fish being sought in similar areas to commercial fishermen. The Macleay is also acknowledged as providing important habitat for Australian Bass, a significant recreational species. (Webb 1997)

The Macleay estuary is a filled delta system dominated by fluvial processes. It can be divided into three broad process zones that reflect differing degrees of fluvial and tidal interactions. Marine flood tide zone is dominated by marine derived sediment and extends upstream from the mouth of the Macleay River to Jerseyville Bridge including the Macleay Arm. The fluvial- marine transitional zone extends from Jerseyville Bridge upstream to Kinchela and includes most of Clybucca Creek. The larger fluvial zone extends from Kinchela to the study limit at the tidal limit at Belgrave Falls. This zone includes Belmore, Kinchela and Upper Clybucca Creek (Cohen Sept 2005).

Some of the mapping used in this report is broadly based on these process zones. Due to the large area covered in the EMS study, mapping of the study area has often been divided in the following three sub-regions (refer to **Illustrations 1.2, 1.3 and 1.4**):

- |                |                                    |                      |
|----------------|------------------------------------|----------------------|
| ▪ Sub-region A | Macleay Arm and Entrance           | Marine process       |
| ▪ Sub-region B | Middle Reach – Gladstone/Smithtown | Transitional process |
| ▪ Sub-region C | Upper Reach – Kempsey              | Fluvial process      |

## 1.5 Planning Framework

A planning framework outlining the planning instruments, policies and management plans relevant to the development and management of Estuary Management Plans is attached in full at **Appendix D** and outlined below.

### 1.5.1 NSW Estuary Management Process

The development and implementation of Estuary Management Plans is overseen by Estuary Management Committees established by Kempsey Shire Council. An estuary management plan is developed through the NSW Estuary Management Policy 1992 and NSW Coastal Policy 1997. In addition, a range of NSW legislation and policies are also relevant.

NSW Estuary Management Policy 1992 is a State Government initiative aimed at managing the increasing pressures on estuarine systems. The introduction of this policy meant that the then Department of Public Works (now Department of Environment, Climate Change and Water) in partnership with local Councils was responsible for the preparation of Estuary Management Plans. The aim of this policy was to ensure

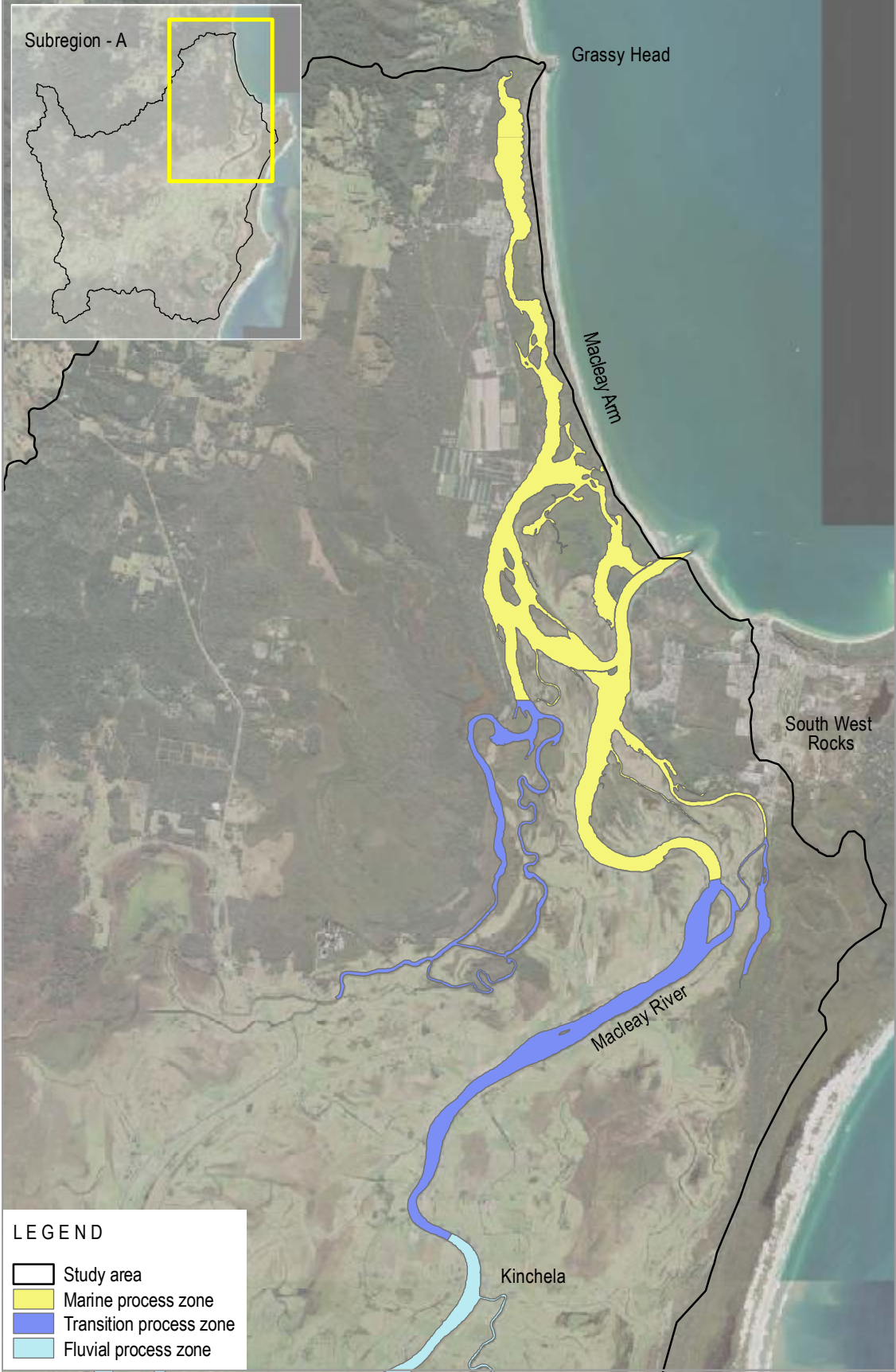


estuaries were ecologically sustainable while allowing estuaries to be used in a manner which facilitated social and economic gain.

The NSW Coastal Policy 1997 deals with population and economic growth whilst protecting the natural, cultural, heritage and spiritual values of the coastal environment. The policy has a strong focus on the principles of Ecologically Sustainable Development (ESD).

The NSW Coastal Policy 1997 acknowledges that the management of coastal zones is the responsibility of State and Local governments as well as the community. The Macleay River and its foreshores fall within the defined coastal zone, therefore the coastal policy needs to be considered in the preparation of the Macleay Estuary Management Plan. Councils are required to implement the policy when making local environmental plans applying to land within the coastal zone and to take the provisions of the policy into consideration when determining development applications in the coastal zone.

Information shown is for illustrative purposes only

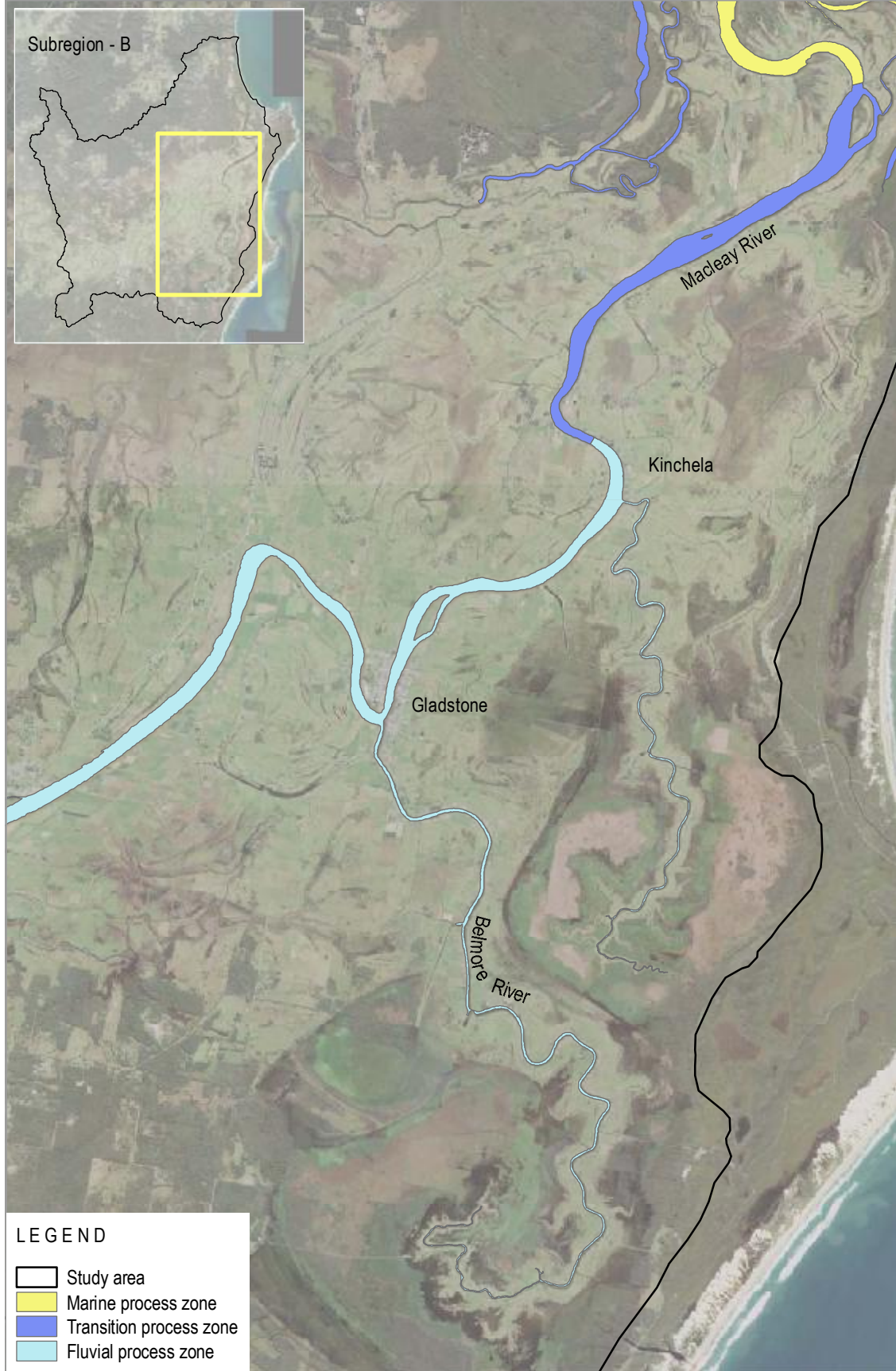


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Information shown is for illustrative purposes only

Drawn by: RE Reviewed by: MVE Date: August 2010  
Source of base data: Kempsey Shire Council



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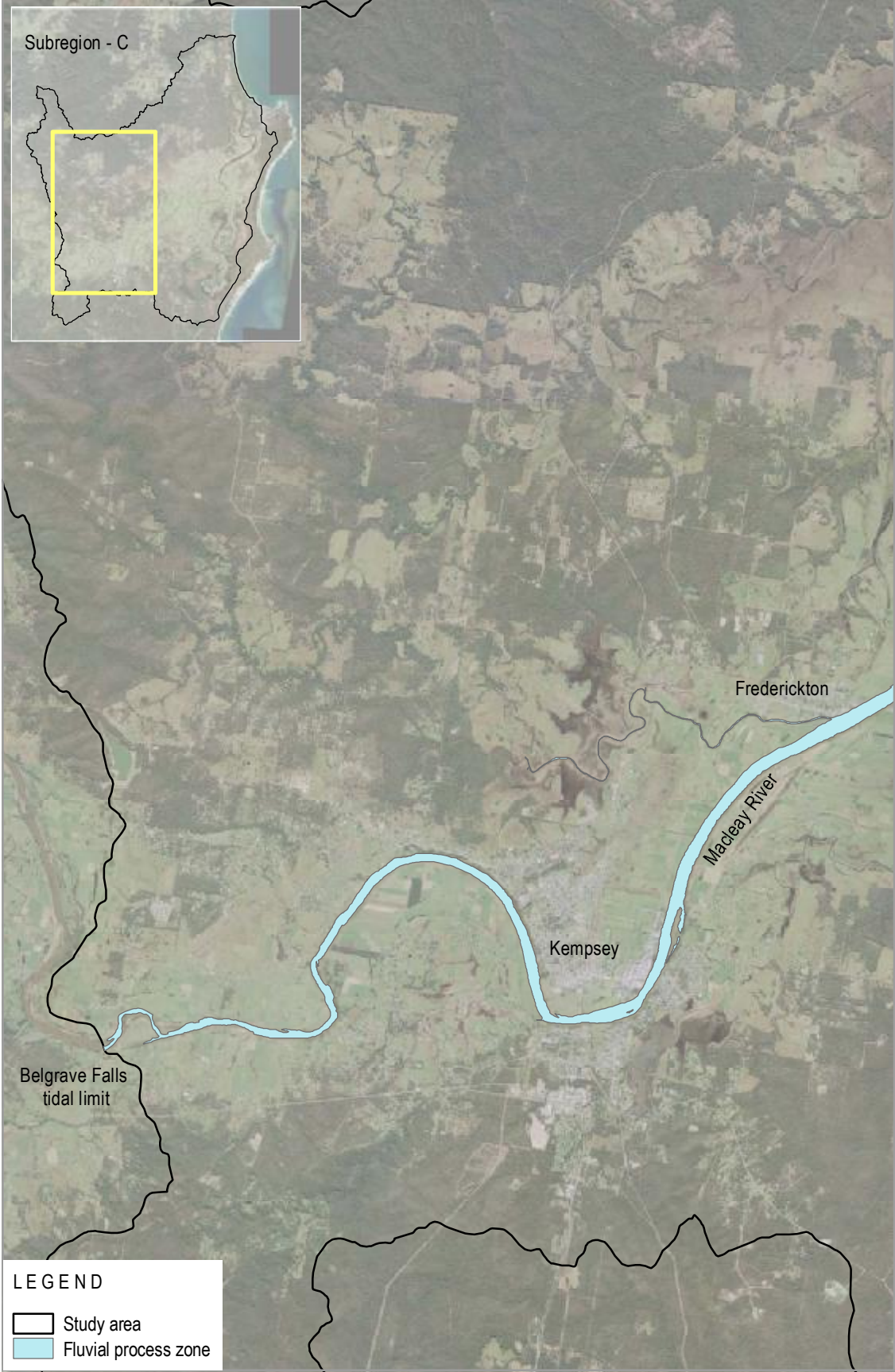
Macleay River Estuary Management Study  
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## Estuary Process Zones - Subregion B

Illustration 1.3



Information shown is for illustrative purposes only



0 2 km



### 1.5.2 NSW Government and Regional Framework

The following legislative and policy frameworks apply to estuary management in NSW:

- Coastal Protection Act 1979;
- Environmental Planning and Assessment Act 1979 (including State Environmental Planning Policies);
- Threatened Species Conservation Act 1995;
- National Parks and Wildlife Act 1974;
- Fisheries Management Act 1994;
- Protection of the Environment Operations Act 1997;
- Native Vegetation Act 2003;
- Catchment Management Authorities Act 2003;
- Heritage Act 1977;
- Noxious Weeds Act 1993;
- Protection of the Environment Administration Act 1991;
- Other relevant Acts:
  - Natural Resources Commission Act 2003;
  - Crown Lands Act 1989;
  - Local Government Act 1993; and
  - Environment Protection and Biodiversity Conservation Act (Commonwealth) 1999.

The following Government Policies apply to the Macleay River:

- NSW Government Sea Level Rise Policy Statement (Draft);
- DoP Planning Guidelines;
- NSW State Plan 2006;
- North Coast Rivers – March 2003;
- Healthy Rivers Commission – Independent Inquiry into Coastal Lakes 2002; and
- Rivers of Tomorrow – November 2003.

### 1.5.3 Council Planning Framework

The following Kempsey Shire Council planning documents apply to the Macleay River Estuary Management Plan

- Kempsey LEP 1987;
- Kempsey Local Government Development Control Plans;
- Kempsey Shire Ecologically Sustainable Development Strategy; and
- Kempsey Integrated Water Cycle Management Study.

Kempsey Shire Council has prepared a draft LEP consistent with the Standard Instrument – Principal Local Environmental Plan (SLEP). The draft LEP is currently being reviewed by NSW Department of Planning and is due for public exhibition in early 2011. The new LEP will be gazetted by June 2011.

## Estuary Values

This section aims to identify and analyse the key values and issues that define the Macleay estuary. An important element of this process is the contribution of the local community and stakeholders in providing an understanding of:

- important estuary uses;
- the different values the community and stakeholders derive from the estuary;
- issues with uses and values of the estuary; and
- community and stakeholder aspirations for those uses and values.

### 2.1 Community and Stakeholder Consultation

Community and stakeholder input to this study has been sought in a number of ways including:

- **Community Meetings:**  
An initial round of open public meetings was held at Stuarts Point, South West Rocks and Kempsey in September / October 2009 near close to the commencement of the study. The purpose of the meetings was to inform the community of the general objectives and scope of the study and to obtain initial input on community values, uses, issues and objectives for the estuary;  
A second round of open public meetings will be held at Stuarts Point, South West Rocks and Kempsey in June / July 2010 to discuss and prioritise management objectives identified in the draft EMS;
- **Community Survey:**  
A general survey and boating survey was conducted over a two month period from 21 December 2009 to 5 February 2010. The surveys comprised a questionnaire to gain further feedback on values, uses, issues and objectives for the estuary and specific information on boating in the estuary;
- **Comment on Draft Documents:**  
An initial draft of the Estuary Management Study report has been provided to members of the Coast and Estuary Management Committee for comment. The comments have been incorporated into this final draft;
- **Community working groups:**  
volunteers from the initial round of open public meetings will assist in the role of an information 'conduit' between the GeoLINK team and the local communities over the duration of the project;
- **Media releases:**  
media releases articles advising the general public of each round of the open public meetings, the availability of the community survey, and the release of the Draft Estuary Management Study have run appeared in local papers over the course of the study;

#### 2.1.1 Initial Round of Community Meetings

The venues for the public meetings have been selected based on three 'community-scale' catchments to better address local issues:

1. **Stuarts Point**: to cover the Grassy Head / Stuarts Point / Fishermans Reach / Clybucca area (covering the Macleay Arm area and the Borrigalla and Clybucca Creek areas);
2. **South West Rocks**: to cover the South West Rocks / Jerseyville area (covering the entrance and Back Creek); and

3. **Kempsey**: to cover the Kinchella / Gladstone / Smithtown / Frederickton / Kempsey / Belmore River area (covering the agricultural floodplains and upper reaches of the study area).

The purpose of the initial meetings was to gain input from the community in regard to their values, issues and objectives for the Macleay estuary. The meetings were held on weekday evenings. The initial round of community meetings attracted only a small number of participants. However those present at the meetings offered plenty of significant feedback on different issues. A full summary of the input is provided in **Appendix E**. The main points are summarised below.

#### 2.1.1.1 *Community Values Expressed at Initial Public Meeting*

The main aspects of the Macleay estuary valued by participants included (in no specific order):

- **Back Creek**: considered a valuable location for its amenity and as a tourist attraction;
- **Riparian vegetation** and the ecological attributes of the Macleay Arm are considered to have a high value compared to southern areas of the estuary;
- **Recreational fishing**: was commented on by a large number of participants. Valued aspects of recreational fishing included Bass fishing, Golden Hole location near the entrance to Yarrahapinni wetlands, fishing competitions, tourism attraction associated with fishing in the estuary, and the ability to access ocean fishing in close proximity to the continental shelf;
- **Migratory birds** which use the estuary;
- **Swimming** at Stuarts Point;
- **Non-indigenous heritage**: associated with Macleay Arm and old river pilot station & signalling;
- **Indigenous heritage**: associated with Clybucca midden.
- **Boating use**: having boating access to the river; and the range of boating opportunities on the river ranging from the common open runabouts (tinnys) to canoeing and dragon boat racing;
- **Passive recreation**: walking and picnicking;
- **Yarrahapinni wetlands**: improvements in the wetland were recognised. The role of the floodgate structure in deterring boating within the wetland was considered a positive outcome.

#### 2.1.1.2 *Community Issues Raised at Initial Public Meeting*

Issues raised at the meetings have been grouped in regard to the main estuary issues addressed in the EMS:

**Table 2.1 Community Issues Raised at Initial Public Meeting**

<i>Issue</i>	<i>Comments</i>
Riparian Land and Bank Erosion	Concerns were expressed about existing rock armour on riverbanks impacting on erosion elsewhere and cattle access causing bank erosion. There was also concern that bank erosion work by rural landowners is not recognised in the community. The recovery of habitat / in-stream vegetation after flooding was also raised as a concern.
Floodgates and Drains Management	Concerns were raised that deoxygenated water from drained areas is having a big impact on estuary health; and that landowners are wearing the costs of some previous flood mitigation work.

<b>Issue</b>	<b>Comments</b>
Flooding (it is noted that the scope of the EMS does not directly address flooding):	Different views and concerns were held over the impact of various infrastructure on flood levels including concern that the height of levee banks makes flooding worse in extreme flood events, concern over the impact of Pacific Highway upgrade on flooding, and concern the Belmore Flood Control Structure (Fabri Dam) has been raised which increases upstream flood levels.
Boating	Concerns included boat launching facilities (wash-out of Geenhills boat ramp, insufficient parking at boat ramps); and safety issues relating to abandoned oyster beds around Fishermans Reach.
Fishing	Concerns were expressed that commercial fishing bans elsewhere have increased commercial fishing in Macleay estuary which is depleting fish numbers; that there is illegal beach fishing by tourists; and there is a decline in crab numbers. Beach hauling has also been noted as an issue.
Sedimentation and Dredging	A large number of comments were made on this topic including issues of 'silting up' at a number of locations particularly from Stuarts Point to Fishermans Reach; and suggestions that dredging is required to facilitate boat navigation in some locations.
Seagrass beds	Concern was voiced that large amount of seagrass beds have not recovered after the 2001 floods. There was also concern that seagrass habitat in north Macleay Arm area was being disturbed by commercial netting across the river.
Water Quality	A large number of comments were made on this topic. This included concern that declining water quality was making Macleay Arm undesirable for swimming and causing fish kills. Concerns were expressed regarding stormwater pollution and litter; caravan septic system overflows; and leachate from buried material at the old Stuarts Point tip.

### 2.1.1.3 Community Objectives Expressed at Initial Public Meeting

Community objectives or aspirations for the estuary have also been grouped in regard to the main estuary issues addressed above:

**Table 2.2 Community Objectives Raised at Initial Public Meeting**

<b>Topic</b>	<b>Objectives</b>
Riparian Land and Bank Erosion	<ul style="list-style-type: none"> <li>▪ improve / increase riparian buffer between farmland and the river;</li> <li>▪ fence riverbanks to prevent cattle access;</li> <li>▪ protect riparian zone;</li> <li>▪ provide more funding for land owners to undertake riverbank protection works;</li> <li>▪ establish speed limits for larger boats to limit erosion damage to banks;</li> </ul>
Floodplain Wetlands / Floodgates and Drains Management	<ul style="list-style-type: none"> <li>▪ revert wetlands back to more of a 'natural' state;</li> <li>▪ raise the inverts of drainage channels that drain the wetlands and open the floodgates more often/wider?</li> </ul>



<b>Topic</b>	<b>Objectives</b>
Boating	<ul style="list-style-type: none"> <li>▪ address speed/usage of jet skis;</li> <li>▪ establish speed limits for larger boats to limit erosion damage to banks;</li> <li>▪ provide mooring facilities at South West Rocks (near Mattys Flat) and for boat visits from Stuarts Point / Fishermans Reach</li> </ul>
Fishing	<ul style="list-style-type: none"> <li>▪ 2 bag limit for Bass is considered desirable;</li> <li>▪ keep cattle out of river to help Bass numbers;</li> <li>▪ need 'holes' for fish habitat / structures to attract prawns / crustaceans;</li> <li>▪ rotate fishing sanctuary zones in different areas of the estuary (test a no-take zone for a short period including a monitoring program);</li> <li>▪ no netting or fishing in the seagrass area in north of Macleay Arm</li> <li>▪ providing sanctuary zone in north of Macleay Arm</li> </ul>
Sedimentation and Dredging	<ul style="list-style-type: none"> <li>▪ dredging was suggested for locations raised in the 'issues'</li> </ul>
Water Quality	<ul style="list-style-type: none"> <li>▪ improve water quality / monitoring in Back Creek;</li> <li>▪ sewerage works for saltwater development;</li> <li>▪ enforce designated truck wash-down sites to control / treat runoff</li> </ul>
Climate Change	<ul style="list-style-type: none"> <li>▪ incorporate sea level rise into planning documents</li> </ul>
Tourism / Recreation	<ul style="list-style-type: none"> <li>▪ 'primitive' camping sites should be considered / planned;</li> <li>▪ improve Back Creek for tourism and amenity;</li> <li>▪ provide boardwalks from Stuarts Point to Fishermans Reach (with interpretive signage) and to middens &amp; Yarrahapinni wetland;</li> <li>▪ improve cleared access (non- boating) to river for general passive recreation: weed clearing – lantana / coral trees etc.</li> <li>▪ actively promote of river / river activities to increase tourism;</li> </ul>
Estuary Health	<ul style="list-style-type: none"> <li>▪ Biological monitors such as bird numbers were suggested as a measure of success for estuary improvements</li> </ul>

### 2.1.2 Community Survey

A general survey and boating survey were conducted over a two month period from 21 December 2009 to 5 February 2010. The survey period coincided with school summer holidays when visitor numbers and recreational and commercial tourism activity in the region were at a peak. This provided an opportunity to capture input from the widest possible catchment of users of the estuary and also specifically users of boating facilities and access points.

#### 2.1.2.1 Survey Results

The results for the specific 'Boating Survey' are contained in the Marine Infrastructure Assessment report in **Appendix E**. The results of the 'General Survey' are summarised below.

A total of 162 completed forms for the 'General Survey' were received at the conclusion of the survey period (see full results in **Appendix E**). Respondents identified themselves as residents from the following locations:

- 33% from the Macleay Arm Area;

- 22% from the South West Rocks / Jerseyville area;
- 21% from the Frederickton / Kempsey / Greenhill area;
- 9% from the Kinchella / Gladstone / Smithtown area;
- 6% from elsewhere within Kempsey LGA;
- 2% from Port Macquarie / Hastings LGA;
- 2% from Nambucca LGA;
- 2% from elsewhere on the Mid-North Coast;
- 1% from elsewhere within NSW; and
- 1% from interstate / overseas.

