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Assessment of Selected Riparian Systems of the Ross and Black River Basins Townsville / Thuringowa Region

REPORT

Report prepared for Creek to Coral

June 2007

Director

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1 INTRODUCTION

1.1 SCOPE OF WORKS

C&R Consulting were commissioned by Creek to Coral (a joint venture of the Townsville and Thuringowa City Councils) to undertake a desktop review of riparian condition of selected river systems within the Ross and Black River Basins. The study includes a review of existing aerial photography, satellite imagery, vegetation maps, and soils maps, limited ground truthing where necessary, and pre-existing knowledge of the study area.

1.2 RIPARIAN ZONE DEFINITION AND FUNCTION

The riparian zone is defined as the area of vegetated land adjacent to bodies of water such as streams, creeks, rivers or wetlands, and includes gullies and depressions where water only flows during wet periods. The width, characteristics and species composition of the natural riparian zone vary according to the geographical location of the water body, the location of the water body in the landscape, the climatic characteristics of the region, and the hydrogeomorphic features of the region (i.e. the ability of the adjacent landscape to capture and retain water/moisture).

Along river systems, the width, complexity, and species composition of the riparian zone is controlled by the geomorphology and underlying geology of the relevant section of the river. Riparian zones vary with stream flow characteristics and include over-bank flow channels and multiple stream flow heights within the channel.

Undisturbed landscapes associated with water courses are complex. Surficial swales and sand bars are built up and manipulated during flood events to create a landscape that traps and retains waters for subsequent slow seepage through the soil profile. Chemical dissolution within the soil profile creates a series of cemented layers that act as aquifers, providing moisture to deep rooted trees while slowing the movement of the water through the soil profile. In the semi arid tropics of North Queensland these cemented layers become interdigitated by the processes of formation and erosion. These interdigitated cemented layers retain waters percolating through the soil profile, but provide sufficient pathways for the subsequent slow release to the stream channel.

The hydrogeomorphic landscape created within the natural system establishes a series of interception zones, or multiple barriers, to trap, retain and slowly release runoff waters to the river channel or water body. In an undisturbed system, these features function to –

(a) Retain waters for subsequent release to the water body long after rainfall has ceased,

(b) Retain soil moisture for the maintenance of a multi-layered vegetation structure;

(c) Trap sediments and nutrients prior to entry to the water course, and

(d) Establish a complex hyporheic zone that supports the entire river system.

1.3 PHYSICAL BACKGROUND OF THE TOWNSVILLE/THURINGOWA REGION

Riparian diversity in the Townsville Region is dependent on a number of physical and chemical factors, including climate, hydrology/geomorphology (hydrogeomorphology), and soil structure.

1.3.1 Climate

The geographical location of Townsville and Thuringowa in the seasonally arid tropics indicates that it will be subjected to a rainfall pattern that is notoriously unreliable in its intensity, duration,

and location, both temporally and spatially. Hot humid summers and mild dry winters are normal, while rainfall distribution, intensity and duration are highly variable.

Mean annual rainfall measured at Townsville is approximately 1140mm, although rainfall distribution is highly seasonal with around 70% of the annual rainfall occurring in the January to March period, and the sum of the average values for April to November well below the average figures for both January and/or February.

Annual average rainfall variation is also large, ranging from approximately 270mm minimum to 2370mm maximum. Around 60% of the years receive less than 75% of the average annual rainfall, with only a 40-50% probability of greater than average rainfall occurring in January or February. In addition, it is not uncommon to receive half the annual rainfall in a single rain event of 3 – 5 days.

The annual number of sunny days is estimated as 300 per year, and even during the wet season evaporation may, on most days, exceed rainfall. Hence, unless preceded by periods of gentle wetting of the soils, run-off is usually high due to the formation of surface crusts, and while it has been estimated that the amount of rainfall required to fully saturate the nearby Haughton River catchment is around 60mm (Bureau of Meteorology, 2000), this saturation point can only be achieved if the catchment has been pre-wetted.

The combination of hot sunny days, long periods without rainfall, and highly irregular rainfall intensity and duration, creates a situation where evaporation exceeds precipitation for the majority of the year. Under these circumstances base-flow from fractured rocks and recharge zones at the base of the hills, gains considerable importance in the maintenance of riparian zones by providing moisture and/or water to the river system long after surface flow has disappeared (refer Section 1.2.2 *HydroGeomorphology)*..

Hence, across the narrow coastal plains of the Townsville / Thuringowa region, where rainfall is highly seasonal and evapotranspiration throughout the majority of the year is high, streams and rivers are usually ephemeral, transporting surface water through the channel for very short periods of each wet season. Under these conditions, riparian zones can be almost non-existent, particularly in the 1st and 2nd order streams of the drier catchments where streamflow is highly irregular and usually of very short duration.

Well developed riparian zones are generally restricted to river systems fed by a series of interdigitating, shallow aquifers, or from highly fractured rocks of the upper catchments. In areas where well developed riparian zones exist, the true width may be considerably limited relative to climates where rainfall distribution is more evenly distributed throughout the year. Thus, in the seasonally arid tropics, bank collapse and sediment transport during intense rainfall events is often high, even under normal circumstances. When an overlay of anthropogenic disturbance (e.g. industrialisation, land clearance, agricultural expansion, and/or urban expansion) is placed on top of the natural situation, the impact on surface and sub-surface flow, and subsequently, or consequently, the riparian zone, can be extreme. Under these circumstances, a circle of compromise can be set in motion where bank stability and sediment buffering capacity are further compromised by the over-exposure of poorly vegetated, dry, erosive and dispersive soils.

1.3.2 HydroGeomorphology

The narrow coastal plains of the Townsville region are relatively flat and featureless. Small first and second order drainage features start in hills and mountains, flowing generally unimpeded to the flatter broader coastal plains where they converge to form 3rd and 4th order streams or rivers. Under the climatic conditions mentioned above, the majority of these systems are ephemeral with above ground flows visible for a relatively short period after rain has fallen. However, below the surface, flows, cavity waters and pore waters contained within the hyporheic zone may retain water

and provide subsurface environmental flows to riparian zones throughout the year. These factors, combined with modified systems where large unnatural bodies of water are held in the landscape for excessive periods of time, provide a diverse set of conditions for riparian zones to exist. Under such conditions, the natural development of riparian systems is generally governed by the river continuum concept. Representative river sections that relate to riparian variability are given in Table 1.

Table 1: Representative River Sections and Associated Vegetation Types

Representative River Section	Vegetation Type
Estuarine Zone (Saline / Brackish)	Mangrove development, often backed by wide expanses of highly saline inter-tidal areas favorable to the development of saltpans and salt marshes and accompanying saline tolerant saltwater couch and samphire vegetation units. In other near coastal areas, marine environments, sand dunes and associated fresh and saline swales are found.
Ephemeral Freshwater Zone	Extensive range of vegetation types can be found, including several types of *Melaleuca* and *Eucalypt* forest,
Zones of Permanent Freshwater	Predominantly areas of vine thickets and rain forest
Wetland and Billabong Systems	Several types of *Melaleuca* and *Eucalypt* forest dependent on water holding capacity of the soils, drainage, soil chemistry, and access to available waters

1.3.3 Soils

The dominant soils of the area are solodic, usually with a very thin (2-5cm) sandy or silty loam A1 horizon overlying a strongly bleached sandy loam A2 horizon. There is often an abrupt change to mottled grey or yellowish heavy alkaline clay in the B horizon. These clays are usually highly expansive and dispersive. Rainfall is intermittent, highly irregular, and strongly seasonal. Vegetation cover is sparse, leaving the highly dispersive, erodible, and frequently self-mulching soils relatively unprotected. Under natural conditions the impact on the landscape can be extreme, with large quantities of newly derived material transported to stream and river channels. Bank erosion, or bank collapse, is a physical response to river flow during high energy events, as well as a reaction to bank slumping caused by saturation during periods of extended rainfall. When both events coincide (i.e a long period of rainfall followed by a high energy rainfall event) the combined impact on bank stability can be significant.

For the above reasons it is probably advantageous to briefly describe the soils of the Townsville / Thuringowa region that will obviously impact on either riparian development, or bank erosion and water quality if the riparian zone is removed. The most dominant soils of the Townsville / Thuringowa region are described below.

Soil Group	Description
Solodic	These soils tend to be very dense with low permeability and a high concentration of sodium ions leading to high dispersivity. The A Horizon of these soils is usually acidic with an underlying alkaline B Horizon. Loss of the A Horizon by surface flow and/or loss of the B Horizon by dispersive processes, can have profound effects on vegetation types present. Vegetation developing on these soils is predominantly a combination of *Eucalyptus platyphylla, Corymbia tessellaris* and *C.dallach*iana with a mid stratum layer of *Melaleuca viridiflora* and *M.nervosa* an under story of *Themeda triandra* and *Heteropogon contortus* is observed.
Red Earths	This soil type is typically found in semi-arid to sub-humid climates. The surface soil is reasonably thick and the soils are best described as deep, freely drained mediums, with clear boundaries between the A and B horizons. Vegetation developing on these soils is predominantly deep rooted myrtaceous species forming a floristic assemblages of a open woodland or forest tree species observed in these environments include *Eucalyptus platyphylla, Corymbia clarksoniana, C.tessellaris* and *C.dallachiana*. In drier areas *Eucalyptus platyphylla* may be replaced by *E.crebra. A*n understory of *Themeda triandra, Heteropogon contortus, Mnesithea rottboellioides* and *Bothriochloa decipiens* may be observed.
Yellow Earths	These soils are similar to the red earths, but usually have a higher clay content. This may mean reduced infiltration but greater moisture retention properties. Vegetation developing on these soils is predominantly *Melaleuca viridiflora, M.nervosa* with infrequent *Grevillea striata* and *Xantohria johnsoneii.* The understory may include *Themeda triandra, Panicum decompositum, Dichanthium sericeum* and *Sporobolus* and *aristida* spp.
Siliceous Sands	Broad group varying in colour and characterised by their deep uniform sand to clayey sand texture and absence of any distinct horizons. The A1 Horizon may accumulate organic matter, giving it a dark appearance. However, if vegetation is not present, this horizon may be absent due to its weak structure. Vegetation developing on these soils is highly varied, ranging from open eucalypt woodland to Acacia shrub land. They differ from other vegetation assemblages in that species observed in these areas are more drought tolerant.
Red Podzolic	These soils are typical of warmer sub-humid environments. They exhibit a thin organic to organic-mineral layer (typically aluminium and/or iron), overlying a yellow/brown leached sandy loam. Vegetation developing on these soils are a c0mbination of *Eucalyptus crebra, Corymbia tessellaris* and *C.dallachiana.* In wetter areas a mid-stratum layer of *Melaleuca viridiflora* and *M.nervosa* may be observed. An understory of *Themeda triandra* and *Heteropogon contortus* will also be observed

1.3.4 Vegetation Cover

Natural vegetation cover across the coastal alluvial plains of the semi-arid tropics is naturally sparse, giving little protection to the extremely friable soils under normal conditions. Greater coverage is governed by proximity to accessible waters, either as surface flow, surface ponding, groundwater, or the ability of soils to hold water within their structure.

1.3.5 Riparian Development in the Townsville / Thuringowa Region

Riparian development in the Townsville / Thuringowa region is controlled by:

(e) Physical parameters (soils, geology, hydrogeomorphology).

(f) Climatic variables; and

(g) Location in the landscape

Proximity to water (either surface waters, groundwaters, or waters retained within the soil profile) is the single most dominant factor in the development of the riparian zone. While vegetation type and diversity is consequently also determined by the availability of a water source, the type, permanency, quantity, and quality of the water source will have a profound effect on species location. For example, water quality in the soil profile will alter significantly during the year with natural groundwater salinity varying by an order of magnitude between seasons.

In the semi-arid tropics where climatic conditions are extreme and rainfall is highly irregular, both in intensity and distribution (refer Section 1.2.1), the variety of water sources is possibly greater than in any other climatic region. Within a distance of less than 40km, access to water in the Townsville / Thuringowa region varies from saline in the lower estuaries to permanent freshwater in the upper catchments, with fresh and saline wetlands, permanent / semi-permanent lagoons, billabongs, and ephemeral wetlands in between.

Hence, in the Townsville / Thuringowa region riparian zones and associated habitats are spatially extensive and varied, consequently leading to relatively high ecosystem diversity. Further, the majority of the riparian zones have developed in concert with a specific suite of climatic and physical properties. Any interruption to these parameters can have significant impacts on the function of the riparian zones. This is of particular importance where the riparian zones act as buffers to ecologically sensitive waterways, or where those waterways drain into highly sensitive marine environments.

River basins of the Townsville / Thuringowa region drain into the Great Barrier Reef Marine Park, the Great Barrier Reef World Heritage Area, a State Marine Park, a State National Park, Dugong Protected areas, migratory bird habitats covered by RAMSAR, JAMBA, CAMBA and BONN Conventions, and declared Fish Habitat Areas. Any modification or alteration of riparian systems needs to accommodate the proximity of these highly valued areas to the catchments of the Townsville / Thuringowa region.

Additional management implications arise from the presence of rare, threatened and endangered flora and fauna covered by both the Environment Protection and Biodiversity Conservation Act 1999 (Commonwealth) and a variety of State Acts and Policies including the Nature Conservation Act (1992) and the Vegetation Management Act (1994).

1.4 STUDY AREA

The study area of the Ross and Black River Basins is shown in Figure 1. For ease of interpretation, the Ross and Black River basins are handled separately. Within this broader context, each basin is divided into catchments (e.g. the Ross River Basin includes the catchments

of the Ross River, Ross Creek, Stuart Creek and Bohle River). Where appropriate, each catchment is subdivided into sections, predominantly according to topography (upper reaches), and/or geographic peculiarity (e.g. Lake Ross surrounds). The relevant basins, their catchments, and appropriate sections, are shown in Figure 1: *Study Area.* The full extent of non-remnant and cleared vegetation is also incorporated into the maps data base to assist data interpretation. A full list of the vegetation types that occur within the study area are given in **Appendix 1**

The following colour legends are used in all maps:

GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

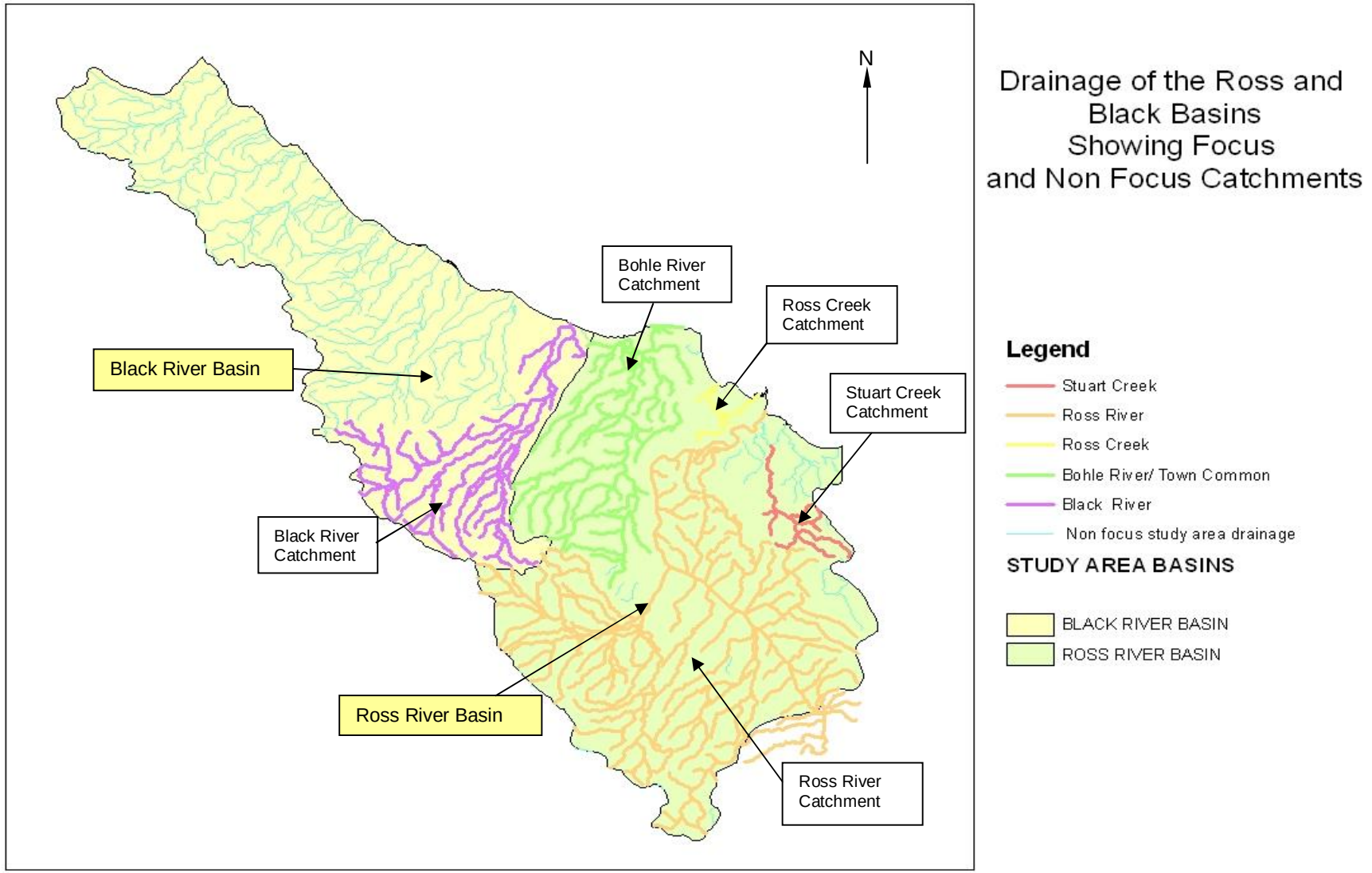


Figure 1: Study Area: Drainage Basins, Catchments, and Relevant Catchment Sections of the Black and Ross River Basins

2 METHODOLOGY

Creeks and rivers within the study area have been evaluated using the minimal buffer width required by the current Vegetation Management Act (2004). However, the requirements of the Vegetation Management Act are, by necessity, generalised and predominantly based on climates considerably different to the tropical, seasonally arid, climate of the Townsville / Thuringowa region (refer Section 1.2 above).

