Lismore Urban Stormwater Management Plan:

Volume 2 – Background Information

FINAL

26 February 2016

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Cover photos: Browns Creek, Diadem Street Lismore (May 2015); Bio-retention system at Nesbitt Park carpark, South Lismore (Source: LCC website)

PROJECT 15-013 – LISMORE URBAN STORMWATER MANAGEMENT PLAN

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1. INTRODUCTION

This Urban Stormwater Management Plan (USMP) has been prepared to improve the sustainability of Lismore's urban stormwater management systems. The plan builds on Lismore City Council's 2007 Urban Stormwater Management Plan and focuses on providing an effective framework for stormwater management to address priority issues. The USMP provides a review of Council's asset management and planning processes to ensure that stormwater systems are designed, constructed and maintained to best practice standards. Stormwater improvements are proposed in locations that will maximise the environmental, social and economic benefits to the community. The aim is to deliver the greatest benefit to the community at least cost.

The USMP integrates both stormwater quality and quantity objectives delivered within the context of Council's asset management framework, thus taking a holistic, long-term approach to urban stormwater management. The USMP aims to achieve the following outcomes:

1. To improve water quality through delivery of effective structural (capital, renewal and maintenance works) and non-structural (education, regulatory, policy development and research) stormwater management programs; and
2. To manage water quantity such that damage to private property, Council and community assets caused by localised flooding is minimised through improved asset management, maintenance and asset upgrades as well as new assets where these are warranted.

The Urban Stormwater Management Plan (USMP) identifies urban stormwater management issues and formulates management actions. Volume 1 of the USMP provides an Implementation Plan for the priority management actions and Volume 2 (this document) provides the background information.

Table 1: Structure of USMP Volume 2 (this document)

Section	Title	Description
2	Study Area Characteristics	The topography, waterway catchments, climate, waterways, geology, ecology, soils and land use in the urban area are described in terms of their contributions to issues relating to stormwater management.
3	Description of the Urban Stormwater System	The urban stormwater system characteristics and function of drainage infrastructure and treatment assets are described.
4	Impacts of Urban Stormwater on Waterways	The impacts of urbanisation on receiving waterways including pollution, modified hydrology and habitat impacts are described.
5	Urban Stormwater Management Areas	For the purposes of this plan, urban stormwater management areas were developed based on combinations of the urban stormwater catchments
6	Existing Management Framework	Council's existing management framework is discussed in terms of the planning context, activities, asset management framework, revenue and expenditure, development requirements and community involvement.
7	Stakeholder Consultation	Consultation with Council and external stakeholders has provided valuable information in terms of identification of issues and development of priority management approaches.
8	Urban Stormwater Management Goals and Objectives	Goals and objectives developed from Council's adopted strategic direction and stakeholder feedback have been used to assist with prioritisation of issues and development of management approaches.

Section	Title	Description
9	Stormwater Management Issues	The administration and governance issues, site-based issues and future development considerations have been identified.
10	Stormwater Management Approaches	Administrative and site-based management approaches are briefly discussed in this section including prioritisation of on-ground improvement projects.
-	References	Provides references for data sources and further reading.
-	Glossary and Abbreviations	Key terms and abbreviations are defined.

2. STUDY AREA CHARACTERISTICS

2.1 Location

The city of Lismore is located in the Northern Rivers Region of NSW within the Richmond River catchment. The study area (shown on Figure 1) is defined by the topographical catchment encompassing all current urban areas of Lismore (approximately 63 km^2) which account for 52% of the study area (based on Lismore LEP 2012 zoning). The remainder of the study area is made up of rural and environmental protection areas (47% and 1%, respectively).

Lismore is located on the Wilsons River floodplain near the confluence of the Wilsons River and Leycester Creek. The Wilsons River joins the Richmond River approximately 36 km (by river) downstream of Lismore. The Richmond River flows to the ocean at Ballina 63 km (by river) downstream from the Wilsons River confluence.

2.2 Topography

Topography in the study area varies considerably from the elevated land at Richmond Hill, Lismore Heights and Goonellabah (elevation of approximately 100 - 180 m AHD) to the floodplain areas of the Lismore CBD and North and South Lismore (elevations of approximately 10 - 20 m AHD). Parts of Lismore have very steep slopes, whereas the majority of the floodplain has low relief. East Lismore has an undulating topography at elevations of approximately 20 - 40 m AHD.

2.3 Climate

The region experiences a mild subtropical climate with high intensity rainfall. The majority of rain falls in the summer and autumn months. Mean annual rainfall is reported to be 1,163 mm with an average number of 98 rain days per year from 2002 - 2015 (BOM, 2015a). On average, January is the wettest month and July and September are the driest. Average maximum daily temperatures range from 30°C in summer to 20°C in winter (BOM, 2015).

Location-specific intensity, frequency and duration of rainfall analysis is available on the Bureau of Meteorology (BOM) website. The Intensity, Frequency and Duration (IFD) analysis (rainfall depth for durations, exceedance per year and annual exceedance probability) of rainfall at Lismore is included in Appendix 1. In early May 2015, approximately 220 mm of rainfall was experienced over 3 days, corresponding to a 20% to 50% AEP event. This event highlights the high intensity, short duration rainfall events often experienced in Lismore.

2.3.1 Climate Change

Natural variations in temperature and rainfall in NSW are influenced by the naturally variable climate systems. Although there is natural variability in the climate, there is consensus among the majority of leading climate scientists that the rate and magnitude of climate change is outside the expected range of this natural variability. Climate change is an important consideration for strategic planning.

The effects of climate change in the northern rivers are likely to include increased heat waves, extreme winds and fire risk and generally a drier climate. Despite this trend toward drier conditions, there is also potential for seasonal increases in extreme rainfall events (CSIRO, 2007). It is generally anticipated that the rainfall events will become more intense in response to climate change, even if average rainfall reduces. This may result in effects such as more floods as well as greater capacity for erosion and runoff and pollution of waterways within the catchment.

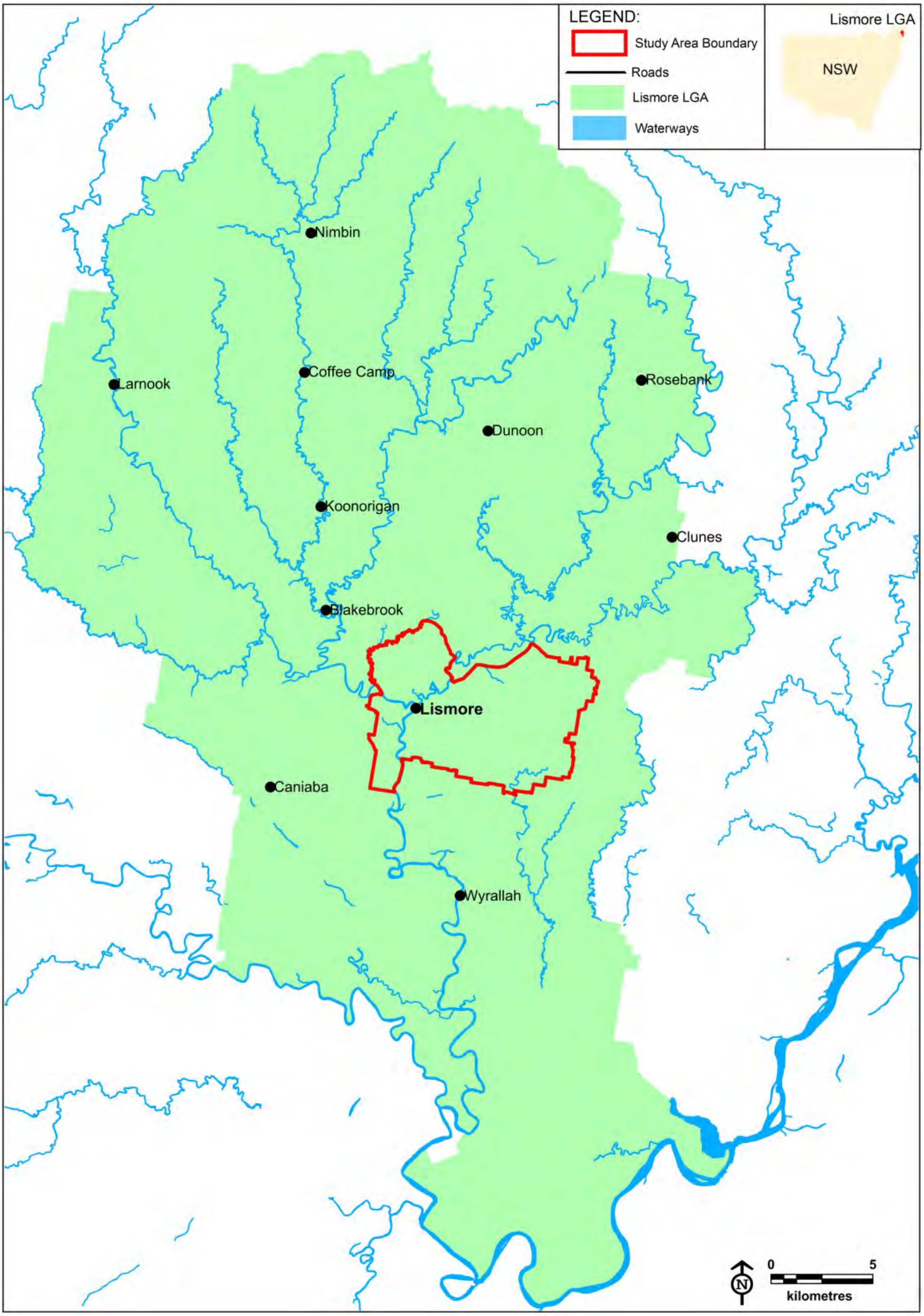


Figure 1: Location of the study area

2.4 Waterways

The study area includes the mid Wilsons River and the upper Tucki Tucki Creek catchments within the broader Richmond River catchment (Figure 3).