Boating is the main activity or use of the river (122 respondents) with recreational fishing (103) and picnicking/walking (101) equal second, and swimming third (78).

Responses in regard to the importance of estuary values are shown in **Plate 2.1** and include:

- water quality is considered the most important value for the estuary (160 respondents voted either “very important” or “important”). Responses regarding other values included:
- ‘protecting the riverbanks from erosion’ was the next highest ranked value (152 votes) followed by;
- ‘native riverside vegetation’ (149 votes);
- most of the listed values in the survey question generally received a tick for “very important” or “important”;
- all other values except for “Riverside tourist accommodation” received at least 120 votes for either “very important” or “important”;
- Other suggestions of valued features included: the ‘natural’ setting; the vast range of wildlife in the Macleay Arm area; and mangroves.

Current access arrangements to the river, its creeks and adjoining banks: 60% to 70% of respondents were happy with boat ramp access, and vehicle and pedestrian access. Only 53% of respondents were happy with current disabled access. There were a large number of suggestions for improved or increased walkway and cycleway access along the riverbank particularly between Stuarts Point and Fishermans Reach or Yarrahapinni, and in the vicinity of Kempsey township. There was also a suggestion for improved signage / ‘entry statement’ reflecting the attributes of the estuary for visitors to the area or tourists passing through the area.

Current health rating of Macleay River estuary:

- water quality is rated as “moderate” to “very good” by 83% of respondents;
- fish populations / aquatic ecosystems: 45% rated it as “very poor” to “poor”; 36% “moderate” and 19% “good” to “very good”;
- riverside vegetation : 34% “very poor” to “poor”; 37% “moderate” and 28% “good” to “very good”;
- bank stability: 40% “very poor” to “poor”; 40% “moderate” and 20% “good” to “very good”;
- navigation: 28% “very poor” to “poor”; 40% “moderate” and 31% “good” to “very good”;
- floodplain backswamps: 44% “very poor” to “poor”; 38% “moderate” and 18% “good” to “very good”;
- and
- oyster harvest areas: 18% “very poor” to “poor”; 59% “moderate” and 23% “good” to “very good”.

Support for creation of fishing sanctuary zones in some critical locations?

- 38% indicated “strong support”;
- 21% “moderate support”;
- 35% “no support”;

- 9% “don’t know”; and
- there were comments indicating concern that this question may lead to the creation of sanctuary zones without any further consultation beyond the survey .

Issues of concern:

- “poor water quality and fish kills after flooding” received the highest number of ‘votes’ (145) for either “very concerned” or “concerned”;
- the order of the issues of concern based on the number of votes for either “very concerned” or “concerned” were:
  - spread of aquatic weeds (141);
  - inadequate treatment of stormwater and effluent (138);
  - commercial / industrial development along the river edge (136);
  - acid sulfate soils (131);
  - bank erosion (131);
  - degraded floodplain backswamps / wetlands (130);
  - overfishing (127);
  - operation of floodgates and drainage works (127);
  - protection of the shellfish industry (124);
  - lack of habitat protection (123);
  - lack of riverside vegetation (123);
  - urban / residential development along the river edge (119);
  - scenic amenity (117);
  - dredging of the river (112);
  - cultural heritage (indigenous) (84);
  - sea level rise and climate change (69); and
  - other (please describe) (26): the impact of commercial fishing / netting on fish stock and the impact of floodgates on fish passage / ecological processes both received a significant number of votes as an additional issue (approximately 10 to 20 votes); fertilizer / pesticide / herbicide runoff from farmland was also suggested by a number of respondents as an additional issue.

### 2.1.3 Stakeholder Consultation

The organisations listed below were consulted to obtain initial input to the study. Input received from various organisations has been incorporated into the assessment of the relevant issues in the EMS. Letters that were received from organisations have been included in **Appendix E**.

- |  |  |
|--|--|
| ▪ Kempsey Shire Council  | ▪ Macleay Valley Coast Tourism             |
| ▪ NSW Department of Environmental and Climate Change and Water (DECCW) | ▪ Macleay Landcare Network                 |
| ▪ NSW Fisheries (now Primary Industries - Industry & Investment NSW)   | ▪ Kempsey Local Aboriginal Land Council    |
| ▪ Coast and Estuary Management Committee                               | ▪ Booroongen Djugun Aboriginal Corp        |
| ▪ Northern Rivers Catchment Management Authority                       | ▪ Macleay Landcare Network                 |
| ▪ NSW Department of Water and Energy (now DECCW – NSW Office of Water) | ▪ Chamber of Commerce – Kempsey & District |
| ▪ DECCW – Parks and Wildlife   | ▪ Chamber of Commerce & Industry           |

Incorporated – South West Rocks

- DECCW – Coastal Waters Unit
- Land and Property Management Authority
- NSW Maritime
- Macleay River District Fishermans Cooperative
- Bass Kempsey
- NSW Food Authority

## 2.1.4 Discussion of Results

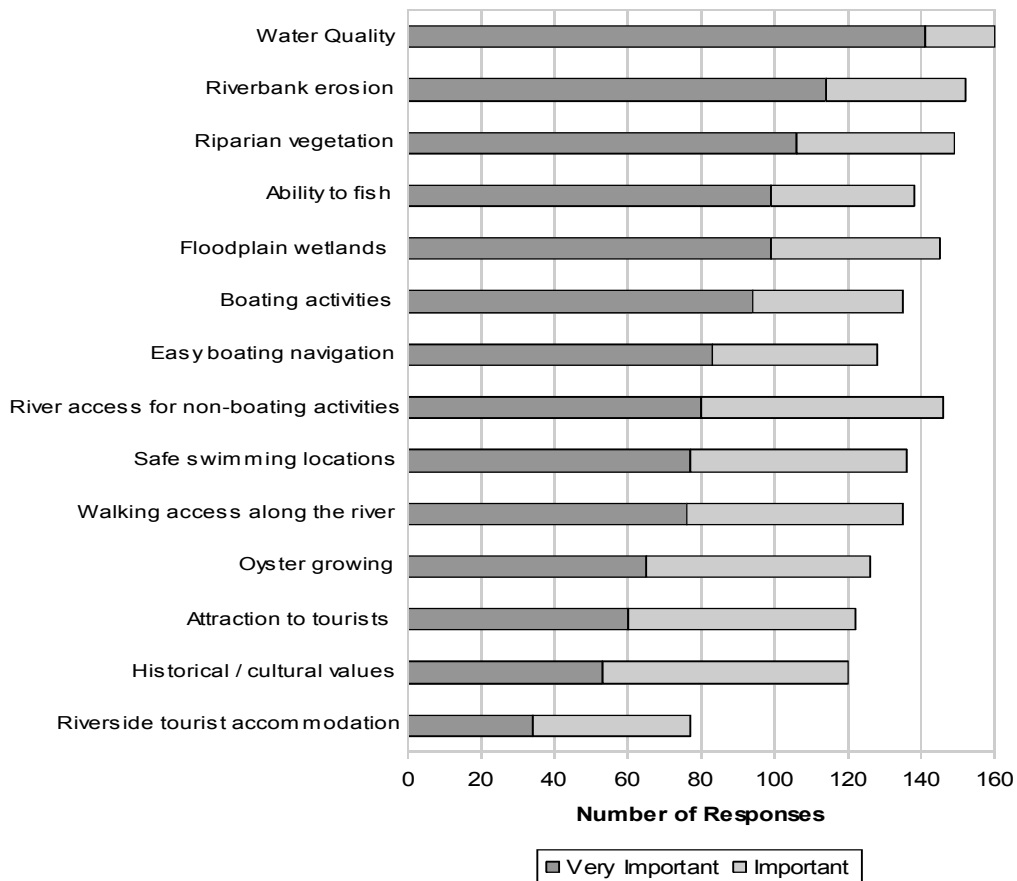
### 2.1.4.1 Community Values

The estuary values derived from the public meetings and survey results may generally be classified as:

- values associated with recreational use of the estuary; and
- physical estuary features valued by the community.

In respect to values associated with recreational use, the main values are boating; recreational fishing; passive recreation (picnicking / walking); and swimming.

The main physical attributes of the estuary that are valued by the community are water quality, riverbank protection (from erosion), riparian vegetation and floodplain wetlands. A ranking of values from the survey results based on the number of “very important / important” responses is shown in **Plate 2.1**.

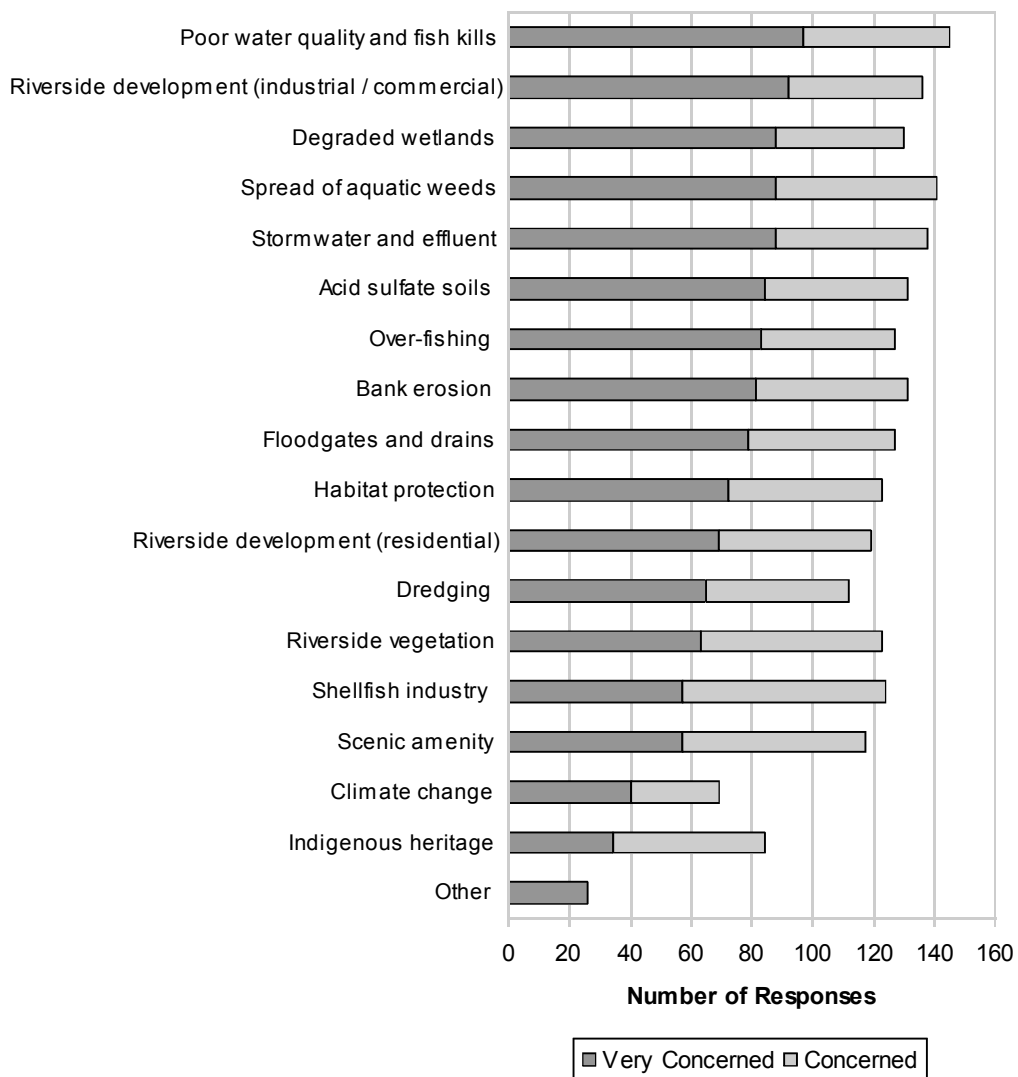


**Plate 2.1** Ranking of Values from Community Survey

2.1.4.2 Issues

The public meetings indicate that the main community issues concern water quality and the impact of sedimentation on boating navigation. This is based on the larger number of comments provided at the meetings in respect to these two issues compared with other issues. The community survey results support the finding that water quality is one of the major concerns for the estuary. The issue of sedimentation impacting on boating navigation was not highlighted in the survey results however this may be a result of the wording of the survey which asked if dredging was an issue. A ranking of concerns from the survey results based on the number of “very concerned / concerned” responses is shown in **Plate 2.2**.

Other community issues arising from the survey results generally reflect the issues of concern and their relative importance raised by the Coast and Estuary Management Committee and the Catchment Management Committee. The committee issues and priorities are outlined in **Section 2.3**.



**Plate 2.2** Ranking of Concerns from Community Survey

### 2.1.4.3 Objectives

Community objectives for the estuary generally relate to maintaining or improving the recreational values and physical attributes valued by the community. The main objectives are summarised as:

- **Riparian Management and Bank Erosion** : expand riparian areas and protect the banks from impacts such as cattle access and erosion;
- **Floodplain Wetlands / Floodgates and Drains Management** : revert wetlands back to more a 'natural' state and minimise the impact of floodgates and drains on water quality;
- **Boating**: improve boat launching facilities and managed boating areas to avoid conflict between different boating activities;
- **Fishing**: protect fish stocks by investigating impacts of commercial fishing and implementing measures such as sanctuary zones;
- **Sedimentation and Dredging** : investigate dredging to improve boating navigation;
- **Water Quality**: improve water quality in Back Creek and Macleay Arm and minimise fish kills from drainage systems;
- **Tourism / Recreation**: improve access to the river for non-boating activities; support river-based tourism; improve amenity of Back Creek in regard to water quality and boating navigation; and investigate walking paths / boardwalks in Macleay Arm area; and
- **Climate Change**: incorporate sea level rise into planning.

## 2.2 Ecological Values

Aside from the inherent ecological values of a large estuarine system the ecological values of the Macleay River estuary include:

- A large and diverse fauna. This is the basis of a large recreational fishing industry and the Macleay River Estuary general fishery. Under sustainable harvest conditions the Macleay River fisheries provide a degree of local food security;
- A large, healthy population of East Australian Bass, an iconic sportfish;
- Threatened aquatic species including the estuary cod ( *Epinephelus coioides* ), and black cod ( *Epinephelus daemeli* ) are known to inhabit waters of the Macleay. In the case of the estuary cod, anecdotal evidence suggests that the population is a large and healthy one;
- Regular visits by aquatic mammals are known to occur. During the preparation of this study, bottle nose dolphins ( *Tursiops aduncus* ) were sighted on the Macleay River as far upstream as the Jerseyville Bridge;
- A large and diverse avifauna. Wetland areas on the Macleay are host to a wide variety of migratory and resident birds, including at least 9 species listed under the NSW *Threatened Species Conservation Act 1995* and 47 migratory species listed under the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999* . Important species include the black necked stork, brolga, osprey, black tailed godwit and common greenshank;
- Extensive mangrove, saltmarsh and seagrass ecosystems. These systems account for a significant proportion of the overall productivity of the river in addition to providing habitat for fish and invertebrates. These systems are important since many marine species rely on or utilize estuarine ecosystems to complete parts of their lifecycle. Salt Marsh habitat on the North Coast is listed as an Endangered Ecological Community. Mangrove, saltmarsh and seagrass habitat are listed and protected as Marine Vegetation under the Fisheries Management Act 1994; and
- numerous significant wetlands, including 66 protected under SEPP 14 legislation and 2 listed under the Directory of Important Wetlands of Australia (DIWA).

## 2.3 Summary of Estuary Values and Issues

The estuary management study is largely directed by the values, issues and objectives derived from the community and stakeholders. To assist understanding the range of issues and objectives for the estuary, a summary is provided in **Table 2.3**.

**Table 2.3 Summary of Community and Stakeholder Estuary Values and Issues**

<b>Topic</b>	<b>Value</b>	<b>Issues</b>	<b>Objectives</b>	<b>Importance / Priority</b>
Riparian Management and Bank Erosion	<ul style="list-style-type: none"> <li>Riparian vegetation is significantly valued by community</li> <li>Riparian vegetation: ecological benefits for habitat / corridors; scenic qualities; assists erosion control</li> </ul>	<ul style="list-style-type: none"> <li>Lack of native riparian vegetation corridor</li> <li>riverbank erosion</li> <li>overuse of rock armouring for embankment protection;</li> </ul>	<ul style="list-style-type: none"> <li>increased riparian areas and protection from impacts such as cattle access and erosion</li> <li>address bank erosion areas</li> </ul>	High
Floodplain Wetlands Management	<ul style="list-style-type: none"> <li>significantly valued by community</li> <li>wetlands form a large component of the estuary and provide important functions in regard to estuary health</li> </ul>	<ul style="list-style-type: none"> <li>most of the wetlands are degraded which impacts on water quality, habitat, and fisheries</li> </ul>	<ul style="list-style-type: none"> <li>understanding key functions of floodplain wetlands and relative importance of specific wetland areas</li> <li>rehabilitate degraded wetlands</li> </ul>	High
Acid Sulfate Soils	-	<ul style="list-style-type: none"> <li>the floodplain is underlain by high risk ASS</li> <li>impacts on water quality, soils, agricultural productivity</li> </ul>	<ul style="list-style-type: none"> <li>minimise exposure of ASS</li> <li>remediate acid scald areas</li> </ul>	High
Floodgates and Drain Management	<ul style="list-style-type: none"> <li>important for flood mitigation, wetland management and pasture management</li> </ul>	<ul style="list-style-type: none"> <li>over-drainage of backswamps increases exposure of ASS and causes acid scalding, poor water quality, reduced agricultural productivity, and degraded wetland habitat</li> <li>Drainage of backswamp areas has enabled changes in pasture species resulting in water quality issues during extended flood events</li> </ul>	<ul style="list-style-type: none"> <li>actively manage floodgates to achieve best outcomes in terms of flood mitigation and water quality / ASS management / wetland management; and</li> <li>clear management regime in both flood and non-flood events.</li> </ul>	High



<b>Topic</b>	<b>Value</b>	<b>Issues</b>	<b>Objectives</b>	<b>Importance / Priority</b>
Boating	<ul style="list-style-type: none"> <li>boating activities highly valued by community</li> </ul>	<ul style="list-style-type: none"> <li>Siltation and weed growth along foreshores preventing water access and navigation at key locations of the river;</li> <li>lack of adequate, safe launching facilities, particularly for short term mooring;</li> <li>need for improved amenities to enhance riverside locations for family day use;</li> <li>conflict between incompatible uses and their proximity to nearby residential areas;</li> </ul>	<ul style="list-style-type: none"> <li>improve boat launching facilities and manage boating use areas to avoid conflict between different boating activities</li> </ul>	High
Sedimentation and Dredging	<ul style="list-style-type: none"> <li>satisfactory navigation of waterways</li> </ul>	<ul style="list-style-type: none"> <li>Impact on boating navigation is a significant issue to community</li> </ul>	<ul style="list-style-type: none"> <li>determine if dredging is a potential management option for improving navigability in specific locations</li> </ul>	High (based on community feedback from the survey regarding boating navigation)
Tourism	<ul style="list-style-type: none"> <li>river-based tourism is a significant tourism industry for the region</li> </ul>	<ul style="list-style-type: none"> <li>increased demand on boating facilities</li> </ul>	<ul style="list-style-type: none"> <li>improve access to the river for non-boating activities; support river-based tourism; improve amenity of Back Creek in regard to water quality and boating navigation; and investigate walking paths / boardwalks in Macleay Arm area</li> </ul>	Medium

<b>Topic</b>	<b>Value</b>	<b>Issues</b>	<b>Objectives</b>	<b>Importance / Priority</b>
Habitat Protection / Threatened Species	<ul style="list-style-type: none"> <li>■ floodplain contains a significant proportion of the states mangroves and wetlands</li> <li>■ floodplain provides an opportunity to support regional habitat corridor</li> </ul>	<ul style="list-style-type: none"> <li>■ habitat areas are fragmented within the floodplain</li> <li>■ a very small proportion of the estuary has environmental protection under Councils LEP / Parks management</li> </ul>	<ul style="list-style-type: none"> <li>■ Protect and manage critical habitats</li> </ul>	High
Fishery Management	<ul style="list-style-type: none"> <li>■ Recreational fishing highly valued by community</li> </ul>	<ul style="list-style-type: none"> <li>■ Threats to fisheries from poor water quality associated with floodplain drainage systems</li> <li>■ Loss of key habitat associated with wetlands</li> </ul>	<ul style="list-style-type: none"> <li>■ Community objective to protect fish stocks</li> <li>■ Address causes of poor water quality relating to drainage systems</li> <li>■ Improve fish productivity and key habitat areas</li> </ul>	High
Water Quality	<ul style="list-style-type: none"> <li>■ highly valued by community</li> </ul>	<ul style="list-style-type: none"> <li>■ poor water quality is a significant issue to community</li> <li>■ impacts associated with floodplain drainage systems</li> <li>■ water quality impacts on fisheries</li> </ul>	<ul style="list-style-type: none"> <li>■ Community objective to improve water quality in Back Creek and Macleay Arm and minimise fish kills from drainage systems that result in fish kills</li> <li>■ Address causes of poor water quality associated with drainage systems</li> </ul>	High
Climate Change	<ul style="list-style-type: none"> <li>■ moderately valued by community</li> </ul>	<ul style="list-style-type: none"> <li>■ Sea level rise impacts on estuary ecology, floodplain wetlands, drainage systems, floodplain agriculture, and infrastructure</li> </ul>	<ul style="list-style-type: none"> <li>■ incorporate sea level rise into estuary planning framework</li> </ul>	High Importance Medium Priority
Heritage Issues	<ul style="list-style-type: none"> <li>■ moderately valued by community</li> </ul>	<ul style="list-style-type: none"> <li>■ No significant issues</li> </ul>	<ul style="list-style-type: none"> <li>■ Heritage issues to be considered in the development of other management strategies</li> </ul>	Low

<i>Topic</i>	<i>Value</i>	<i>Issues</i>	<i>Objectives</i>	<i>Importance / Priority</i>
Estuary Health	<ul style="list-style-type: none"> <li>▪ highly valued</li> </ul>	<ul style="list-style-type: none"> <li>▪ Lack of understanding of ecological health of Macleay estuary</li> <li>▪ Lack of understanding of interactions of estuary components</li> </ul>	<ul style="list-style-type: none"> <li>▪ improve understanding</li> <li>▪ develop monitoring system to measure ecological health</li> </ul>	High

## 2.4 Estuary Uses

### 2.4.1 Land Use Zoning

The entire Macleay estuary and 25% of the Macleay Catchment fall inside the Kempsey Shire Local Government Area (LGA). The Upper Macleay Catchment falls with four LGAs - Walcha, Armidale Dumaresq, Uralla and Guyra (WMAwater, 2009).

Land use zonings in the estuary are shown in **Illustration 2.1**. Eight major land use zoning categories exist for the Macleay estuary with:

- almost 90% of the total Macleay catchment zoned Rural of which approximately 60% is zoned Rural 1 (a1). Forestry 1(f) and Agricultural Protection 1(a3) occupy the other rural zonings;
- National Parks and Reserves 8(a) covers approximately 7% of the catchment;
- Protection (7) covers approximately 4% of the catchment; and
- Urban areas (including residential, business, industrial zonings and special use areas) occupy less than 1% of the catchment (WMAwater, 2009).

Kempsey Shire Council is currently preparing a new LEP consistent with the Standard Instrument – Principal Local Environmental Plan (SLEP). According to the SLEP, there are three waterway zones that may be applicable to waterways:

Zone W1	Natural Waterways
Zone W2	Recreational Waterways
Zone W3	Working Waterways

Applying the most appropriate zoning will need to consider the tenure, anticipated usage and any land use protective or management measures.

### 2.4.2 Land Use

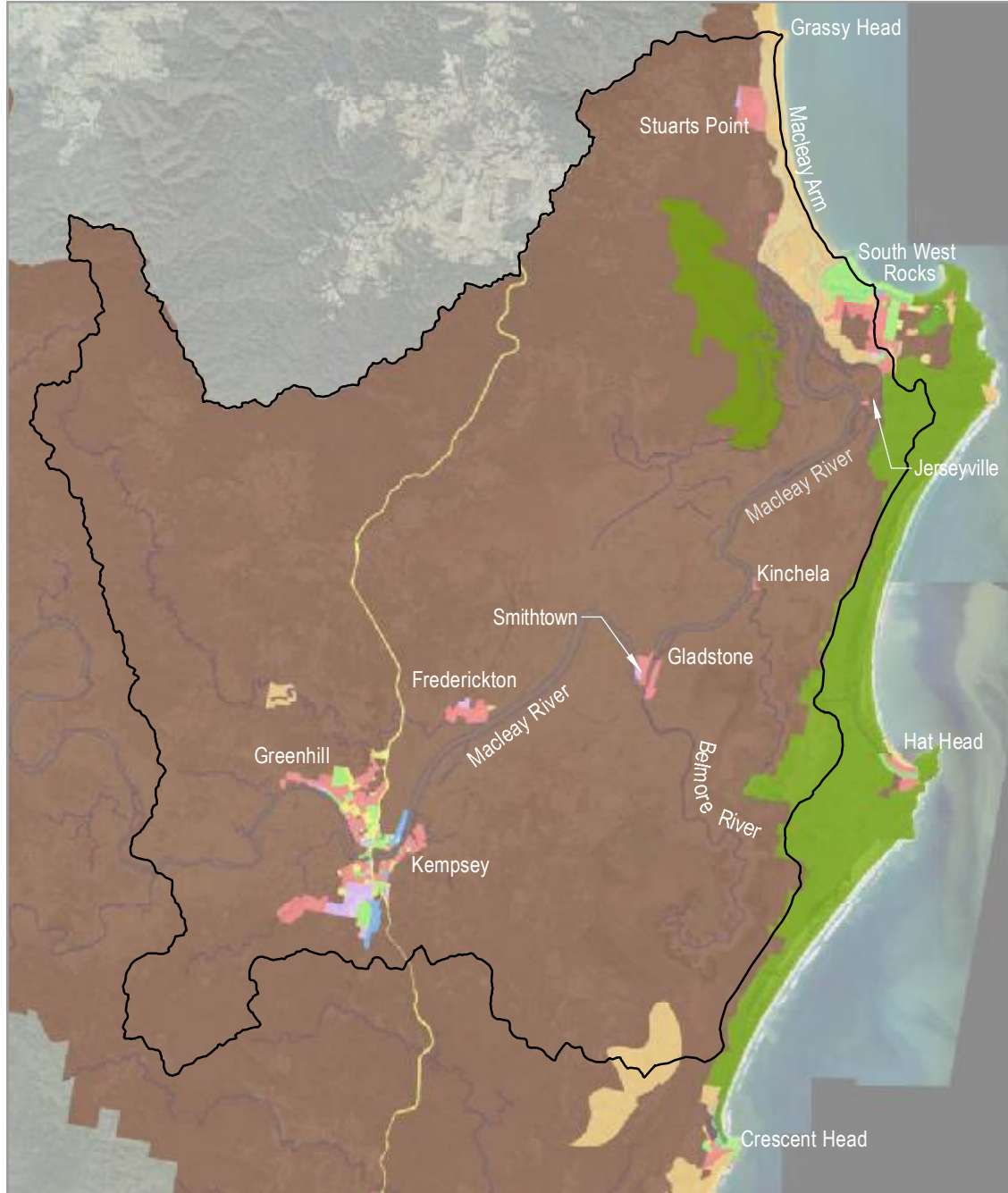
#### Historical Land Use

Historically, the Macleay area was inhabited by Aboriginal peoples. European land use began with settlement in the 1830s. Timber cutting and ship building were the main land uses up until the early 1900s (WMAwater, 2009).