In recognition of these differences (refer Section 1.2.1 *Climate*), the riparian zone has been extended to encompass a buffer zone recommended by Geosciences Australia. This includes vegetation communities that would not traditionally be considered riparian communities, but which exist in all major drainage areas of the study area and whose value is equally important for bank stability and buffering capacity.

The required widths of the riparian zone as defined by the Vegetation Management Act (2004) are:

1st and 2nd order streams	50m from each high bank
3rd and 4th order streams	100m from each high bank

Where the high bank can not be clearly identified, the centre line of the major drainage channel has been used in accordance with the recommendations in the Geosciences Australia topographic data suite. A larger buffer width has been used in these cases to overcome the inability to assess the high bank. Widths suggested by Geosciences Australia are:

1st and 2nd order streams	75m from each high bank
3rd and 4th order streams	150m from each high bank

Additionally, the full extent of riparian vegetation has also been displayed. Riparian areas outside the 150m buffer zones are also displayed to demonstrate the full extent of relevant riparian regional ecosystems.

3 RIPARIAN EVALUATION / RESULTS

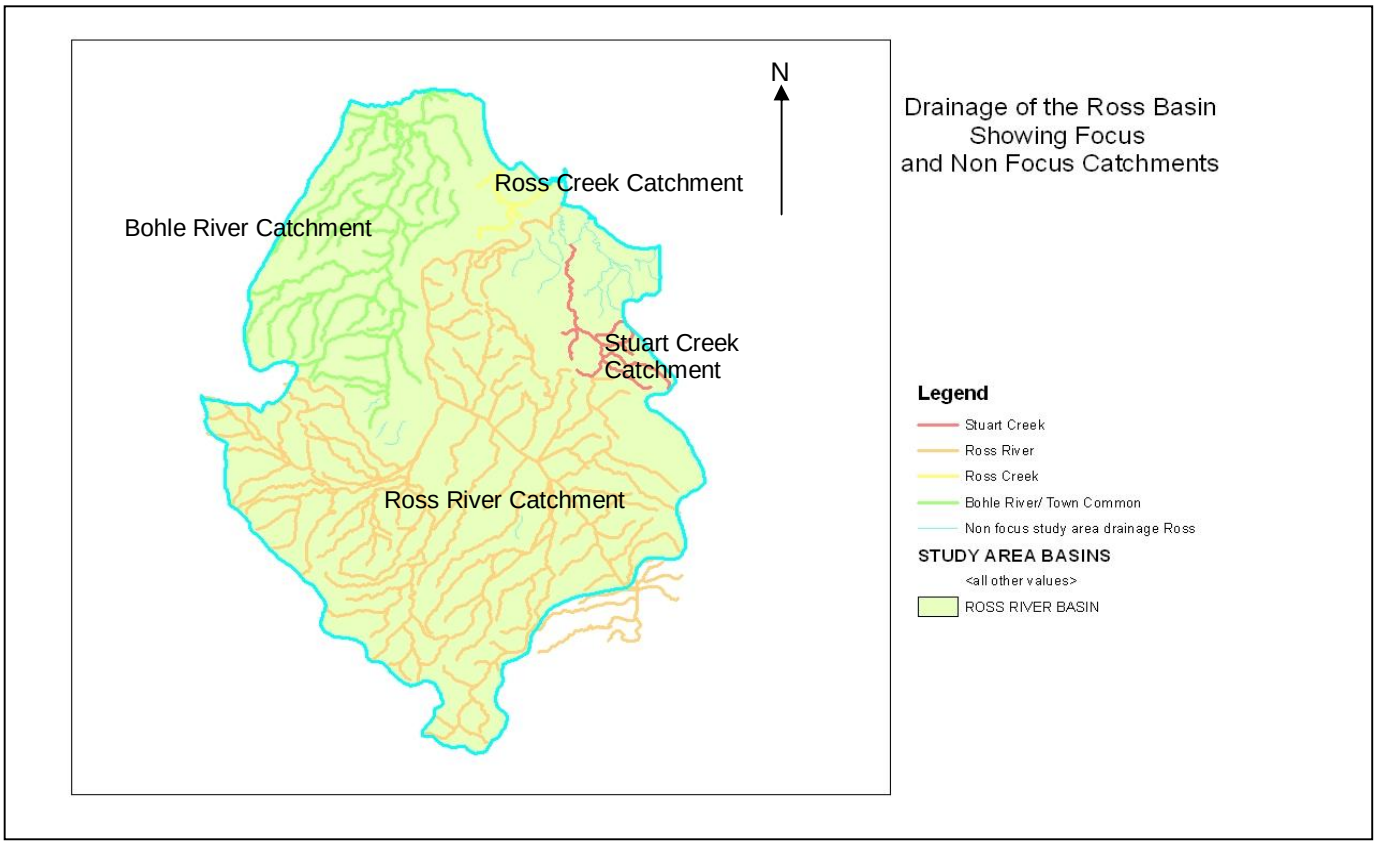
3.1 ROSS RIVER BASIN

Four catchments are included in the Ross River Basin:

(i) Ross River
(ii) Ross Creek
(iii) Stuart Creek
(iv) Bohle River

Each catchment will be reviewed individually. For ease of analysis, each catchment (excluding Ross Creek) has been divided according to topography and other parameters. These sub-divisions and the appropriate catchments are shown on Figure 1: *Study Area, Ross and Black River basins,* and Figure 2: *Ross River Basin.*

Figure 2: Ross River Basin



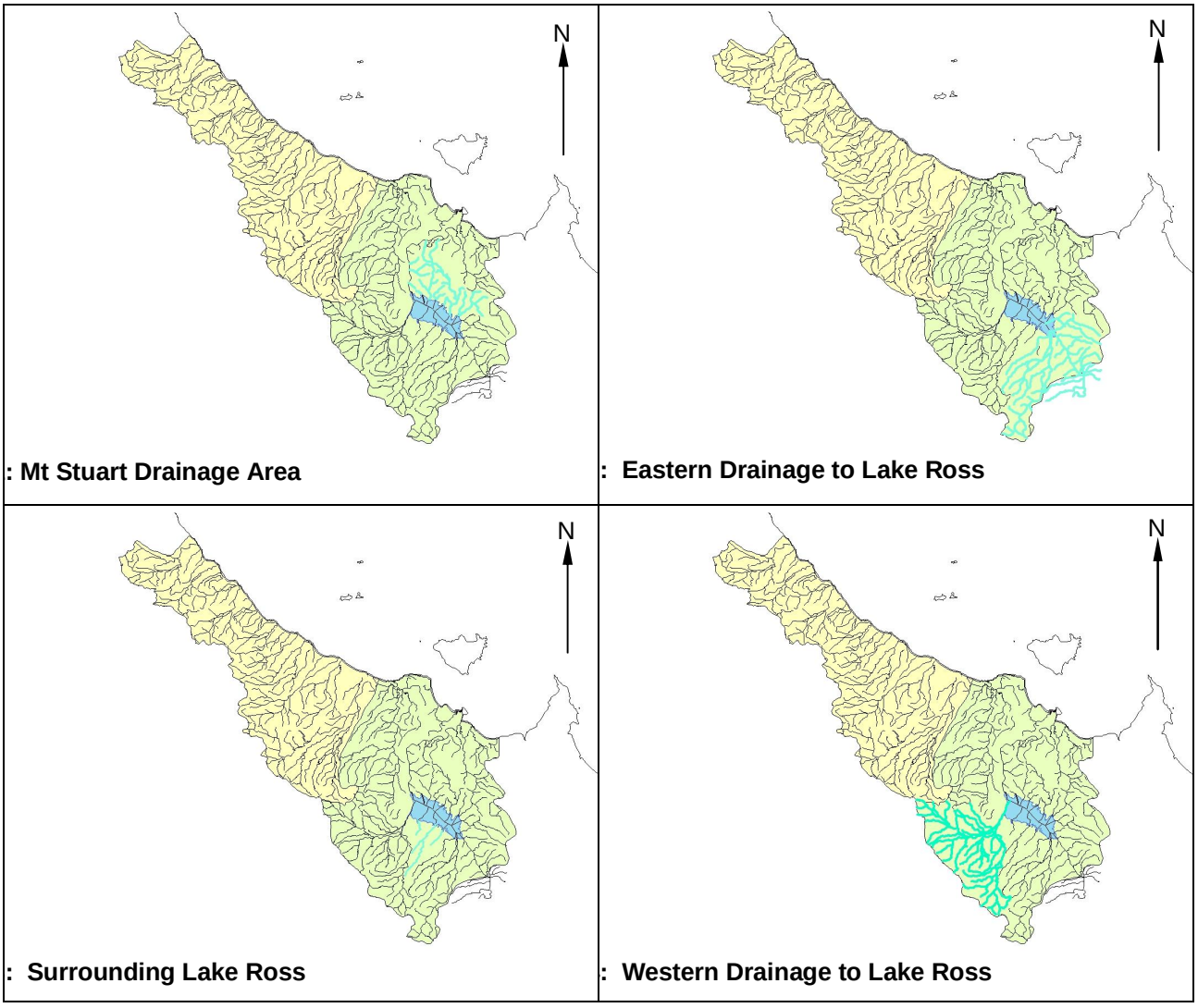
3.1.1 Ross River Catchment (Ross River Basin)

For convenience, the Ross River Catchment is divided into three reaches, and then further divided into sections:

- Upper Reaches
  - Section 1: Mt Stuart drainage area
  - Section 2: Eastern drainage to Lake Ross
  - Section 3: Surrounding Lake Ross
  - Section 4: Western drainage to Lake Ross
- Middle Reaches
  - Section 5: Ross Dam to Black Weir,
  - Section 6: Black Weir to Aplins Weir.
  - Section 7: Aplins Weir to Cleveland Bay.

These divisions are shown in Figures 3 and 4.