Peak stream discharges occur between January and June which generally correspond with high summer rainfall. Similarly, lowest river flows typically occur from September to November, corresponding with the drier months of the year (Figure 2). Streams and rivers in the upper catchments of the Wilsons River have considerable groundwater inputs (Santos *et al.,* 2009).

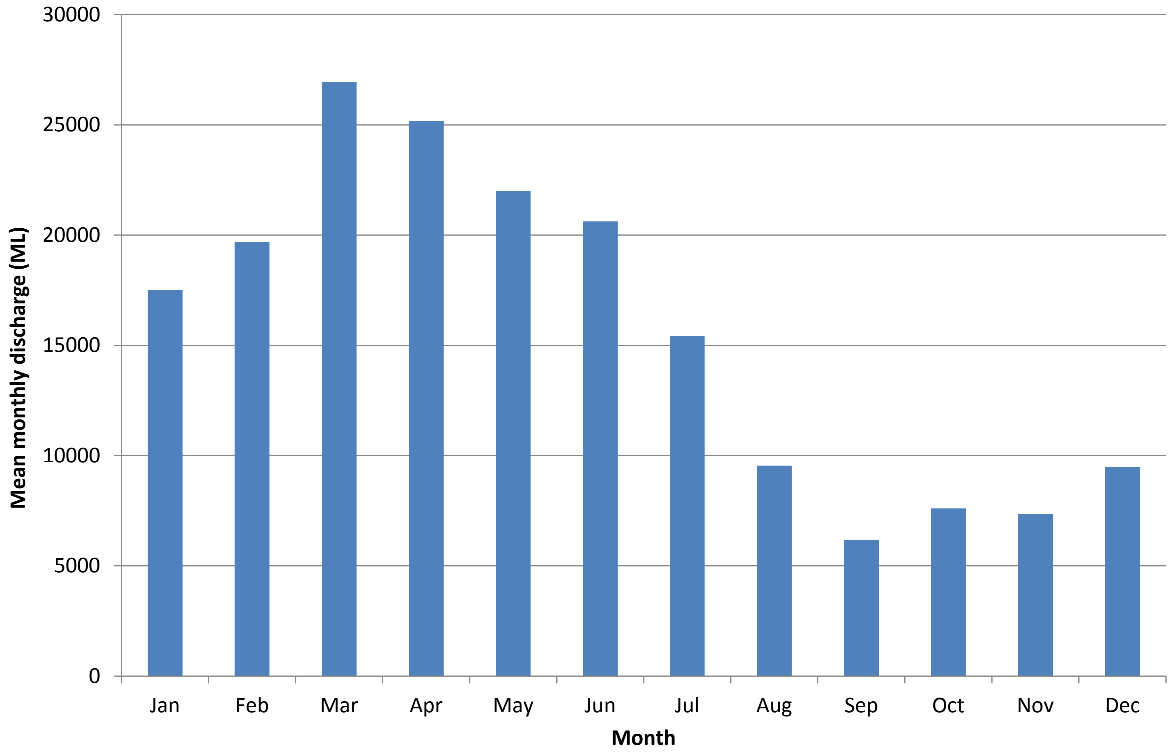


Figure 2: Wilsons River mean monthly discharge at Eltham

Source: NOW (2015)

2.4.1 Tucki Tucki Creek

Tucki Tucki Creek is a permanently flowing creek with a catchment that encompasses an area of approximately 215 km^2. The upper catchment is generally steep where it originates near Alphadale Road before flowing in a westerly direction where its northern catchment and tributaries drain the majority of the urban area on the southern slopes of the Goonellabah ridge north of the Rous Road ridge. The southern side of the upper catchment is dominated by agriculture, in particular macadamia plantations. From the Rous Road ridge, Tucki Tucki Creek flows in a southerly direction through rural areas before eventually entering the Tuckean Swamp and the Richmond River.

2.4.2 Wilsons River

The upper tributaries of the Wilsons River originate within the Nightcap Ranges before being joined by several major tributaries including Coopers Creek at Corndale and Leycester Creek at Lismore. The majority of the upper catchment is dominated by agricultural land use and several small villages.

Approximately 7.5 kilometres of river reach traverses through the urban area from the northern to the southern extent. Land use is varied and has developed close to riverbanks reflecting the early development of Lismore. The CBD and North and South Lismore business precincts are located within close proximity to the river, as is the railway line and large industrial operations including Hurford's Timber Mill and Norco. Residential areas on the riverbank include the edges of Molesworth Street, Winterton Parade, and in North Lismore on Wotherspoon, Baillie and Terania Street. Open space areas which function as floodways include Currie Park, Riverside Park, Pritchard Park, the Lismore Turf Club, the greyhound track at Colemans Point, and various sports fields (LCC, 2007). A caravan and Tourist Park, Trinity College grounds and some farmland also add to the open space areas.

From Lismore the Wilsons River flows in a general southerly direction through agricultural areas (mainly grazing and tea tree plantations) before joining the Richmond River at Coraki. The Richmond River flows eastward from Coraki where it enters the Pacific Ocean at Ballina.

The Wilsons River water supply catchment area stretches from the rainforests of Upper Wilsons Creek and Huonbrook in the north, to Bangalow in the east and Lismore in the south west. Water is extracted from Wilsons River at Howards Grass (5 km upstream from Lismore) as a major source of 'raw' drinking water for the region. The Wilsons River is tidal at the Howards Grass drinking water extraction point and therefore the drinking water catchment extends downstream of this point to accommodate tidal influence. Rous Water then pumps this water up to Nightcap Water Treatment Plant for treatment prior to distribution to consumers across the region through existing water distribution infrastructure (refer Section 6.1.2).