Early settlements were formed in lower Macleay, including the establishment of Kempsey in 1835. Between 1863 and 1875 there were 18 floods of which eight were considered serious. However, the advantages of settling on the floodplains for many years outweighed the disadvantages (Telfer, 2005).

The Upper Tablelands were settled and cleared for agriculture, including beef, and sheep grazing. Cropping also occurred to the west. Escarpment, gorge and upper hill countries were not suited to cultivation, but some areas were logged (WMAwater, 2009).

Small areas of mining of metals and antimony occurred along the catchment, with a few major mines. These mines were situated at Hillgrove, Rockvale, Enmore-Rose, Halls Peak (near Jeogla) and Mungay Creek (near Willawarrin). Much contamination (including effluent runoff, acid mine drainage, arsenic, and antimony) has occurred in the Macleay catchment due to waste materials disposal and leakage from the mining systems (WMAwater, 2009).



### LEGEND

-  Study area
-  Rural (1)
-  Residential (2)
-  Business (3)
-  Industrial (4)
-  Special Uses (5)
-  Open Space (6)
-  Protection (7)
-  National Parks (8)



### Current Land Use

Land uses in the Macleay catchment are diverse, and include cattle and sheep grazing on tablelands, dairying, horticulture and cropping, light industry, mining and quarrying, forestry, residential development, tourist development, fishing and oyster farming (WMAwater, 2009).

Upper tablelands of the Macleay are cleared for grazing and cropping. The escarpment, gorge and upper hill countries are mainly vegetated, with National Park, Crown Land or State Forest the main uses, with some minimal logging continuing. The floodplain and estuary of the Macleay is mainly cleared for agriculture, including grazing pasture and crop production. Mining land uses have decreased recently, with only the Hillgrove mine still operational (WMAwater, 2009).

Settlements along the Macleay catchment include the major towns of Armidale, Kempsey, Walcha, Guyra and South West Rocks, which comprise residential, commercial and light industrial land uses (WMAwater, 2009).

General land use characteristics of the estuary study area include:

- intensive horticulture around Fishermans Reach;
- unsewered townships of Stuarts Point and Fishermans Reach adjoining Macleay Arm;
- National Park adjoining the eastern boundary of the estuary (Hat Head National Park) and to the west of Fishermans Reach (Yarrahapinni Wetlands National Park); and
- Agriculture consisting primarily cattle grazing through the middle floodplain portion of the study area. This landuse occurs largely on drained and flood and acid prone lands.

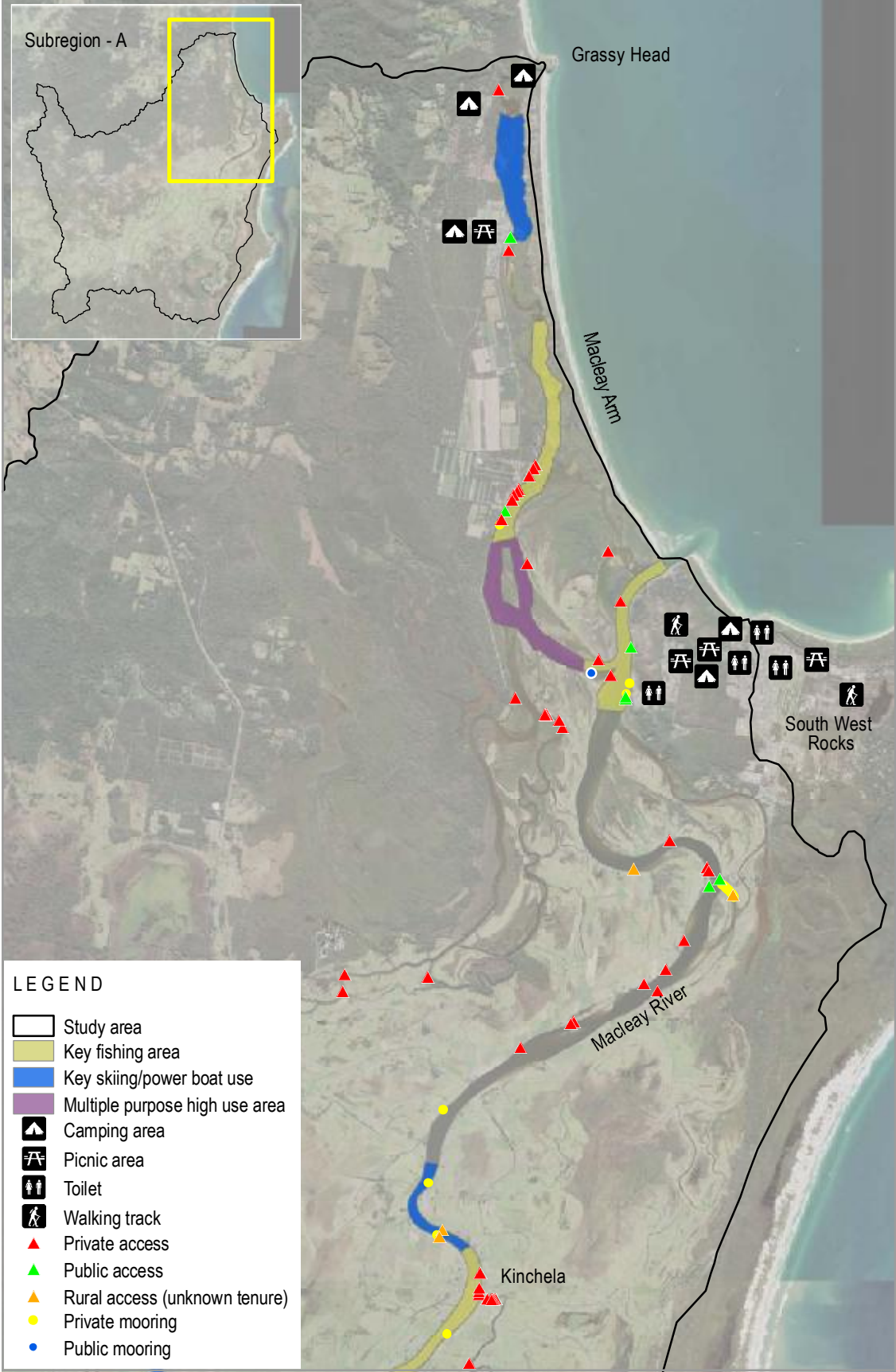
### 2.2.3 Waterway Use

Waterways in the Macleay estuary support significant boating and fishing activities. **Illustrations 2.2 to 2.4** show the locations of current waterway access and usage.

The fisheries resources of the Macleay include the estuary general fishery and shellfish aquaculture. Estuary prawn trawling is no longer a significant industry on the Macleay. Oyster farming is the most valuable fishery managed by NSW Industry and Investment. The Macleay contributes in an average year approximately \$500,000 worth of production which represents approximately 2% of the total production for NSW.

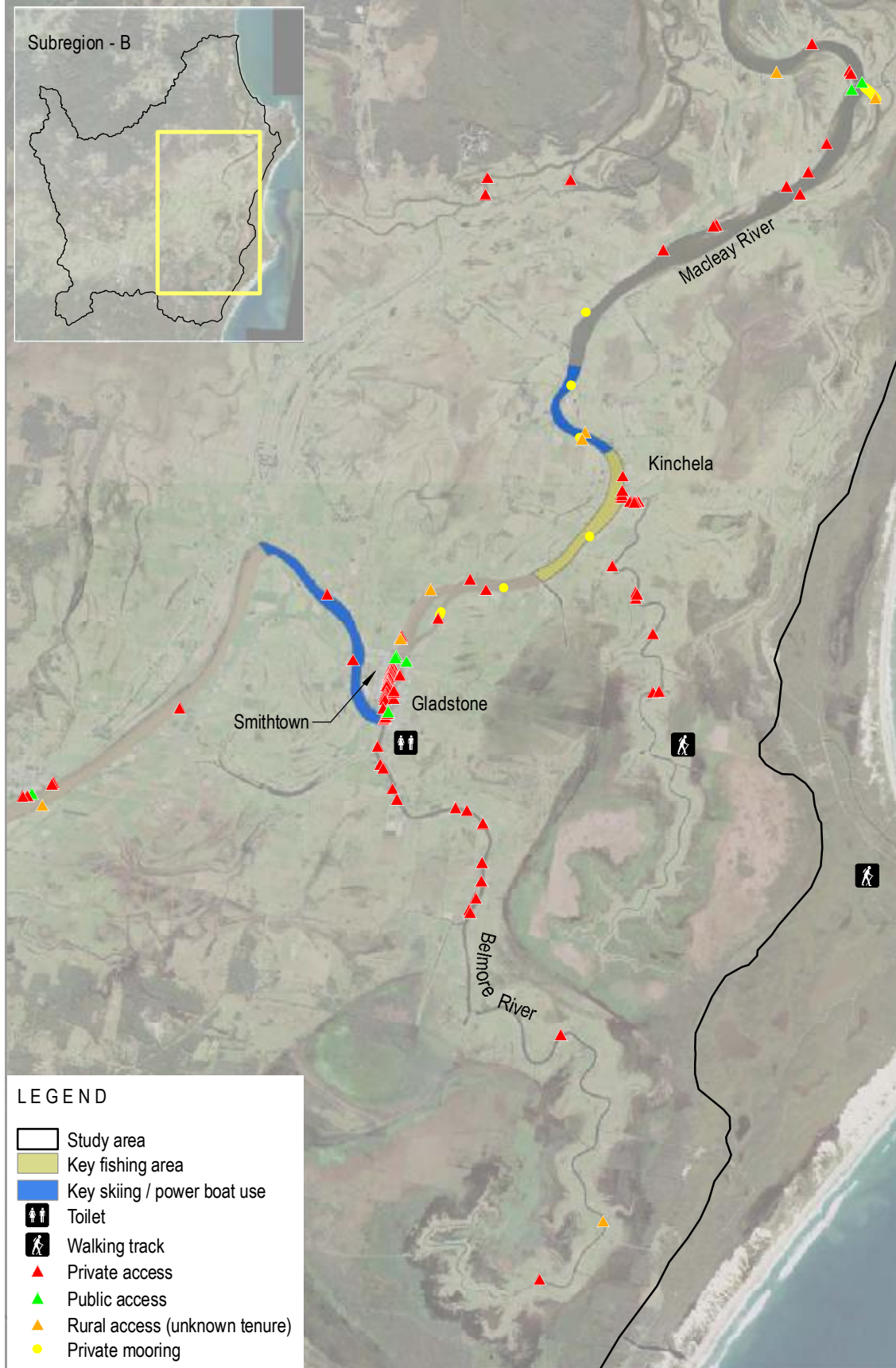
Recreational fishing is estimated to be worth in excess of \$40 million to the mid north coast regional economy (Telfer 2005). Over 74000 recreational fishers, representing almost 30% of the population, operated on the mid-north coast of NSW during the survey period (NSW Fisheries 2001). The Macleay estuary is likely to represent a significant proportion of the above numbers. The majority of the recreational catch was taken in estuarine waters and the Macleay is the second largest river system in the mid north coast region.

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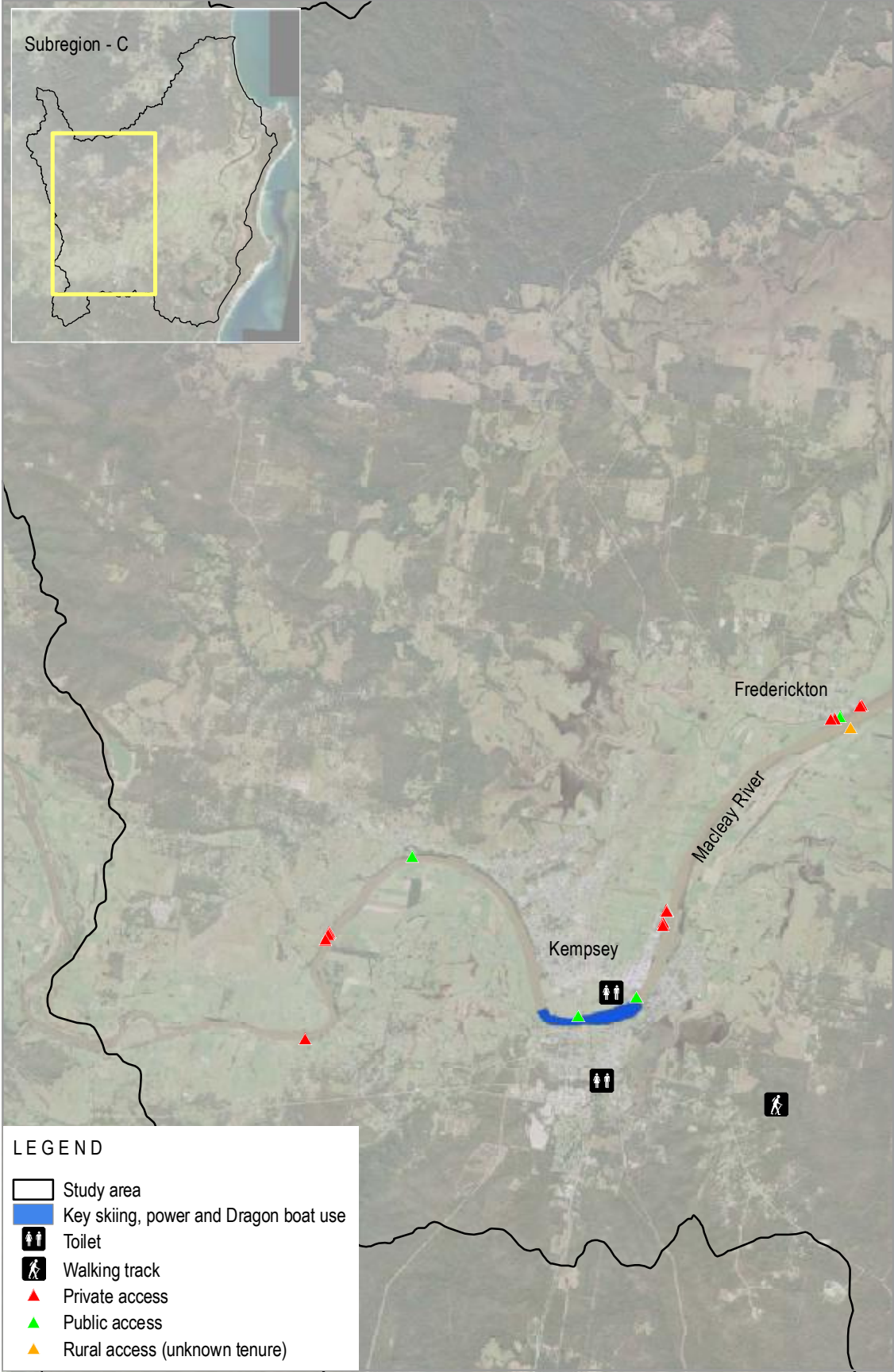
## Estuary Access and Usage - Subregion A







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## Riparian Management and Erosion

Riparian management and bank erosion have been identified by the EMC as a major issue for the Estuary Management Planning Process. Some of the outcomes desired by the EMC include;

- reducing bank erosion and retaining the river in its current location;
- increasing stability of all riparian lands;
- protecting existing areas of native riparian vegetation and rehabilitation of other areas;
- creating vegetated corridors throughout the estuary; and
- improving treatment of riverside public lands within villages and towns.

The following discussion outlines the current status of bank erosion and riparian management issues in the estuary, outlines a set of guiding principles and objectives for riparian and bank management, and recommends management strategies that will be further considered in the development of the Macleay River Estuary Management Plan.

### 3.1 Current Status

#### 3.1.1 Bank Erosion

A survey by Cohen (2005) indicates approximately 10% of Macleay River and its tributaries experience minor to severe erosion and the remaining 90% are stable. Approximately one quarter of the stable banks are stabilised with rock revetment or other material, the remainder are considered naturally stable. The fluvial process zone (from Belgrave Falls to Kinchela) has the most severe bank erosion in the estuary (Table 3.1).

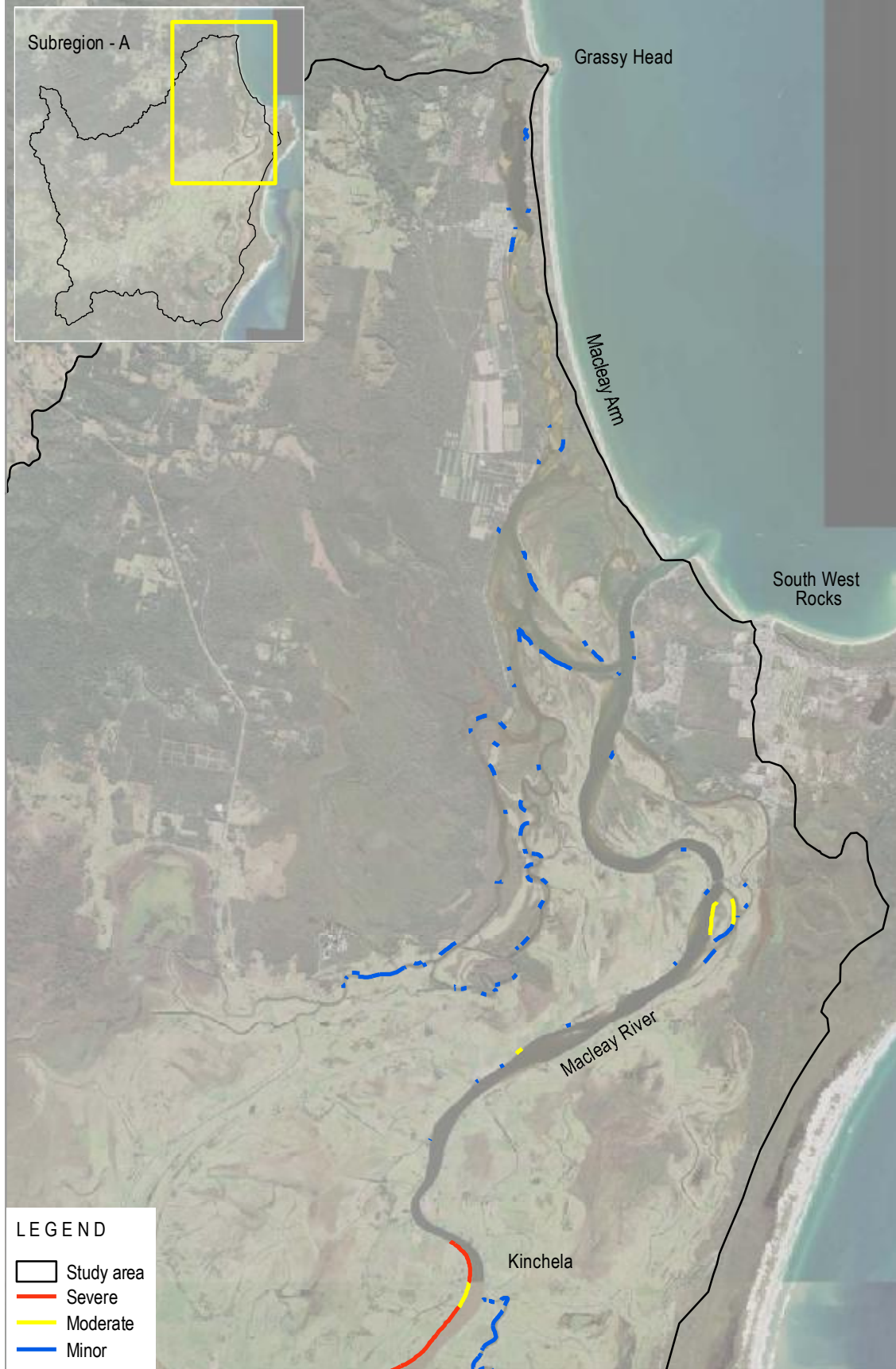
The erosion statistics presented do not include erosion resulting from the 2009 floods. A resurvey of the estuary study area is beyond the scope and resources of the EMS. However, the pre-2009 survey results are considered satisfactory for the purpose of developing appropriate management strategies and priorities.

The results of the erosion mapping from 2005 are shown in Illustration 3.1 to 3.3.

**Table 3.1 Bank Erosion Statistics**

	Total Length (km)	Survey length (km)	Stable (km)	Minor Erosion (km)	Moderate Erosion (km)	Severe Erosion (km)	% Naturally Stable	% Rock Stabil'd	% Minor	% Moderate	% Severe
Entire Estuary	357	270	245	18	4	3	65	25	7	2	1
<b>Process Zones:</b>											
Fluvial	187	134	120	8.0	2.8	3.0	70	20	6	2	2
Transitional	81	69	61	6.3	1.2	-	51	38	9	2	-
Marine	96	70	66	3.8	-	-	72	22	6	-	-

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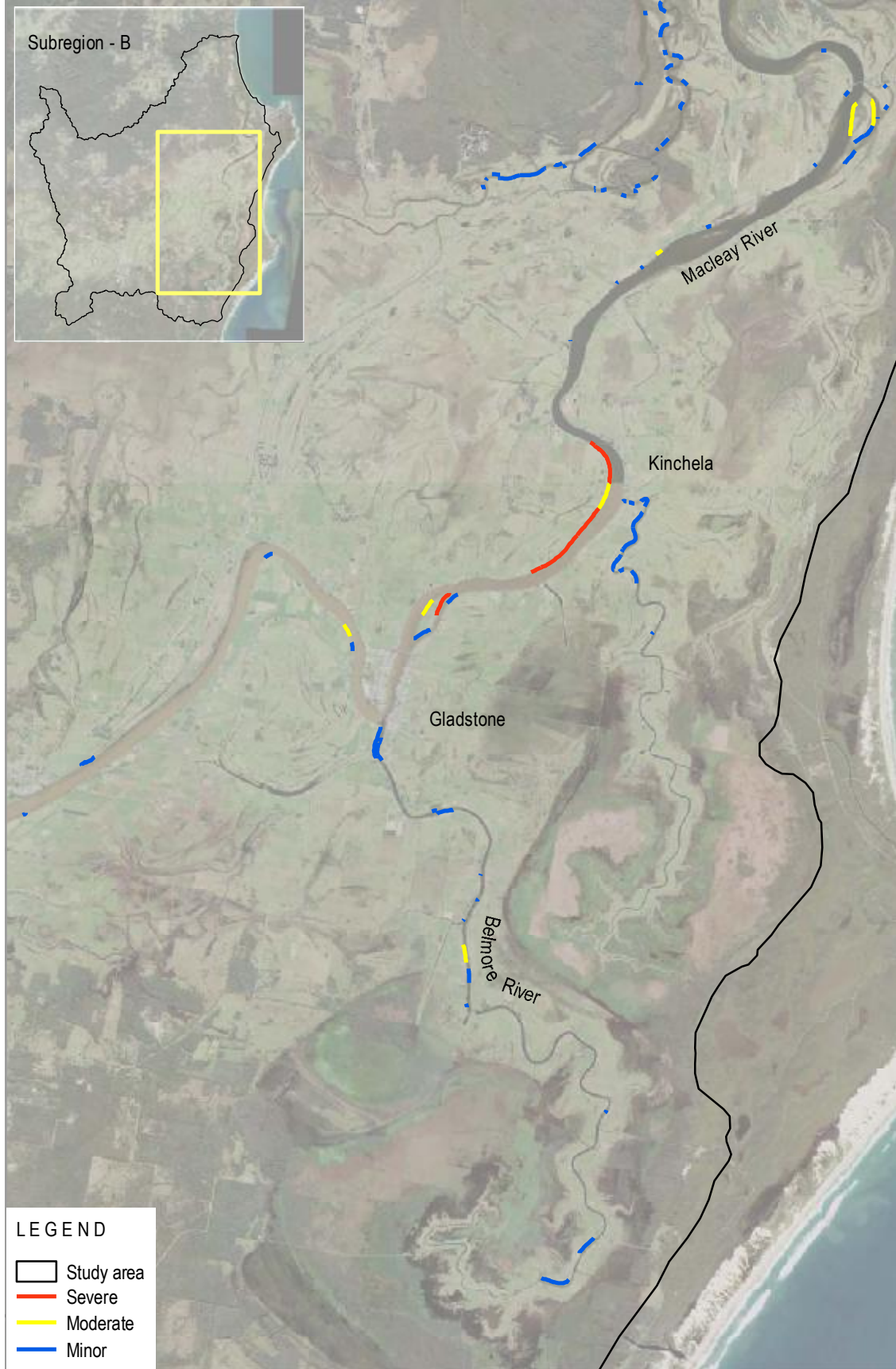
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Information shown is for illustrative purposes only

Drawn by: RE Reviewed by: MVE Date: May 2010  
Source of base data: Kempsey Shire Council



0 2 km

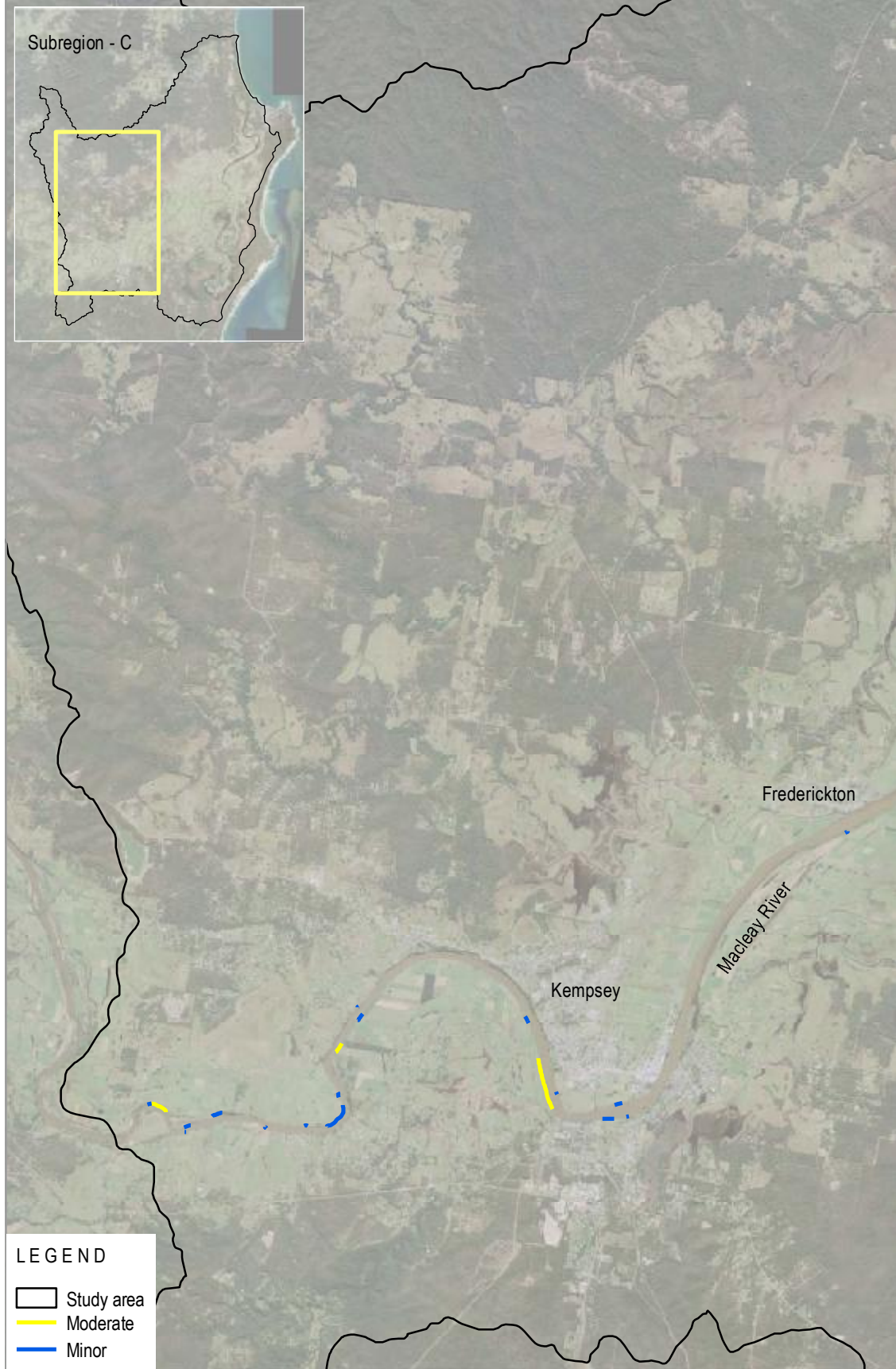
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1352705

## Existing Bank Erosion - Subregion B

Illustration 3.2

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0 2 km





The major causes of bank erosion are dependent upon a number of factors including underlying morphology of the banks and floodplains, dominant processes, native vegetation cover, extent of existing bank protection measures, and adjacent land and waterway usage. According to Cohen (2005), the dominant causes of bank erosion in the Macleay estuary are:

- Fluvial processes (i.e. driven by freshes and floods);
- Wind and/or boat waves;
- In-channel sedimentation;
- Stock disturbance/reduced riparian vegetation; and
- Presence of rockwork on adjacent banks.