Figure 3: Ross River Upper Reaches

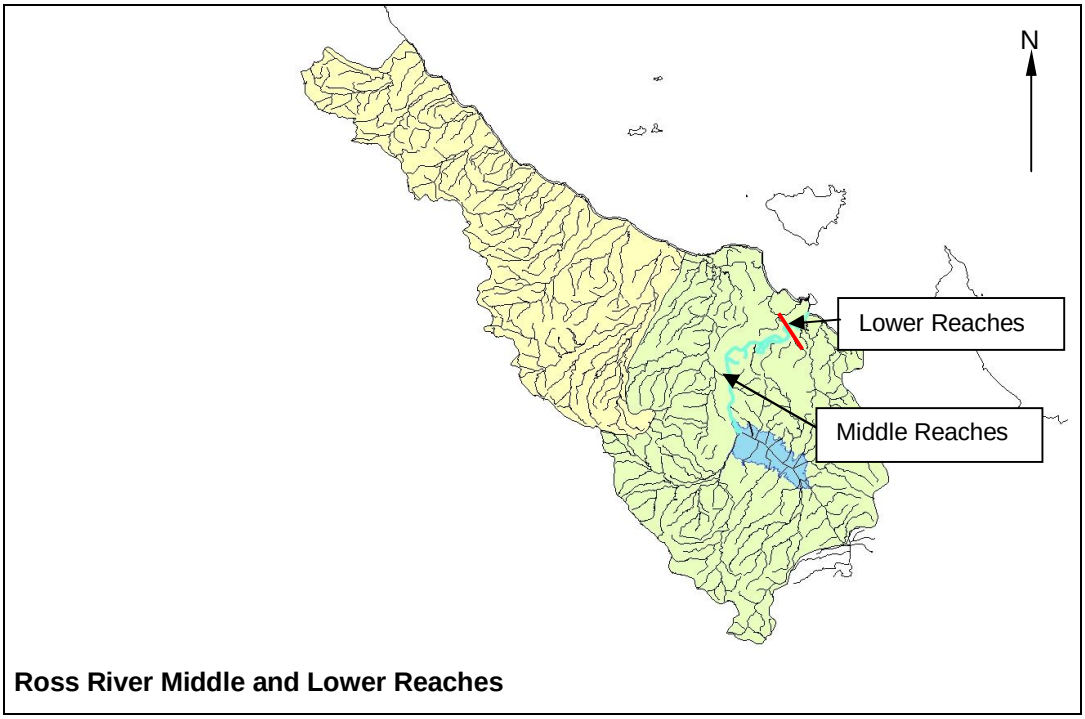


: Mt Stuart Drainage Area

: Eastern Drainage to Lake Ross

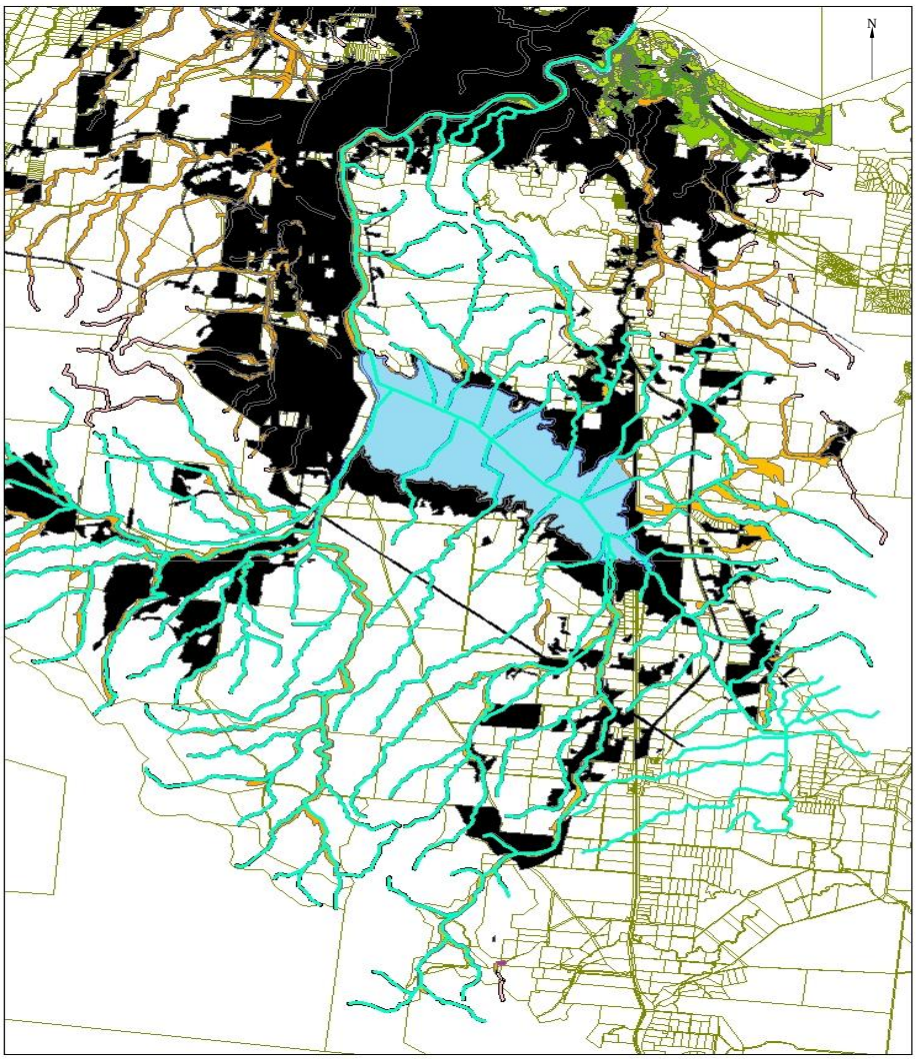
: Surrounding Lake Ross

: Western Drainage to Lake Ross



Ross River Middle and Lower Reaches

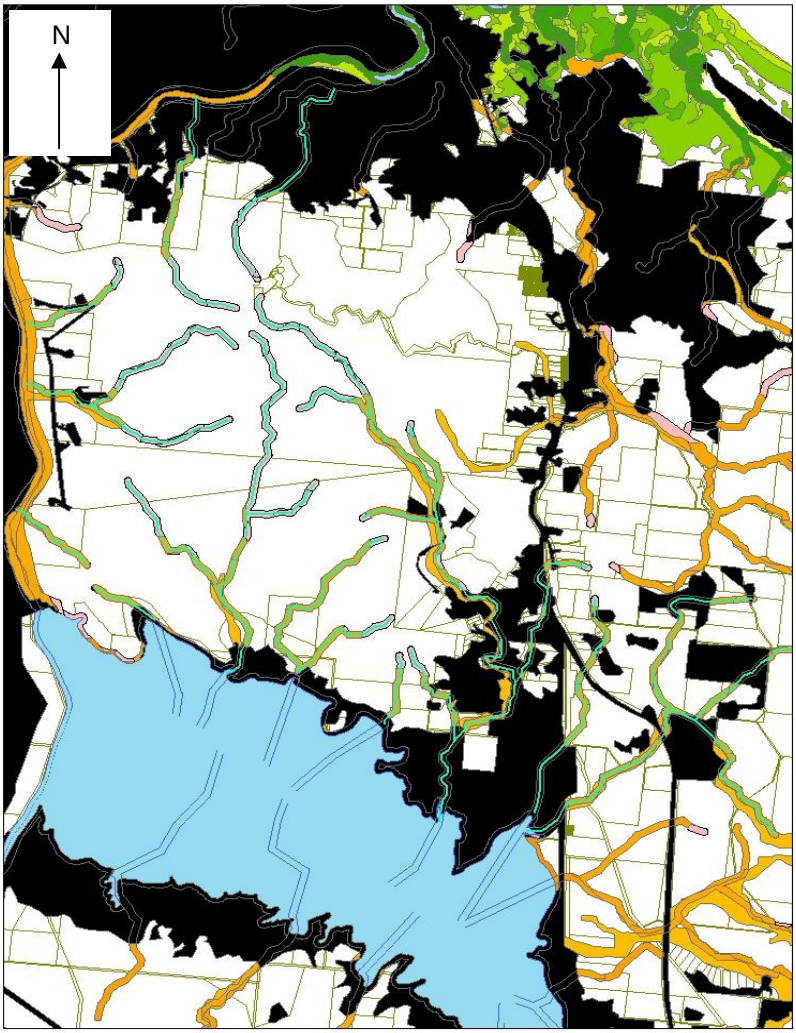
Figure 5: Riparian Systems of the Ross River Catchment



GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.1.1 Section 1 - Ross River (Upper Reaches,): Mt Stuart Drainage Area, Ross River Catchment

Figure 6: Riparian Systems of the Mt Stuart Drainage Area of the Ross River Catchment.



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BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

The upper reaches of Ross River within the Mt Stuart area have a moderate to good riparian cover, primarily due to the inaccessibility of the area and inclusion in the Mount Stuart Training Area. However, significant areas of non-remnant vegetation exist throughout the area, with some areas (such as the northern side of Mt Stuart draining through the suburb of Annandale) relatively well managed with recent works upgrading drains and drainage channels to include a riparian system (vegetated drains).

Areas on the southern side draining to Lake Ross, are also predominantly non-remnant riparian vegetation. However, although there is little remnant vegetation remaining (most probably due to the construction of the dam), the riparian condition of the area is considered relatively good with significant stands of para grass providing soil stabilisation and buffering capacity from potential erosion during rainfall events. The para grass also contains significant faunal values, providing habitat for wading birds and frogs (e.g. *Litoria falax*).

Areas that may be of particular concern include drainage lines with no riparian vegetation buffer on the eastern side of the Mount Stuart Training Area. These areas include drainage lines which may potentially traverse through old munitions dumps and training sites. This, combined with the highly sodic and erodibile soils within the area, is of particular concern for these drainage features.

Areas on the western side of Mt Stuart include 1st and 2nd order streams with no riparian zone present. These are thought to traverse through cattle grazing areas where the soil has a high sodicity and hence is susceptible to severe erosion.

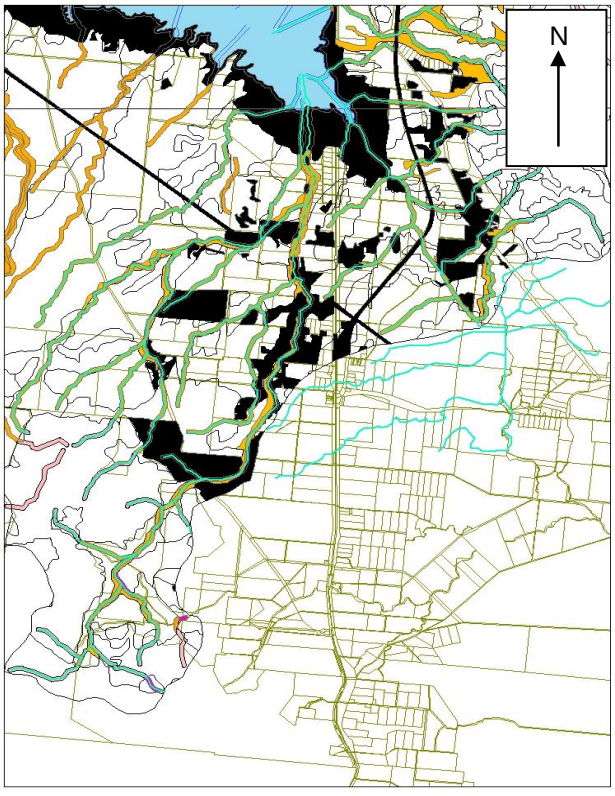
3.1.1.2 *SECTION2 - ROSS RIVER (UPPER REACHES): EASTERN DRAINAGE TO LAKE ROSS, ROSS RIVER CATCHMENT*

The riparian condition of the eastern drainage system in the upper reaches of Ross River is moderately modified. Significant areas adjacent to 3rd/4th order streams have little to no riparian buffers. The adjacent land uses to these areas are thought to be used for cattle grazing and agriculture. It is also possible that there may be significant quarrying activities taking place adjacent to these areas.

It should be noted that although there are significant areas adjacent to the Ross River catchment that flow to Major Creek, it is believed that in times of extreme flooding, the Ross River and Major Creek may join. This possibility has not been included in this study.

Areas to the north that also drain into Lake Ross are also predominantly non-remnant riparian vegetation. However, although there is little remnant vegetation left (most probably due to the construction of the dam), the riparian condition of the area is known to be relatively good with significant stands of para grass providing a soil stabilisation and buffering system from any potential run off. The para grass also contains significant fauna values providing habitat for wading birds and frogs such as *Litoria falax*

Figure 7: Riparian Systems of the Eastern Drainage Section of the Ross River Catchment into Lake Ross.



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ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
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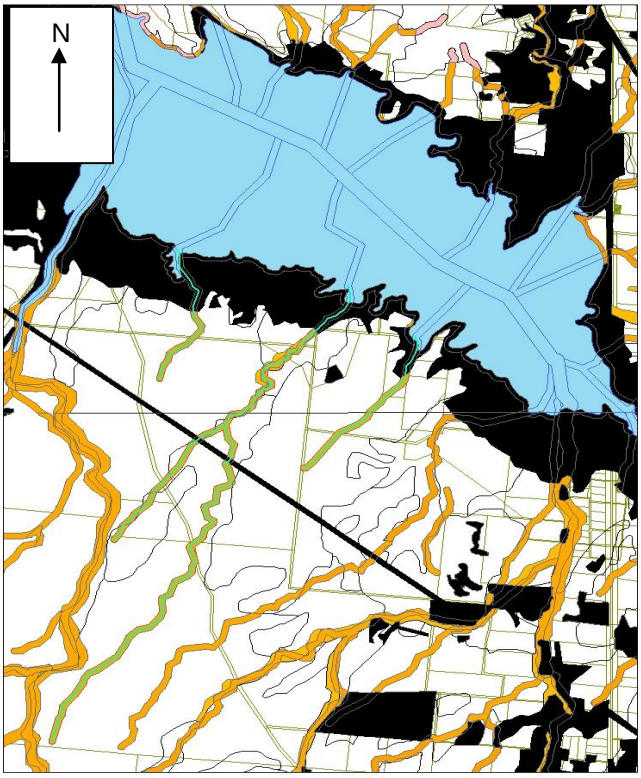
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.1.3 *Section 3 - Ross River (Upper Reaches): Drainage of Areas Surrounding Lake Ross, Ross River Catchment.*

The riparian condition within the Lake Ross area of Ross River is highly modified. The two 1st order creeks running directly into Lake Ross have substantial riparian vegetation present with little non-remnant vegetation present until they join the Lake Ross area. Virtually all riparian vegetation and vegetation buffering capacity has been removed from the area bordering Lake Ross. The exception is an area in the far north west where a reasonable non-remnant buffer zone is present. Although non-remnant, the majority of this vegetation has significant riparian value. It should be noted that while the area has been mapped as non-remnant, this is an artifact of water logging the original vegetation. Long seasonal inundation has degraded the previous landscape (predominantly *Melaleuca nervosa/veridflora* and *Eucalyptus* open forest) leaving vast stands of dead trees. These areas have been replaced by other wetlands surrounded by melaleuca species (e.g. *M.leucadendra*) better suited to the new conditions. Para grass also provides a soil stabilisation and buffering system from any potential run off during rainfall events, as well as providing refuge habitat for wading birds and frogs such as *Litoria falax.* Alteration of these areas may have significant impact on the aesthetic, faunal and water quality values of the dam.

Figure 8: Riparian Systems of the Lake Ross Section of the Ross River Catchment



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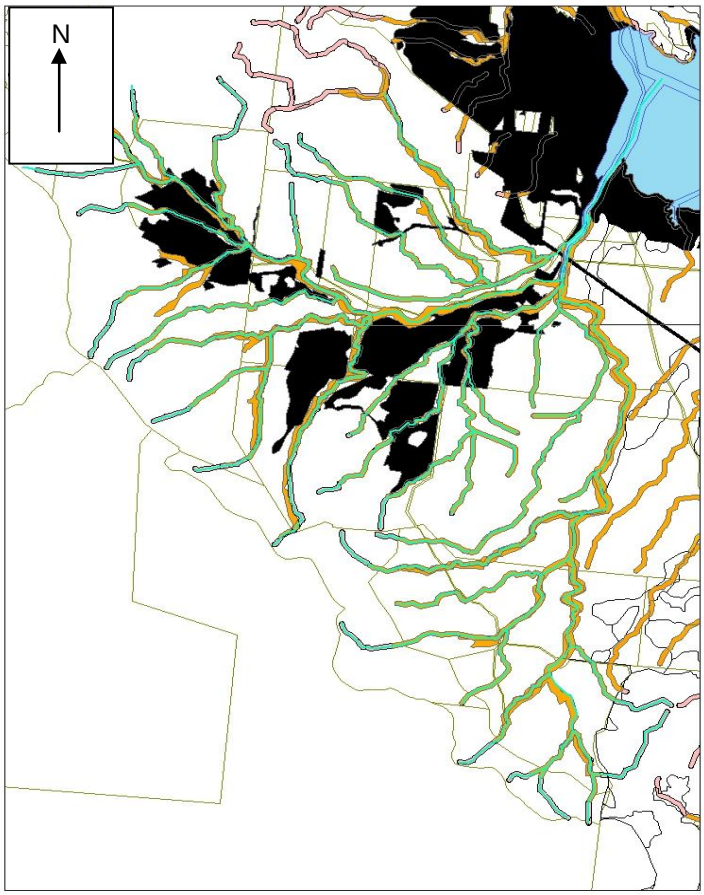
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.1.4 *SECTION 4 - ROSS RIVER (UPPER REACHES),: WESTERN DRAINAGE TO LAKE ROSS*

The riparian condition within the western upper reaches of Ross River is good. Significant areas adjacent to 3rd/4th order streams have been cleared. However, in most cases these only just intersect the 150m buffer. Within the 1st and 2nd order streams there are areas that have little to no buffer zone present. However, compared to adjacent catchments, these are minimal. Adjacent land uses are agriculture and cattle grazing. There are significant quarrying / dredging activities taking place in and around these areas.

Areas to the north leading into Lake Ross also contain non-remnant riparian zones. However, although there is little remnant vegetation left (predominantly due to the construction of the dam), the riparian condition of the area is known to be relatively good with significant stands of para grass providing a soil stabilisation and buffering system from any potential run off. The para grass also contains significant fauna values providing habitat for wading birds and frogs such as *Litoria falax*

Figure 9: Riparian Systems of the Western Drainage System of the Ross River Catchment to Lake Ross .



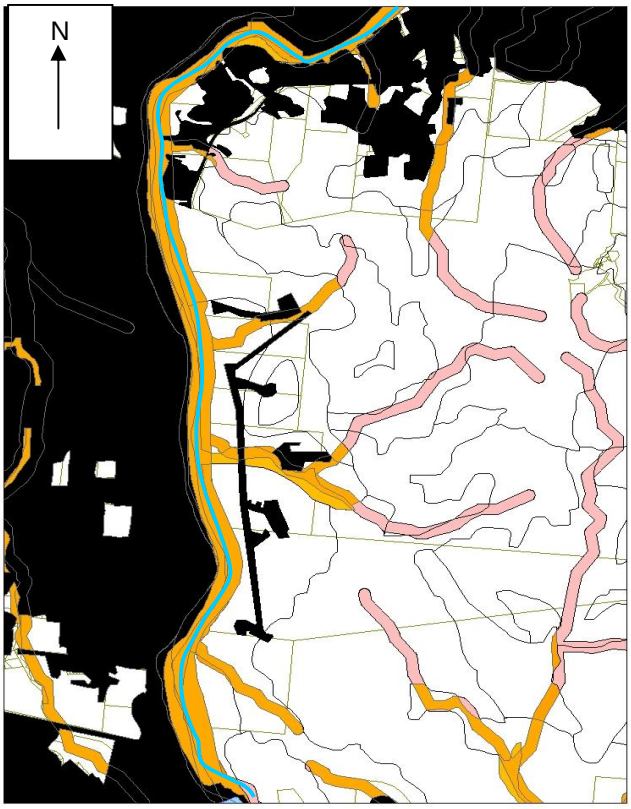
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.1.5 *SECTION 5 - ROSS RIVER (MIDDLE REACHES): ROSS RIVER DAM TO BLACK WEIR*

The riparian condition in the middle reaches of Ross River is highly variable. Significant areas adjacent to 3rd/4th order streams have been cleared to the high bank.

The land use along the western bank of Ross River is almost exclusively modified parkland / residential. The eastern bank of Ross River is zoned as "Special Usage" within the Mt Stuart Training Area). Sand mining from the bed of the river, and access tracks along the banks for both sand mining and Army activities, have compromised the width of the riparian zone, but the remaining strand line that constitutes the riparian zone is healthy and acts as a reasonable buffer to runoff from the adjacent hills. The major threat to the flora, fauna and habitat values of the riparian zone adjacent to the Mt Stuart Training Area is the annual Army burn-off. It is recommended that investigations be undertaken into the most suitable type of burn-off for this vegetation species. Downstream of the Townsville / Thuringowa overpass, residential development along the right bank has almost entirely removed the riparian zone to the mid-bank of the river. In its present condition it is doubtful this area could sustain a major flow through Ross River and considerable bank erosion is highly probable should such an event occur. As this area surrounds an artificial, but now functioning wetland of medium to high environmental value, excessive levels of turbidity or suspended sediments could cause unnecessary harm to environmentally sensitive areas.

Figure 10: Riparian Systems of the Middle Reaches of Ross River, Ross River Dam to Black Weir .



ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.1.6 *Ross River (Middle Reaches): Black Weir to Aplins Weir*

Large areas within this reach have been mapped as non-remnant. However, the condition of this non-remnant riparian zone is quite good. This is mainly the area from Black to Aplins Weir, which, although having a highly modified riparian condition is still functioning as a buffer system for **localised** overland flows. These areas are also highly modified with para grass providing habitat for wading birds and frogs, including *Litoria falax, Litoria rubella, Litoria rothii, Litoria grasilenta and Litoria inferfrinata (Litoria inferfrinaa* is only found locally within the para grass of the Bush Garden near Aplins Weir). The first and second order streams flowing in from Annandale are highly modified. However these areas have recently been upgraded with grassed slopes and native vegetation.