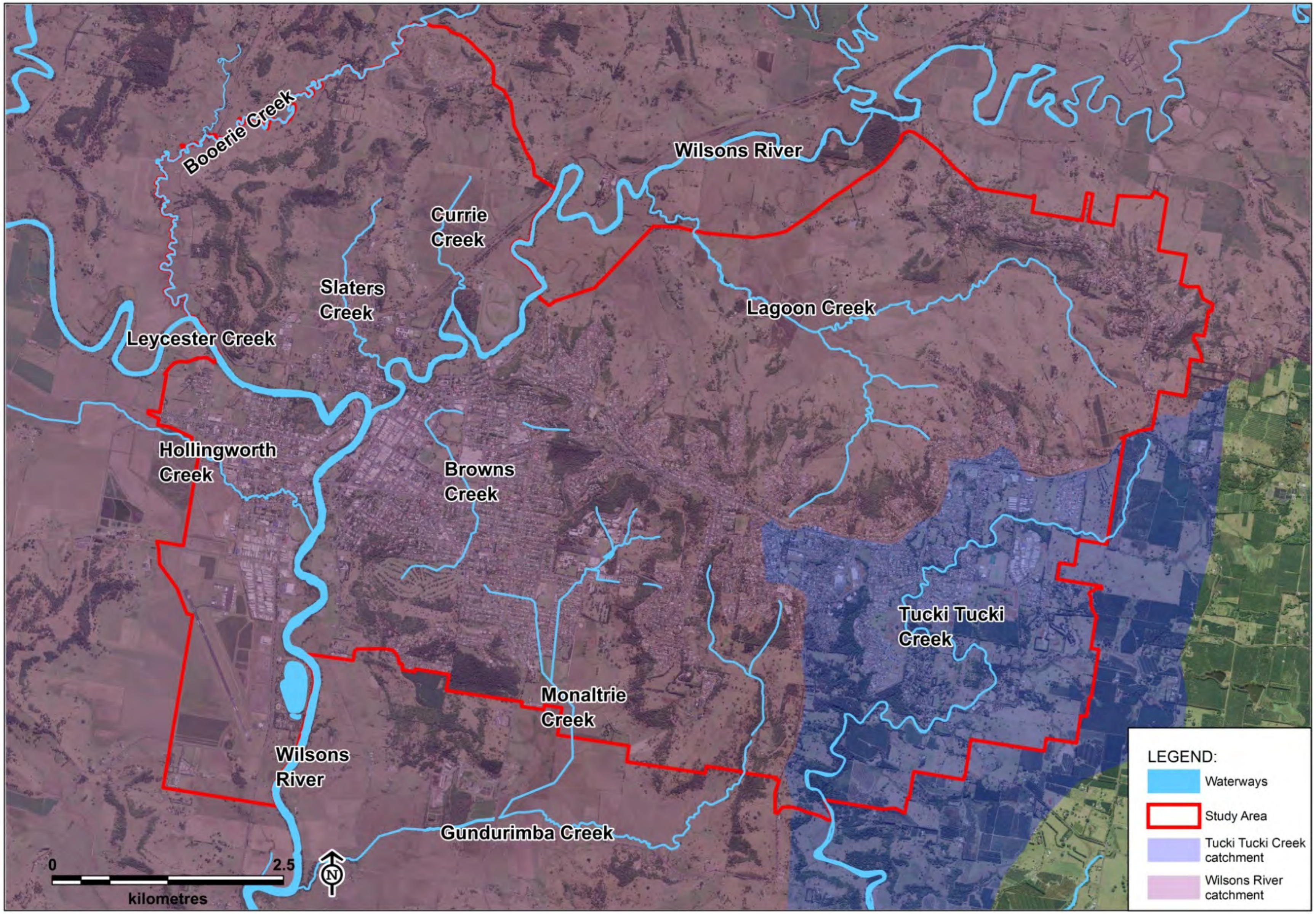


Figure 3: Main waterway catchments within the study area

The urban area of Lismore/Goonellabah within the Wilsons River catchment is drained by an extensive network of drains, creeks and ephemeral streams that eventually drain into the Wilsons River. The main waterways within the Wilsons River catchment draining the Lismore/Goonellabah urban area include the following (Figure 3):

- Gundurimba Creek - a small ephemeral stream that receives stormwater from the urban areas on the western side of Rous Road and eastern side of Invercauld Road in Goonellabah. The creek conjoins with Monaltrie Creek near Wyrallah Road before flowing into the Wilsons River at Monaltrie;
- Monaltrie Creek catchment lies within East Lismore. Its tributaries drain the escarpment above Southern Cross University and the western slopes of the Invercauld Road ridge before joining a concrete canal that drains the majority of the Military Road area. The concrete canal ends at Wade Park where the channel returns to a natural channel and is joined by another major tributary also in the form of a concrete canal which drains the area of East Lismore between the South Lismore Bowling Club and the golf course. Downstream of the junction of the two major tributaries, Monaltrie Creek is joined by several smaller ephemeral tributaries before entering Gundurimba Creek at Wyrallah Road adjacent to the East Lismore STP;
- Lagoon Creek catchment is bordered by Ballina Road to the south, Trinity Drive ridge to the west and Richmond Hill Road ridge to the east. Lagoon Creek tributaries drain the northern escarpment of Goonellabah including the urban areas on the ridges before flowing in a northerly direction through farmland, under Bangalow Road before discharging into the Wilsons River opposite Woodlawn within 300 m of the Wilsons River Source extraction point;
- Browns Creek catchment encompasses much of the Lismore urban area. Its southern headwaters originate on the eastern slopes of Girards Hill above the golf course. From there it flows in a northerly direction under Wyrallah Road, Ballina Road and the surrounding urban area through a series of pipes, open concrete canals and open natural channels before flowing past Lismore Square through the sports fields of Lismore Park. The main creek conjoins with a northern tributary at what is known as the ‘Bat Cave’ behind the CBD area where it is piped under the Browns Creek carpark and discharges into the Wilsons River. The northern tributary receives stormwater from the urban area from around the hospital north of Uralba Street/Rotary Drive and areas of Lismore Heights south west of High Street;
- Currie Creek originates on the escarpment on the southern side of Tullera where it flows south and discharges into the Wilsons River adjacent to the racecourse. Its catchment encompasses agricultural land and the racecourse;
- Slaters Creek headwaters drain the eastern escarpment of the North Lismore plateau, then flow south past the speedway/showground and the saleyards before joining the Wilsons River opposite the greyhound track;
- Booerie Creek originates in farm land to the north west of Tullera. The creek meanders south through grazing and horticulture land before joining Leycester Creek south of North Lismore Plateau;
- Leycester Creek headwaters originate to the north west of Lismore before flowing in a south easterly direction through rural areas before joining the Wilsons River at Lismore. Leycester Creek receives stormwater from areas of North and South Lismore; and
- Hollingworth Creek is a small stream originating in the agricultural area to the west of Lismore. From here it flows east receiving discharge from the Lismore STP and stormwater from areas of South Lismore before discharging into the Wilsons River near Riverside Park.

2.5 Flooding

Lismore experiences three broad types of flooding:

- Wilsons River catchment flooding - caused by widespread large storm systems. These floods generally occur over the broader catchment involving large rises in river levels inundating low lying areas;
- Localised catchment flooding - caused by small storm systems. These events are generally localised involving a quick rise and fall of floodwaters; and
- Poor site drainage - local low gradient areas where runoff is poorly conveyed during heavy rainfall.

2.5.1 Catchment (Wilsons River) Flooding

Lismore typically experiences relatively frequent river flood events with the town experiencing a river flood on average once every four years since European settlement. A combination of factors increases the frequency and magnitude of flooding (LCC, 2014):

- Its latitude and location close to the coast make Lismore susceptible to extreme weather;
- Its location at the confluence of Wilsons River and Leycester Creek;
- The catchment above Lismore is fan-shaped and the valleys and streams are steep providing a relatively quick transfer of rainfall to runoff;
- The low level of the floodplain with significantly lower levels in central Lismore;
- The Wilsons River floodplain has been extensively modified by a complex network of constructed drains, modified canals, river diversion, artificial levee banks and floodgates;
- Many natural wetlands have been drained and filled for agriculture and urban development; and
- The large floodplain to catchment ratio.

Catchment scale flooding of urban areas in Lismore is primarily an issue in areas situated on the floodplain such as North and South Lismore. Such flood events occur after widespread rainfall within the broader Richmond River catchment. There is usually significant warning of rising flood waters, with modest rates of rise and fall and events often lasting for several days.

Catchment flooding issues are addressed by flood risk management plans (FRMP) prepared by Council. In 2002 the first Lismore Floodplain Risk Management Plan was adopted by Council. The Lismore Flood Levee Scheme included (RRCC, 2005):

- A levee constructed along the bank of the Wilsons River to provide protection up to the 1 in 10 year flood event (10% Annual Exceedance Probability) for Central Lismore;
- Modifications to the existing 1 in 10 year levee in South Lismore;
- The raising of houses in North Lismore with habitable floor levels below the 1 in 10 year flood level, subject to certain conditions;
- The acquisition of easements required for the construction of the levees; and
- The voluntary acquisition of houses located in the flood prone areas, in the vicinity of, but not protected by the levee works.

The CBD Levee prevents floodwaters from entering the CBD for all floods up to the 1 in 10 year flood i.e. 10.9 m AHD at the Rowing Club Gauge. Bigger floods will overtop the Browns Creek Spillway first (crest 10.95 m) and flows will be concentrated initially in the Browns Creek Floodway. As the river level continues to rise floodwaters will overtop the Gasworks Creek spillway (crest 11.25 m) and back up into the CBD. A little later flood waters will overtop the Spinks Park spillway (crest 11.6 m). In a very large flood the entire levee system will be overtopped. The South Lismore Levee and the CBD levee will overtop at roughly the same time. The scheme is operated by closing flood gates, closing road gates and operating pumps when necessary (RRCC, 2005).

In 2014 a new FRMP was adopted by Council. This plan will allow Council to ensure the use of flood prone land is planned and managed in a manner compatible with the assessed frequency and severity of flooding. This planning involves an understanding of the level of risk and assessing the options and cost to address the risk. The plan will allow a determination of measures available to lessen the hazards relating to public safety and reduce the damage potential to property.