The relative role of these controls varies considerably between process zones and is partly determined by local factors including whether the bank has a deep or shallow water profiles, the local land and waterway usage, the estuary planform, sediment distribution, and relative dominance of fluvial/tidal/marine processes. Furthermore, the history of catchment disturbance in the Macleay valley, including the 1.24 million tonnes of sediment that have been dredged from the estuary between 1929 and 1963, continues to have important impacts on estuarine processes (Telfer, 2005).

In terms of types of erosion occurring in the estuary, there are generally two main drivers of erosion processes, 'episodic processes' being the primary driver of erosion in upper more fluvial dominated reaches, and 'continuous processes' which are more prevalent in middle to lower reaches of the estuary.

Types of episodic or event-based processes include:

- Slab type block failure resulting from inundation and subsequent slumping, with material generally not remaining in situ;
- Rotational failures and slumps related to either subsoil drainage or draw-down effects as water level drops with rapidly receding flood levels, with material generally remaining in situ; and
- Scour resulting from high velocity flows often acting on the bank toe. Material does not remain in situ. Scour associated with major flooding can remove the evidence of slab type block failures.



**Plate 3.1 Rotational Slump Failure**



**Plate 3.2 Bank Notching by Wind / Boat Waves**

Types of continuous processes include:

- Slab type block failure resulting from undercutting of the bank toe as a result of wave or wind action or scour, with material often remaining in situ;
- Notching of the bank toe or fretting as a result of wave action (wind or boat) and subsequent undercutting and failure; and
- Disturbance of banks through unmanaged stock access, inappropriate land use, or the removal and/or suppression of riparian vegetation.



**Plate 3.3 Stock Impacts on Banks**

Source: Cohen, 2005

Although separating the types of processes facilitates explaining how erosion occurs in estuaries, in reality the processes are interrelated. For example, continuous effects such as unmanaged stock access can lead to suppression of the mangrove and river reed fringe which as a result of continuous wave wash from wind and boats can cause the banks to become undermined and susceptible to episodic damage from flood events.

As a consequence it is important to accurately determine the causes and types of erosion occurring at sites where remedial action is planned if a long-term and cost-effective solution is to be achieved.

### 3.1.2 Riparian Vegetation

Riparian habitats are a significant component of estuarine and floodplain environments. Riparian habitat values include fisheries habitat, terrestrial habitat, bank stability and maintenance of soil structural integrity, landuse “buffers”, water quality and filtering values and aesthetic values (WBM 2006).

The vegetation of the Macleay estuary has been described in numerous studies over the past three decades including:

- East Kempsey Vegetation Mapping project (Telfer and Kendall, 2006);
- Wetland mapping undertaken by Wetland Care Australia (2006); and
- Riparian vegetation mapping by ID Landscape Management Pty Ltd as part of the Macleay Estuary Data Compilation study (Geco Environmental 2005).

Most relevant to the EMS and EMP is the 2005 assessment by ID Landscape Management of the Macleay Estuary riparian vegetation. The study assessed the type and condition of bank vegetation, the occurrence and distribution of weed species, and the presence of important vegetation species. Fourteen percent (14%; 48km of river bank) was identified as being in intact condition, in that the vegetation assessed was considered to be in essentially ‘natural’ condition with few signs of disturbance. Two thirds of river banks (232km) were considered to have a high degree of disturbance (identified as having a high degree of removal of vegetation structure or degradation of native cover with either extensive or minimal weed invasion depending on management practices), with a further 19% (67km) of banks mapped as having low, or low-moderate levels of disturbance. The major disturbance factors identified were (Geco Environmental, 2005):

- Clearing of the bank/riparian vegetation;
- Ongoing disturbances associated with grazing and some agricultural practices;
- Disturbance associated with infrastructure including roads in close proximity to the river, and bank protection works;
- Weed invasion including into otherwise intact remnant vegetation; and
- Disturbance associated with periodic flooding.

### 3.1.3 Riparian Weeds

The assessment of riparian vegetation undertaken by ID Landscape Management for the 2005 Estuary Data Compilation Study mapped the extent of weed infestation in the estuary riparian zone. The most serious environmental weeds (Category 1) include madder vine ( *Anredera cordiflora* ), balloon vine ( *Cardiospermum grandiflorum* ), cats claw creeper ( *Macfadyena unguis-cati* ), spike rush ( *Juncus acutus* ), small-leaved privet ( *Ligustrum sinense* ), water hyacinth ( *Eichhornia crassipes* ), and bitou bush ( *Chrysanthemoides monilifera subsp. Rotunda* ).

In 2005 it was estimated that some 193 km or 56% of riverbanks were mapped with common to heavy infestations of one or more Category 1 weed species. **Illustration 3.4** to **Illustration 3.6** shows the distribution of common to heavy infestations of Category 1 weeds as mapped in 2005 and the results of additional mapping of the extent of *Juncus acutus* as mapped in Birch and GeoLINK (2010).

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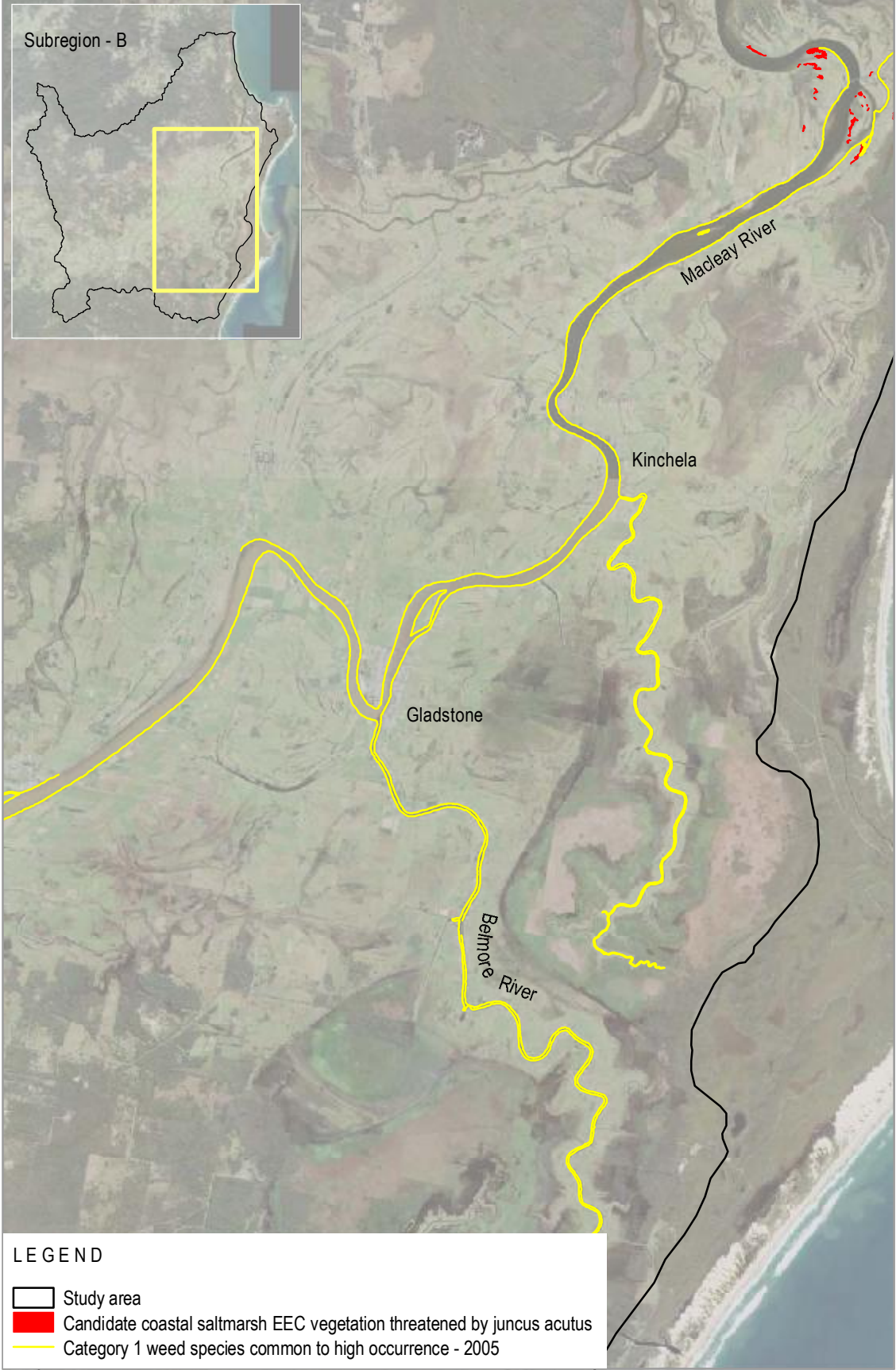


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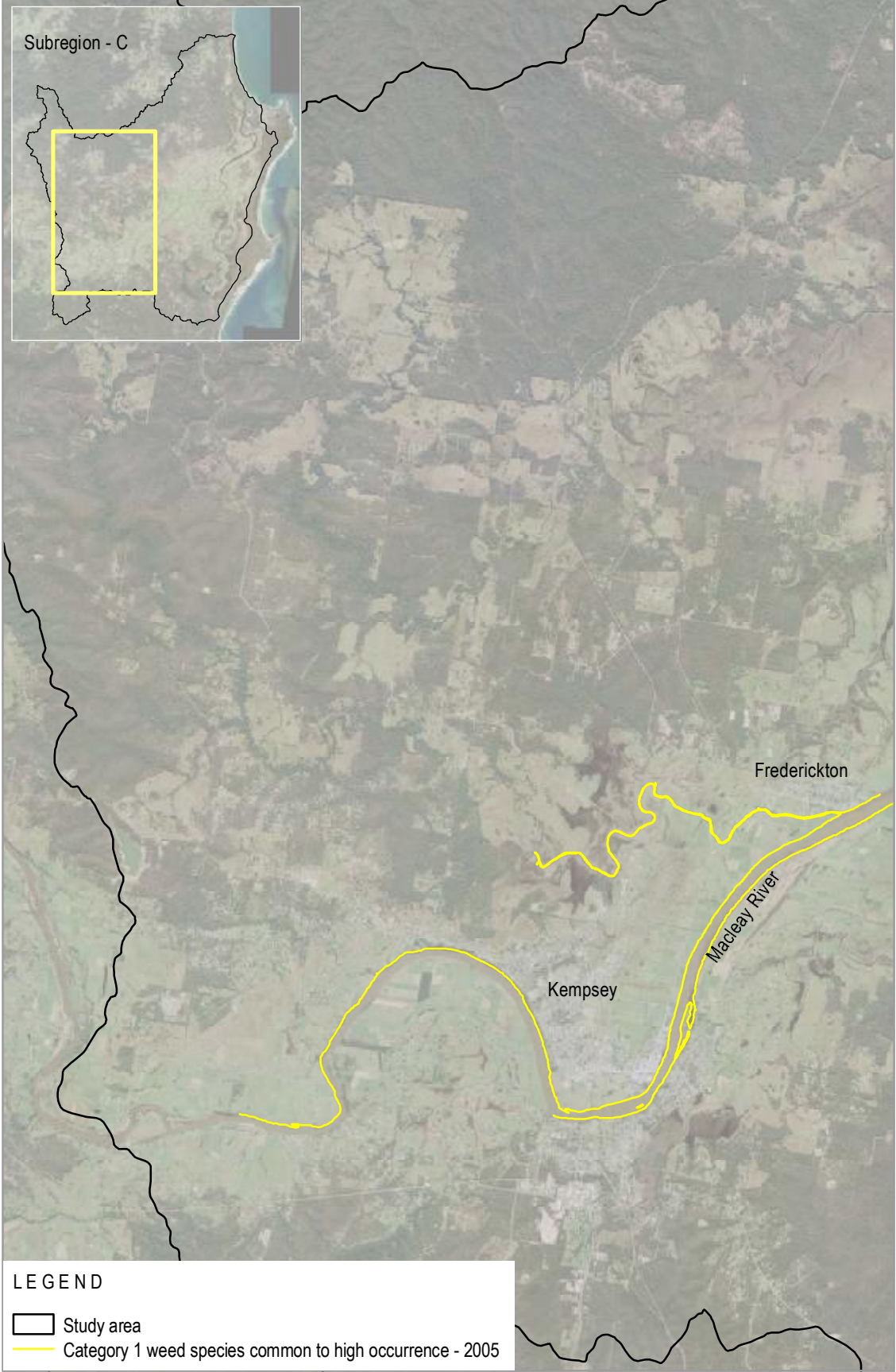




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### 3.1.4 Riparian Remnants and High Value Vegetation Types

The location and extent of riparian and floodplain vegetation remnants have been mapped using various methodologies over the past 10-15 years including:

- Forest ecosystems and candidate endangered ecological communities (EEC) under the Kempsey East Vegetation Mapping Project (Telfer and Kendall, 2006);
- Preliminary mapping of Littoral Rainforest EEC, Lowland Rainforest EEC, Coastal Saltmarsh EEC, and Swamp Oak Forest EEC by ID Landscapes for the Macleay Estuary Data Compilation Study (GECO Environmental, 2005);
- Mapping of estuarine vegetation types including seagrass, saltmarsh and mangroves by DPI Fisheries in 2006;
- Mapping of floodplain wetlands by WetlandCare Australia 2006;
- Mapping of SEPP14 and SEPP26 (Department of Planning).

Importantly, eight EEC were identified as potentially occurring on or adjacent to the Macleay estuary by ID Landscape Management in 2005. **Illustration 3.7** to **Illustration 3.9** shows the location of significant riparian vegetation types and potential floodplain remnants associated with estuarine or backswamp systems.

Condition assessments of riparian remnants have not been undertaken. However an estimate of condition may be inferred from the vegetation assessments undertaken by ID Landscape Management in 2005. This has been done by comparing reaches of potential remnant with the riparian condition assessments and level of weed infestation, including areas of mangrove forest and of coastal saltmarsh not affected by *Juncus acutus* infestation. **Illustration 3.10** to **Illustration 3.11** highlights areas that are inferred by this methodology to be potentially high value remnant riparian vegetation. It is recommended that site assessments be undertaken to determine the actual status of the vegetation communities identified.

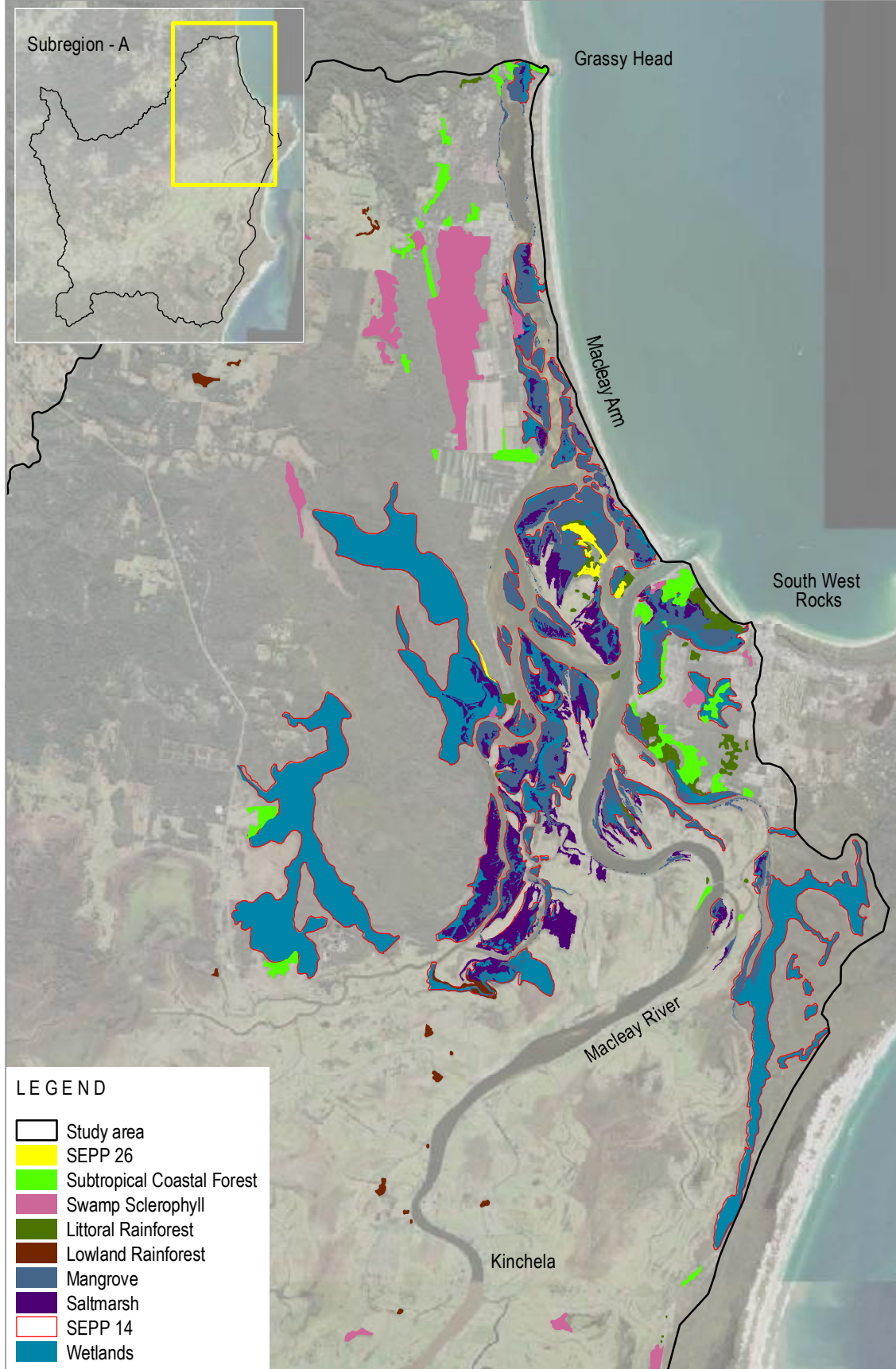
### 3.1.5 Previous Erosion and Riparian Management Works

A wide range of bank erosion and riparian rehabilitation works have been implemented over the past 80 years in the Macleay with the vast majority of works being rock walls/revetment undertaken in the flood mitigation era (i.e. post the 1949/1950 floods and into the late 1970s). The following statistics detail the range of bank protection works identified during a survey of works undertaken as part of the Macleay Estuary Data Compilation Study (GECO Environmental, 2005);

- brush groyne or log/timber bank protection (160m total on Macleay River and Clybucca Creek);
- revegetation and fencing on riverbanks (1500m total on Macleay River and Clybucca Creek, plus an additional 450m at two sites at Jerseyville undertaken since the 2005 survey);
- rock fillets / embayments (2 sites on Macleay River between Kinchella and Jerseyville);
- wave energy curtains constructed of various materials (Fatorini Island);
- tyre walls (approximately 900m in Kinchella Creek, Macleay Arm and Macleay River);
- reprofiling of banks in combination with revegetation (upper Macleay River estuary); and
- standard rock revetment (70.6km with the 55km on Macleay River, 13km on Clybucca Creek/Andersons Inlet, 960m on Macleay Arm, 750m on Spencers Creek, 500m on Belmore River, and 400m on Kinchella Creek).

**Illustration 3.12** to **Illustration 3.14** shows the distribution of known rehabilitation sites within the Macleay estuary as of 2005.