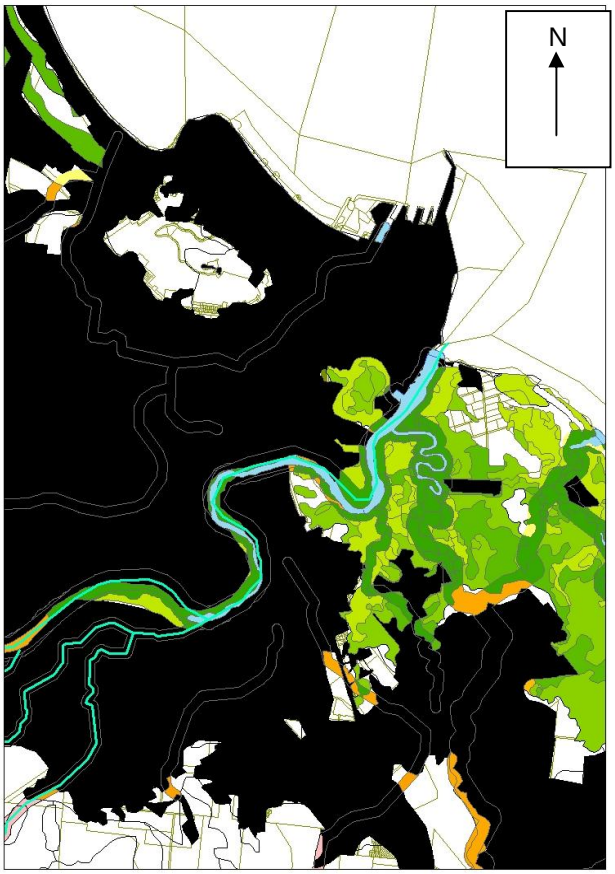
Figure 11: Riparian Systems of the Middle Reaches of Ross River, Black Weir to Aplins Weir .

YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.1.7 *Ross River (Lower Reaches): Aplins Weir to Cleveland Bay*

Large areas within this reach have been mapped as non-remnant. However, conditions within this reach vary from excellent to poor. From the base of Aplins Weir to the down stream edge of the Townsville Golf Course there are vast expanses of *Sporobolus* grasslands. These are generally within the high banks of the river. For the majority of the time this vegetation has an excellent buffering capacity for wet season first flush events. This area also provides habitat for wading birds. Estuarine crocodiles have been observed in the area. Below the Townsville Golf Course (from the Townsville Golf Course to Rooneys Bridge) is an area of poor riparian condition and areas on both the left and right bank are known to be at risk from soil erosion. Sediment inputs into the river in this area are from unknown origins. It is recommended that this section of Ross River be considered as an area of prime focus. The riparian system from Rooneys Bridge to the mouth of the river, is in relatively good condition with good expanses of estuarine vegetation running parallel to the high banks. Areas where this is not the case are on the northern bank from the Ross Island barracks to the Townsville Port Authority reclaimed area. This is an industrial area were there is a higher probability of contamination from overland flows.

Figure 12: Riparian Systems of the Lower Reaches of Ross River, Aplins Weir to Cleveland Bay.



GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.1.8 SUMMARY OF CONDITIONS WITHIN THE ROSS RIVER CATCHMENTS

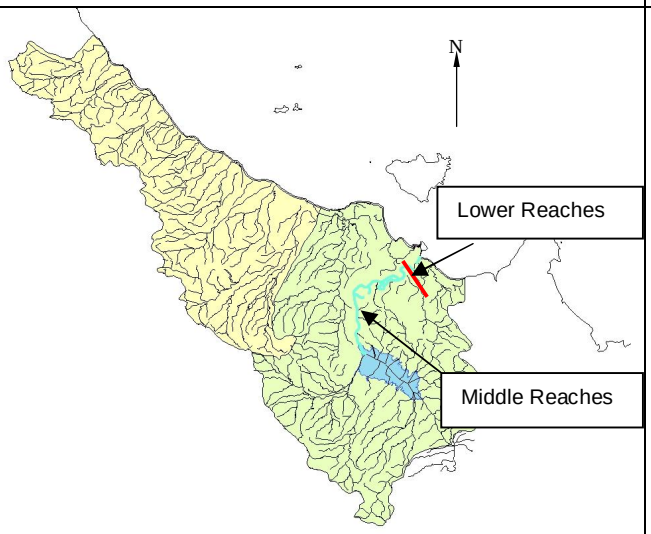
General

Para grass *(Brachiaria m*utica) is one of the major features of this catchment and is one of the most contentious and complex management issues within this area. Despite its weed status, para grass provides habitat for numerous faunal species, including the Black Throated Finch. In addition, the thickly matted grass provides a buffer for water quality and shoreline protection in the lower riparian zone.

Ross River Upper Reaches

1st and 2nd order streams are generally in good condition with threats to bank stability arising mainly from a combination of

- Agricultural and grazing practices,
- Removal of remnant buffer zones, and
- The presence of sodic and erodible soils.



Ross River Middle and Lower reaches

Middle Reaches: Highly modified remnant condition. However, large areas within these have quite adequate, although modified, non-remnant zones

Lower Reaches: Large area mapped as non-remnant, but riparian condition ranges from poor to excellent. Area between Townsville Golf Course and Rooneys Bridge is in particularly poor condition and is recommended for consideration as an area of prime focus.

3.1.2 Ross Creek Catchment

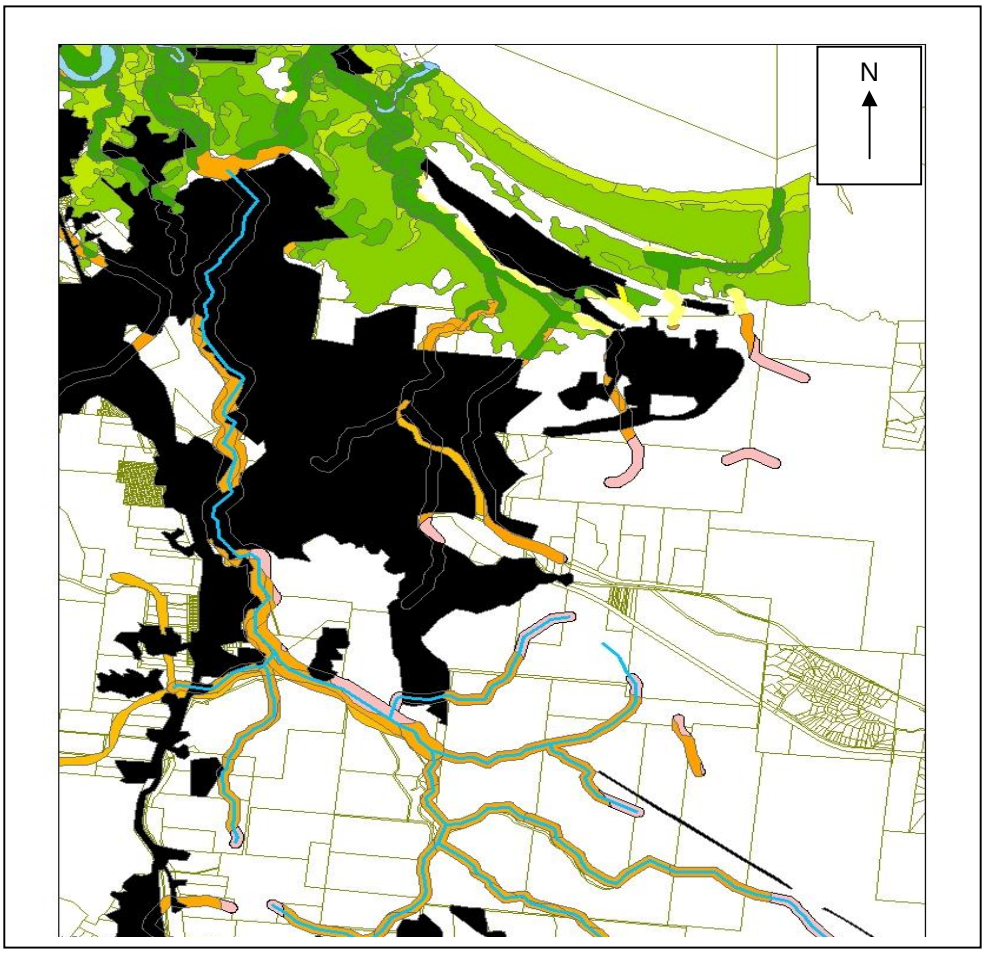
The Ross Creek catchment has been heavily modified. Little to no remnant riparian vegetation exists and while estuarine riparian zones exist within the creek, their extent and functionality is limited. Adjacent land uses are highly varied with minimal possibility of major overland sediment loads entering the creek. However, leaching from the numerous historic legal and illegal dumps along the creek banks and filled areas adjacent to the creek, may be an issue. Other contaminants such as hydrocarbons may also be an issue.

Figure 13: The Riparian Systems of Ross Creek

GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.3 Stuart Creek Catchment of the Ross River Basin

Figure 14: Riparian Systems of Stuart Creek

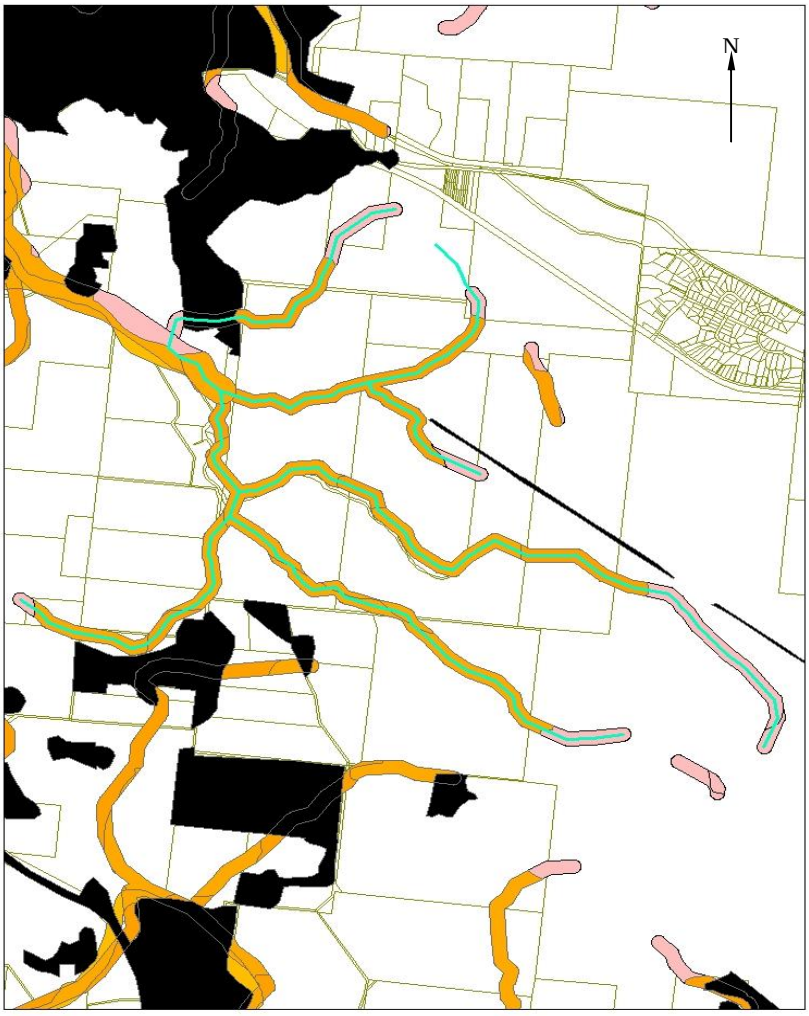


GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.3.1 *THE RIPARIAN SYSTEMS OF THE UPPER REACHES OF STUART CREEK*

The upper reaches of Stuart Creek are in an almost pristine condition with minimal disturbance within the designated buffer zones. Significant, non-designated, riparian zones are also present within the upper reaches of the creek. Only small sections of non-remnant vegetation exist within the 75m buffer zone of the most northerly 1st order creek.

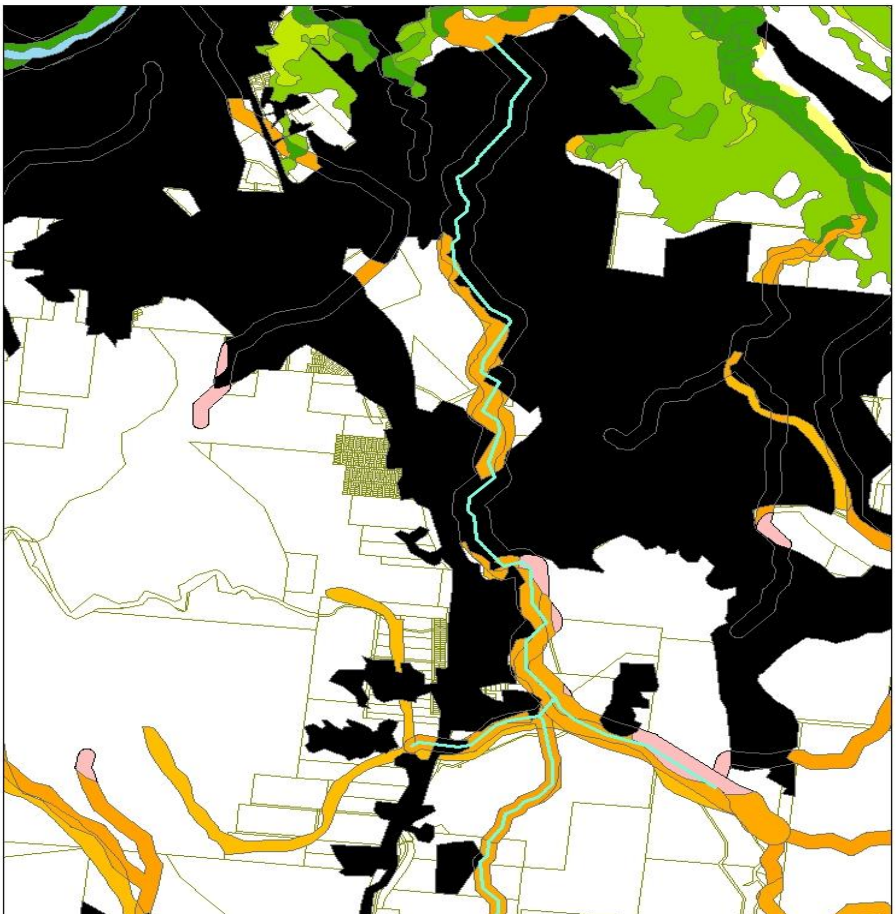
Figure 15: The Riparian Systems of the Upper Reaches of Stuart Creek



GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.3.2 THE RIPARIAN SYSTEMS OF THE MIDDLE REACHES OF STUART CREEK

Figure 16: Riparian Systems of the Middle Reaches of Stuart Creek



GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

The Middle Reaches of the Stuart Creek catchment are highly modified with a significant amount of disturbance and run off potential from non-remnant vegetated areas. Significant areas of note include:

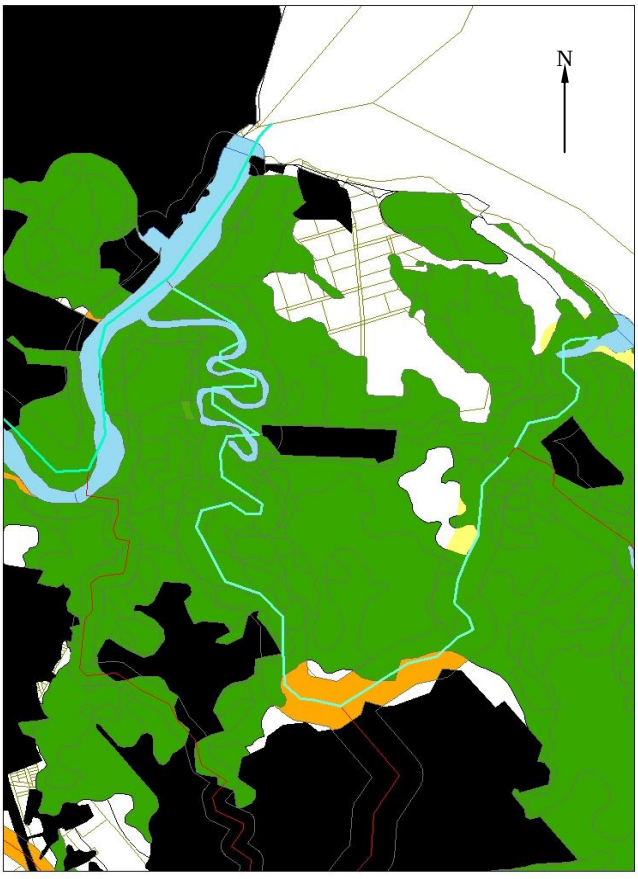
(a) Stony Creek catchment: High levels of disturbance and potential sediment erosion from quarrying activities associated with little, to no, buffering capacity along the stream channels.