2.5.2 Localised Catchment Flooding

Localised flooding is caused by small storm systems producing intense rainfall bursts usually over shorter timeframes than flooding in the Wilsons River. Localised flooding events are usually short-lived but can build up dramatically in response to intense rainfall events. It is anticipated that the intensity of such events will increase with continued climate change. Such flooding is usually exacerbated by constriction of natural drainage points, where the discharge capacity is not adequate to pass the rain collected in the local catchment. In these situations, stormwater drainage systems are overwhelmed and backwater effects can encroach on urban areas. Localised flooding of this nature is often related to design and maintenance of stormwater infrastructure and has the potential to lead to property damage, public safety risk, transport interruption and loss of amenity. Safety hazards associated with localised flooding include:

- Uncontrolled flows entering stormwater infrastructure which present opportunities for thrill-seekers and pose high risk of entrapment, particularly for children;
- The risk of drowning in open water bodies such as concrete channels;
- The risk of trips and falls due to submerged objects;
- Risk of contact with pathogens due to poor stormwater quality;
- Increased risk of sewer overflows contributing to impacts on receiving water quality and risk of pathogen contact; and
- Public safety is also threatened when stormwater discharge exceeds the capacity of assets such as road culverts, leading to inundation and potentially rapid water velocities over roads.

Figure 4: Local catchment flooding at Wade Park East Lismore and Browns Creek, CBD (May, 2015)

Several examples of localised short-term flooding have been identified within the Lismore urban areas particularly in South Lismore, North Lismore, East Lismore and parts of the CBD area. Stormwater design is problematic in low-lying areas as many stakeholders expect stormwater systems to be 100% effective in resolving localised flooding issues and may not understand site limitations in achieving this. Such limitations include the absence of natural drainage lines to receive discharge water, low gradients which prevent the efficient conveyance of water and downstream constraints which further reduce drainage effectiveness. Stakeholders also may not fully understand the different mechanisms by which inundation of low lying land occurs and to what extent this is controllable through urban stormwater management strategies. In some cases, poor design infrastructure or lack of maintenance exacerbates the inherent issues associated with efficient stormwater management of low-lying land.

Inundation of low-lying land is caused by a range of factors and can have differing effects in terms of the frequency and extent of inundation, event duration, predictability and type of impact. Localised flooding is likely to increase with continued climate change (refer Section 2.3.1) with increased storminess contributing to catchment scale flooding and demands on stormwater infrastructure.

2.5.3 Poor Site Drainage

Parts of Lismore, particularly the CBD and North and South Lismore, are very flat and current stormwater systems often fail to convey water during heavy rainfall due to the combination of low gradients and high tail-water levels (e.g. flooding creeks or drainage canals). Specific factors that contribute to poor site drainage in low gradient urban areas are:

- Low gradients mean that there is little tolerance available in establishing site contours and drainage lines. Movement of stormwater assets over time, errors during construction and external influences on tail-water levels can have significant effects on the efficiency of stormwater systems in low-gradient areas;
- Low gradients dictate that larger stormwater systems are required to convey design stormwater discharges. Larger systems are proportionally more expensive or can reduce the amount of land available for beneficial uses. Current development guidelines do not necessarily foresee or cater for such situations, which need to be assessed carefully on a case by case basis; and
- Poorly draining soils and high groundwater levels provide little opportunity to utilise on-site infiltration to disperse stormwater. Infiltration devices, although often desirable in other situations, will often not be effective in low-lying areas, leading to ponding and poor conveyance from the site.

Figure 5: Poor site drainage Union Street South Lismore (May, 2015)

2.6 Water Quality

2.6.1 LCC Water Quality Monitoring Data

The LCC Waterways Program collected water quality data between 1998 and 2011 at a number of sites in the Lismore LGA. The data was reported as part of Council's SOE Reporting. The three sites located with proximity to the Lismore urban area were: Site 9 - Simes Bridge (Wilsons River upstream of Lismore CBD); Site 10 - Robert White Bridge (Leycester Creek, South Lismore); and Site 11 - Lismore Lake Boat Ramp (Wilsons River downstream of Lismore urban areas). While there was considerable variation between sites and across years, generally the physico-chemical parameters (pH, turbidity, dissolved oxygen (DO) and salinity (EC)) were within acceptable ranges for ecosystem health under average flow conditions. Nutrients (Total Nitrogen -TN and Total Phosphorus - TP) and faecal coliforms were generally in excess of ecosystem health and primary recreation trigger values for most years at most sites. Nutrients, turbidity and faecal coliforms measured at Site 10 (Leycester Creek) and Site 11 (Lismore Lake Boat Ramp) were generally higher than at Site 9 (upstream of Lismore CBD) for most years, indicating that sources of these pollutants are likely to be present in the Leycester Creek catchment (primarily agricultural land) and possibly further input is coming from the Lismore urban areas.

2.6.2 Rous Water Monitoring Data

Rous Water monitors water quality at a number of sites in the Wilson River (refer Appendix 2) to assess catchment health and risks to drinking water supply. A comprehensive water quality dataset has been supplied by Rous Water for sites around Lismore spanning the last nine years from 2004 to 2015.

In general the physico-chemical indicators (pH, turbidity, DO and EC) were within recommended guidelines for ecosystem health at all sites. The maximum recommended guideline for median turbidity (50 NTU) was not exceeded at any site over the monitoring period indicating good overall water clarity during average flow conditions. There were occasional high turbidity readings at several sites, indicating the waterways do experience turbid conditions at times and this is likely to be associated with rainfall/runoff events. Similar to what was found in the LCC Waterways monitoring, overall turbidity levels were slightly higher at the sites in Leycester Creek (WR06) and downstream of Lismore CBD (WR01), compared to sites further upstream on the Wilson River. Dissolved oxygen levels were good at all sites with median values of between 8 mg/L and 9.5 mg/L. pH fluctuated with some occasional values below pH 6.5 which is considered to be consistent with natural variation. Sites on Leycester Creek and downstream of Lismore showed slightly elevated pH levels on average compared to the upstream sites. Similarly EC showed a greater range of values and typically higher levels at these sites compared to upstream.

Both nutrients (TN and TP) and faecal indicator bacteria (*E.coli*) were in excess of water quality objectives at all sites indicating nutrient and pathogen sources are present in the catchment both upstream and downstream of Lismore, and are having a negative impact on water quality. A similar spatial trend to turbidity was observed for both nutrient and *E.coli* concentrations which were higher at WR06 and WR01 compared to the sites further upstream. Despite elevated nutrient concentrations, median Chlorophyll *a* values were within guidelines for ecosystem health at all sites, indicating that other factors (e.g. good flow regime) is limiting the growth of algae in the main waterways.

2.6.3 Wilsons River Catchment Management Plan and Risk Assessment

Rous Water developed a risk-based catchment and investment strategy to direct activities aimed at protecting drinking water quality of the Wilsons River Source and an environmental monitoring program to guide the management of the catchment. The plan assessed the catchment identifying potential water quality issues/hazards and identified measures to address them.

In recognition of the threat posed by runoff from urban areas, the Wilsons River Catchment Management Plan established an Urban Land Management Program, the goals of which included:

- Appropriate water sensitive planning and development across all urban and rural residential zones, including density controls and environmental constraints mapping; and
- Minimise adverse impacts on waterways through continuous improvement in stormwater and recycled water discharge quality and reduction in contaminants.

Key elements within this program included the following elements that are of relevance to Lismore's USMP:

- Raise awareness amongst catchment residents, government agencies, emergency services and local businesses that they are living in a water supply catchment;
- Rous Water to be involved in the preparation and review of Local Environment Plans (LEPs) and Development Control Plans (DCPs) and major development projects;
- Investigate stormwater run-off as a source of water for irrigation and other uses;
- Investigate the reason for high *E. coli* counts and nitrogen concentrations in Wilsons River at Ballina Street;
- Encourage better drainage at road/waterway crossings (links to Road Management Program); and
- Encourage use of Water Sensitive Urban Design (WSUD) in urban areas.

2.6.4 Richmond River Ecohealth Program

The Richmond River Ecohealth program (Ryder *et al*., 2015) is an aquatic health monitoring program designed to measure the health of the waterways within the Richmond River catchment (including the Wilsons River). The program looks at key environmental indicators including water quality, riparian vegetation, geomorphic (channel) condition, macroinvertebrates (waterbugs), fish (distribution and population sizes) and plankton and reports on their condition. A total of 48 sites were monitored during the program to determine the overall health of the catchment. Of the 48 sites, three (LC1, WR4, WR3), are located in the mid Wilsons River catchment and are considered relevant to the Lismore urban area. LC1 is located in Leycester Creek at the upstream extent of South Lismore, WR4 is located in the Wilsons River upstream of Lismore and WR3 is located in the Wilsons River just downstream of the Lismore CBD (Figure 6). All three sites received a water quality rating of 'F' for the reporting period, indicating very poor water quality within Leycester Creek and the Wilsons River both upstream and downstream of Lismore.