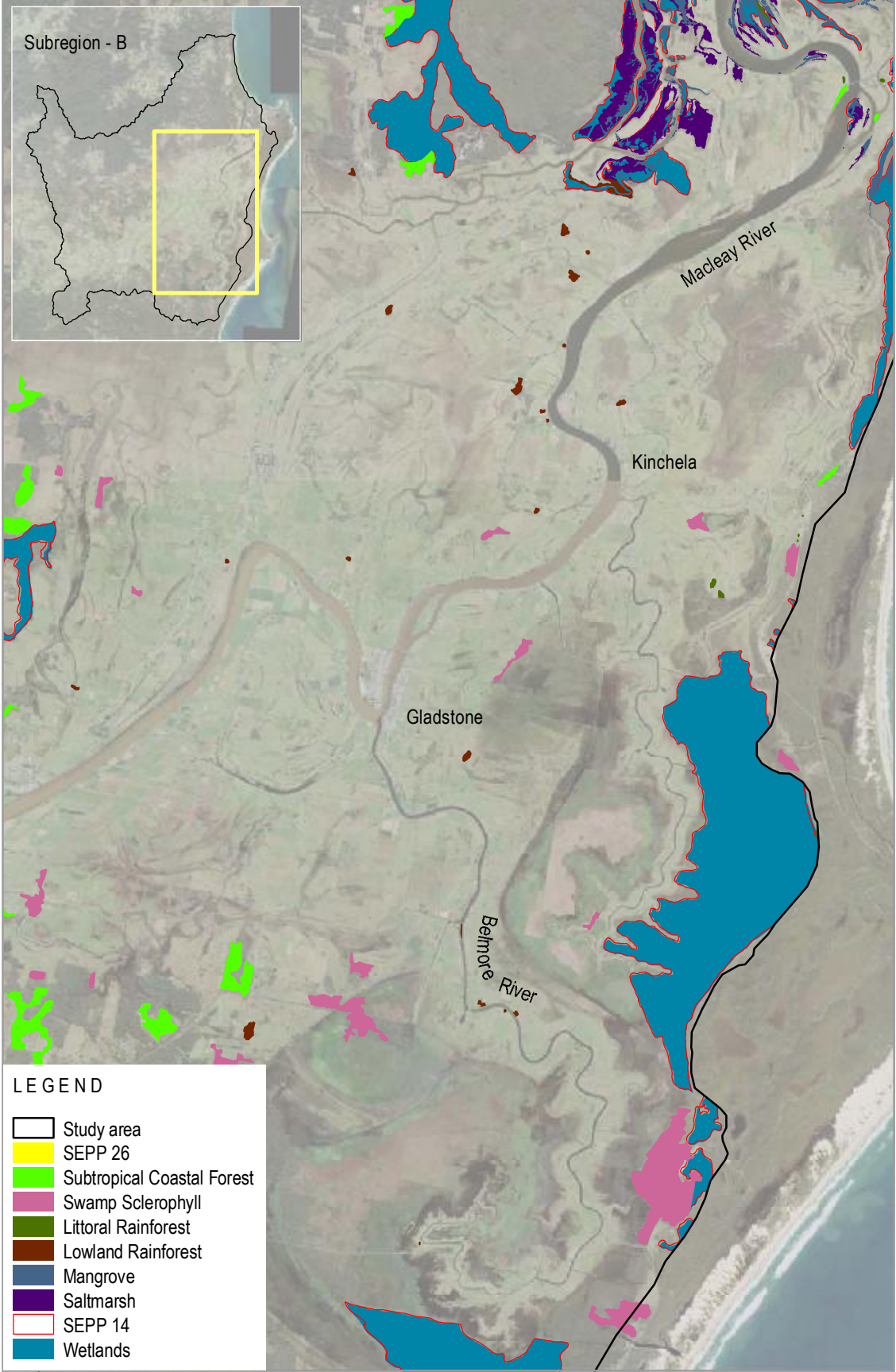




### Riparian Vegetation Types and Floodplain Remnants - Subregion A



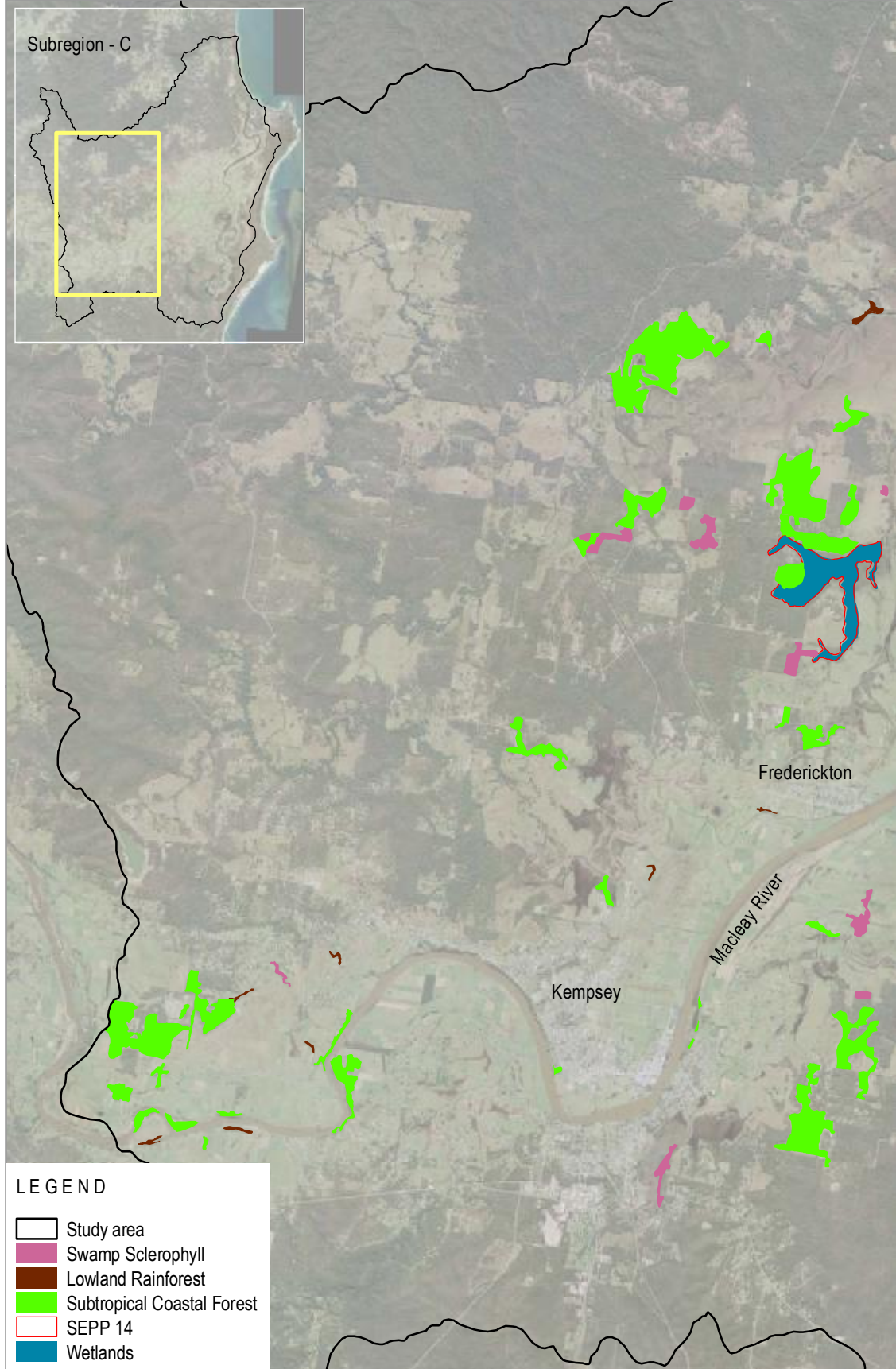
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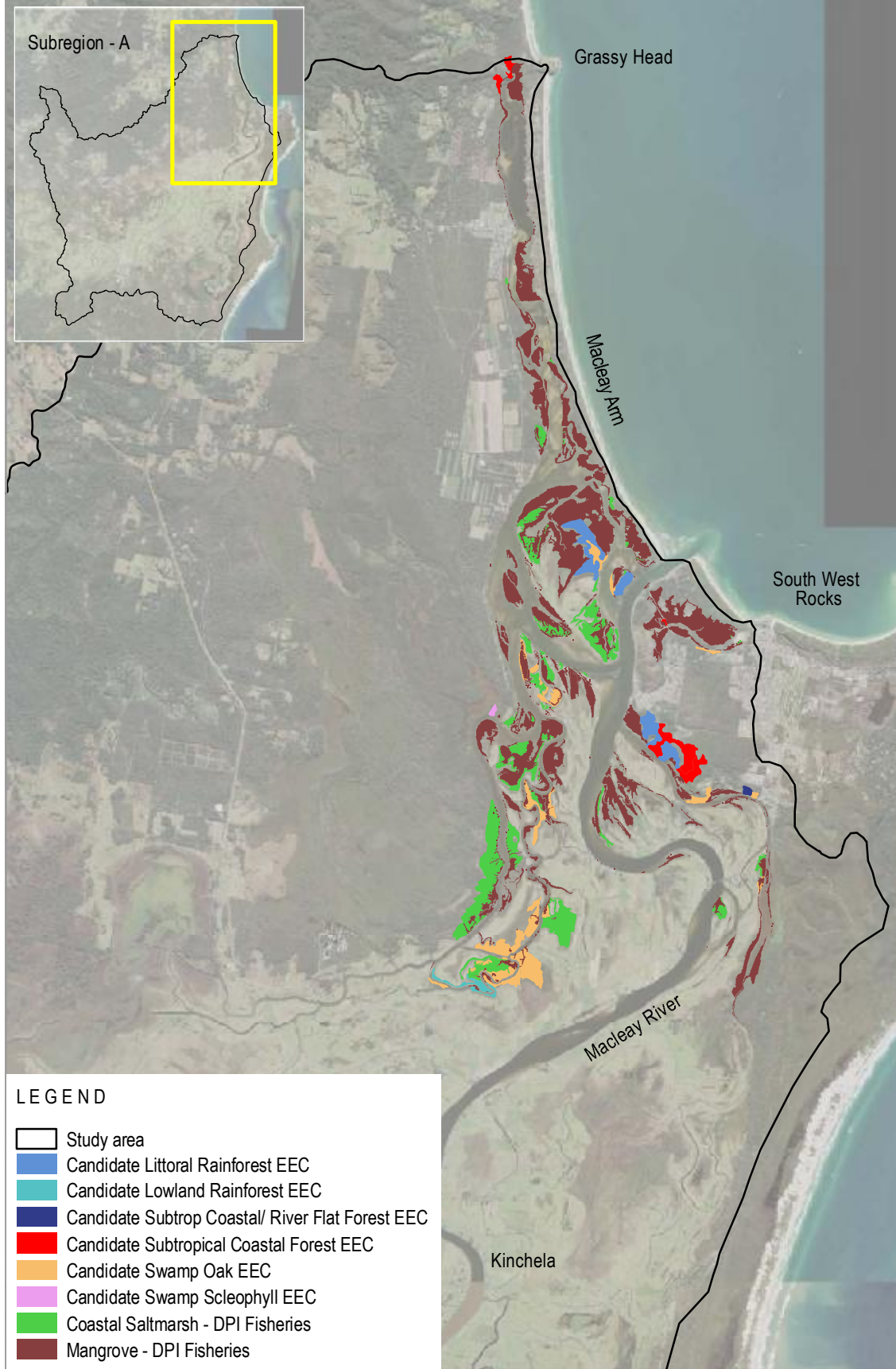
### Riparian Vegetation Types and Floodplain Remnants - Subregion B







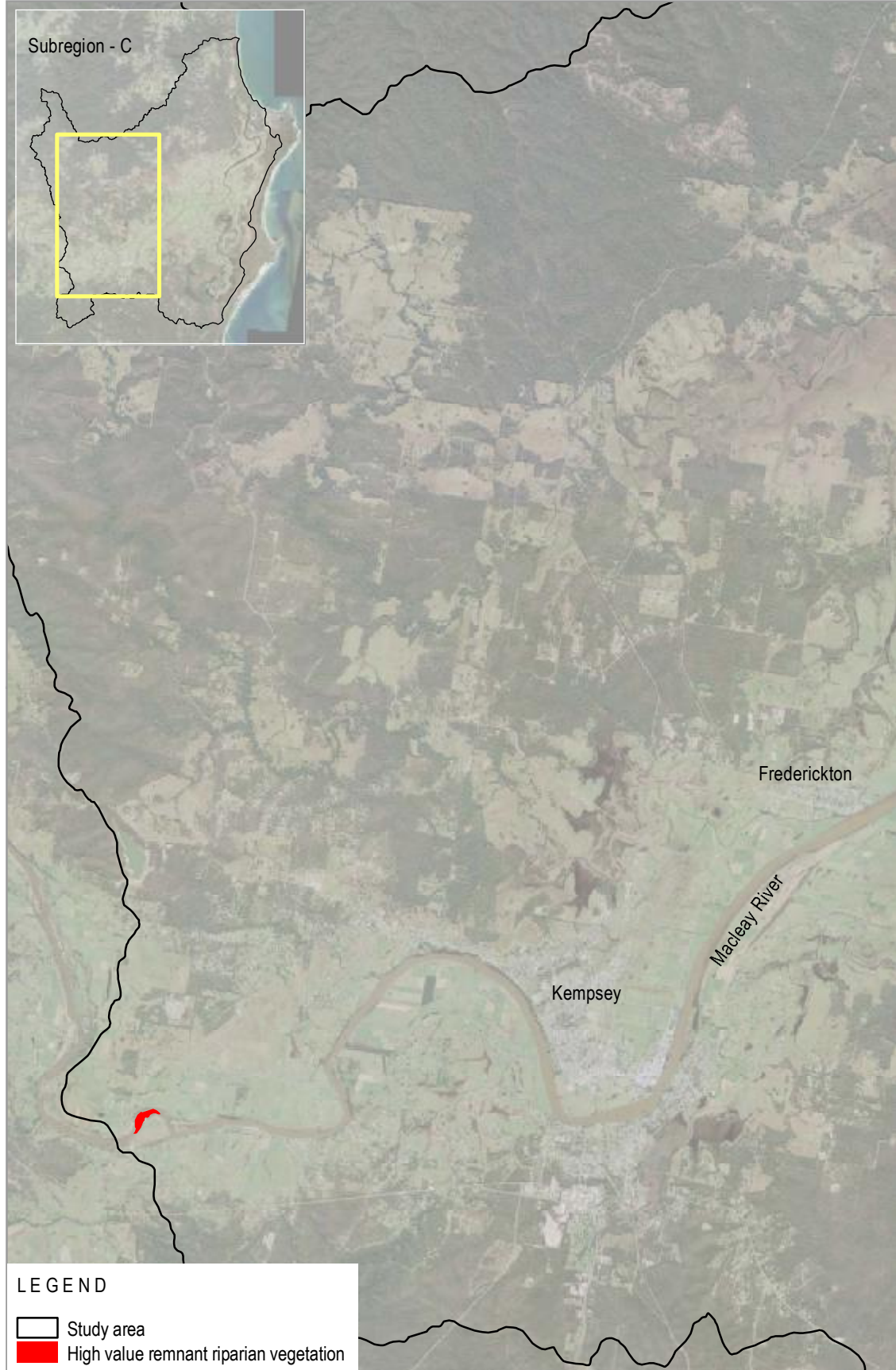
### Riparian Vegetation Types and Floodplain Remnants - Subregion C



0 2 km







0 2 km

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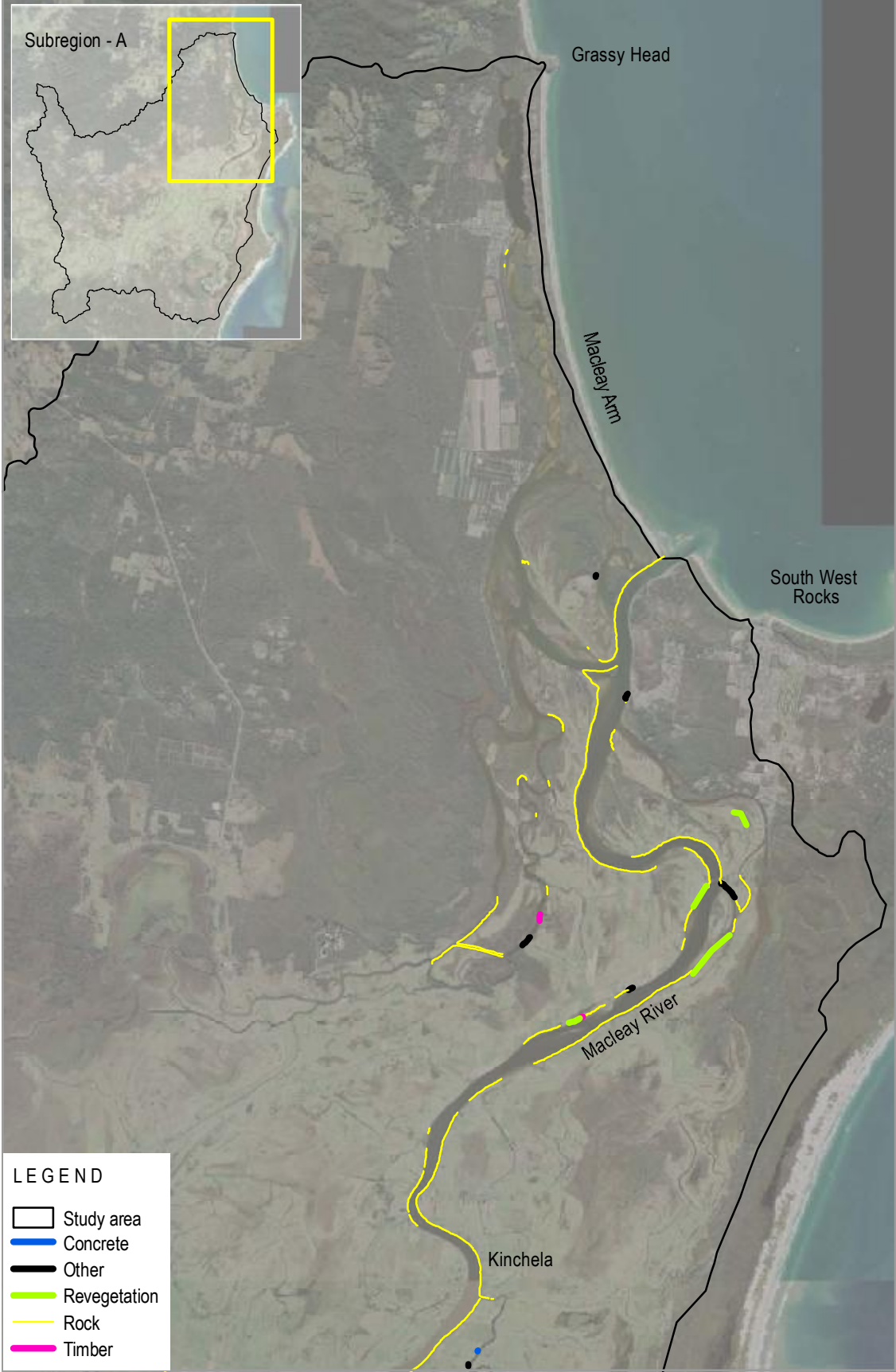
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### High Value Remnant Riparian Vegetation - Subregion C

Illustration 3.11



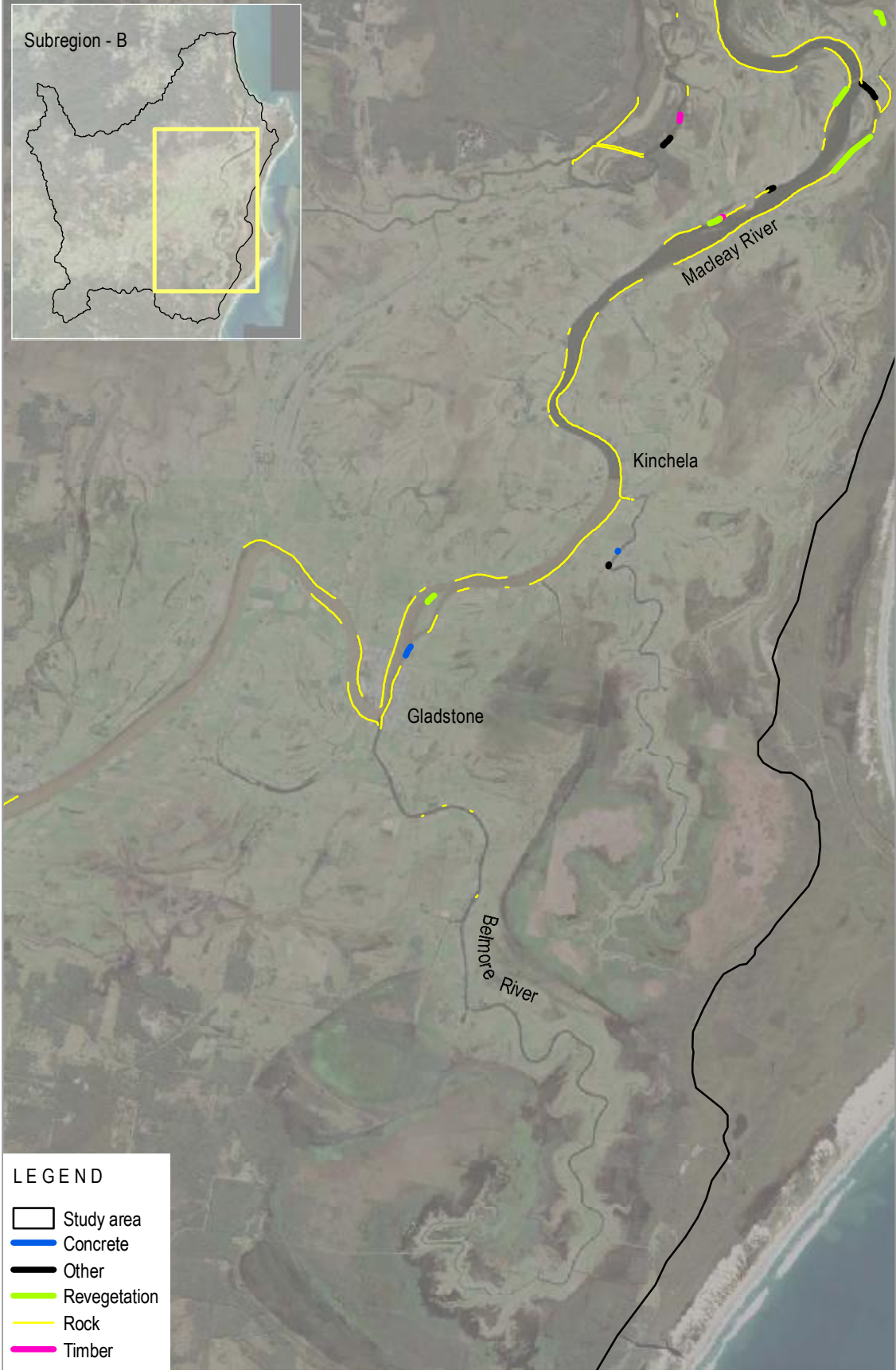
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**LEGEND**

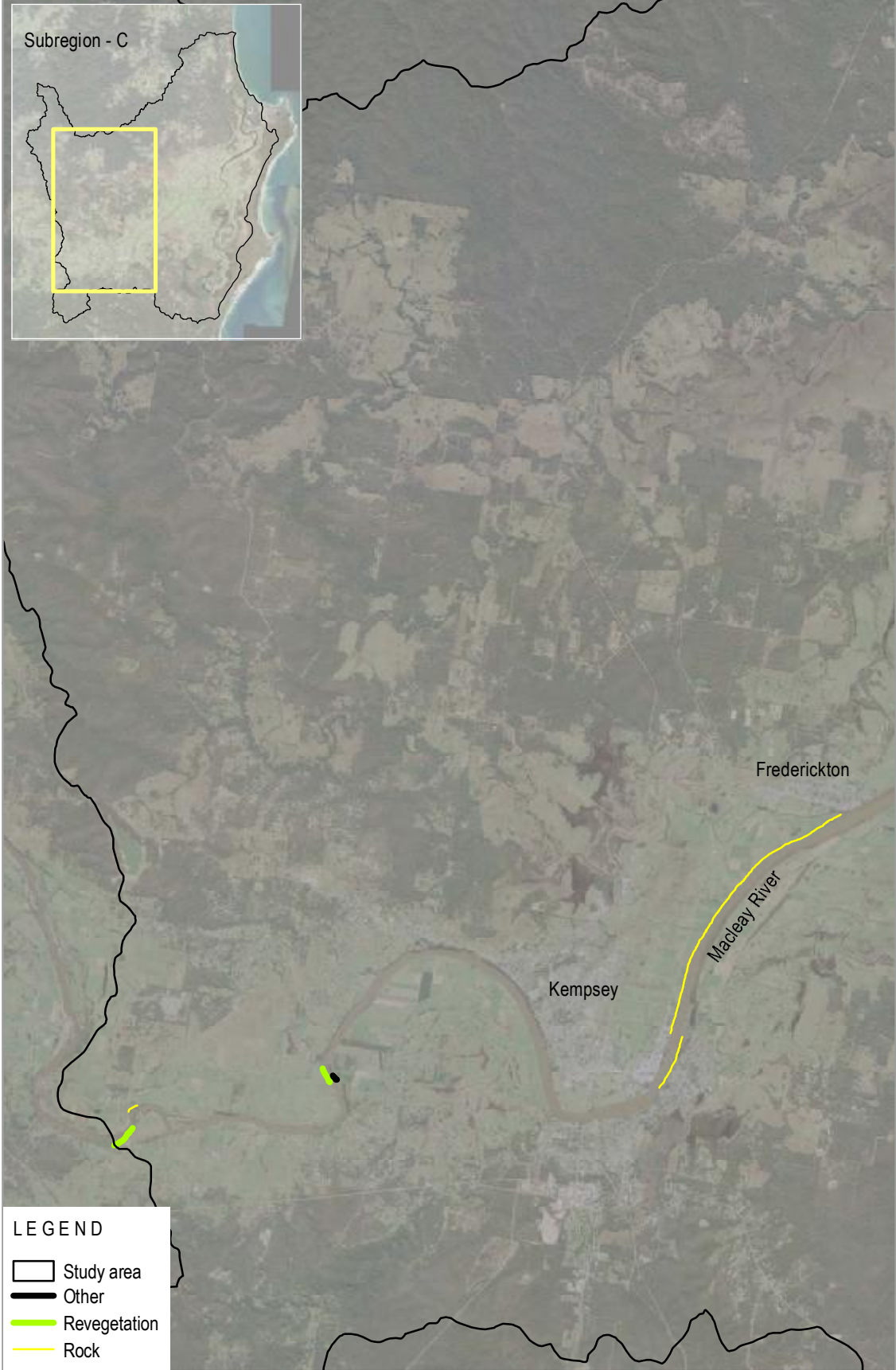
-  Study area
-  Concrete
-  Other
-  Revegetation
-  Rock
-  Timber



### Previous Erosion and Riparian Management Works - Subregion B



Information shown is for illustrative purposes only



0 2 km



### Previous Erosion and Riparian Management Works - Subregion C



Of interest, in recent years there have been several trials of low cost 'soft-engineering' style solutions to bank erosion in the estuary. These include the use of wave energy curtains using shade cloth and geofabric suspended from lengths of PVC to limit wave wash, and the use of low brush groynes also to limit wave wash. The rationale behind the trial of such methods is twofold: firstly to find a cheap and easily implemented alternative to hard options such as rock revetment, and secondly to reduce the impact of revetment style structures on the ecologically important interface between the waterway and the banks. Unfortunately both methods have proved to have limited effectiveness over the medium to long term in arresting bank erosion (J. Schmidt 2010, pers. comm. 19 February).

Examples of current best-practice bank protection works will be provided in the Macleay River Estuary Management Plan and include:

1. natural regeneration / stock control;
2. rock revetment / revegetation; and
3. rock embayments / fillets / revegetation.

## 3.2 Management Issues

### 3.2.1 Bank Erosion Management Issues

Bank erosion management issues have been identified using a number of sources including the Macleay Estuary Data Compilation Study; consultation with Council, DECCW, CEMC and other stakeholders; and the consultant team's own observations. The management issues include:

- The loss of valuable riverside land;
- Increased turbidity and sedimentation in the estuary as a result of bank erosion;
- Costs and ongoing maintenance of erosion protection works;
- A lack of native riparian vegetation along the banks of the Macleay River;
- The extensive use of rock revetment as the main treatment for bank protection resulting in a significant change in river bank associated habitat; and
- Undesirable riverbank treatment associated with riverside urban development.

### 3.2.2 Riparian vegetation management issues

Riparian vegetation management issues have been identified using a number of sources including the Macleay Estuary Data Compilation Study; consultation with Council, DECCW, CEMC and other stakeholders; the consultant team's own observations; and the ecological study undertaken by Birch and GeoLINK (2010). Issues particularly relevant to riparian habitats include:

- The Macleay River 'riparian corridor' is highly degraded due to the extent of clearing and the paucity of remnant pockets along the riparian margin or in pockets across the floodplain. Weed infestations are extensive. Nevertheless the riparian margin does act as a conduit for a variety of mobile species;
- The extent of Category 1 weed infestation in the Macleay estuary, and the significant difficulties and costs associated with attempting to eradicate these weeds from even small areas of infestation poses difficult questions for management in terms of dealing with the weed issue;
- Degradation of remnant vegetation due to landuse disturbances, weed incursion, and vulnerability to bank erosion (particularly in relation to saltmarsh communities in wave wash zones); and
- Disturbance associated with unmanaged stock access to the banks and riparian areas.