(b) Land uses within, and adjoining, the non-buffered systems include industrial areas. It is recommended that these areas should be the focus of a revegetation programme.

3.1.3.3 *THE RIPARIAN SYSTEMS OF THE LOWER SECTIONS OF STUART CREEK*

Although no remnant riparian buffer zones exist within 150m of a third to fourth order stream in the lower section of Stuart Creek, the estuarine sections of the creek are in pristine condition with no disturbance within the designated buffer zones. Significant, designated, riparian zones extend well outside the buffer width of 150m with a moderate degree of connectivity to the estuarine systems of Ross River. The surrounding creek areas are a perfect representation of a mangrove marine sequence with mixed mangrove forest zoning into a marine couch grassland and finally a samphire clay plain. The riparian value of this sequence can not be understated, offering significant buffering capacity for overland flows and high ecological and habitat values. Further the distributaries of Stuart Creek offer the last remaining access paths for catadromous and anadromous fishes. All other flow pathways between the marine waters of Cleveland Bay and the fresh waters of the upper river systems have been cut by dams, weirs, or other infrastructure.

Figure 17: Riparian Systems of the Lower Sections of Stuart Creek



GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

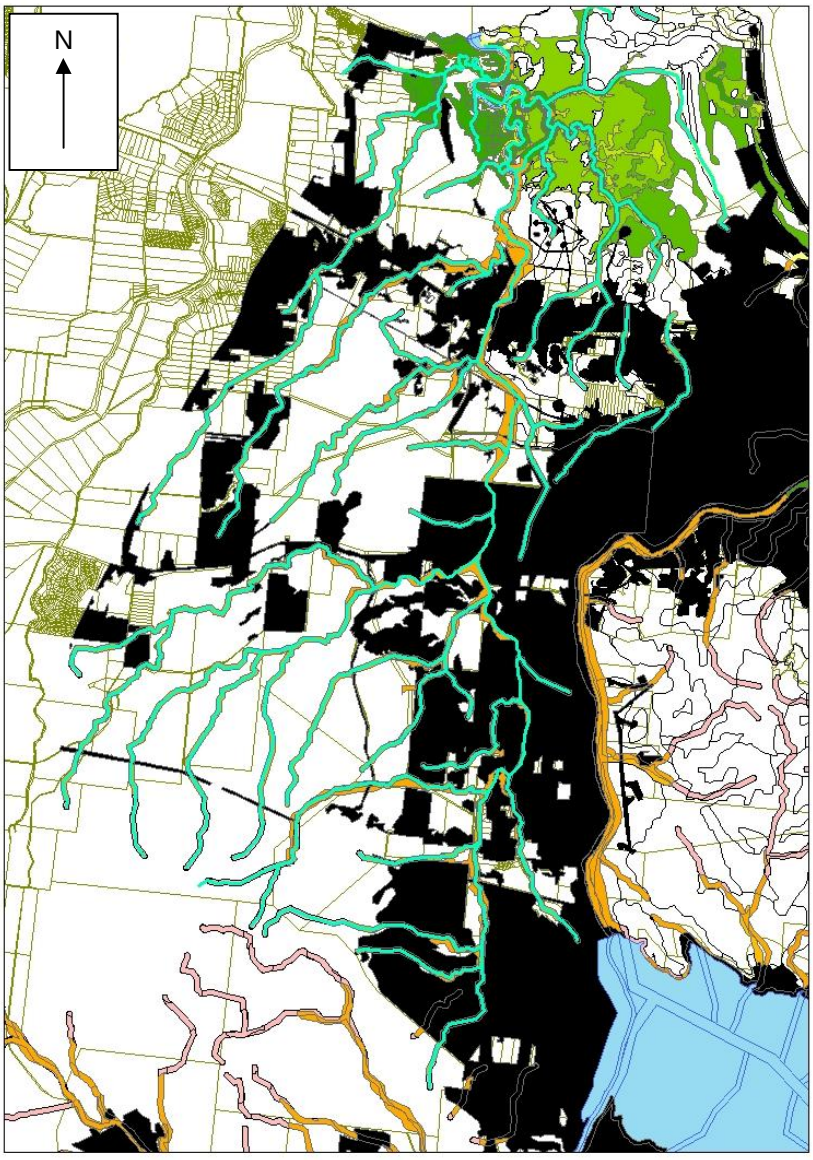
3.1.3.4 SUMMARY OF CONDITIONS WITHIN STUART CREEK

General	
Upper Reaches 	Almost pristine condition with minimal disturbance within the buffer zones. Significant non-designated riparian zones present. Only minor area of non-remnant vegetation in the 75m buffer zone on the most northerly 1st order creek.
Lower Reaches 	Highly modified with a significant amount of disturbance and run off potential from non-remnant vegetation areas May have problems from lack of riparian vegetation in areas where quarrying activities and industrial land uses are active. High levels of disturbance and potential sediment erosion from quarrying activities in areas with little, to no, buffering capacity.

Estuary 	The estuarine areas of Stuart Creek are in pristine condition with vast expanses of designated riparian vegetation outside the recommended buffer zone.

3.1.4 Bohle River Catchment of the Ross River Basin

Figure 18: Riparian Systems of the Bohle River

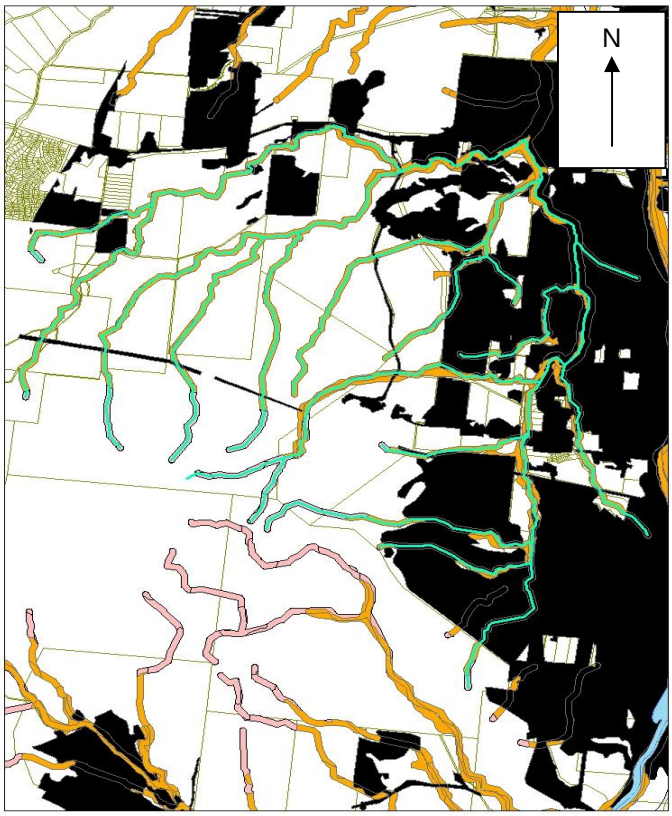


GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.5 The Riparian Systems of the Upper Reaches of the Bohle River (Little Bohle / Big Bohle Confluence)

The Upper Bohle catchment is highly modified, with significant reaches of both 1st /2nd order streams and 3rd/4th order rivers having little to no remnant riparian vegetation. The Little Bohle to the west has relatively good condition in its 1st and 2nd order reaches. However areas within the Big Bohle and the lower reaches of the Little Bohle have little to no riparian value. This is predominantly due to extensive clearing for cattle grazing. Riparian zones within these areas are infested with several invasive weeds including Chinee apple and Rubber vine. Unlike para grass these hold little riparian value apart from limited bank stabilisation properties. Extensive studies in the area have shown that almost all the soils within this area are highly sodic and dispersive.

Figure 19: Riparian Systems of the Upper Reaches of the Bohle River to Little Bohle / Big Bohle confluence.



GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.6 The Riparian Systems of the Middle Reaches of the Bohle River

The Middle Section of the Bohle River catchment is highly modified with significant reaches of both 1st /2nd order streams and 3rd/4th order rivers having little to no remnant riparian vegetation. These include significant stretches of 3rd/4th order streams directly adjacent to areas that are used for cattle grazing. It also includes a complex system of 1st and 2nd order streams within the Bohle Industrial Area and adjacent to Louisa Creek, with no recognised riparian vegetation. Significant para grass infestations do occur within these areas, offering some bank stability and habitat protection.

Figure 20: Riparian Systems of the Middle Reaches of the Bohle River Catchment

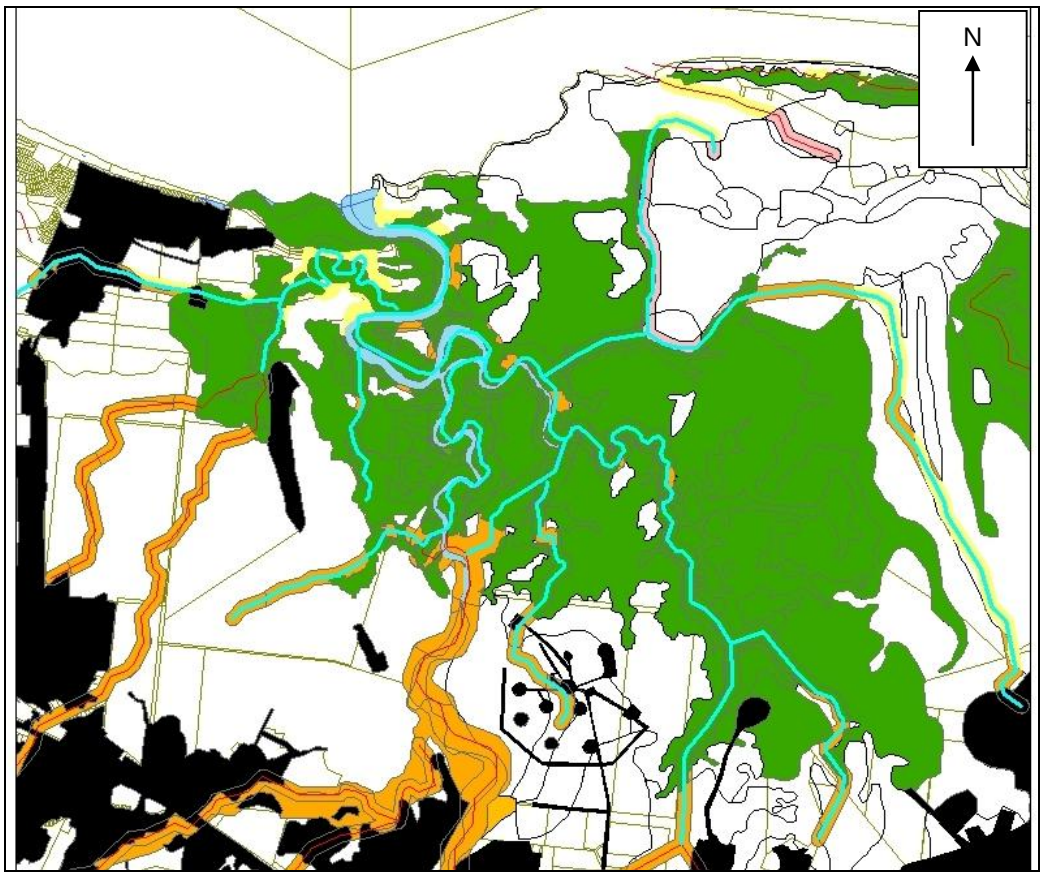
GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.6.1 *THE LOWER SECTION OF THE BOHLE RIVER*

The lower reaches of the Bohle River catchment are in relatively good condition and should remain so with protection within the Town Common and the Bohle River Fish Habitat Area. The Estuarine section is in pristine condition with no disturbance within designated buffer zones.

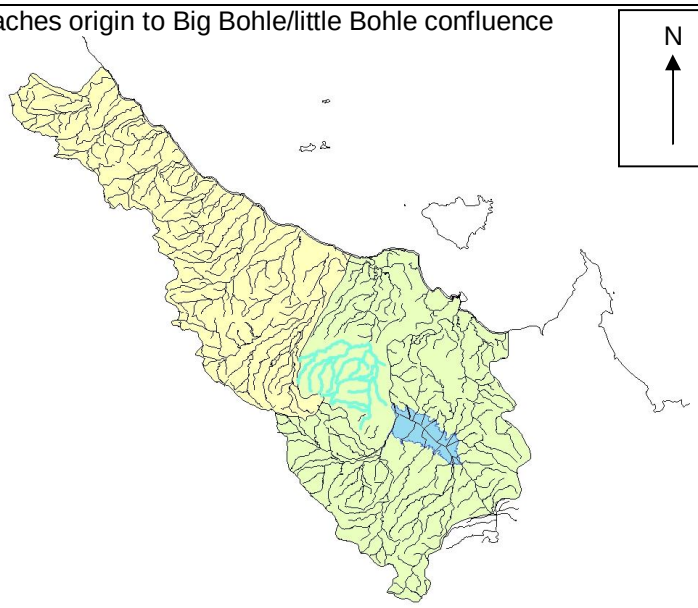
The surrounding creek areas are a perfect representation of a mangrove marine sequence with mixed mangrove forest zoning into a marine couch grassland and, finally to a samphire clay plain. The riparian value of this sequence can not be understated with high ecological significance and buffering capacity for overland flows.

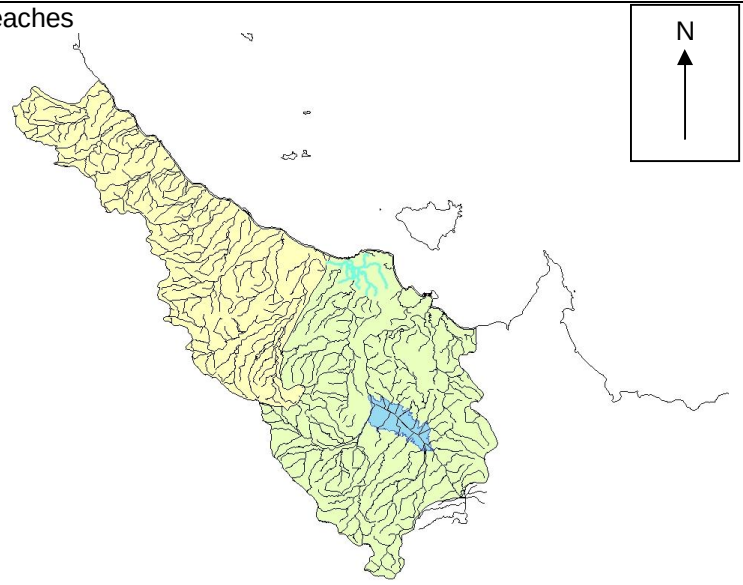
Figure 21: Riparian Systems of the Estuarine Section of the Bohle River



GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.6.2 *SUMMARY OF CONDITIONS WITHIN THE BOHLE RIVER CATCHMENT*

Upper Reaches origin to Big Bohle/little Bohle confluence 	The 1st and 2nd order streams in the upper reaches are generally in poor condition with little to no remnant vegetation cover. Areas are highly infested with chinee apple *(Ziziphus mauritiana)* and rubber vine *(Cryptostegia grandiflora*). While these plants are considered to have little to no riparian value, the protective value of the chinee apple to small birds has recently been attracting attention. Sodic and erodible soils are present within the area and overland flow across the unprotected soil profile may carry cause gullying and the consequent transport of significant sediment loads into the channel.
Mid Reaches 	Lower reaches have highly variable riparian condition with the Bohle Industrial Area and Louisa Creek catchment having a significantly modified riparian zone.

Lower Reaches 	Areas within the lower reaches of the Bohle (towards the mouth and within the Town Common) have an extensive intact riparian system ranging from modifided wetland to marine mangroves.