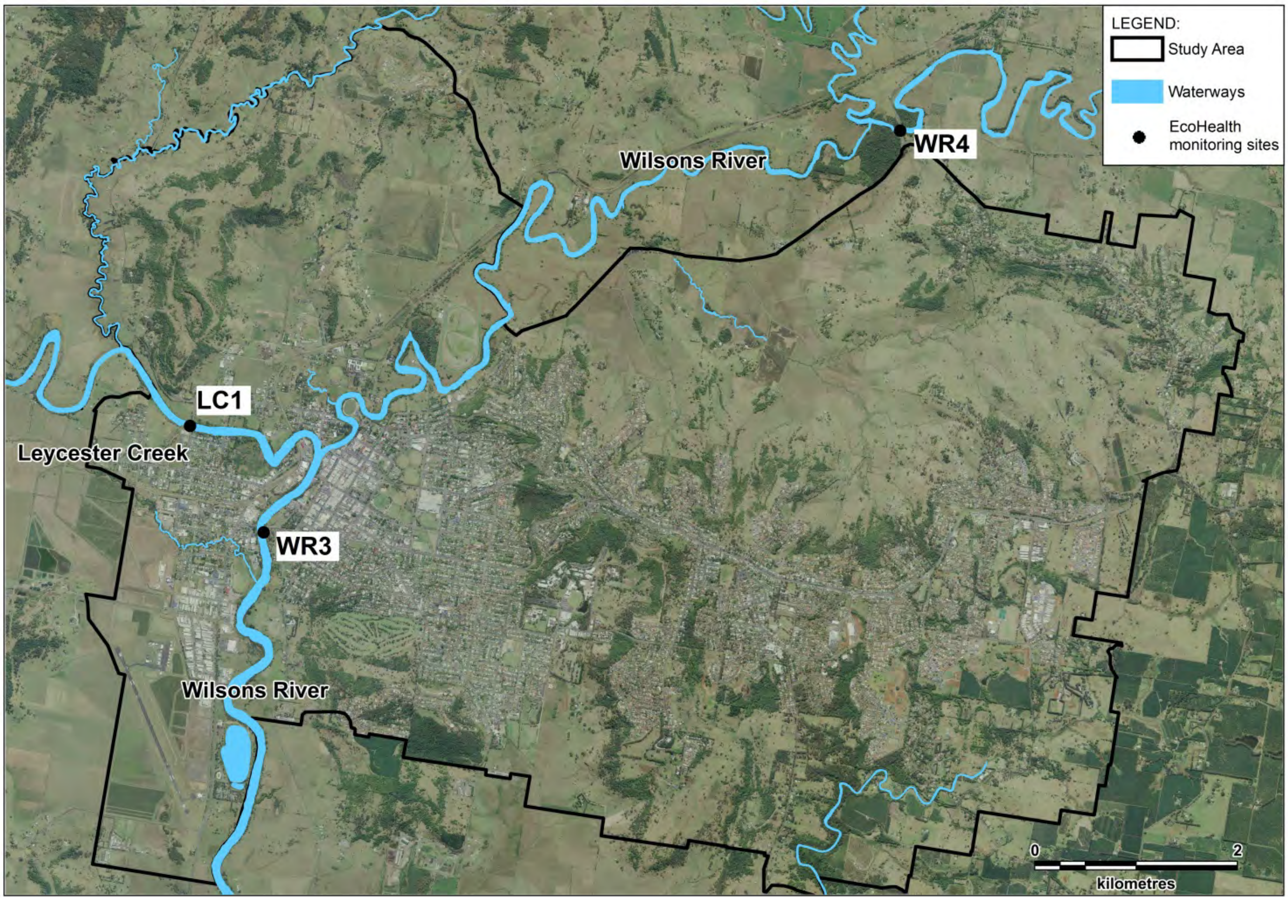


Figure 6: Richmond River Ecohealth Program monitoring sites

Source: Ryder *et al*. (2015)

2.6.5 Other Urban Water Quality Studies

Students from Southern Cross University in Lismore have been involved in various studies on the water quality in the Lismore urban area. Some studies are discussed below.

McMellon (2011) examined various aspects of stormwater management in Lismore with a view to assisting LCC identify priority areas for management. Nine of the ten sub-catchments that discharge into the Wilsons River were assessed and samples taken from their discharge points during twelve events between March and June 2011. The study found that average pollutant concentrations from the nine sub-catchments exceeded ANZECC guidelines for aquatic ecosystem health during rainfall events. However, the overall mean concentrations of TSS, and TN were at the lower range and TP was comparable to recommended typical values for urban stormwater. In addition, the total nutrient export from the nine sub-catchments during rainfall events was approximately 5.7% of the load delivered by the upstream rural catchments to the Wilsons River at Lismore. The sub-catchments with the largest nutrient contribution during rainfall events were Lagoons Creek, Browns Creek and Monaltrie Creeks. Point sources of pollution were detected in Hollingworth Creek (South Lismore STP) and Slaters Creek (cattle sale yards). Treatment devices tested (ponds and vegetated channels) were most effective during low to medium rain events. At higher flows the treatment devices were too small to be effective.

Rogers (2008) investigated sources of faecal contamination within the Browns Creek stormwater catchment and both upstream and downstream of the stormwater outlet on Wilsons Creek during rain events. Faecal coliform concentrations exceeded ANZECC guidelines for secondary recreation at all sites during event sampling with the exception of the upstream site during the February event. Human sources of faecal contamination (believed to be from sewage overflows) were identified within the stormwater system and the contribution was variable for different events and at different locations. Model calculations within the drain estimated that bird faeces were the dominant contribution followed by human faecal matter. At the drain outlet human faecal matter was the dominant contributor followed by small contributions of dog and flying fox faeces (Rogers, 2008).

2.7 Geology and Soils

The underlying geology along the floodplain of the Wilsons River and Leycester Creek is comprised of channel and floodplain alluvium, gravel, sand, silt and clay. Lamington Volcanics dominate the geology in the elevated parts of the study area and comprise basalt, sub-alkali basalt with members of rhyolite, trachyte, tuff, agglomerate, conglomerate and andesite (GeoScience Australia, 2014).

Soil types arising from alluvial geology and present along the river channel and floodplain areas include drainable black clayey alluvials, alluvial kraznozems and wet dark clayey alluvials. These soils tend to have high water retention capacity and high organic matter content. The volcanic geology present in elevated areas such as East Lismore, Goonellabah, Lismore Heights and Richmond Hill give rise to kraznozem soils, mildly leached chocolate soils and alluvial kraznozems along creek lines (LCC, 2015a). These soils are derived from basalt rock and are generally well-drained, deep and friable and red-brown in colour. The key features of soil landscapes within the study area are listed in Table 2.

Table 2: Key features of soil landscapes in Lismore urban area

Soil Landscapes	Soil types	Soil Depth	Erosion Hazard	Fertility
Goonellabah	Kraznozem soils, chocolate soils and alluvial kraznozems along creek lines	>200 cm	Moderate – mass movement	Moderate to High
Lismore Heights and East Lismore crests and upper slopes	Kraznozem soils, chocolate soils	50-100 cm	High-surface and mass movement	Low to Moderate
East Lismore lower slopes	Transitional zone from red to black basaltic soils	>200 cm	High- surface movement	Low
Floodplain (alluvial)	Drainable black clayey alluvials, alluvial kraznozems and wet dark clayey alluvials	>200 cm	Moderate – stream bank erosion	Moderate-low

Source: Adapted from LCC (2007)

2.8 Flora and Fauna

The Lismore region is characterised by rich species diversity and is home to many rare and threatened flora and fauna species. The urban areas of Lismore contain pockets of bushland including those mapped as High Conservation Value (HCV) and highly likely Endangered Ecological Communities (EECs). Lismore urban areas and surrounding rural and bushland landscapes have a higher than average population of koalas including a significant urban koala population in south-east Lismore. Micro bats (including the vulnerable Little Bentwing-bat) are known to utilise habitats throughout the urban areas of Lismore (Blackthorn, 2013) including stormwater infrastructure such as the ‘Bat Cave’ in Browns Creek (LCC, 2007). Significant aquatic species known to occur in waterways downstream of the urban areas and therefore subject to impacts from stormwater include the Endangered Purple Spotted Gudgeon (Tucki Tucki Creek) and Platypus (also observed in Tucki Tucki Creek).