The management of these threats will form a key component to the long-term protection and restoration of the riparian corridor. Ideally an entire riparian corridor would be restored and protected. However, due to the substantially modified state of large portions of the riparian zone along the estuary, best practice management is to undertake such works at priority sites.

## 3.3 Management Objectives

### 3.3.1 Guiding Principles for Bank and Riparian Management

It can be seen from the data presented above and the illustrations showing the distribution of bank erosion and riparian management issues in the Macleay catchment that, as with many other NSW north coast estuaries, there are more river management issues than there are resources available to resolve them. As a result, a system for setting priorities is necessary if the available resources are to be used as effectively as possible to improve overall estuary health.

From a purely river health perspective, the highest priority should be given to protection of reaches in good condition by removal of threatening processes, and implementation of appropriate rehabilitation and preventative actions in easily restored or high value reaches. However, it is recognised that many of these reaches are on private land which, depending on circumstances, may limit the practical implementation of any management actions.

From the same perspective, undertaking rehabilitation works solely in reaches that are in poor condition should be avoided as such works are: likely to have little effect on the overall health of the system; are likely to be high cost and high risk; and may take up valuable resources that may be better utilised preventing areas in good condition from becoming degraded.

Whilst, these principles form a logical framework for assisting the priority setting process, it is recognised that other factors such as social, economic, cultural, and political considerations also play influential roles in estuary management decisions. For example, the protection of important community assets such as roads, bridges or boating facilities are obvious examples of where social and economic considerations may override river health objectives.

### 3.3.2 Setting Priorities for Bank Protection

In accordance with the principles outlined above, the following priorities are suggested for bank protection works:

- **Highest Priority**  
Sites where bank erosion threatens existing community infrastructure or property, or high value ecological systems including riparian and remnant vegetation;
- **High Priority**  
Sites where bank protection or riparian management works have already been implemented but where on-going erosion or other identified disturbance factors are threatening the works and future stability of the banks and/or values of the site;
- **Moderate Priority**  
Sites where erosion is considered to be serious but where significant and ongoing commitment is required by both landholders and responsible government agencies and funding bodies. Many moderate priority sites have very poor riparian vegetation and ongoing disturbance factors such as wind or boat wave wash or impacts from unmanaged stock access. These factors would need to be addressed in any erosion mitigation strategy to justify expending resources on these sites;
- **Low Priority**  
All remaining reaches assessed in the 2005 field surveys of bank erosion and riparian vegetation are considered to be low priority in terms of consistency with the guiding principles outlined above.

It is recommended that the priorities be reviewed periodically. For instance, flood events, changes to estuary use, or the construction of new public infrastructure adjacent to the estuary may result in a reassessment of the priorities presented.

**Illustration 3.15** to **Illustration 3.17** shows the locations of the ‘Highest Priority’ and ‘High Priority’ sites for bank erosion management identified using the prioritisation process detailed above (based on 2005 survey data).

### 3.3.3 Setting Priorities for Riparian Management

In accordance with the principles outlined above, the following priorities are suggested for riparian management:

- **Highest Priority**  
Sites where erosion or weed invasion (particularly by Category 1 weed species) threaten existing high value ecological systems including riparian and remnant vegetation or important riparian corridor linkages.
- **High Priority**  
Sites where bank protection, riparian management works or landholder management agreements have already been implemented to protect high value riparian or remnant vegetation but where on-going erosion or other identified disturbance factors are threatening the values of the site.
- **Moderate Priority**  
Sites where riparian or remnant vegetation values are already considerably compromised by historic and/or ongoing land use management practices or significant weed incursion, and where a considerable ongoing commitment would be required by both landholders and responsible government agencies and funding bodies.
- **Low Priority**  
All remaining reaches assessed in the 2005 field survey of riparian vegetation are considered to be low priority in terms of consistency with the management principles outlined above.

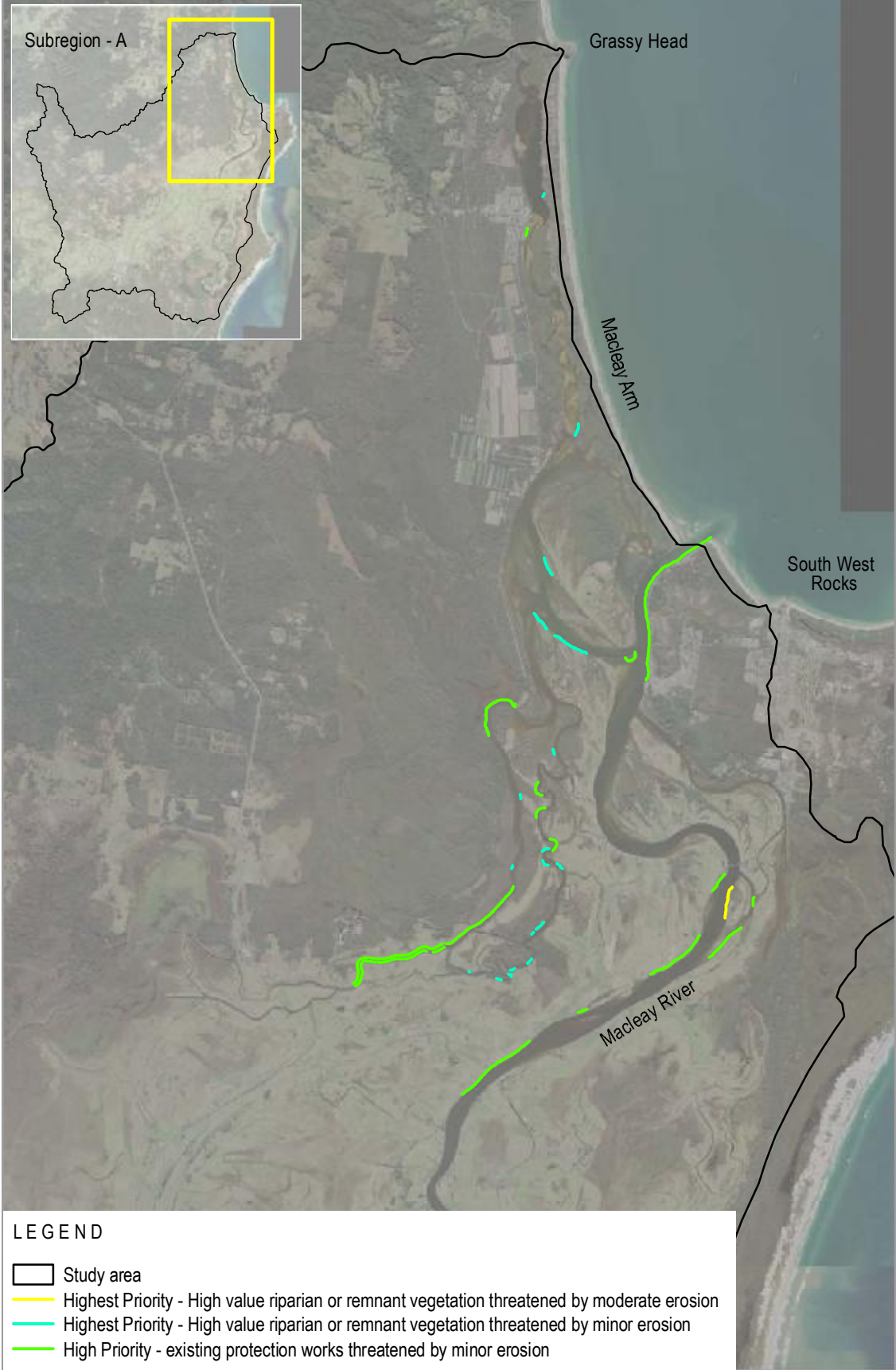
**Illustration 3.18** shows the locations of Highest Priority sites for riparian management in the Macleay River estuary identified using the above prioritisation process (based on limited 2010 updating of the 2005/2006 survey data). The Highest Priority sites for riparian management are all located in the lower portion of the estuary (Subregion A).

### 3.3.4 Bank and Riparian Management Objectives

Based on the principles and priorities discussed above, the following series of objectives for management of bank erosion and riparian vegetation in the Macleay estuary have been developed:

<b>Management Objective 3/1</b>	Protect existing public infrastructure threatened or vulnerable to bank erosion;
<b>Management Objective 3/2</b>	Protect important riparian conservation values where threatened by bank erosion, weed invasion, or land management practices;
<b>Management Objective 3/3</b>	Protect existing bank and riparian management works;
<b>Management Objective 3/4</b>	Utilise best-practice erosion control, riparian management techniques and flood mitigation works to improve overall estuary health;
<b>Management Objective 3/5</b>	Improve the condition and continuity of the riparian corridor;
<b>Management Objective 3/6</b>	Manage recreational boat use in areas of high vulnerability / susceptibility to wave wash erosion.

Information shown is for illustrative purposes only



0 2 km

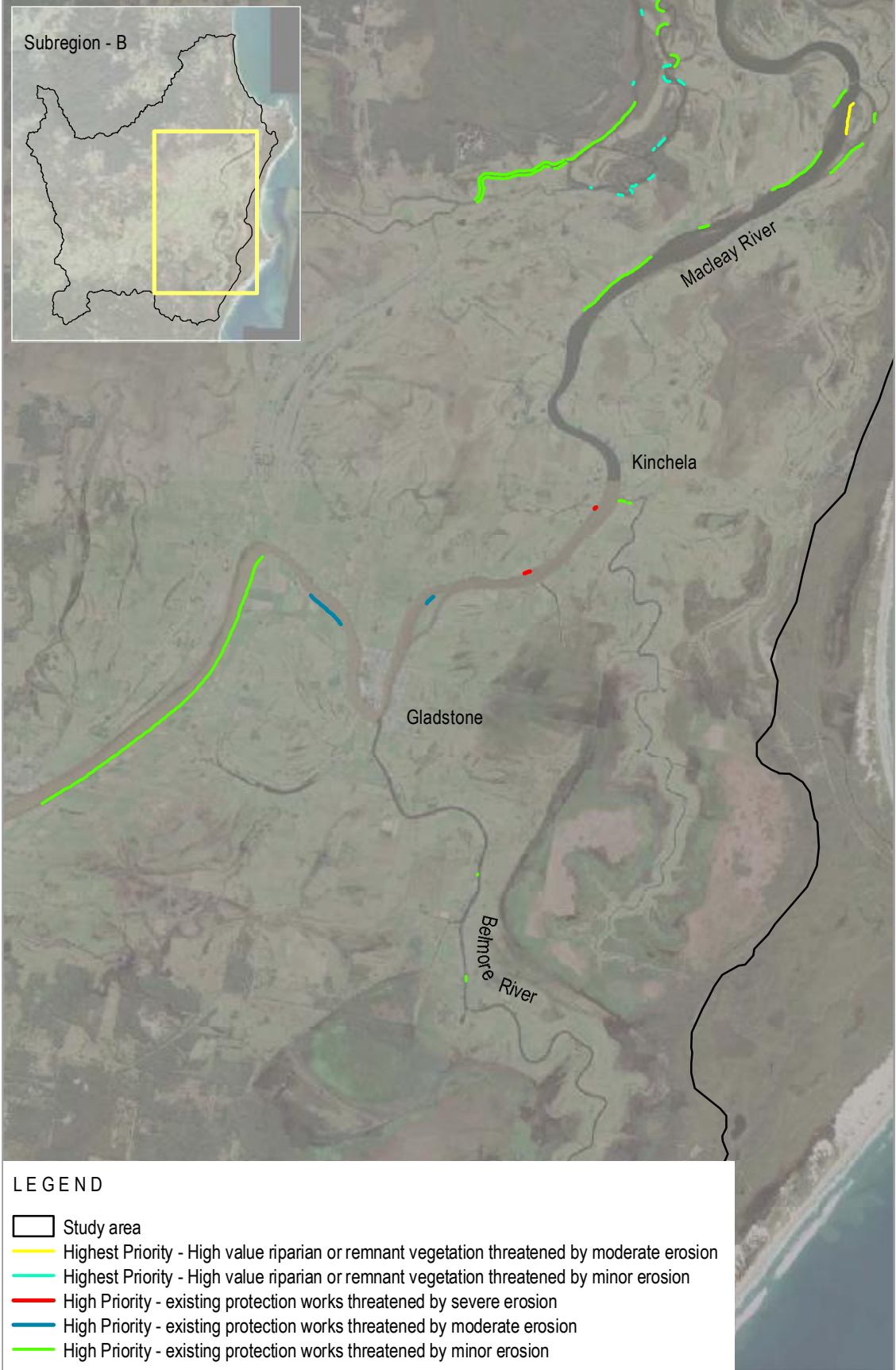


### Highest and High Priority Sites for Bank Erosion Management - Subregion A

Macleay River Estuary Management Study  
1352241

Illustration 3.15

Information shown is for illustrative purposes only



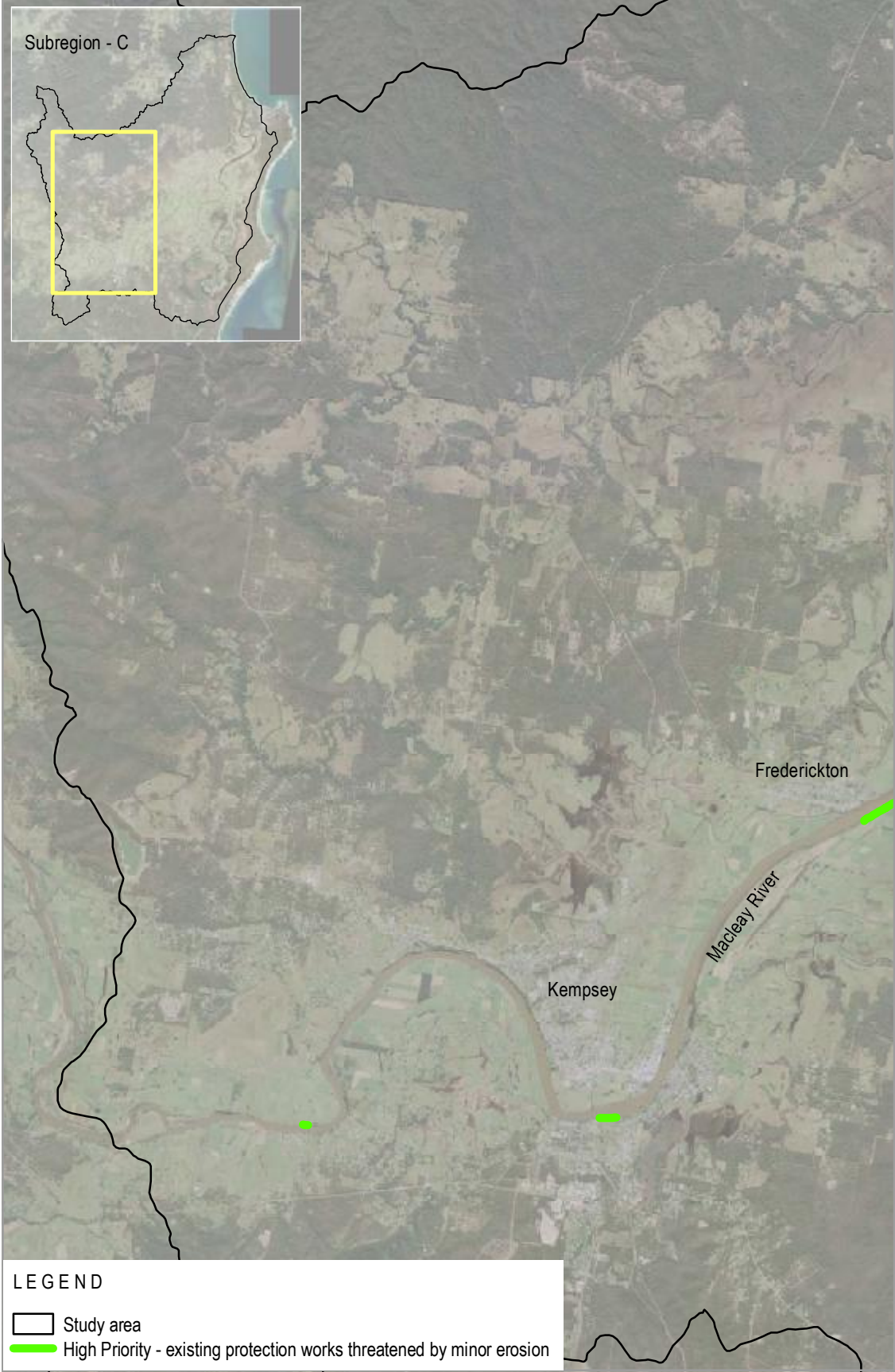
### Highest and High Priority Sites for Bank Erosion Management - Subregion B

Macleay River Estuary Management Study  
1352242

Illustration 3.16



Information shown is for illustrative purposes only



LEGEND

- Study area
- High Priority - existing protection works threatened by minor erosion



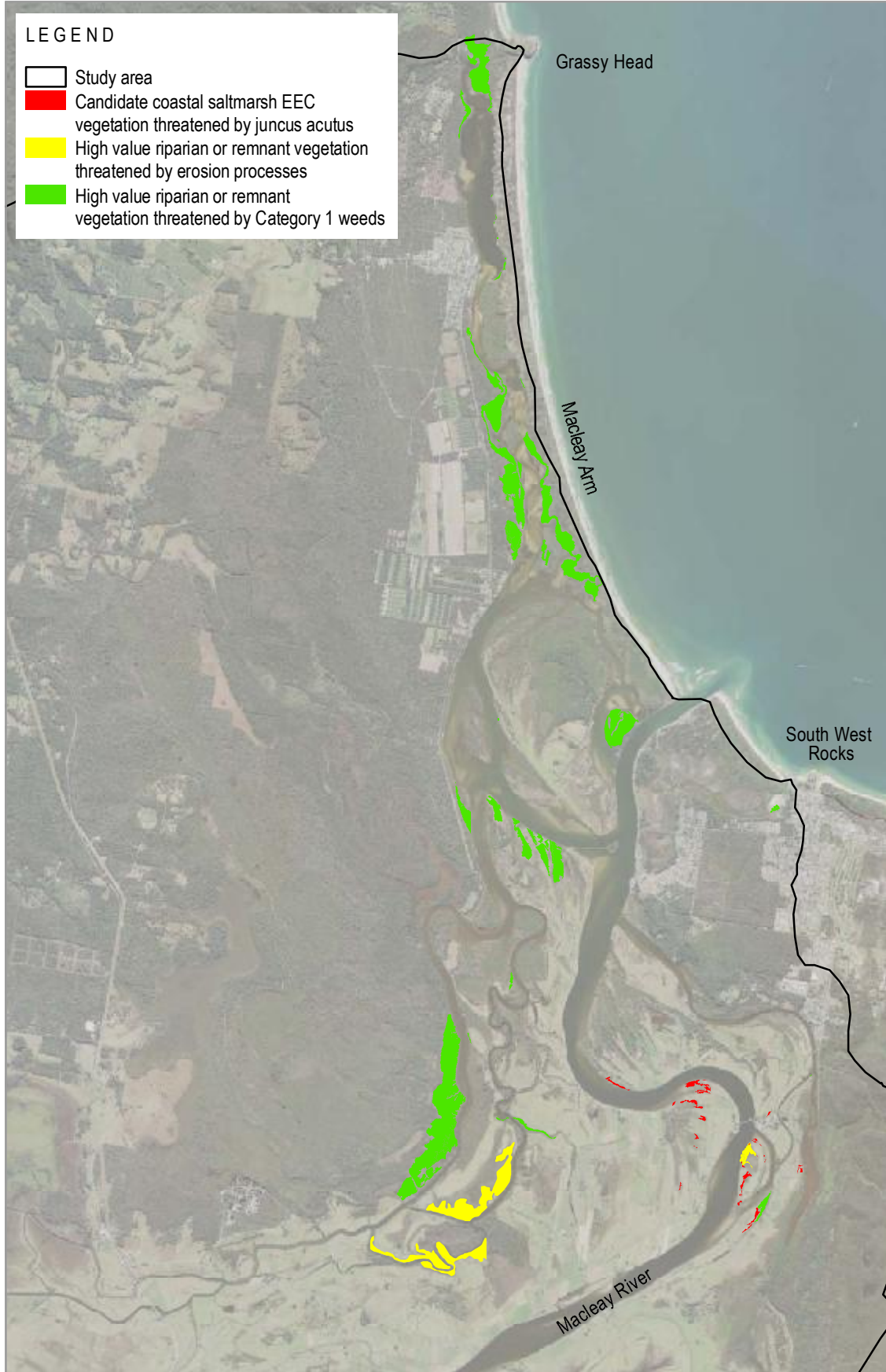
0 2 km



**Highest and High Priority Sites for Bank Erosion Management - Subregion C**

Macleay River Estuary Management Study  
1352243

Illustration 3.17



0 1.5 km



## 3.4 Management Strategies

### 3.4.1 Protect Existing Public Infrastructure

**Summary:** Roads, bridges, and other infrastructure such as boat ramps and public access ways are particularly at risk from damage during flood events. Using the available 2005 survey data there were no sites identified where public infrastructure was at risk from either severe or minor erosion. It is recognised, however, that the 2009 floods may have caused some damage to estuary related public infrastructure. Where this is the case, actions to remediate erosion in these areas are justified on the basis of early intervention saving many thousands of dollars of damage and so such works can generally be considered to have a high benefit to cost ratio.

Steps Required	Objectives Addressed	Key Responsibilities
Identify sites where bank erosion is impacting public infrastructure (eg. public bridges, wharves, jetties, boat ramps.)	3/1 3/3	No sites have been identified based on 2005 data However, ongoing post-flood assessment by KSC, LPMA and NSW Maritime is recommended.
Identify most suitable remediation techniques utilising best-practice erosion control guidelines.	3/1 3/4	KSC, DECCW, NRCMA,
Seek funding as required	3/1	KSC, DECCW Estuary program
Implement works according to best-practice guidelines	3/1	KSC or suitably qualified contractor

### 3.4.2 Protect Important Riparian Conservation Values

**Summary:** Coastal saltmarsh EEC, littoral rainforest EEC, swamp sclerophyll forest ECC, mangrove communities, and remnant riparian forests are just some of the high value ecosystems that occur within the Macleay River estuary. With the exception of mangrove forests, the distribution of many vegetation communities has been significantly reduced over the past 150 years (GECO Environmental, 2005). Protection of any remaining remnants should therefore be a priority for erosion and riparian management. Sites identified through the prioritisation process discussed in **Section 3.3.3** are shown in **Illustration 3.18**.

Steps Required	Objectives Addressed	Key Responsibilities
Identify sites with important riparian conservation values	3/2 3/5	Identified in this EMS (see <b>Illustration 3.18</b> )
Undertake site assessment to identify the most appropriate protection/remediation techniques. Issues to be addressed may include weed management, land use management practices. This will be undertaken for three of the highest priority sites as part of the Estuary Management Study	3/2 3/4 3/6	KSC, DECCW, DPI Fisheries (saltmarsh), NRCMA, Landcare, or specialist bush regeneration contractors
For public lands seek funding as required. For private lands, seek landholder agreement and support under a suitable incentive scheme or funding arrangement.	3/2	KSC, DECCW Estuary program, NRCMA, Landcare, Landholders.

Implement works according to best-practice guidelines	3/2 3/4 3/5	Suitably qualified bush regeneration contractors and landholders/public authorities where applicable.
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### 3.4.3 Protect Existing Bank and Riparian Works

**Summary:** There are more than 72 km of estuary bank protection and riparian revegetation works in the study area representing a significant investment of effort and resources. Many sites require minor maintenance works to assist the ongoing rehabilitation of the sites. An initial investigation of sites requiring maintenance or further protection has been undertaken using the data available at the time of the commencement of this EMS. **Illustration 3.19** to **Illustration 3.21** shows the location of these sites, however further investigation through field inspection is recommended.

<i>Steps Required</i>	<i>Objectives Addressed</i>	<i>Key Responsibilities</i>
Identify existing bank or riparian works sites that require further protection or maintenance.	3/1 3/3	A preliminary list of sites has been generated for this EMS. However, further field investigation is recommended. KSC, DECCW
Undertake site assessment to identify the most appropriate protection/remediation techniques.	3/3 3/4 3/6	KSC, DECCW
Seek funding as required	3/3	KSC, DECCW Estuary program, NRCMA.
Implement works according to best-practice guidelines	3/4	KSC or suitably qualified contractor

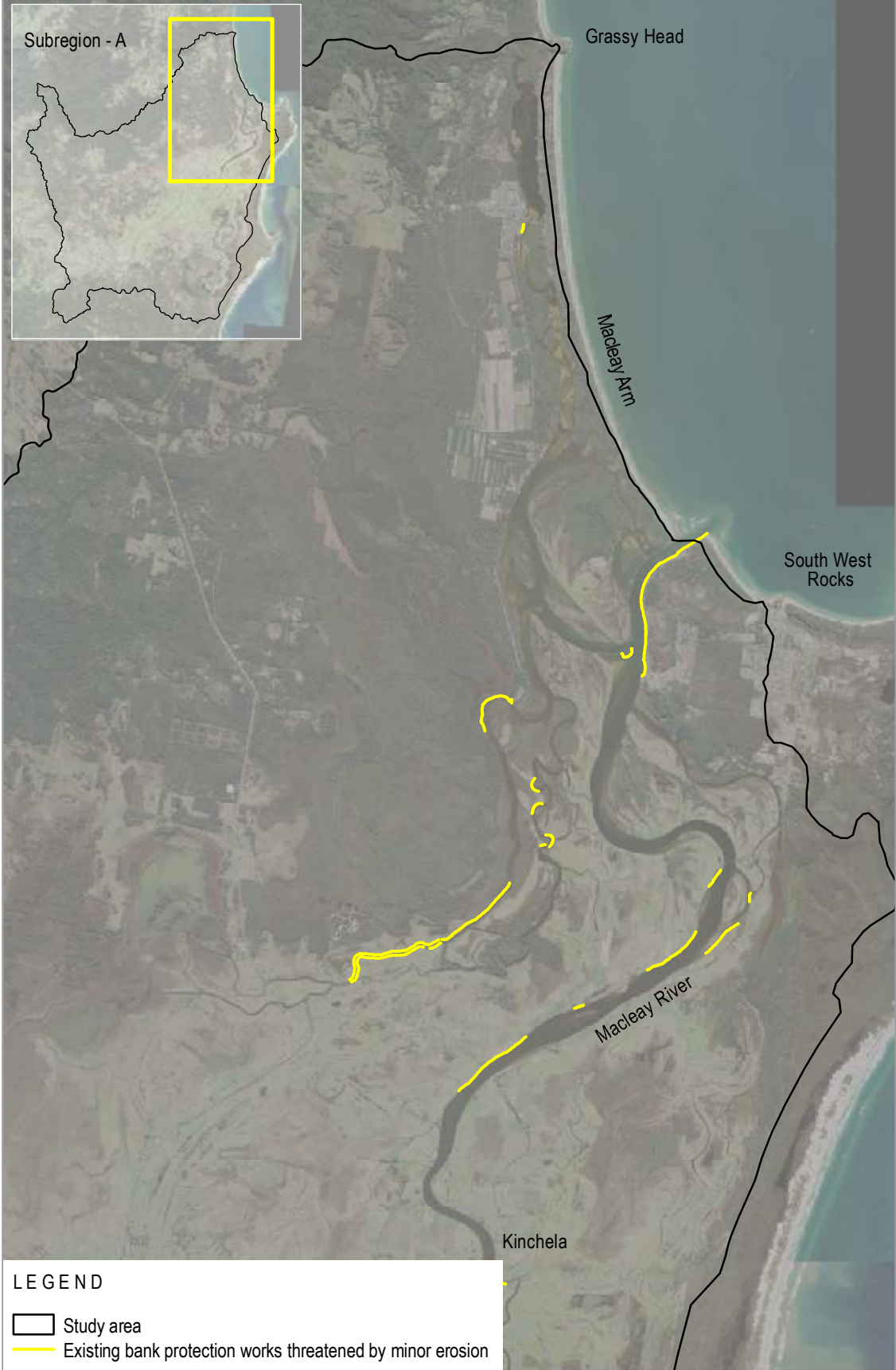
### 3.4.4 Utilise best-practice erosion control, riparian management techniques and flood mitigation works

**Summary:** This includes using appropriate materials, incorporating estuary health goals, and re-establishing native riparian vegetation.