3.1.7 The Black River Basin

Figure 22: Black River Basin

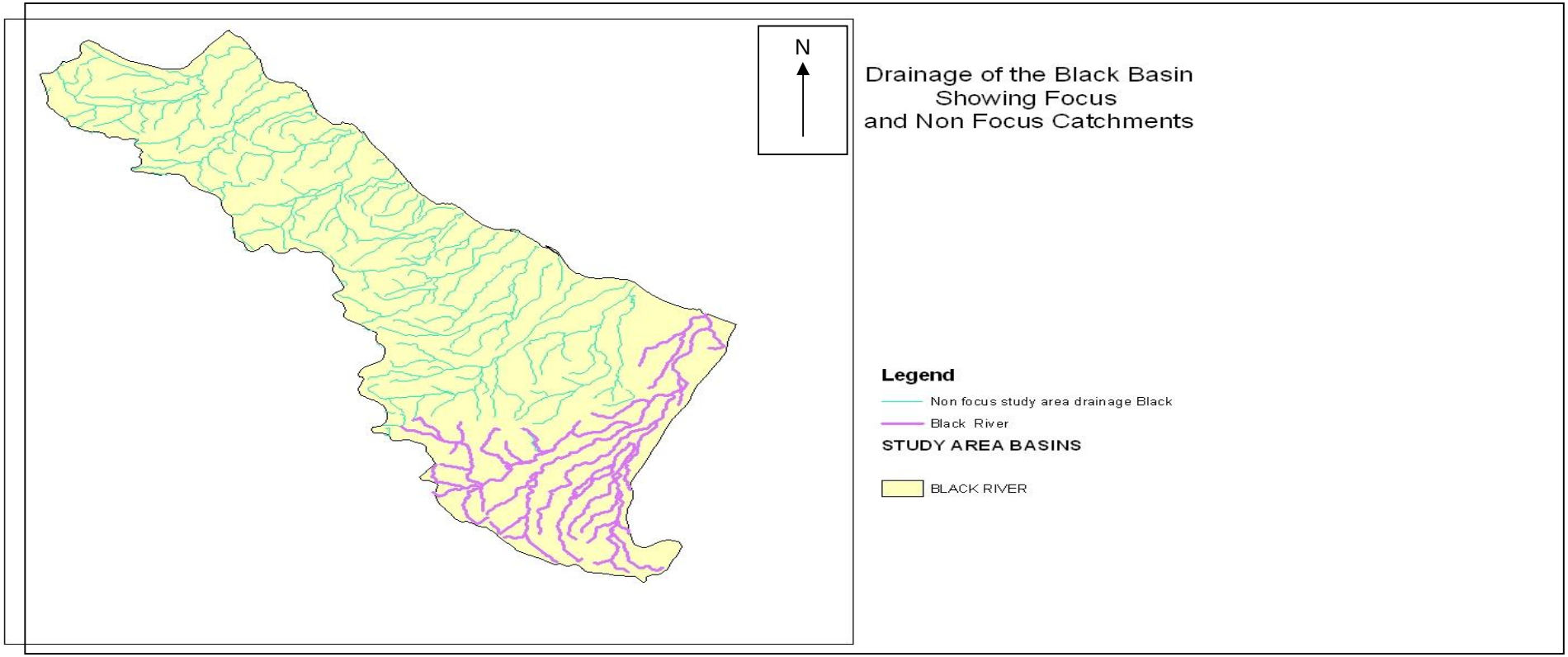
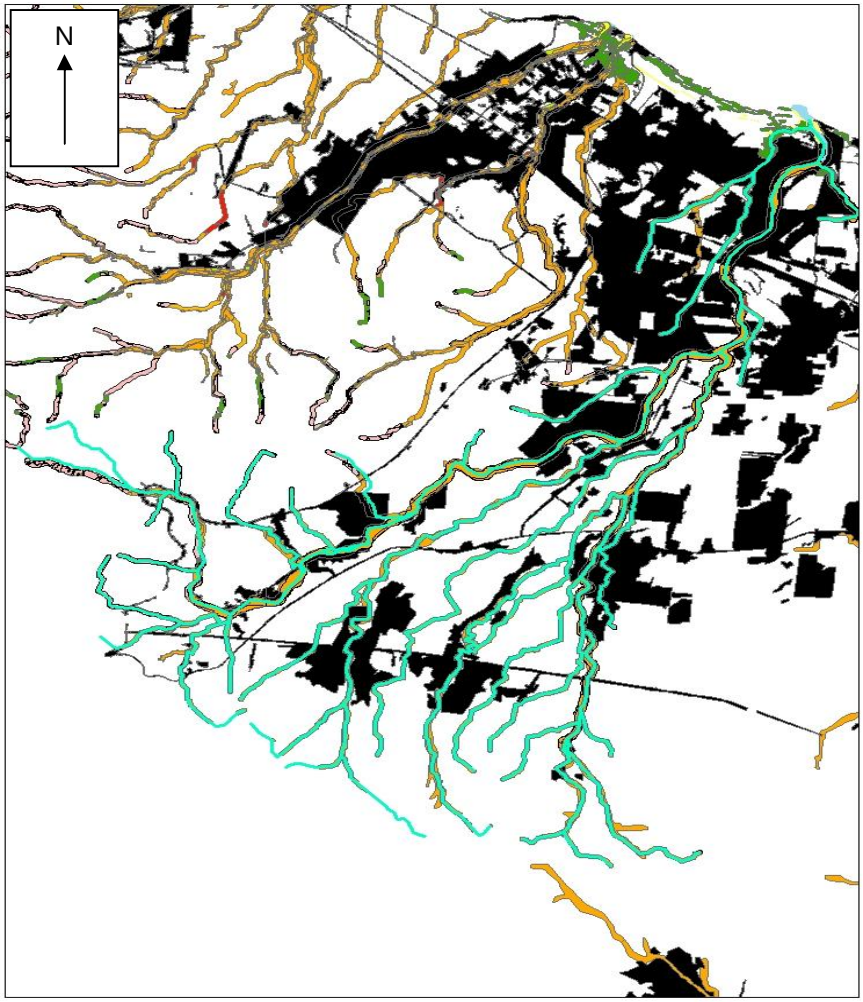


Figure 23: Riparian Systems of the Black River

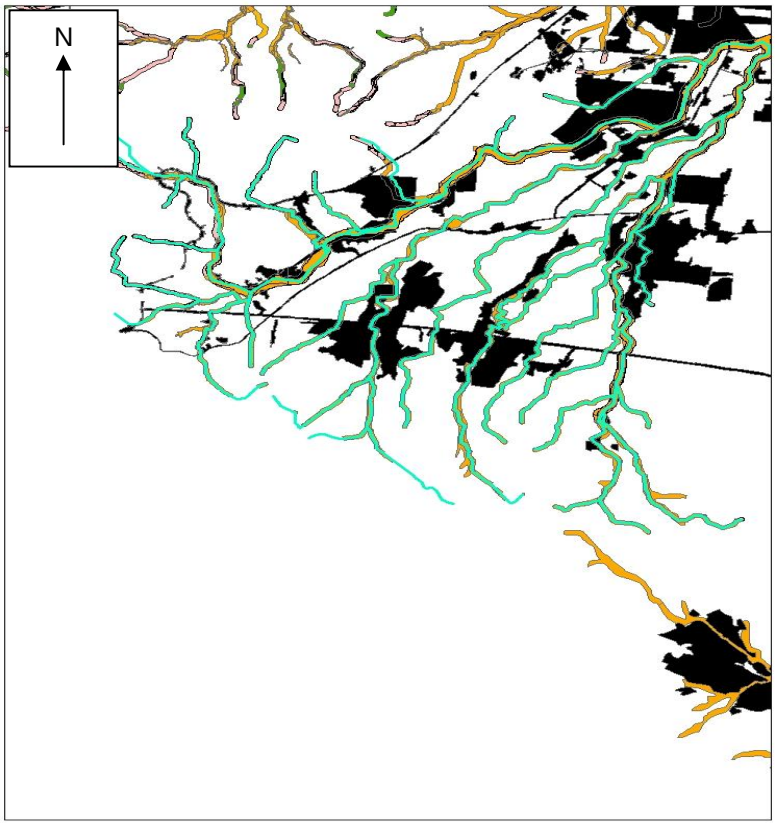


GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.8 The Riparian Systems of the Upper Reaches of the Black River (Source to Alice/Black Rivers Confluence)

The riparian condition within the upper reaches of the Black River is relatively good. The majority of the 1st and 2nd order streams in the upper reaches have maintained a natural riparian condition, with little non-remnant vegetation. Significant areas adjacent to 3rd/4th order streams have been cleared. However, in most cases these only just intersect within the recommended 150m buffer zone. Within the 1st and 2nd order streams of the area there are areas with little to no buffering capacity. Adjacent land usage for the majority of the upper reaches is rural residential with agriculture and grazing. The upper reaches of the Black River catchment enter into the Wet Tropics Bio Region. This is a unique vegetation community and provides habitat for the extremely rare Gulbaru Gecko (*Phyllurus gulbaru)*, which has only been recorded from this catchment.

Figure 24: The Riparian Systems of the Upper Reaches of the Black River (Source to Alice / Black Rivers Confluence

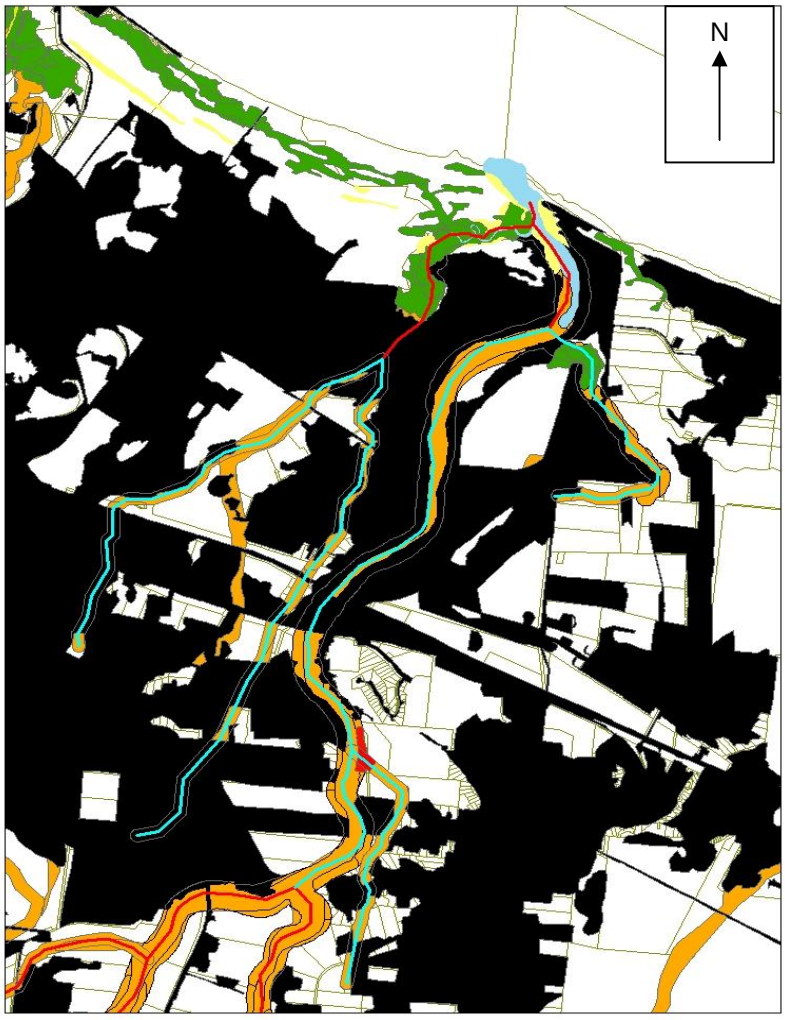


GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.9 The Riparian Systems of the Mid Reaches of the Black River (Alice / Black Rivers Confluence to Estuarine Areas)

The Mid reaches of the Black River catchment are highly modified with significant reaches in both 1st /2nd order streams and 3rd/4th order rivers having little to no remnant riparian vegetation. These include significant stretches of 3rd/4th order stream directly adjacent to areas that are used for cattle grazing and industrial use areas.

Figure 25: Riparian Systems of the Mid Reaches of the Black River (Alice/Black Rivers Confluence to Estuarine Areas



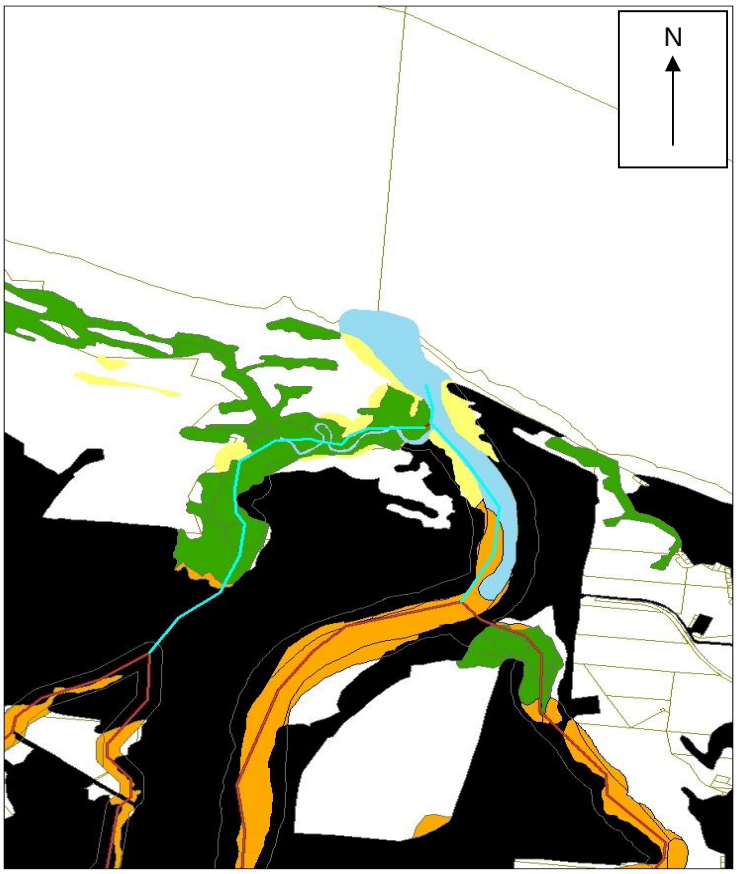
GREEN	Estuarine/mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.10 Estuarine Riparian Systems of the Black River

The estuarine riparian vegetation of the Black River is significantly modified with no recognised riparian vegetation seen directly adjacent to 3rd/4th order streams. There are significant stretches of sand dune vegetation that are currently providing decent riparian vegetation values near the mouth of the Black River. However in the Black River industrial areas there is little to no recognised riparian vegetation present.

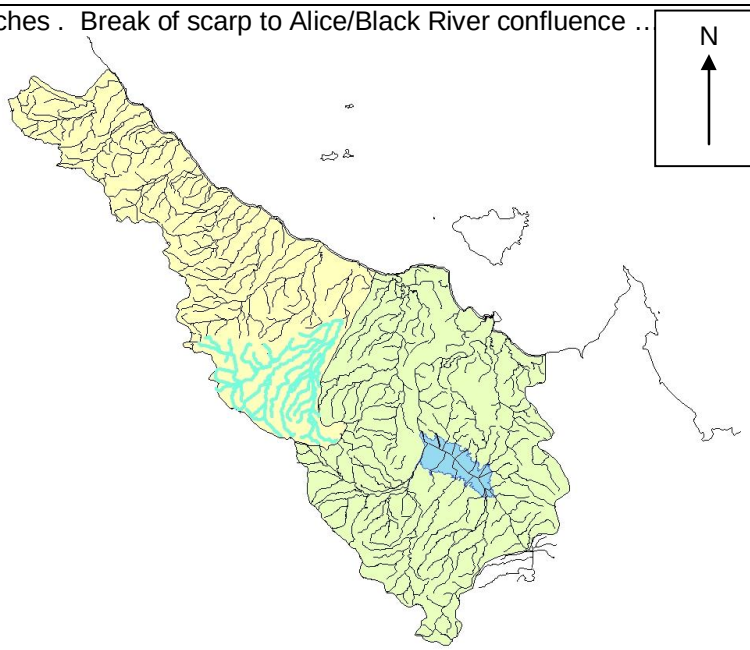
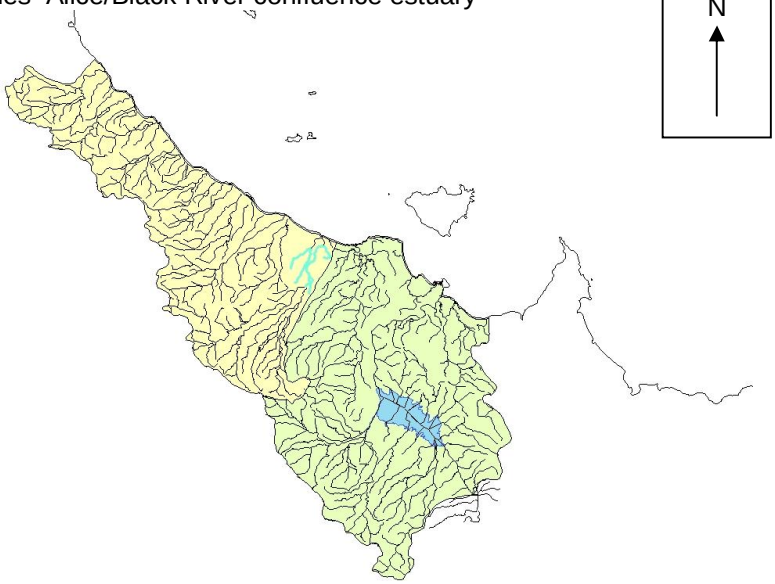
The lower Black River catchment is highly modified with significant reaches in both 1st /2nd order streams and 3rd/4th order rivers having little to no remnant riparian vegetation. These include significant stretches of 3rd/4th order stream directly adjacent to areas that are used for cattle grazing and industrial use areas. It also includes a system of 1st and 2nd order streams within the Black River industrial area with no recognised riparian vegetation

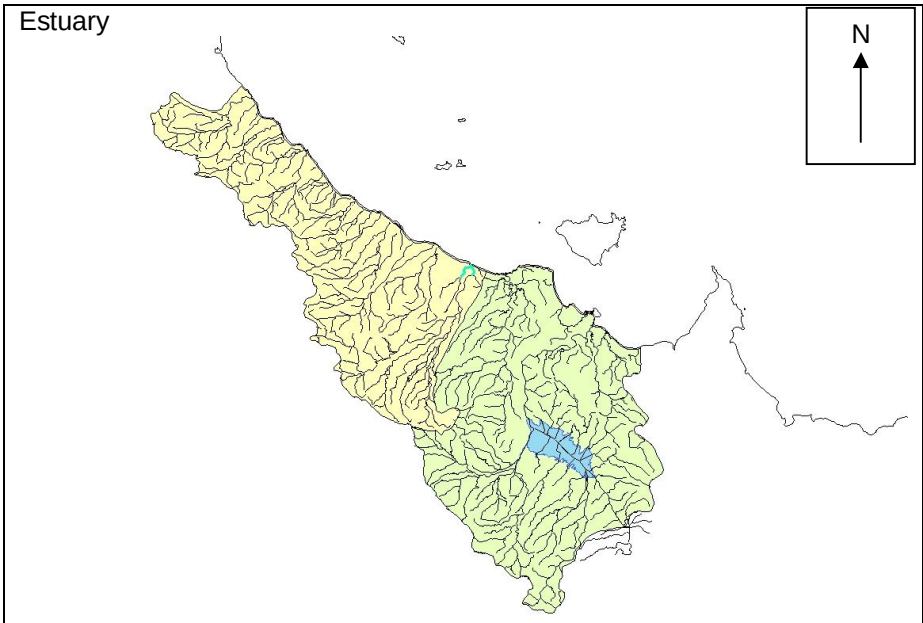
Figure 26: Estuarine Riparian Systems of the Black River



GREEN	Estuarine / mangrove systems.
YELLOW	Sand dune wetlands and associated riparian zones.
ORANGE	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on alluvial plains.
PINK	Vegetation associated with creek lines/river systems, wetlands, and associated riparian vegetation on granitic rock.
BLACK	Areas of non-remnant vegetation.
BLUE	The creek system under analysis.