The *Biodiversity Management Strategy for the Lismore LGA* (LCC, 2015e) identifies pressures to biodiversity and challenges to protecting and enhancing biodiversity in the Lismore LGA. Increased urbanisation was identified as having a range of adverse impacts on water quality and hydrology including those relevant to stormwater:

- Alteration to natural flow regimes;
- Alteration of groundwater hydrology;
- Increased nutrient load and turbidity of runoff;
- Sedimentation; and
- Pollution via runoff.

The Strategy recommends management actions on both public and private land in urban and rural landscapes. Actions relevant to stormwater management in Lismore urban areas include:

- Action 9: Input into reviews of asset management plans, specifically:
    - e) Stormwater Drainage Assets Management Plan (LCC, 2012).
- Action 49: Urban Green Corridors Plan incorporating:
    - Mapping of urban green corridors including habitat and bushland areas, wetlands, riparian areas etc.;
    - Mapping of priority riparian corridors and stormwater areas for rehabilitation or revegetation;
    - Identification of areas of high conservation value within the urban environment for protection and enhancement e.g. Platypus habitat in Tucki Tucki Creek; and
    - Identify potential priority environmental offset sites for future developments that are required to offset their adverse environmental impacts.

The 2012 SOE report card identifies 5 of the 7 NSW aquatic Key Threatening Processes (KTPs) as occurring in the Lismore LGA including degradation of riparian vegetation and instream structures that alter natural flow regimes (LCC, 2012).

2.9 Riparian Vegetation

Plants growing along the banks of rivers and creeks are known as riparian vegetation. This vegetation stabilises riverbanks, stops erosion and subsequent siltation and contributes food, such as organic matter and falling insects, to the stream. It also partially filters out pollutants, such as sediments, pesticides and fertilisers, being carried towards the waterway, acting as a buffer strip. The roots of trees bind and stabilise the soil of riverbanks, minimise siltation, provide shelter and help to retain the general channel shape, including such important habitat features as pools, riffles and backwaters. Waterways with well-developed riparian vegetation also have a greater diversity of instream habitat for fish than those with no trees along their banks (DPI, 2015).

The Richmond River Ecohealth program (Ryder *et al*., 2015) assessed the geomorphic condition and riparian vegetation status of three sites located in the mid Wilsons River catchment. The Leycester Creek site (LC1) and the Wilsons River site downstream of Lismore received a geomorphic condition grading of C+ (fair) while the Wilsons River site upstream of Lismore was graded D (poor). The riparian condition grades were F (very poor) for the Wilsons River sites and D- (poor) for the Leycester Creek site.

Richmond River County Council undertook a riparian vegetation condition assessment of the lower Wilsons River catchment. The study included sections of the Wilsons River, Leycester Creek and Tucki Tucki Creek located within the urban stormwater management area (Figure 8). The riparian vegetation of these areas consists of a range of vegetation types including a combination of Camphor Laurel, Camphor Laurel - Rainforest, Camphor Laurel - Eucalypt, Camphor Laurel - River Oak, Floodplain Rainforest, Forest Red Gum - Tallow wood, Rainforest, River Oak, Rainforest – Camphor Laurel, River Oak – Camphor Laurel and Indian Coral Trees, In general, the riparian zone was in a moderate to poor condition. Riparian areas were also given a restoration priority ranking. Several sections of the Wilsons River and Leycester Creek, particularly on outside bends, were given high priority as were small sections in Tucki Tucki Creek.

A lack of riparian vegetation along natural channel stormwater infrastructure can cause water quality problems, particularly erosion and siltation issues. BushBoss (undated) conducted a study on the riparian condition of the creeks (the majority of which serve as urban stormwater conveyance infrastructure) within the Monaltrie Creek catchment. The study found that the majority of the riparian vegetation is dominated by weeds and is of a poor habitat value. Erosion was found to be occurring to some extent in all creeks surveyed. Of note, was a large section of severe erosion within the gully that flows parallel to Cynthia Wilson Drive. The riparian corridor along the section of this gully is in poor condition with significant weed growth within the creek and erosion of the banks (Figure 7).

Figure 7: Bank erosion and riparian weeds along the creek near Airforce Road, East Lismore

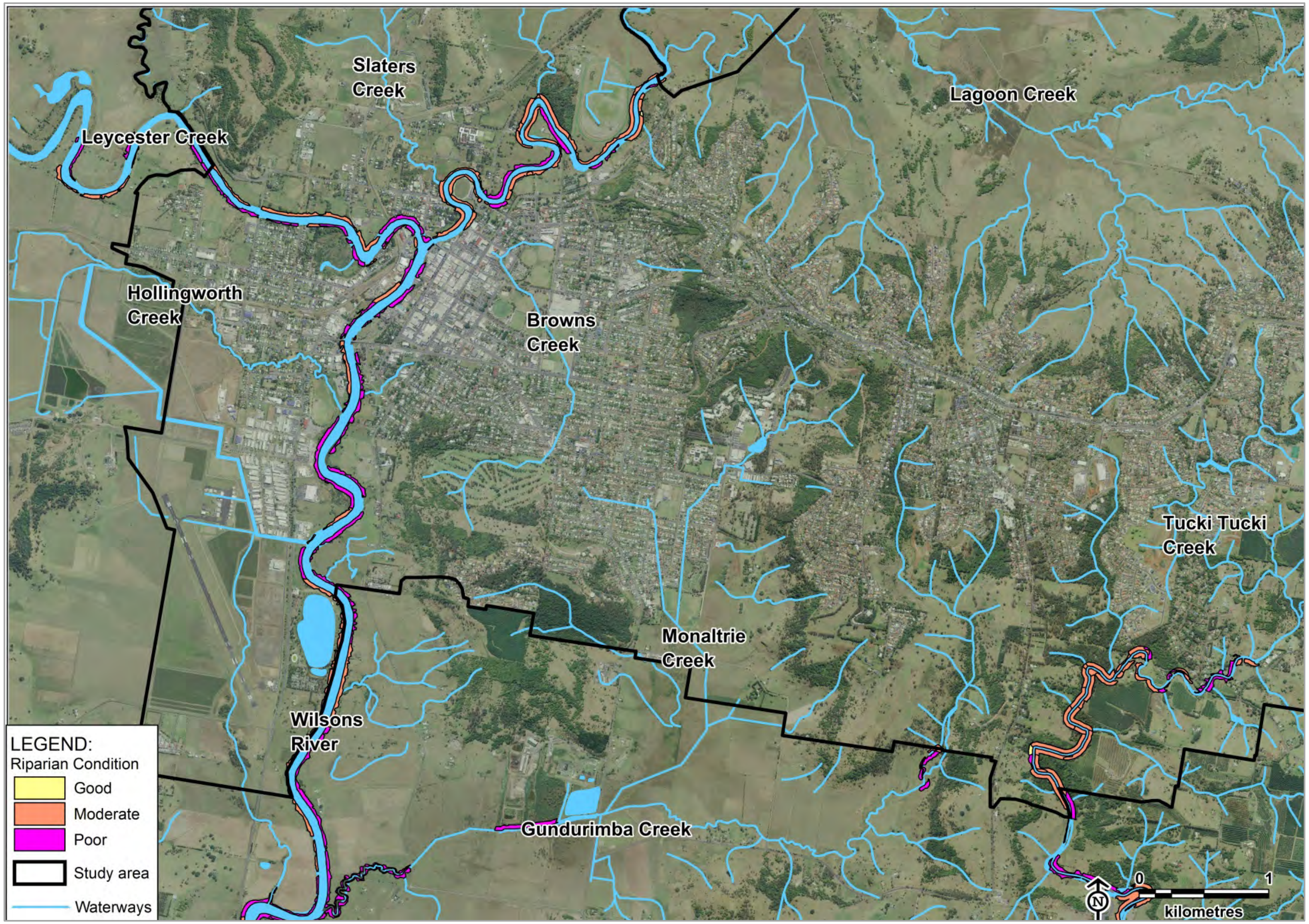


Figure 8: Riparian condition mapping

Mapping supplied by RRCC

The beneficial attributes of riparian vegetation along natural waterways also extend to stormwater drainage infrastructure, particularly in the case of open drains and swales where the presence of established native vegetation helps to stabilise banks, reduce erosion/sedimentation, improve water quality through the uptake of nutrients and trapping of pollutants and litter, and in the long-term reduces maintenance of assets (e.g. reduces need for mowing and weeding/spraying etc.). Vegetated stormwater assets also enhance the natural values of urban areas, create habitat and increase amenity. LCC has completed a number of projects within urban areas to restore riparian zones including examples along sections of Browns Creek, Gas Works Creek downstream of litter cages on Keen Street and areas along a tributary of Tucki Tucki Creek in the vicinity of the Goonellabah Sports and Aquatic Centre (Figure 9).