<i>Steps Required</i>	<i>Objectives Addressed</i>	<i>Key Responsibilities</i>
Collate best-practice guidelines for erosion control, riparian management works and flood mitigation works	3/4	Examples of best-practice techniques will be provided in the final EMP document. The EMP document will also provide site specific concept design illustrations for three of the highest priority areas.
Incorporate best practice management (BPM) into conditions where development approval is required for works.	3/4 3/5	KSC, DECCW
Restrict funding access for projects not implementing BMP techniques. Implement works according to best-practice guidelines	3/4 3/5	DECCW, NRCMA

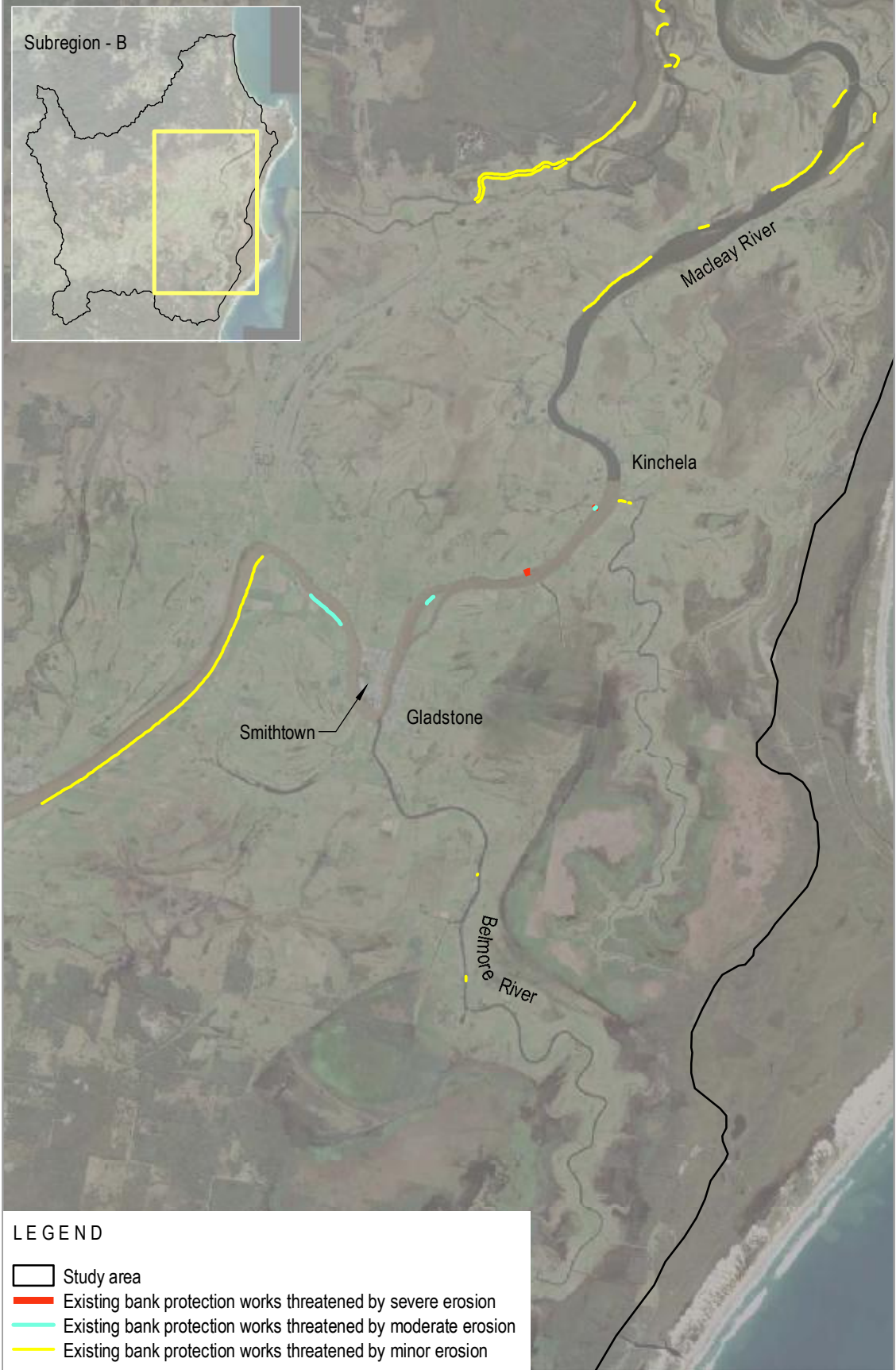


Information shown is for illustrative purposes only



### Existing Bank and Riparian Works Requiring Maintenance - Subregion A

Information shown is for illustrative purposes only



**LEGEND**

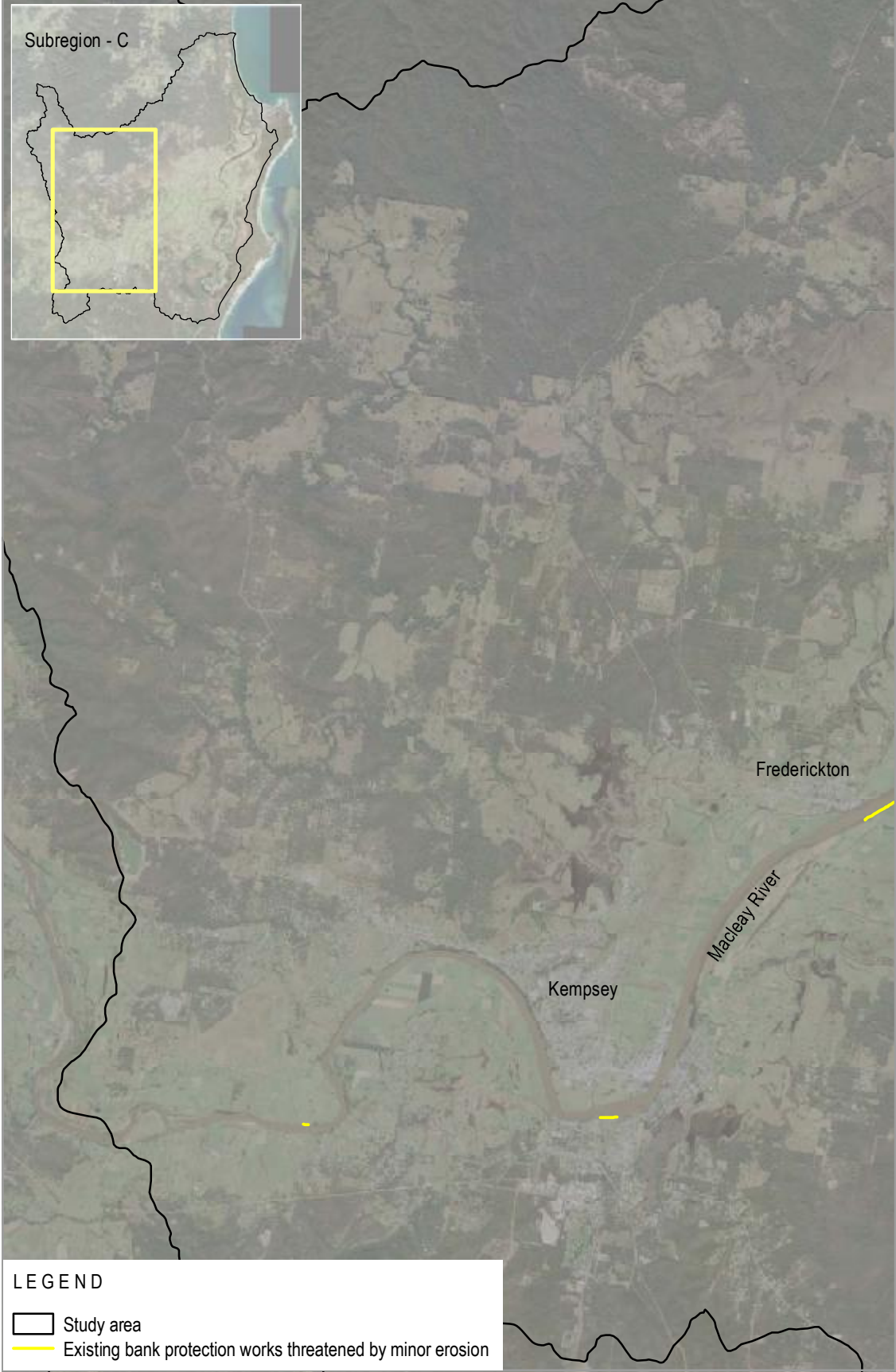
- Study area
- Existing bank protection works threatened by severe erosion
- Existing bank protection works threatened by moderate erosion
- Existing bank protection works threatened by minor erosion



**Existing Bank and Riparian Works Requiring Maintenance - Subregion B**



Information shown is for illustrative purposes only



0 2 km



### Existing Bank and Riparian Works Requiring Maintenance - Subregion C

Macleay River Estuary Management Study  
1352249

Illustration 3.21



### 3.4.5 Improve the condition and continuity of the riparian vegetation

**Summary:** Outside of areas where rock bank protection works have been implemented there is a high correlation between the presence/absence of structurally diverse native riparian vegetation and absence/presence of bank erosion. This suggests that in order to decrease erosion rates in the estuary it will be necessary to improve the condition of riparian vegetation. Removing disturbance factors such as unmanaged stock access and controlling invasive environmental weeds (such as madiera vine, coastal morning glory, coral trees, etc) can assist natural regeneration. However, considerable effort is required to achieve long-term success and follow-up maintenance is essential. The locations of reaches of riparian vegetation in good and very good condition are shown in **Illustration 3.10** to **Illustration 3.11**. Incentive funding for landholders could be targeted towards these areas to ensure that they remain in good condition. Planning controls may also assist in this regard.

<i>Steps Required</i>	<i>Objectives Addressed</i>	<i>Key Responsibilities</i>
Develop an incentive funding program to facilitate broad-scale riparian improvement works in the estuary.	3/4 3/5	KSC, DECCW, NRCMA, and Landcare
Implement the incentive program.	3/5	Landcare
Develop conditions for leasehold land along the estuary foreshore that encourage best-practice riparian management including managed stock access, weed control, and native vegetation retention.	3/5	LPMA, KSC
Implement planning controls that encourage the retention and/or improvement of riparian vegetation along the estuary	3/5	KSC

### 3.4.6 Manage recreational boat use

**Summary:** There are a plethora of signs indicating boat speed limits in areas deemed susceptible to boat wash erosion in the lower reaches of the estuary. Despite this, there are still areas which are being impacted by boat wave wash. In particular, areas within the Macleay Arm and Clybucca Creek are currently being impacted (Geco Environmental, 2005). In other areas, the contribution of wind waves versus boat wave wash is less certain but boat wash is still likely to be a contributory factor (eg. Kinchella Bend).



Source: Cohen, 2005

<i>Steps Required</i>	<i>Objectives Addressed</i>	<i>Key Responsibilities</i>
Improve and consolidate signage to reduce confusion	3/1 3/3	NSW Maritime, DECCW
Investigate the use of channel marker devices to keep boat users away from susceptible banks	3/3 3/4 3/6	NSW Maritime
Develop an education and awareness program to encourage local and visiting boat users to observe existing controls on boat speed and no wave wash zones.	3/3	NSW Maritime, DECCW
Enforce current speed regulations	3/4	NSW Maritime



## Floodplain Wetlands Management

### 4.1 Current Status

Floodplain wetlands are intrinsically connected to estuarine ecology and health and thus must be considered in the development of an Estuary Management Plan. Floodplain wetlands, in an undisturbed state, interact with the estuary in a number of ways (see Sheaves *et al.* 2006):

- floodplain wetland vegetation can deliver carbon in bioavailable forms to the estuary, increasing overall productivity;
- floodplain wetlands can provide habitat for many estuarine species and form an essential part of the life cycle of some estuarine species; and
- floodplain wetlands can retain and process catchment runoff, improving estuarine water quality and reducing the erosive forces associated with floodwaters.

Land clearing, drainage and flood mitigation works have changed floodplain wetlands and drastically altered their ecology. In addition, second and third order impacts of these changes have been experienced on the Macleay which may include (following Middleton 1989);

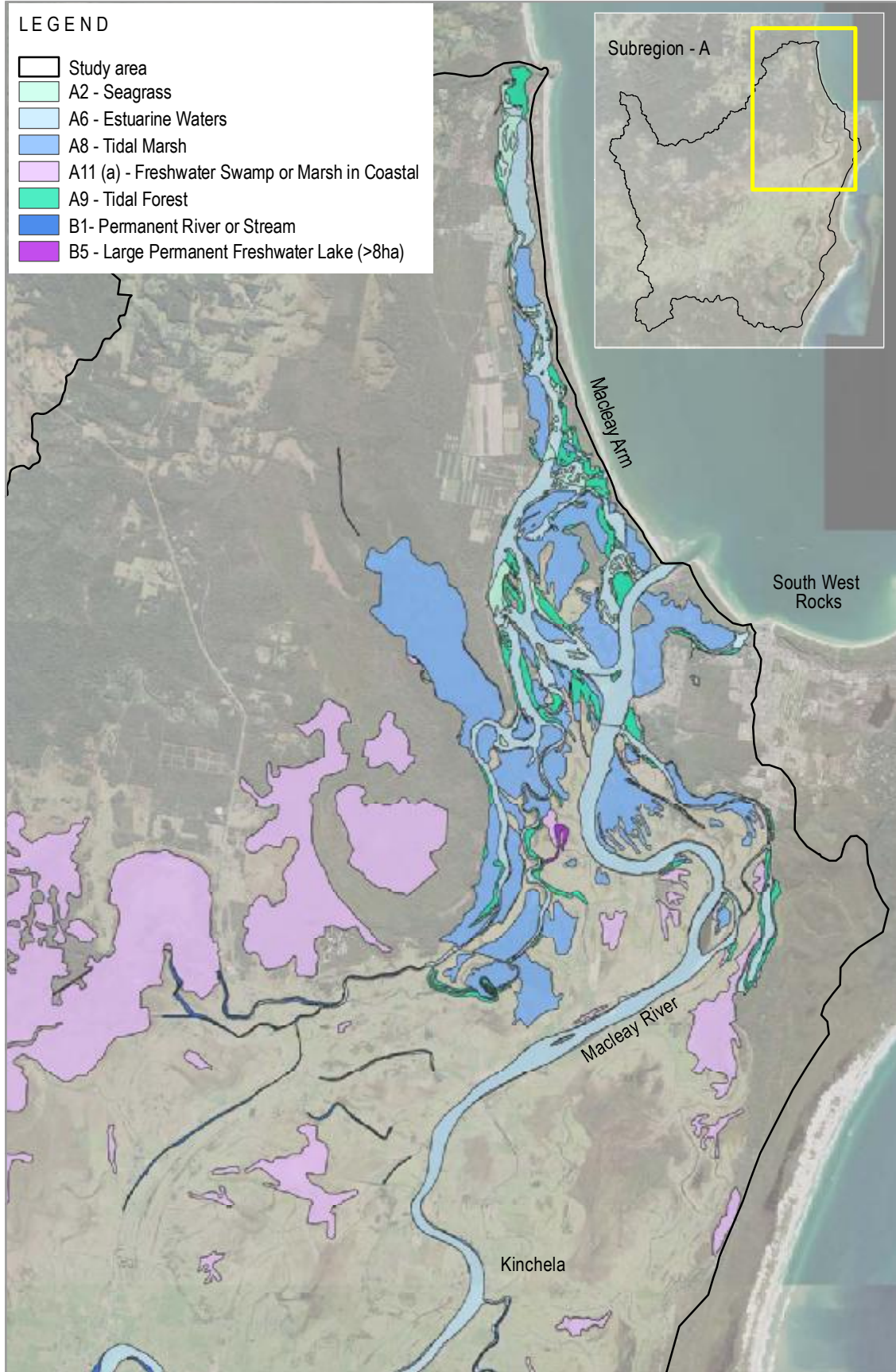
- the loss of renowned fishing sites;
- high levels of oyster mortality in wet years;
- fish kills; and
- declining prawn catches.

A significant number of respondents (44%) to the General Survey undertaken for the present study described the health of the Macleay backswamps as poor to very poor.

#### 4.1.1 Wetland Extent and Distribution on the Macleay

There are a variety of maps of wetlands on the Macleay floodplain including maps produced by Pressey (1989), the North Coast Environment Council (NCEC, Parkhouse *et al.* 1999) and Wetland Care Australia (WCA, Burns *et al.* 2006). The Wetland Care Australia maps have not been 'ground-truthed'. Each of the mapping sources differs in the methods used to define wetlands and, subsequently, the exact placement of wetland boundaries and the total extent of wetland area.

The extent of wetlands is difficult to describe, mainly due to differences in the perception of what constitutes a wetland. The most recent maps of the Macleay floodplain wetlands was produced by Wetland Care Australia as part of a program to map the extent of wetlands in the Northern Rivers Catchment area (Burns *et al.* 2006). These maps are included in this report as **Illustration 4.1, 4.2 and 4.3**. These maps were produced by compiling existing geospatial data from a variety of sources to define wetland areas and to classify them according to Directory of Important Wetlands in Australia (DIWA) guidelines. They also assigned conservation prioritisation attributes to mapped wetland areas using existing data. Notably, the WCA maps do not include the wetland areas known as East Kempsey Swamp, Frogmore and Raffertys. These areas form a significant part of the total wetlands on the Macleay floodplain and this is a significant oversight. There are also some erroneous errors in the wetland types for the areas of Kinchela Swamp. A stated aim of the WCA project is to update the maps as improved information becomes available and it is recommended as part of this EMS that these areas be included in any subsequent review or update.



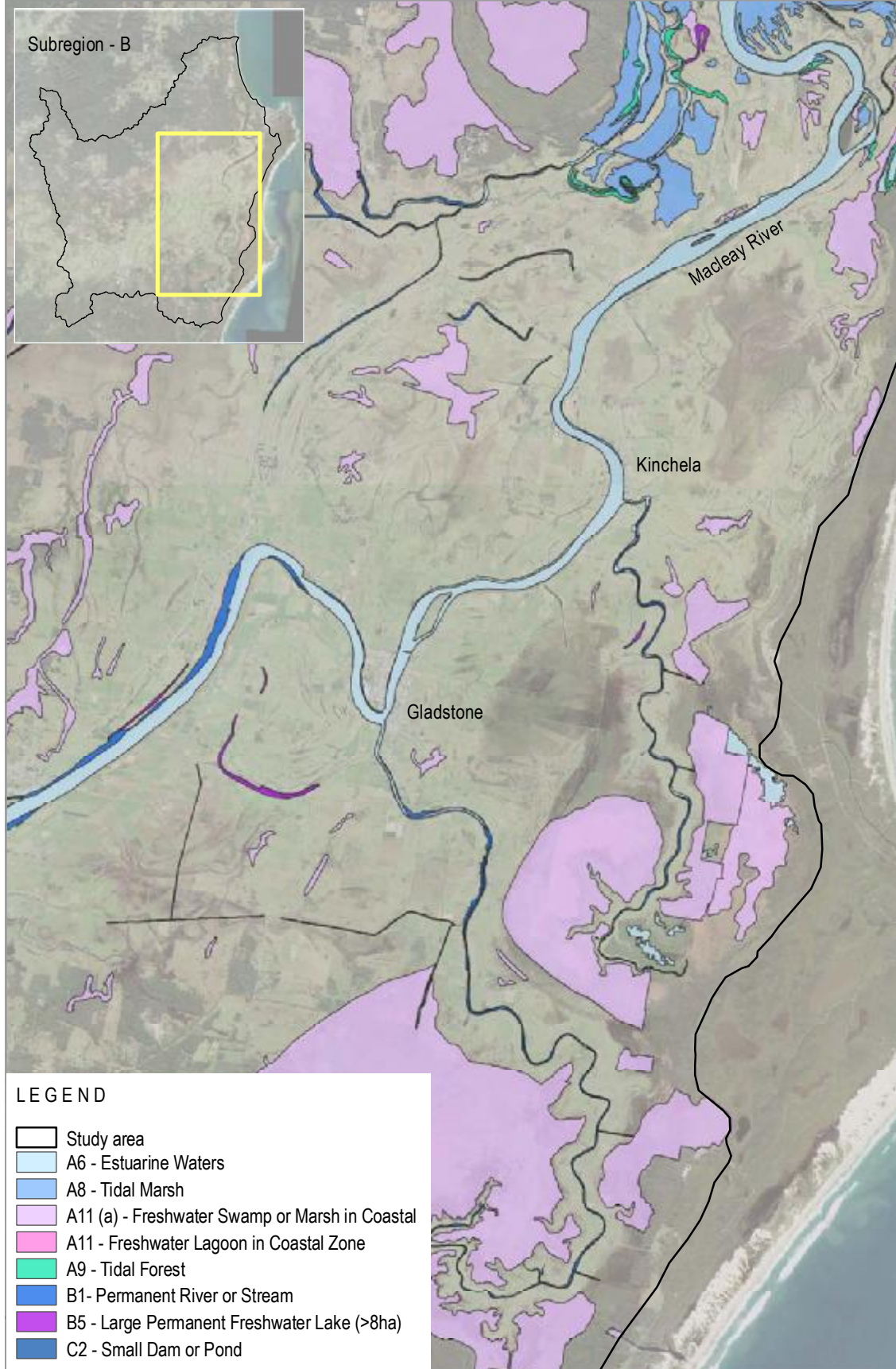
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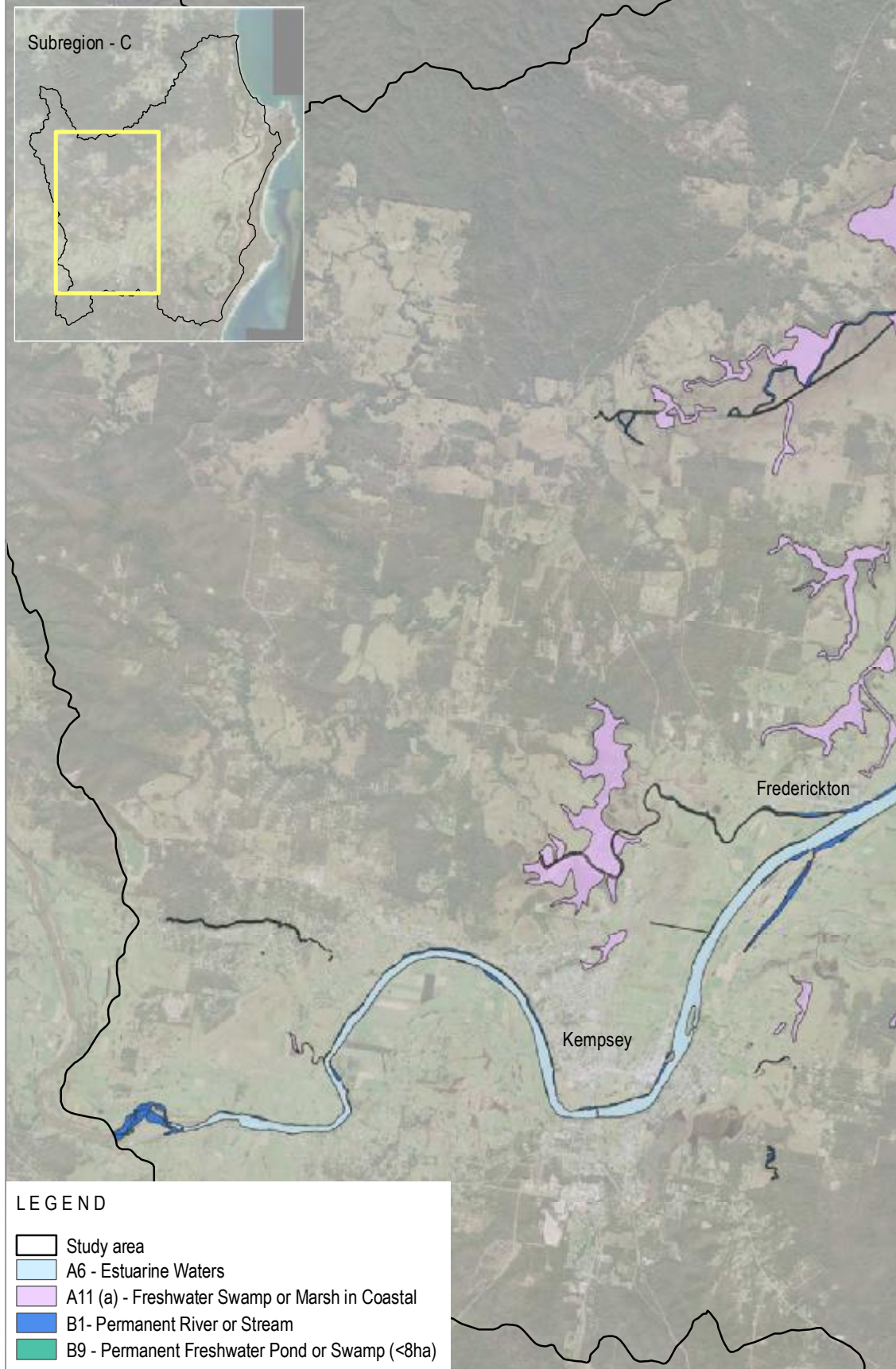
### Distribution of Wetlands within the Study Area - Subregion A

Macleay River Estuary Management Study  
1352715

Illustration 4.1







According to Burns et al. (2006) the part of the Macleay River floodplain found within the study area contains approximately 73km<sup>2</sup> of freshwater floodplain wetlands areas (not including Rafferty's and Frogmore). This represents approximately 70% of the total wetland area inside the study boundaries, including estuarine waters and other marshlands. The Macleay floodplain holds approximately 15% of the coastal floodplain wetlands in NSW (Kingsford et al. 2003).