3.1.10.1 *SUMMARY OF THE RIPARIAN CONDITION OF THE BLACK RIVER CATCHMENT.*

General	Highly varied
Upper Reaches . Break of scarp to Alice/Black River confluence .. 	Pristine condition with little to no incursion into the recommended riparian zone.
Mid Reaches Alice/Black River confluence estuary 	Poor condition with minimal natural riparian vegetation remaining on the high, mid, or low banks, and with substantial modification of all overflow channels

Estuary 	Poor to moderate condition with a high degree of modification in places. This is somewhat offset by the relatively good riparian condition at the mouth.

4 DISCUSSION AND RECOMMENDATIONS

In general, the riparian zones of the upper catchments are in good to excellent condition. In these catchments, the quality of the riparian zone improves with distance from the limit of urban development.

The middle reaches of all catchments are listed as poor to very poor, with the quality of the riparian zone dependent on the history of urban development adjacent to the river system. In these areas, the deterioration of the riparian zones is closely linked to the impact of residential and/or industrial development, and the lack of enforcement of riparian clearance regulations. This is particularly noticeable in Ross River where riparian zones have been removed, or significantly reduced, along the western bank of the river from the mouth to the southern banks of Lake Ross, and where large areas have also been removed from the eastern bank in the vicinity of major residential developments

The riparian zones of the lower catchments (excluding Ross Creek) are generally noted as being in good to very good condition. Most mangrove systems are still relatively intact, with most marine zones now protected under various Acts and Regulations.

Heavily modified riparian zones of the lower catchments are generally restricted to creeks and rivers that have a long association with the early development of Townsville. For example:

- Ross Creek was artificially separated from Ross River for flood mitigation purposes. Previously an anabranch of Ross River, Ross Creek now functions as a highly modified tidal estuary. Modification along both sides of the lower creek date back to the late 1800s when banks were stabilised and breakwaters installed for Port activities. Tidal creeks were used as authorised and unauthorised dumping grounds from around the same period. Low lying areas have been infilled, both legally and illegally, to provide industrial land close to the Port. More recently, large areas further along the creek were reclaimed using waste material from cyclone Althea. Hence, the riparian zone has been modified to the extent that the majority of the mangrove systems are regrowth forests with only small, isolated pockets of remnant vegetation remaining along a small area adjacent to the Causeway.
- The western side of the estuarine section of Ross River has been modified for maritime purposes. Large areas of mangrove vegetation have been removed along this bank, restricting riparian zones to small, disconnected pockets.

The exception is the Black River where the removal of the riparian zone in the middle and lower reaches is the combined result of sand extraction, over extraction of groundwaters, and the deliberate removal of riparian buffer zones abutting private properties.

A summary of each catchment is given in Section 4.2 *Summary Table.*

4.1 RECOMMENDATIONS

Ideally, native riparian vegetation should be retained and it is strongly recommended that future development must conform to the requirements of the Nature Conservation Act (1992), the Vegetation Management Act (1994), and all Regulations and Guidelines relevant to the retention of riparian zones.

Consideration should be given to revegetating areas that have been cleared especially where there is a particular problem such as streambank erosion. This is particularly relevant to the Black River

where the clearance of the natural vegetation has extended to the channel way and the inner banks of the stream channel, resulting in significant bank erosion and morphological alteration of the river channel.

Where streambank erosion is extreme (e.g. Black River), it is recommended that consideration be given to restabilising the banks by rehabilitating the areas adjacent to the banks in a manner that resembles the original geomorphology. This would require a degree of stream bank modification together with the reinstallation of a series of swales along old river channels, followed by a revegetation programme. Initial revegetation of small drainage lines may be beneficial in this instance.

Revegetation programmes should consider a deliberate programme of overplanting. Riparian vegetation is closely balanced to adjacent ecosystems in undisturbed catchments. Disturbed areas may require a programme of positive intervention to advance the rehabilitation process.

Where riparian rehabilitation is specifically designed to improve water quality, the revegetation programme should be designed to suit that purpose. For example, the revegetation of drainage channels through paddocks or through industrial areas should be given initial attention.

It is anticipated that the rehabilitation of riparian zones in the Townsville/Thuringowa region will require several revegetation techniques dependent on the nature of the site, the type of disturbance present, and the ultimate aim of the rehabilitation programme. Site-specific methodologies should be developed that are relevant to each situation.

The distributaries of Stuart Creek remain the only uninterrupted flow pathways between the marine waters of Cleveland Bay and the fresh waters of the upper river systems. All other channels have been cut by dams, weirs, or other infrastructure, removing the opportunity for catadromous and anadromous fishes to move easily between the fresh and marine water bodies for breeding purposes. It is strongly recommended that every effort should be made to retain this resource, and to rehabilitate degraded sections of the river system where this is threatening the free movement of these fishes.

4.2 SUMMARY TABLE

Catchment	Focus Area	Summary of Conditions	Cause of Condition	Major Impacts / Threats / Values
Ross River	Mt Stuart Upper Reaches	**Moderate-Good**	▪ Small first order creeks within the Mt Stuart Training Area have poor vegetation cover, erodible and dispersive soils, and may also traverse through old munitions dumps	**Major Impact:** Water quality from erosion from old munitions dumps. **Major Threat:** **Values:**
	Upper Reaches of Ross River, East of Lake Ross	**Poor-Moderate**	▪ Large areas adjacent to major drainage lines have no remnant riparian vegetation. ▪ Catchment soils are highly dispersive and erodible.	**Major Impact:** Bank stability and sediment runoff. Annual burnoffs **Major Threat:** Erosion and sediment control. **Values:** Provides habitat for numerous rare, and threatened species
	Lake Ross	**Poor-moderate**	▪ Highly modified system with no remnant vegetation present within the whole of the system. ▪ **However**, within this zone there is a modified zone with significant buffering capacity and habitat value.	**Major Impact:** Weeds **Major Threat:** Weed, Agriculture and Fire Management. Pathogen and nutrient impacts on Lake Ross Water Quality[1] **Values:** Townsville / Thuringowa potable water storage area
	Upper reaches of Ross River, west of Lake Ross	**Moderate-Good**	▪ Relatively good condition. ▪ Majority of the inflowing rivers have adequate vegetation buffer zones. ▪ Major impact within this zone is quarrying activities	**Major Impact:** Turbidity and bank erosion from quarrying activities. **Major Threat:** Overland flows and/or erosion could diminish water quality and bank stability within industrial / extractive industries areas within this catchment. **Values:** Protection for Townsville / Thuringowa potable water supply
	Ross River, middle reaches (Dam wall to Black Weir)	**Varied: Moderate to Very Poor**	**Negative Causes:** ▪ Residential development. ▪ Lack of enforcement of riparian clearance regulations. ▪ Annual burn-off. **Positive Causes:**	**Major Impact:** Residential development has had a major impact on the western bank of Ross River from Apex Park to the Dam. It is estimated that almost 90% of the original vegetation has been removed from this area. Between Apex Park and the Black Weir a significant proportion of the native vegetation

[1] NQ Water are currently developing a Lake Ross Storage Area Management Plan

Catchment	Focus Area	Summary of Conditions	Cause of Condition	Major Impacts / Threats / Values
			▪ "Special Usage" Zone within Army Reserve. ▪ Well managed park lands between Apex Park and Loam Island.	remains intact, and where modified for social access, the native vegetation has been retained. Bank clearance associated with residential development between the Water Treatment Plant and Black Weir. **Major Threat:** Annual Army burn-off. It is recommended that investigations be undertaken into the most suitable type of burn-off for this vegetation species. Continued encroachment along the western bank of Ross River for social usage. Sell-off of additional land along the eastern bank of Ross River with little or no enforcement of riparian and buffer zone protection. **Values:** "Special Usage" within the Army Reserve offers a high degree of protection to the remaining riparian zone along this stretch of the river. Social usage of the permanent status of the impounded waters.
	Ross River, middle reaches (Black Weir to Aplins)	**Poor**	▪ Heavily modified for residential development	**Major Impact:** Residential development **Major Threat:** Algal blooms from nutrient input. Aquatic weed proliferation **Values:** Aesthetic. Social usage of the permanent status of the impounded waters.
	Ross River, lower reach (Aplins Weir to Cleveland Bay)	**Poor to Good**	▪ Riparian condition ranges from poor to excellent. ▪ Area between Townsville Golf Course and Rooneys Bridge is in particularly poor condition and is recommended for consideration as an area of prime focus	**Major Impact:** Commercial and Residential Development Interruption to catadromous and anadromous fish movements by the construction of inaccessible weirs. **Major Threat:** Continued removal of riparian vegetation for commercial and residential development. **Values:** Social use. Significant habitat for juvenile marine species.

Catchment	Focus Area	Summary of Conditions	Cause of Condition	Major Impacts / Threats / Values
Ross Creek	Ross Creek	**Poor**	▪ Modified native vegetation remaining above and adjacent to, Woolcock Street crossing. Minor native riparian vegetation remaining below the crossing with a sharp decrease, to total removal of native vegetation, with proximity to the Port.	**Major Impact:** Adjacent land uses are zoned commercial industrial or residential. Interruption to catadromous and anadromous fish movements by the construction of a barrage blocking entry to and from Ross River. **Major Threat:** Disturbance of old dump sites adjacent to the riparian zone. Removal for aesthetic purposes. **Values:** Remaining riparian vegetation consists almost totally of mangrove species noted for their ability to filter pollutants from the waters.
Stuart Creek	Upper Catchment	**Good**	▪ Little clearing within the designated buffer zone from the high bank maintaining natural riparian values.	**Major Impact:** Nil **Major Threat:** Future residential and/or industrial / agricultural development. **Values:** Relatively unimpacted
	Mid Catchment	**Poor**	▪ Significant clearing has occurred within the designated buffer zone, with major impacts coming from quarrying and industrial activities within these areas.	**Major Impact:** Overland flows and/or erosion could diminish water quality and bank stability within industrial / extractive industries areas within this catchment. **Major Threat:** Industrial expansion. Leaching from industrial areas. **Values:** Transition zone between a relatively unimpacted upper catchment and a highly productive estuarine system.
	Lower Catchment	**Moderate- Good**	▪ Lower reaches have extensive estuarine riparian zones.	**Major Impact:** Industrial activity in the middle catchment. **Major Threat:** Industrial expansion. Groundwater contamination from industrial activities in the middle catchment. **Values:** Highly productive estuarine system. Last remaining unnterrupted opportunity for catadromous and anadromous fishes to move freely between the fresh water sections of the river and the marine waters of Cleveland Bay.

Catchment	Focus Area	Summary of Conditions	Cause of Condition	Major Impacts / Threats / Values
Bohle River	Upper Reaches	**Poor-Moderate**	▪ Large areas adjacent to 1st and 2nd order streams with little to no buffering capacity.	**Major Impact:** Upper reaches are highly infested with weeds that provide little to no riparian value. Highly erodible and dispersive soils within the region could mean there is poor bank stability **Major Threat:** Urban and industrial expansion. Over extraction of groundwaters from surrounding areas. Uncontrolled stream bank access. **Values:** Currently limited. Requires riparian rehabilitation for adequate protection of the Bohle Fish Habitat Area.
	Mid Reaches	**Poor- Moderate**	▪ Highly modified with significant reaches having little to no remnant riparian vegetation, including areas adjacent to grazing lands. ▪ No recognisable riparian vegetation units buffering the Bohle Industrial Area ▪ Significant para grass infestations do occur within these areas, offering some bank stability and habitat protection.	**Major Impact:** (1) Bank destabilisation and destruction of riparian zone. (2) Intermittent interruption of catadromous and anadromous fish movement by unofficial road corridors, sand extraction, and bank realignment. **Major Threat:** Uncontrolled bank access. Careless industrial development. Unaudited, or poorly audited, environmental practices. Damage to the Bohle Fish Habitat Area. **Values:** Currently limited. Major protection to the waterbody is through the expansion of the weed, Para Grass.
	Lower Reaches	**Poor-Good**	▪ Highly variable area including the Bohle / Louisa Creek Industrial Areas which have zones of little to no remnant or natural riparian vegetation remaining. ▪ Other areas in the lower reaches of the Bohle and Town Common area have well established riparian features of national significance.	**Major Impact:** Adjacent land use, including commercial and industrial.areas. **Major Threat:** Industrial and urban expansion. **Values:** Supports Bohle Fish Habitat Area
Black River	Upper Reaches (Source to confluence of Alice and Black Rivers	**Moderate-Good**	▪ The majority of the areas is in good condition with minimal incursion into the recommended buffer zone.	**Major Impact:** No major impacts. Minor impacts from straying stock. Some grazing at the bottom of the range. **Major Threat:** Poorly planned tourism activities. Poorly managed farm management practices. **Values:** Habitat for a number of rare, threatened

Catchment	Focus Area	Summary of Conditions	Cause of Condition	Major Impacts / Threats / Values
				and endangered species, including the Gulbaru Gecko (*Phyllurus gulbaru).*
	Mid Reaches Confluence of Alice and Black Rivers to Black River Bridge)	**Poor**	▪ Adjacent areas have been highly modified with significant reaches in both 1st /2nd order streams and 3rd/4th order rivers having little to no remnant riparian vegetation. ▪ Significant stretches directly adjacent to the rivers are currently used for cattle grazing and small crops farming.	**Major Impact:** Rural urban expansion. Borefield extraction. Sand extraction. **Major Threat:** Continued borefield extraction. **Values:** Limited without considerable rehabilitation..
	Lower Reaches Black River Bridge to Black River mouth)	**Poor-Moderate**	▪ Significant areas adjacent to 1st/2nd and 3rd/4th streams cleared to the high bank	**Major Impact:** Poor bank stability and encroachment by industrial areas. **Major Threat:** Groundwater harvesting. Sand mining. Residential development. Riparian Rights. **Values:** Southern bank still has pockets of remnant vegetation.