Figure 9: Riparian restoration along a tributary of Tucki Tucki Creek

There are a number of other areas where riparian restoration and management is undertaken within the study area by community groups including:

- Wilsons River Landcare Group has strategically restored and maintained rainforest on both private and Council owned land along both sides of the Wilsons River between Fawcett Bridge and Simes Bridge for over 20 years;
- In South Lismore the Duckpond Landcare group manages riparian and wetland vegetation on Council reserve at Hollingworth Creek and on private land at The Duckpond;
- In North Lismore the Aboriginal Landcare group, Banyam-Baigham Landcare, is restoring riparian vegetation on Council land at Slaters Creek;
- In Goonellabah the Upper Tucki Tucki Landcare group manages riparian rainforest at various sites within the Tuck Tucki Creek Recreation Park; and
- Rous Water, in partnership with six local schools, LCC, Landcare, WIRES, Friends of the Koala, and Southern Cross University has established a series of riparian zone improvement sites along the Wilsons River and Tucki Tucki Creek (the Wilsons River Catchment Schools Education and Restoration Project). Sites that are located within the study area include riparian zones on the Wilsons River established adjacent to Albert Park Public School, Richmond River High School, Trinity Catholic College, St. Carthages Primary School and a site on Tucki Tucki Creek adjacent to Kadina High School. In undertaking these improvements in riparian condition, the project has also

recognised the critical need to involve schools and young people in restoring waterways, and the collaborative partnership approach required to achieve it.

2.10 Land Use and Zoning

The Lismore Local Environmental Plan (LEP) 2012 controls and guides proposed development. It contains land-use zones, development standards and other matters to consider when assessing potential development. The LEP 2012 applies to all land in the LGA excluding areas affected by the Ministerial review into Environmental Protection Zones E2 and E3. These areas are referred to as 'Deferred Matter' in the LEP 2012 and the Lismore LEP 2000 applies in these areas until the review is complete. Land use zones identify the types of uses or development permitted in each zone. A summary of the land use zones within the study area as defined by the LEP 2012 is provided Table 3 and illustrated in Figure 10.

Table 3: Study area land use

Land Use	**Area (ha)**
Urban Zoning	
Neighbourhood Centre	21
Local Centre	18
Commercial Core	79
Mixed Use	67
Enterprise Corridor	60
Deferred Matter	138
General Industrial	160
Light Industrial	54
General Residential	1605
Low Density Residential	101
Low Density Residential	281
Public Recreation	371
Private Recreation	85
Special uses	278
Total Urban Zoning Area	3,320 (52%)
Rural Zoning	
Primary Production	2,875
Rural Landscape	85
Total Rural Zoning Area	2,960 (47%)
Environmental Zoning	
National Parks and Nature Reserves	27
Natural Waterways	11
Recreational Waterways	7
Total Environmental Zoning Area	45 (1%)

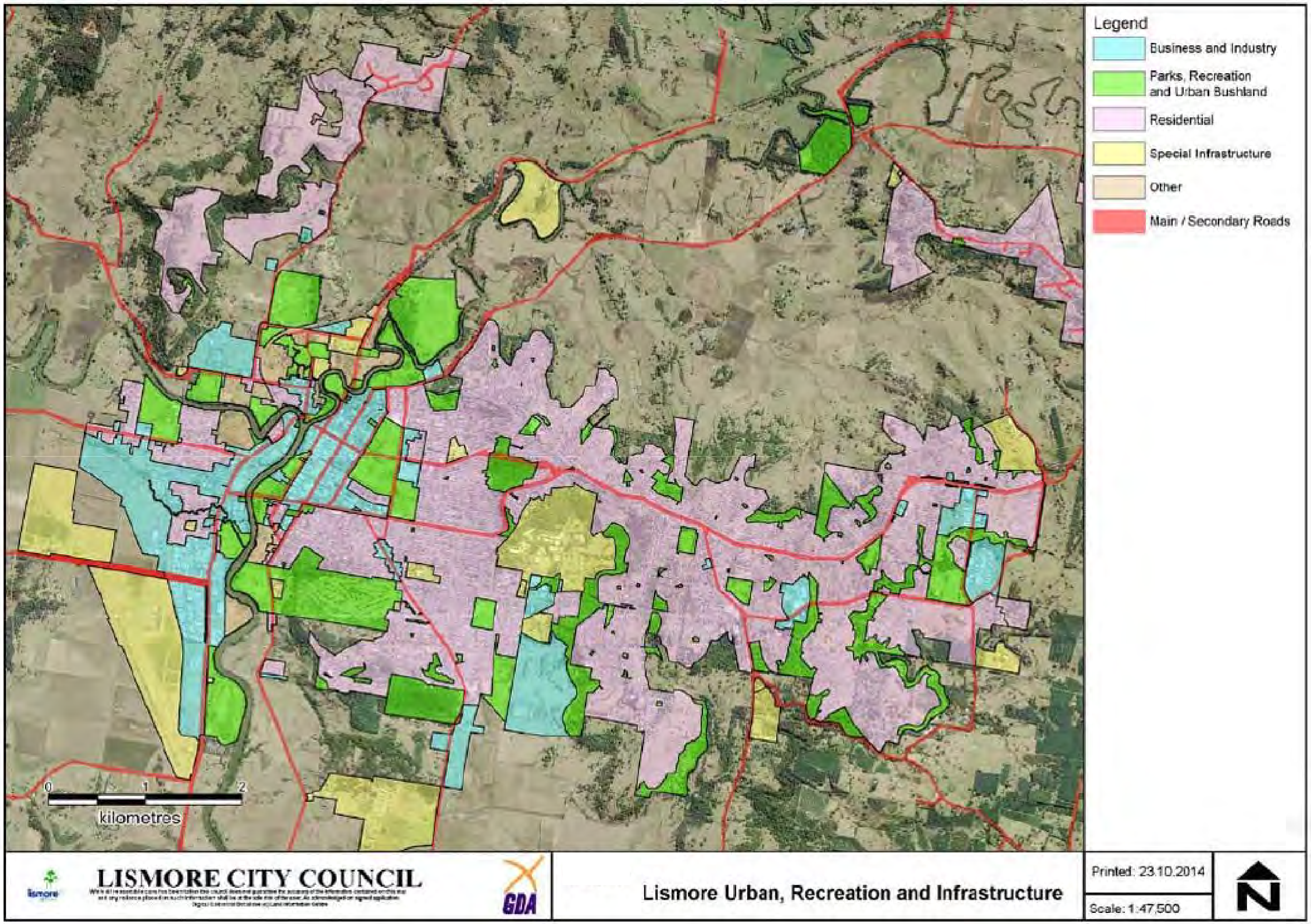


Figure 10: LCC LEP 2012 land zoning

Source: LCC (2015c)

Approximately 52% of the study area is zoned as urban land including commercial, residential, industrial and recreational land uses. The main commercial centre is located within the central business district (CBD) of Lismore. Other main retail areas include large shopping complexes, Lismore Square and at Goonellabah. Southern Cross University, an educational and community hub, encompasses a relatively large area within in East Lismore. The Lismore urban area includes many public and private recreation areas with the main areas being around Lismore Park in central Lismore, Wade Park in East Lismore, Arthur and Nesbitt Parks in North and South Lismore respectively and Hepburn Park in Goonellabah.

Residential areas are distributed throughout the entire urban area from South and North Lismore, Central Lismore, East Lismore through Lismore Heights and Goonellabah. General residential areas are concentrated in East Lismore, Lismore Heights and Goonellabah. Future extension of residential areas to the north of Goonellabah and on North Lismore Plateau is anticipated as well as small pockets of infill development (see Section 2.11).

The main concentration of industrial land in Lismore is situated in South Lismore with small areas located in North Lismore and Goonellabah.

Nutrient-rich soils combined with high rainfall and a temperate/sub-tropical climate provides conditions suitable for a diverse range of land uses in the Lismore area. Approximately 47% of the study area is zoned as rural. Within the study area the main agricultural rural land uses include grazing (cattle), particularly on the lower lying alluvial floodplains, and horticulture (macadamias) concentrated on the kraznozem soil ridges.

2.11 Land Development

The average rate of new dwelling approvals in the Lismore urban area was 87 per year between 2003 and 2013 with an average of 61 lots created each year. 20% of approvals were dual occupancy and multi-unit dwellings. 85% of dwellings were approved in Goonellabah, which reflects the availability of zoned and serviced land (LCC, 2015c).

A diversity of housing and lifestyle choices is available in Lismore urban area and residents have access to a choice of urban or rural residential lifestyles. Apart from land at North Lismore Plateau, to the north-west of the CBD, much of the vacant zoned land is to the south of Ballina Road. There is a strong demand for housing on the northern ridges (north of Ballina Road) on land that enjoys good views and aspect and is relatively level, however there is a limited supply of vacant zoned residential land in this area (LCC, 2015c).