The maps produced by the North Coast Environment Council Inc (Parkhouse *et al.* 1999) were created by superimposing wetland vegetation maps over wetland soil maps. The source data were primarily existing aerial photographs and maps but approximately 60% of all vegetation units mapped were checked from the ground. They mapped 402 km<sup>2</sup> of wetland vegetation in the Kempsey Shire LGA. This figure is difficult to compare to the Wetland Care Australia mapping due to differences between the boundaries of the study area. Telfer (2005) noted that the usefulness of the mapping data is limited by problems with digital transfer into Geographic Information Systems.

Pressey (1989) mapped freshwater wetlands on the Macleay floodplain and described 432 individual units with an approximate total area of 128km<sup>2</sup>. He also described the size distribution of floodplain wetlands on the Macleay noting that the three largest wetland areas account for 73% of the total area and that only 3% of individual wetlands mapped are greater than 1km<sup>2</sup> in size.

A series of maps of the historical extent of the Macleay floodplains has been produced using a mixture of information (M. Tulau *pers comm.* 2009). The resulting maps, though incomplete in some small areas may prove useful in understanding historical changes in habitat availability and the productivity of the estuary. To date, no GIS layer of these maps is available.

#### **4.1.2 Major Wetland Areas on The Macleay**

##### *4.1.2.1 The Swan Pool/Kinchela Swamp*

The Kinchela area is made up of two large contiguous swamp areas located either side of Kinchela Creek to the east of the Belmore River. They have been variously referred to as the Swan Pool, Kinchela Swamp and as east and west Kinchela Swamp. Here they will be referred to as East Kinchela Swamp and West Kinchela Swamp. Much of the swamp area around Kinchela lies at a level of around 0 m AHD. The Kinchela swamp area is, in turn, contiguous with the Belmore Swamp, meaning it is replenished by both Kinchela Creek and the Belmore River (Naylor and Tulau 1999).

The Kinchela Swamps are modified for drainage in a variety of ways and play an important part in the overall flood security of the Macleay Valley. Under flood conditions control gates on the left and right bank of Kinchela Creek allow backfilling of the two swamp areas. When flood waters in the Macleay River subside the swamps are drained by a number of floodgated drains and channels. The major drains are Schoolhouse, Hoffmans and Irwins drains. The drains shortcut the natural connection between the swamps and Kinchela Creek and continue to drain groundwater after surface waters have been removed. A structure known as 'The Lock' is positioned at the point where Kinchela Creek opens out into the east Kinchela Swamp in order to prevent unwanted saltwater intrusion during dry times. East Kinchela Swamp is also connected to Korogoro Creek via a floodgated drain that was cut through barrier dunes on its north eastern margin in 1968. This drain operates automatically once floodwaters in the swamp reach a certain level.

The Kinchela Lock is now owned and managed by the Parks and Wildlife Group (PWG) and will be subject to a management plan administered by the PWG. The PWG estate also owns the majority of the land incorporating the East Kinchela Swamp.

The entire west Kinchela Swamp is privately owned. Many of the landholders in this area have expressed an interest in managing the wetland for improved environmental outcomes (NCEC 1999). A number of

modifications to individual drain and floodgate structures were undertaken as Macleay Acid Sulfate Soil Local Action Group (MASSLAG) projects with funding from the Acid Sulfate Soils Program.

Issues associated with flood mitigation include the decomposition of non-water-tolerant pastures, subsequent effects on the quality of the discharged water and large fish kills in the swamp area as fish that were swept in during backfilling become stranded and die. The water quality of Kinchela Creek has suffered negative effects associated with drainage and the exposure of acid sulfate soils. Kinchela Creek has a low tidal prism relative to its catchment. The effect of this is that poor quality water released or drained from the swamps is slow to be flushed from the system and the negative impacts are prolonged (Tulau & Naylor 1999).

The Kinchela Swamp is listed in the Directory of Important Wetlands of Australia. Most of the area of east Kinchela Swamp is within the boundaries of SEPP 14 wetland 458 but west Kinchela Swamp is not. Areas of the Kinchela swamp, along with the Belmore Swamp were mapped as having the highest conservation value of wetlands on the Macleay (NCEC 1999). Only a relatively small area of this wetland complex falls within SEPP14 boundaries. A remediation program was undertaken for an area described as an acid sulfate soil hotspot in 2004.

#### 4.1.2.2 *Clybucca/Collombatti Wetland*

The extensive Clybucca/Collombatti wetland complex is found in the northernmost area of the Macleay floodplain. It contains a number of large contiguous swamp areas centred on Collombatti Creek and draining through Clybucca Creek. It includes areas historically known as the Seven Oaks Swamp, Doughboy Swamp and Mayes Swamp. The wetlands once formed one of the largest backswamp areas in NSW. Some of the Clybucca wetlands are of very low elevation, particularly those towards the north, such as Mayes Swamp which is lower than 0m AHD in some areas. The elevation grades up towards the south with some areas around Bellimbopinni greater than 2 m above AHD. The Clybucca Swamps are now drained extensively, primarily by the Seven Oaks drainage system. Tidal exchange is controlled by the Clybucca Creek headworks which allow for drainage of the wetlands to 2.5 m below mean tidal level (Tulau & Naylor 1999). A large catchment of approximately 134 km<sup>2</sup> feeds the Clybucca/Collombatti wetland making it unique among the major wetland areas (Belmore swamp has a catchment area of about 1.8km<sup>2</sup>. Prior to extensive drainage works, this factor would have inferred greater permanence of wetland pools in this area.

All of the major swamp areas around Clybucca are on privately owned land. Most of the areas drainage is managed by the Seven Oaks Private Drainage Board. The main part of the Clybucca wetlands, found to the west of the Pacific Highway is not protected by SEPP 14 legislation. Wetlands in this area include stands of swamp mahogany forest and they support a wide range of threatened fauna (NCEC 1999). A variety of programs have been put in place on individual properties, which includes shared infrastructure to manage the large acid sulfate scalds and improve the habitat value of the swamps around Clybucca. A database of these projects is currently being compiled (Birch and Andrighetto 2010).

Wetlands Care Australia (WCA), with support from the Northern Rivers Catchment Management Authority, is currently preparing a management plan for the Clybucca Floodplain Wetlands. The management plan will identify the key values of the Clybucca Floodplain Wetlands and will detail the major issues affecting the land, soil, water and biodiversity of the area. Priorities for management action across the floodplain will be identified and options for projects and funding listed. Priority actions might include managing drains more effectively through bank revegetation and weed control; protecting areas of bushland and riverbanks through stock fencing; managing wetlands and biodiversity while also providing freshwater pasture which may improve productivity and offer better seasonal grazing opportunities (Wetlands Care Australia, 2010).

#### 4.1.2.3 *Belmore Swamp*

The Belmore Swamp is an extensive swamp area surrounding the upstream reaches of the Belmore River, west of and contiguous to the Kinchela Swamps. The Belmore Swamp has also been extensively

modified for drainage and flood mitigation purposes. Aside from the series of small drains that shortcut the natural connection of the wetland with the Belmore River there are two major drainage structures that connect the Belmore Swamp to Killick Creek and the Pacific Ocean respectively. There are also a number of floodgate type structures that control water movement. The Belmore River flood control structure allows flood waters to be stored in the swamp basin during flooding. This water then drains gradually back into the Belmore River as the flood recedes.

The Killick Creek floodgates are located on the drain between the swamp and Killick Creek approximately 1.5 km north of Crescent Head. The floodgates are designed to prevent saltwater penetration from Killick Creek, but also allow drainage of floodwaters from the swamp to the Pacific Ocean via Killick Creek. Issues associated with floodwater storage include the decomposition of non-water-tolerant pastures, subsequent effects on the quality of the discharged water and extensive kills of stranded fish that have been swept into the area. The tidal flushing of the Belmore River is relatively inefficient. The effect of this is that poor water quality conditions persist for up to three weeks after a flood event (Naylor and Tulau (1999).

Drainage of the Belmore Swamp has led to drastic changes in its ecology. There was formerly 1300ha of open water in the swamp that remained there for up to 6 months of the year (Tulau & Naylor 1999). Extensive areas of seasonally inundated rushes have now been replaced by less water tolerant species. The swamp was formerly managed by a number of drainage unions, though none of these is active today. The drains and floodgates are owned and operated by a mixture of Council and individual landholders.

Most of the Belmore Swamp is not protected under SEPP 14 legislation. Areas of the Belmore Swamp, along with the Kinchela Swamp were mapped as having the highest conservation value of wetlands on the Macleay (NCEC 1999). A variety of management efforts are planned or already operating on the Belmore wetlands. A database of these efforts is currently being prepared (Birch and Andrighetto 2010).

#### 4.1.2.4 Yarrahapinni Broadwater

The Yarrahapinni Broadwater wetland complex is formed around the confluence of Borirgalla and Barraganyatti Creeks and Andersons Inlet. The area was long considered one of the most productive parts of the greater Macleay Estuary supporting healthy commercial fisheries and containing extensive mangrove (> 80ha), saltmarsh (> 300ha) and seagrass communities (NPWS 2009). The area also has significant Aboriginal cultural heritage values.

The Yarrahapinni wetlands are unique in the Macleay system, being a tidal/saltwater wetland nestled between dune systems as opposed to a freshwater backswamp on the floodplain such as the Kinchela, Clybucca or Belmore swamps.

The Yarrahapinni wetlands were among the last wetlands on the Macleay floodplain to be drained. In the early 1970s the 4 islands that once formed the entrance to the system were joined with a bund wall levee and floodgates were installed across the easternmost end of the levee. Drainage pathways were deepened and straightened. The works reduced the spread of permanently inundated land and largely removed the tidal influence but did not create any valuable agricultural land in the upstream area.

Currently the wetland is a degraded brackish swamp in the former broadwater area with areas dominated by *Phragmites australis*, *Casuarina glauca* or *Paspalum vaginatum* depending on elevation. Upstream areas are characterised by active acid sulfate soils, soil subsidence and the creation of monosulfidic black oozes. The valuable and productive estuarine habitats had been lost.

In April 2007 600ha of the complex was gazetted under the Yarrahapinni Wetlands National Park. A plan of management for the area is being prepared. PWG is now pursuing the full rehabilitation of the wetlands, with the end goal being to restore the wetlands to a natural state reminiscent of the site prior to the flood mitigation works in the 1970s. The full rehabilitation will be undertaken in a staged approach



allowing for adaptive site management whilst ensuring positive environmental outcomes for all stakeholders.

A restoration plan for the wetlands has been prepared, focussing on the hydrological and groundwater/aquifer interactions (WRL, 2009). This report now forms the basis of the Yarrahapinni Wetlands rehabilitation project.

Interim flushing of the wetlands has been undertaken since December 2007 with the installation of two tidal flushing gates on the floodgates. This enabled partial tidal exchange in the lower reaches of the wetlands and allowed some saltwater flushing and fish passage. From 2007 to 2009, NSW I&I (DPI, Fisheries) staff and Kevin Wilkinson (PhD student), undertook regular monitoring of the fish species in the lower broadwater area of the wetlands. Kevin has also continued to monitor the water quality and water levels in the wetlands since 2007. Changes are already evident with an increased number of estuarine indicator fish species being recorded in the lower reaches. In February 2010 one of the tidal gates was opened entirely. Early indications are that the salinity regime and water level have responded quickly to increased tidal flushing (K. Wilkinson *pers comm.*). NSW Fisheries (now Primary Industries - Industry & Investment NSW) has advised that Yarrahapinni has been gazetted as a 'Closed Fishing Zone' (NSW Department of Industry and Investment – Primary Industries, 2010).

Recent PWG works have included:

- a fauna survey of the wetlands with the data to be entered in Atlas of NSW Wildlife;
- a weed management plan is to be finalised mid 2010; and
- comprehensive vegetation mapping using ADS 40 photography is in progress.

#### 4.1.2.5 Other Major Wetland Areas

There are a number of other significant wetlands on the Macleay floodplain. These include the areas known as the Frogmore Swamp, Raffertys Swamp, East Kempsey Swamp and Christmas Creek swamps. Management and restoration of East Kempsey Swamp is currently being investigated under the Gills Bridge Creek Rehabilitation Project run by Council. This is discussed further in **Section 13** in respect to water quality improvements.

Frogmore and Raffertys swamps are subject to the same drainage pressures as the other major swamp areas though 3 km of the original 3.8 km main drain on Raffertys Swamp has been replaced with a wide, shallow 'dish' drain (WMA Water 2009). In addition to this, a tidally operated floodgate has been installed at the outlet of Raffertys drain to improve water quality and aquatic habitat in the lower sections of the drain.

#### 4.1.3 Macleay Floodplain Wetland Ecology

The ecology of the wetlands on the Macleay floodplain has been drastically altered as a result of physical changes and clearing for specific landuses. Despite this there are some areas that are regarded as being of high conservation value.

A comprehensive survey of freshwater wetlands on the Macleay found 118 wetland plant species. Of these, 73 were present in less than 5% of the wetlands surveyed. Four of the species were described as rare or of specific conservation significance. Twenty of the species recorded were introduced and their occurrence covered approximately 1.5% of the total wetland area at the time of survey. The most extensive of these were *Eichhornia crassipes* a declared noxious weed in all states of Australia, *Salvinia molesta* and *Echinochloa crus-galli*. Of the 432 individual wetlands, only 64 (<15%) had more than 10% of their margins lined with trees, as a result of clearing for grazing. On the other hand, the vast majority of wetlands (324 or 75%) had more than 90% of their margin lined with emergent vegetation (Pressey 1989). At the time of the survey, two species (*Juncus polanthemus x usiatus* and *Persicaria hydropiper*) covered

33% of the wetland area surveyed. In contrast, less than 11% of wetland area surveyed contained more than 15 species.

Of the 438 wetlands surveyed by Pressey (1989) 99% were grazed to some extent by cattle and 96% of the total wetland area was affected by drainage. In addition they found that only 2.5% of wetland area was open water, limiting the habitat value of the wetlands to aquatic animals and waterbirds. The work included ranking the wetlands for conservation though this information was not published with the report.

The vegetation in the Macleay floodplain wetlands was mapped in 1999 using a mixture of aerial photographic analysis and ground truthing exercises (NCEC). Descriptions of the vegetation in each swamp area are contained in **Table 4.1**. The subsequent report focussed on the occurrence of littoral rainforest communities, and the keystone species, swamp mahogany (*Eucalyptus robusta*).

A number of bird species listed under the *TSC Act 1995* or protected under international treaty occupy the Macleay floodplain wetlands (see NCEC 1999, Godrick 1970).

**Table 4.1 Vegetation and Management Issues by Floodplain Area**

<b>Floodplain Area</b>	<b>Dominant Vegetation Communities</b>	<b>Management Issues</b>
Clybucca/Collombatti	Majority sedgeland. Some swamp sclerophyll forest, grassland and <i>Casuarina</i> forest. Small area of <i>Melaleuca</i> and swamp mahogany forest.	<ul style="list-style-type: none"> <li>▪ overdrainage;</li> <li>▪ acid sulfate soils;</li> <li>▪ poor export water quality after flooding and associated fish/oyster kills;</li> <li>▪ uncontrolled encroachment of saline waters above the headworks; and</li> <li>▪ limited areas of open water.</li> </ul>
Belmore	Majority sedgeland. Some fringing <i>Casuarina</i> forest and <i>Melaleuca</i> and swamp mahogany forest. Small area of wet meadow.	<ul style="list-style-type: none"> <li>▪ poor export water quality after flood mitigation operation;</li> <li>▪ major fish kills in Belmore River; and</li> <li>▪ saline intrusion through Killick Ck headworks.</li> </ul>
Kinchela	Majority sedgeland. Some fringing swamp sclerophyll forest	<ul style="list-style-type: none"> <li>▪ overdrainage;</li> <li>▪ vandalism to 'The Lock';</li> <li>▪ poor export water quality;</li> <li>▪ encroachment of stock animals onto PWG managed wetland;</li> <li>▪ <i>Salvinia molesta</i> infestation in drains and open water; and</li> <li>▪ landholder resistance to wetter management of East Kinchela wetland.</li> </ul>

<b>Floodplain Area</b>	<b>Dominant Vegetation Communities</b>	<b>Management Issues</b>
Yarrhapinni	Majority <i>Casuarina</i> forest, <i>Melaleuca</i> forest and saltmarsh.	<ul style="list-style-type: none"> <li>▪ landholder resistance to rehabilitation plans; and</li> <li>▪ lack of funding to complete adequate monitoring of rehabilitation.</li> </ul>
Frogmore	Mostly Grassland. Small area of swamp sclerophyll forest and <i>Casuarina</i> forest	<ul style="list-style-type: none"> <li>▪ overdrainage; and</li> <li>▪ ASS.</li> </ul>
Raffertys	Majority sedgeland	<ul style="list-style-type: none"> <li>▪ lack of monitoring of changes since modification to main drain.</li> </ul>
East Kempsey	Mostly grassland and sedgeland	

#### 4.1.4 Grazing on Macleay River Floodplain Wetlands

The drainage of wetlands on the Macleay floodplain began in the early 20<sup>th</sup> century as a way of accessing land that was thought to be highly productive for the purposes of agriculture. To this day, most of the areas that were historically floodplain wetlands are now grazed to some extent and some cropping and horticulture occurs.

The success of drainage and flood mitigation works in creating viable agricultural land has been mixed. In some cases land claimed by drainage and flood mitigation has proved to be some of the most valuable in the area and in other cases the works have resulted in severe acid scalds and barren, unproductive land.

The impact of grazing on wetland sites is difficult to generalise as it depends on a variety of factors including the density of stock, the specific nature of the site, and stock and pasture management techniques. Retention of land for grazing is the primary obstruction to the management of floodplain wetlands for environmental outcomes.

#### 4.1.5 Wetland Protection, Conservation and Rehabilitation Measures

A number of protection and conservation measures operate on or are relevant to the management of Macleay River floodplain wetlands. Freshwater wetlands on coastal floodplains have been identified as an Endangered Ecological Community and are listed as such under the *Threatened Species Conservation Act 1995* (NSW Scientific Committee 2005). Of the approximately 73 km<sup>2</sup> of total wetlands within the study area, approximately 44 km<sup>2</sup> are contained within the boundaries of SEPP 14 areas. Subsequently, a number of the Macleay floodplain wetlands do not fall under the protection of SEPP14 legislation. This is most likely a result of exclusion criteria, by which, wetlands were excluded from consideration if they displayed all of the following five characteristics:

- presence of functional drains;
- presence of fence lines;
- paddock differentiation;
- signs of reclamation, clearing or contraction of a previously permanently inundated area; and
- lack of a natural boundary with bushland estuary or large waterway.

A variety of rehabilitation/management projects are being undertaken on floodplain wetlands around the Macleay. A summary of these works is provided in **Table 4.2**.

**Table 4.2 Summary of works undertaken on the Macleay floodplain wetlands by area**

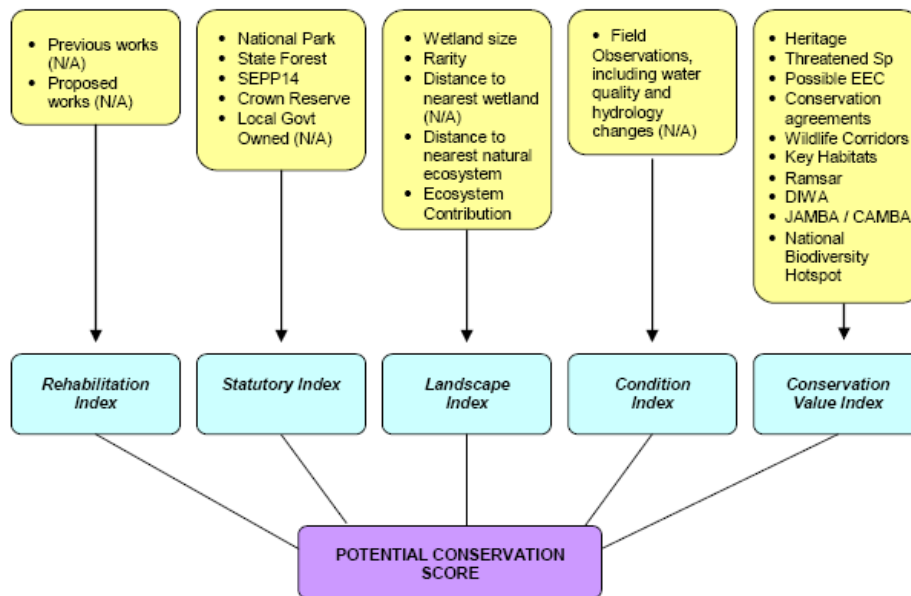
<b>Backswamp Area</b>	<b>Location</b>	<b>Works Description</b>	<b>Notes</b>
Belmore	Scotts Drain	Lifting device and mini-sluiceway installed on Scotts Drain floodgates to allow active management. Tidal waters can now be utilised to remediate the scald. Further works are in the planning stages for this area.	Photographs show lush green growth of rushes has established over the previously scalded area
	Eakins Drain	New culvert installed including a flap gate. Drop boards and lifting device are to be installed.	
	Tracey's Culvert	Dropboards for elevated drain inverts	
	Triple S Ranch	Lifting device and dropboards installed	
	Fischers #2 Drain	Culvert with dropboards installed.	Large area of wetland reinstated.
	McCuddins Drain	Culverts with floodgates and dropboards installed. Drain clearing undertaken so that inundation can occur with tidal movements if so desired.	Photographs show that the previous scald has now been covered with green growth.
	Sillitoe's Drain	Culverts with floodgates installed in existing drain	
	Thurgood Drain	Culvert with floodgate installed in existing drain for wet pasture management	
	Ptolemys Farm	Sluice gate and lifting gear installed on floodgate. Drains cleared to allow inundation of ASS scald. Cattle exclusion fencing also installed.	Scald largely covered with lush growth.
Kinchela	Irwins Drain	Modified headworks for water detention	
	Council Drain	Dropboard structure replaced with new culvert and sluice gate	
	Bradleys Drain	Lifting structure installed on one of the five cells of the floodgates.	
	Kinchela No2.	New culvert with floodgates installed to prevent tidal ingress.	
	The Lock	Fish friendly, automatic (tidally operated) floodgate installed on one of three cells.	

<b>Backswamp Area</b>	<b>Location</b>	<b>Works Description</b>	<b>Notes</b>
	Rogers' Farm	Active water management targeting improved productivity, ASS remediation and improved export WQ.	Project site for Coastal Floodplain and Acid Sulfate Soil Management Project.
	Gladstone Union Drain	Low level weir structure planned for the drain.	Project has not commenced due to landholder resistance
	School House Drain	Cattle exclusion fencing installed to assist in ASS scald remediation.	
	Wilson's Drain	Sluice gate and lifting devices installed for active water management.	
Clybucca/Collombatti	East Drain	Low level weir installed	
	West Drain #1	Low level weir installed	
	West Drain #2	Low level weir installed	
	Various	Revegetation of ASS Scalds to reduce impacts.	
	Yerbury Farm	Variety of structures and methods used for wetter pasture management.	Large areas of ASS scalds now productive pasture areas.
Raffertys	Raffertys Drain	Drains converted to shallow dish type and tidally operated floodgate installed.	Completed in 2005. Photographs show positive results.
	Prattens Farm	Wet pasture management. Large culverts installed in existing drains to support dropboards.	
	Marriots Drain	Lifting device fitted to floodgates for active water management.	
Frogmore	Union Floodgates and various other localities	One of nine cells on the union floodgates to remain open in dry times to improve water quality upstream. Two tidal floodgates installed. Improved lifting devices installed. Twenty small, in-system water control structures installed to avoid undesirable pasture inundation.	WQ monitoring results indicate significant improvements above floodgates when open.
	Darkwater Drain	Modification of existing levee to allow for increased tidal flows.	
Other	Clancys Drain	Modifications to the weir on West drain to provide dropboards to allow active management of water levels.	

Backswamp Area	Location	Works Description	Notes
	Clancys Drain	Culverts with floodgates and dropboards installed in drain.	
	Spencers Inlet	Auto (tidally operated) floodgates installed for improved water quality upstream of drain.	

#### 4.1.6 Prioritisation of wetland areas for future conservation

The wetland areas on the Macleay river floodplain have been prioritised for conservation in three separate studies (Pressey 1987, Parkhouse *et al.* 1999 and Burns *et al.* 2006).



**Illustration 4.4** Wetland conservation prioritisation method used by WCA.

Source: Burns *et al.* (2006)

Note: N/A indicates that no data were available at the time of publication.

WCA used the system depicted in **Illustration 4.4** to prioritise wetland units for conservation. They developed a list of attributes that were considered relevant to the conservation status of wetlands and scored individual wetland units for the presence absence or quality of the attributes. The attributes scores were then used to develop for each wetland an index unit relating to specific attributes. These were then used to generate a potential conservation score for each wetland unit. The specific method used by WCA utilised a data accuracy weighting and significance weight for the each of the attributes and again for each of the indices considered. For the purposes of this study, the potential conservation scores were used to develop conservation rankings as detailed in **Table 4.3**.