Appendix 1
Regional Ecosystems and Vegetation Types
(a) Ross River Basin
(b) Black River Basin

Appendix 1(a): Regional Ecosystems and Riparian Vegetation Types within The Ross River Basin

Landzone	Regional Ecosystem	Description
1	11.1.1	*Sporobolus virginicus* grassland on marine clay plains
1	11.1.2	Samphire forbland on marine clay plains
1	11.1.4	Mangrove forest/woodland on marine clay plains
2	11.2.1	*Eucalyptus platyphylla, Corymbia tessellaris* woodland on sandy coastal plains
2	11.2.2	Complex of *Spinifex sericeus, Ipomoea pes-caprae* and *Casuarina equisetifolia* grassland and herbland on foredunes
2	11.2.3 / 11.2.5	Microphyll vine forest (beach scrub) on sandy beach ridges/*Corymbia-Melaleuca* woodland complex of beach ridges and swales
2	11.2.4	Lagoons in swales
2	11.2.5	*Corymbia-Melaleuca* woodland complex of beach ridges and swales
3	11.3.12	*Melaleuca viridiflora* woodland on alluvial plains
3	11.3.25	*Eucalyptus tereticornis* or *E camaldulensis* woodland fringing drainage lines
3	11.3.27	Freshwater wetlands
3	11.3.30	*Eucalyptus crebra, Corymbia dallachiana* woodland on alluvial plains
3	11.3.31	*Ophiuros exaltatus, Dichanthium* spp. grassland on alluvial plains
3	11.3.35	*Eucalyptus platyphylla, Corymbia clarksoniana* woodland on alluvial plains
3	11.3.4	*Eucalyptus tereticornis* and/or *Eucalyptus* spp. tall woodland on alluvial plains
3	11.3.7	*Corymbia* spp woodland on alluvial plains. Sandy soils
3	11.3.9	*Eucalyptus platyphylla, Corymbia* spp. woodland on alluvial plains
3	9.3.1	*Eucalyptus camaldulensis or E.tereticornis* ± *Casuarina cunninghamiana* ± *Melaleuca* spp fringing woodland on channels and levees. Generally on eastern flowing rivers
11	11.11.15	*Eucalyptus crebra* woodland on deformed and metamorphosed sediments and interbedded volcanics. Undulating plains
11	9.11.4	Mixed open forest including *Eucalyptus portuensis, E.crebra* (sens.lat), *Corymbia clarksoniana, C.citriodora* on shallow soils on metamorphic hills and ranges
12	11.12.13	*Eucalyptus crebra, Corymbia* spp., *E.acmenoides* woodland on igneous rocks. Coastal hills
12	11.12.18 / 9.12.34	Montane shrubland on igneous rocks. Mountain tops/semi-evergreen vine thicket with *Araucaria cunninghamii* on steep hills on acid and intermediate volcanic rocks
12	11.12.4	Semi-evergreen vine thicket and microphyll vine forest on igneous rocks
12	11.12.9	*Eucalyptus platyphylla* woodland on igneous rocks
12	7.12.21	*Eucalyptus grandis* open forest to woodland, or *Corymbia intermedia, E.pellita*, and *E.grandis*, open forest to woodland (or vine forest with these species as emergents), on granites and rhyolites
12	7.12.25	*Eucalyptus cloeziana* woodland to open forest on granite and rhyolite
12	7.12.29	*Corymbia intermedia* and/or *Lophostemon suaveolens* open forest to woodland ± areas of *Allocasuarina littoralis* and *A.torulosa*, of uplands, on granite and rhyolite
12	7.12.61	*Eucalyptus tereticornis* ± *E.granitica* woodland to open forest of moist and dry foothills and uplands on granite and rhyolite
12	9.12.1	*Eucalyptus crebra* (sens lat.) ± *Corymbia erythrophloia* ± *C.*dallachiana woodland on intermediate volcanic rocks
12	9.12.19	*Eucalyptus crebra (sens.lat.), E.shirleyi, E acmenoides, E.exserta* and *Corymbia citriodora* woodland on shallow soils on acid volcanic hills

12	9.12.2	Open forest commonly including *Eucalyptus portuensis, E.crebra (sens.lat.), Corymbia clarksoniana, C.citriodora* on steep hills and ranges on acid and intermediate volcanics close to Wet Tropics boundary
12	9.12.22	*Eucalyptus drepanophylla, Corymbia dallachiana, E. platyphylla* ± *C clarksoniana* ± *E. acmenoides* ± *C. tessellaris* ± *E. tereticornis* open woodland on steep rugged acid volcanic ranges. Close to Wet Tropics boundary
12	9.12.34	Semi-evergreen vine thicket with *Araucaria cunninghamii* on steep hills on acid and intermediate volcanic rocks
12	9.12.39	Melaleuca viridiflora, *Lophostemon suaveolens, Eucalyptus granitica, E. tereticornis, Corymbia citriodora and E.exserta* mixed species woodland on uplands

Appendix 1(b): Regional Ecosystems and Riparian Vegetation Types within The Black River Basin

Landzone	Regional Ecosystem	Description
1	11.1.2	Samphire forbland on marine clay plains
1	11.1.4	Mangrove forest/woodland on marine clay plains
1	7.1.1	Mangrove closed forest to open shrubland of areas subject to regular tidal inundation
1	7.1.2	*Sporobolus virginicus* grassland, samphire open forbland to sparse forbland, and bare saltpans, on plains adjacent to mangroves
1	7.1.5	*Melaleuca viridiflora* or *Melaleuca* spp. ± *Acacia* spp. ± mangrove spp. shrubland, open woodland and open forest on plains adjacent to mangroves
2	11.2.2	Complex of *Spinifex sericeus*, *Ipomoea pes-caprae* and *Casuarina equisetifolia* grassland and herbland on foredunes
2	11.2.3	Microphyll vine forest (beach scrub) on sandy beach ridges
2	11.2.5	*Corymbia-Melaleuca* woodland complex of beach ridges and swales
2	7.2.2	Notophyll to microphyll vine forest on beach ridges and sand plains of beach origin
2	7.2.3	*Corymbia tessellaris* and/or *Acacia crassicarpa* and/or *C.intermedia* and/or *C.clarksoniana* closed forest to woodland, of beach ridges, predominantly of Holocene age
2	7.2.4	*Eucalyptus* spp. (often *E.pellita* or *Corymbia intermedia*) open forest and/or *Lophostemon suav*eolens open forest on swampy sand plains of beach origin, and Pleistocene beach ridges
2	7.2.7	*Casuarina equisetifolia* ± *Corymbia tessellaris* open forest ± groved vine forest shrublands of the beach strand and foredune
2	7.2.8	*Melaleuca leucadendra* open forest to woodland on sands of beach origin
3	11.3.12	*Melaleuca viridiflora* woodland on alluvial plains
3	11.3.25	*Eucalyptus tereticornis* or *E.camaldulens*is woodland fringing drainage lines
3	11.3.30	*Eucalyptus crebra, Corymbia dallachiana* woodland on alluvial plains
3	11.3.31	*Ophiuros exaltatus, Dichanthium* spp grassland on alluvial plains
3	11.3.35	*Eucalyptus platyphylla, Corymbia clarksoniana* woodland on alluvial plains
3	7.3.10	Simple to complex mesophyll to notophyll vine forest on moderate to poorly drained alluvial plains of moderate fertility
3	7.3.12	Mixed eucalypt open forest to woodland, dominated by *Eucalyptus tereticornis* and *Corymbia tessellaris* ± *Melaleuca dealbata*, (or vine forest with these species as emergents), on alluvial plains of lowlands
3	7.3.16	Eucalyptus platyphylla woodland to open forest on alluvial plains

3	7.3.19	*Corymbia intermedia* or *C.tessellaris* ± *Eucalyptus tereticornis* open forest (or vine forest with these species as emergents), on well drained alluvium
3	7.3.20	*Corymbia intermedia* (pink bloodwood) and *Syncarpia glomulifera* (turpentine), or *C.intermedia* and *Eucalyptus pellita* (red stringybark), or *Syncarpia glomulifera* and Allocasuarina (sheoak) spp., or *E. cloeziana* (Gympie messmate), or *C.torelliana* (cadaghi) open forests (or vine forests with these species as emergents). Moderate to steep alluvial fans at the base of ranges.
3	7.3.21	*Eucalyptus portuensis* ± *Corymbia intermedia* open forest to woodland on alluvium
3	7.3.23	Simple to complex semi-deciduous notophyll to mesophyll vine forest on lowland alluvium
3	7.3.25	*Melaleuca leucadendra* ± vine forest species, open to closed forest, on alluvium fringing streams
3	7.3.26	*Casuarina cunninghamiana* woodland to open forest on alluvium fringing streams
3	7.3.28	Rivers and streams including riparian herbfield and shrubland on river and stream bed alluvium, and rock within stream beds
3	7.3.29	Sedgelands and grasslands of permanently and semi-permanently inundated swamps, including areas of open water
3	7.3.32	*Imperata cylindrica* and/or *Sorghum nitidum* and/or *Mnesithea rottboellioides* and/or *Themeda triandra* closed tussock grassland on alluvial plains
3	7.3.34	*Melaleuca* spp. aff. *viridiflora* open to closed forest on broad swampy drainage lines of alluvial plains
3	7.3.35	*Acacia mangium* and/or *A.celsa* and/or *A.polystachya* closed forest on alluvial plains
3	7.3.40	*Eucalyptus tereticornis* medium to tall open forest on well drained alluvial plains of lowlands
3	7.3.43	*Eucalyptus tereticornis* open forest to woodland, on uplands on well drained alluvium
3	7.3.45	*Corymbia clarksoniana* ± *C.tessellaris* ± *Eucalyptus drepanophylla* open forest to open woodland on alluvial plains
3	7.3.46	*Lophostemon suaveolens* open forest to woodland on alluvial plains
3	7.3.49	Notophyll vine forest on rubble terraces of streams
3	7.3.5	*Melaleuca quinquenervia* and/or *Melaleuca cajuputi* closed forest to shrubland on poorly drained alluvial plains
3	7.3.50	*Melaleuca fluviatilis* ± vine forest species, open to closed forest, on alluvium fringing streams
3	7.3.6	*Melaleuca dealbata* ± *Melaleuca* leucadendra open forest on poorly drained alluvial plains
3	7.3.8	*Melaleuca viridiflora* ± *Eucalyptus spp.* ± *Lophostemon suaveolens* open forest to open woodland on alluvial plains
3	7.3.9	*Corymbia tessellaris, Acacia spp., Melaleuca spp*., open forest on poorly drained alluvial plains
3	9.3.1	*Eucalyptus camaldulensis* or *E tereticornis* ± *Casuarina cunninghamiana* ± *Melaleuca* spp. fringing woodland on channels and levees. Generally on eastern flowing rivers
12	11.12.13	*Eucalyptus crebra, Corymbia spp.*, *E.acmenoides* woodland on igneous rocks. Coastal hills
12	11.12.4	Semi-evergreen vine thicket and microphyll vine forest on igneous rocks
12	11.12.9	Eucalyptus shirleyi woodland on igneous rocks

12	7.12.1	Simple to complex mesophyll to notophyll vine forest on moderately to poorly drained granites and rhyolites of moderate fertility of the moist and wet lowlands, foothills and uplands
12	7.12.10	Notophyll vine forest with emergent *Araucaria cunninghamii* on moist and dry granite foothills and uplands
12	7.12.11	Simple notophyll vine forest and notophyll semi-evergreen vine forest of rocky areas and talus, of moist granite and rhyolite foothills and uplands
12	7.12.16	Simple to complex notophyll vine forest of cloudy wet and moist uplands and highlands on granites and rhyolites, including small areas of Araucaria bidwillii
12	7.12.17	*Corymbia torelliana* open forest usually with a well developed simple notophyll vine forest element, on granites and rhyolites
12	7.12.21	*Eucalyptus grandis* open forest to woodland, or *Corymbia intermedia, E. pellita*, and *E. grandis*, open forest to woodland (or vine forest with these species as emergents), on granites and rhyolites
12	7.12.22	*Eucalyptus resinifera* ± *Eucalyptus portuensis* ± *Syncarpia glomulifera* tall open forest to tall woodland (or vine forest with these species as emergents), on moist to wet granite and rhyolite uplands and highlands
12	7.12.23	Corymbia intermedia and/or C.tessellaris ± Eucalyptus tereticornis medium to tall open forest to woodland (or vine forest with these species as emergents), on coastal granite and rhyolite headlands and near-coastal foothills
12	7.12.24	*Eucalyptus portuensis* and *Corymbia intermedia* open forest to woodland (or vine forest with *E. portuensis* and *C.intermedia* emergents), on wet and moist foothills and uplands on granite and rhyolite
12	7.12.25	*Eucalyptus cloeziana* woodland to open forest on granite and rhyolite
12	7.12.26	*Syncarpia glomulifera* ± *Corymbia intermedia* ± *Allocasuarina* spp. closed forest to woodland, or *Lophostemon suaveolens, Allocasuarina littoralis, C.intermedia* shrubland, (or vine forest with these species as emergents), on exposed ridgelines or steep rock
12	7.12.27	*Eucalyptus reducta* open forest to woodland on granite and rhyolite
12	7.12.28	*Eucalyptus platyphylla* ± *E. drepanophylla* ± *Corymbia spp* open woodland to open forest on granite and rhyolite
12	7.12.29	*Corymbia intermedia* and/or *Lophostemon suaveolens* open forest to woodland ± areas of *Allocasuarina littoralis* and *A.torulosa*, of uplands, on granite and rhyolite
12	7.12.34	*Eucalyptus portuensis* and/or *E.drepanophylla, ± Corymbia intermedia* ± *C. citriodora, ± E. granitica*, open woodland to open forest on dry uplands on granite
12	7.12.37	Rock pavements and seepage areas of wet lowlands, uplands and highlands of the eastern escarpment and central range (excluding high granite areas of Hinchinbrook Island and Bishops Peak) on granite and rhyolite, with Allocasuarina (sheoak) spp. shrublands and/or sedgelands
12	7.12.38	Deciduous microphyll vine forest and/or blue-green algae-covered granite and rhyolite boulderfields
12	7.12.40	Closed vineland of wind disturbed vine forest, on granites and rhyolites
12	7.12.48	Wind-sheared notophyll vine forest of exposed granite and rhyolite ridge-crests and steep slopes
12	7.12.52	*Eucalyptus resinifera, Corymbia intermedia, Allocasuarina littoralis, Syncarpia glomulifera, E. drepanophylla* ± *E. reducta* woodland, of dry to moist hills on granite and rhyolite
12	7.12.53	*Corymbia clarksoniana* ± *C. tessellaris, ± Eucalyptus drepanophylla* ± *C. intermedia* open forest to woodland, or *E.drepanophylla* woodland, of moist to dry lowlands, foothills and uplands on granite and rhyolite

12	7.12.60	*Melaleuca viridiflora* ± *Corymbia clarksoniana* ± *Eucalyptus platyphylla* woodland to open forest, on granite and rhyolite
12	7.12.61	*Eucalyptus tereticornis* ± *E. granitica* woodland to open forest of moist and dry foothills and uplands on granite and rhyolite
12	7.12.65	Rock pavements or areas of skeletal soil, on granite and rhyolite, mostly of dry western or southern areas, often with shrublands to closed forests of *Acacia* spp (wattles) and/or *Lophostemon suaveolens* (swamp mahogany) and/or *Allocasuarina littoralis* (black she oak) and/or *Eucalyptus lockyeri* subspecies *exuta*
12	7.12.66	Exposed rocky slopes on granite and rhyolite, with *Lophostemon* confertus low shrubland or low to medium closed forest
12	7.12.69	*Eucalyptus drepanophylla* and/or *E.granitica* ± *Corymbia clarksoniana* ± *C. erythrophloia* woodland, or dry uplands on granite and rhyolite
12	7.12.7	Simple to complex microphyll to notophyll vine forest, often with *Agathis robusta or A. microstachya*, on granites and rhyolites of moist foothills and uplands
12	7.12.9	*Acacia celsa* open to closed forest on granites and rhyolites
12	9.12.2	Open forest commonly including *Eucalyptus portuensis, E crebra* (sens. lat.), *Corymbia clarksoniana, C. citriodora* on steep hills and ranges on acid and intermediate volcanics close to Wet Tropics boundary
12	9.12.22	*Eucalyptus drepanophylla, Corymbia dallachiana, E. platyphylla* ± *C clarksoniana* ± *E. acmenoides* ± *C. tessellaris* ± *E. tereticornis* open woodland on steep rugged acid volcanic ranges. Close to Wet Tropics boundary
12	9.12.22 / 9.12.34	*Eucalyptus drepanophylla, Corymbia dallachiana, E. platyphylla* ± *C clarksoniana* ± *E. acmenoides* ± *C.tessellaris* ± *E.tereticornis* open woodland on steep rugged acid volcanic ranges. Close to Wet Tropics boundary/Semi-evergreen vine thicket with *Araucaria cunninghamii* on steep hills on acid and intermediate volcanic rocks
12	9.12.34	Semi-evergreen vine thicket with *Araucaria cunninghamii* on steep hills on acid and intermediate volcanic rocks
12	9.12.39	*Melaleuca viridiflora, Lophostemon suaveolens, Eucalyptus granitica, E.tereticornis, Corymbia citriodora* and *E.exserta* mixed species woodland on uplands