Employment in Lismore LGA is predicted to increase by 3,111 between 2011 and 2031 as a result of a growing population, a well-qualified and young workforce and above average unemployment and underemployment rates (LCC, 2015c). Additional land is not predicted to be required for employment purposes.

The approved residential subdivisions currently under construction within Lismore urban area are shown in Figure 11 and summarised in Table 4. Stormwater management for these areas is approved by Council in accordance with the Water Sensitive Design DCP Chapter 22. Actual timing of dwelling construction will depend on developer priorities.

Potential future development is discussed in Section 9.2.

Table 4: Approved residential subdivisions currently under construction

Development Area	Area (ha)	Total Anticipated Dwellings					
		2016-2035	2016 -2020	2021 -2025	2026-2030	2031-2035	Total
William Blair	1.7	20	10	10	-	-	38
Sanctuary Hill	12.9	60	20	30	10	-	71
Fischer St	6.7	200	125	40	35	-	200
Just St	7.5	50	30	20	-	-	50
Holland St	5.6	30	30	-	-	-	43
De Re Estate	12.2	58	5	10	20	23	58
Oak Trees	4.8	50	15	10	15	10	76
Ubrihein Estate	10.6	60	-	20	40	-	74
Waterford Park Estate	32.4	80	-	25	20	35	269

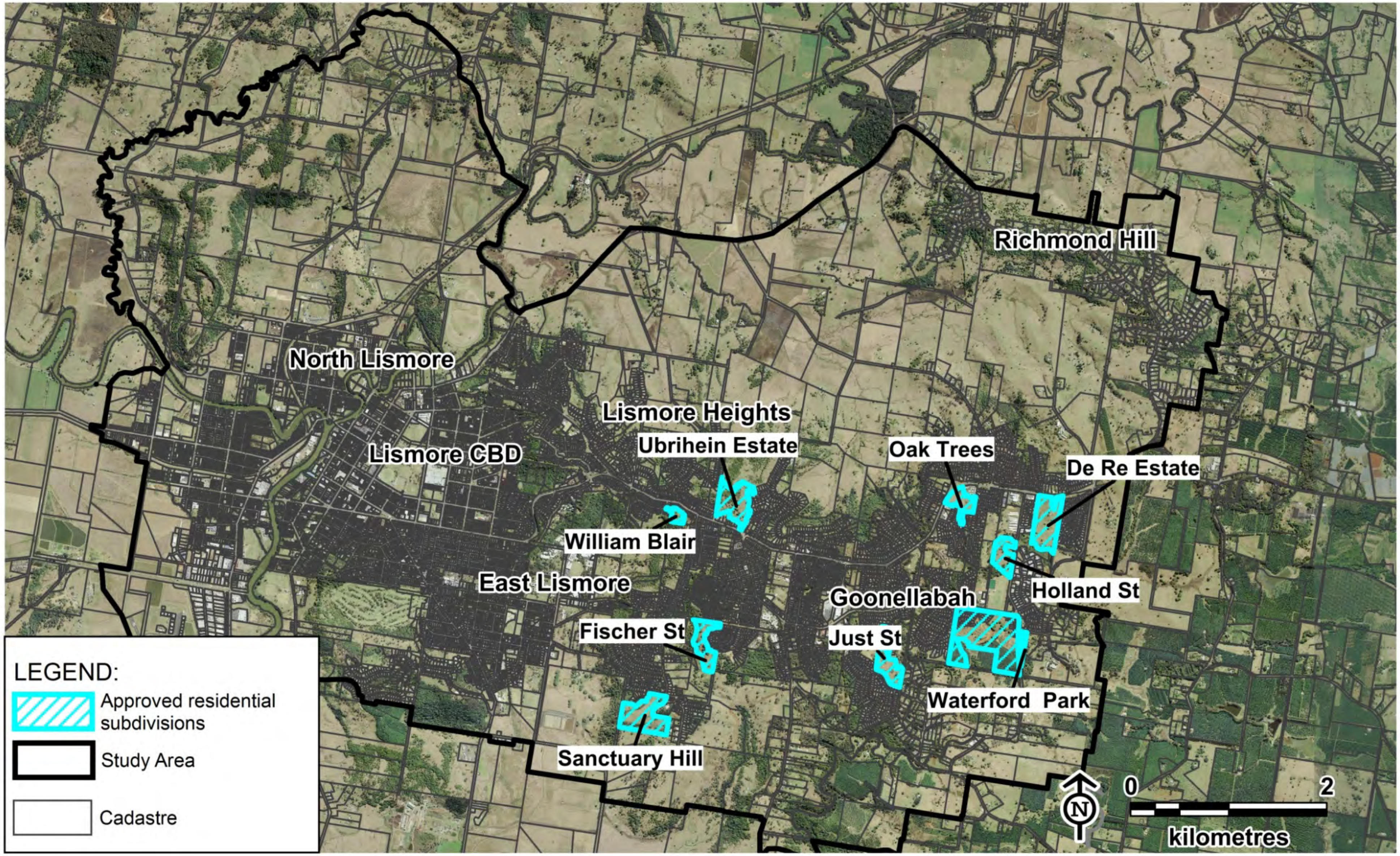


Figure 11: Current approved residential subdivisions

3. DESCRIPTION OF THE URBAN STORMWATER SYSTEM

Urban stormwater infrastructure includes both drainage infrastructure and stormwater quality treatment infrastructure.

Stormwater drainage infrastructure within Lismore includes stormwater pipes, pits, street gutters, inter-allotment drainage (private), open drains such as concrete channels, swales, vegetated channels and natural drains such as gullies and creeks. Table 6 provides a summary of the drainage infrastructure within the Lismore urban area.

LCC has implemented a number of stormwater treatment devices aimed at improving the water quality in Lismore's waterways. Council maintains a stormwater quality device database to gather information on the number, type, maintenance regime and performance of all known devices in Lismore. Stormwater treatment is classified as primary, secondary or tertiary as shown in Table 5. Table 7 provides a description of different types of stormwater treatment devices in use within Lismore.

Table 5: Stormwater treatment types

Type	Description	Examples
Primary Treatment	Removal of the majority of gross pollutants and coarse-medium grained sediments by screening or sedimentation. Without primary treatment, there is a risk that secondary and tertiary treatment devices will become smothered, affecting their treatment capacity.	Gross pollutant capture devices (GPTs) Sediment basins
Secondary Treatment	Removal of the majority of coarse, medium and fine grained sediments, as well as a significant proportion of the pollutants attached to sediments, by enhanced sedimentation and filtration	Grass or vegetated swales Sand filters
Tertiary Treatment	Removal of the majority of sediments, attached pollutants and dissolved pollutants by sedimentation, filtration and biological uptake	Bioretention systems Constructed wetlands

Table 6: Stormwater drainage infrastructure within the Lismore urban area

Drainage Type	Materials	Dimensions	Description	Example
Concrete [1]				
Open concrete channel (conduit)	• Fibre reinforced concrete • Steel reinforced concrete • Stone or masonry	Width: 250 mm -10 m Depth: 300 mm -2 m	Hard lined major drainage system.	
Pipe (conduit)	• Steel reinforced concrete	Diameter: 375 mm-2.4 m	Major or minor drainage system, receives stormwater from surface drainage and conveys it underground and/or under infrastructure such as roads and buildings	

Drainage Type	Materials	Dimensions	Description	Example
Box (conduit)	• Steel reinforced concrete	Width: 150 mm -4 m Height: 100 mm -1.4 m		
Kerb and gutter	Concrete	Standard	Receives surface stormwater runoff from road surfaces and directs it to underground conduits.	
Kerb Inlet Pits	Concrete	Width: 250 mm -1.2 m Length: 250 mm -1.2 m Depth: 400 mm – 2.9 m	Direct surface stormwater to subsurface infrastructure	

Drainage Type	Materials	Dimensions	Description	Example
Overflow Pits	Concrete	Various	Direct sub-surface stormwater to surface	
End Structures (headwalls)	Concrete	Various	Structure at the outlet of subsurface drainage infrastructure.	

Drainage Type	Materials	Dimensions	Description	Example
Inter-allotment drainage	Various, including open drains, concrete pipes and pits.	Various	Private infrastructure used to convey stormwater across lands, other than the development site, to gain access to the public drainage system or a natural watercourse.	
Non-concrete open drainage				
Open drain (swales)	Grass	Various	Open grassed channels that function as both stormwater conveyance and treatment.	
Vegetated channels	Vegetation	Various	Revegetated open channels that function as both stormwater conveyance and treatment.	

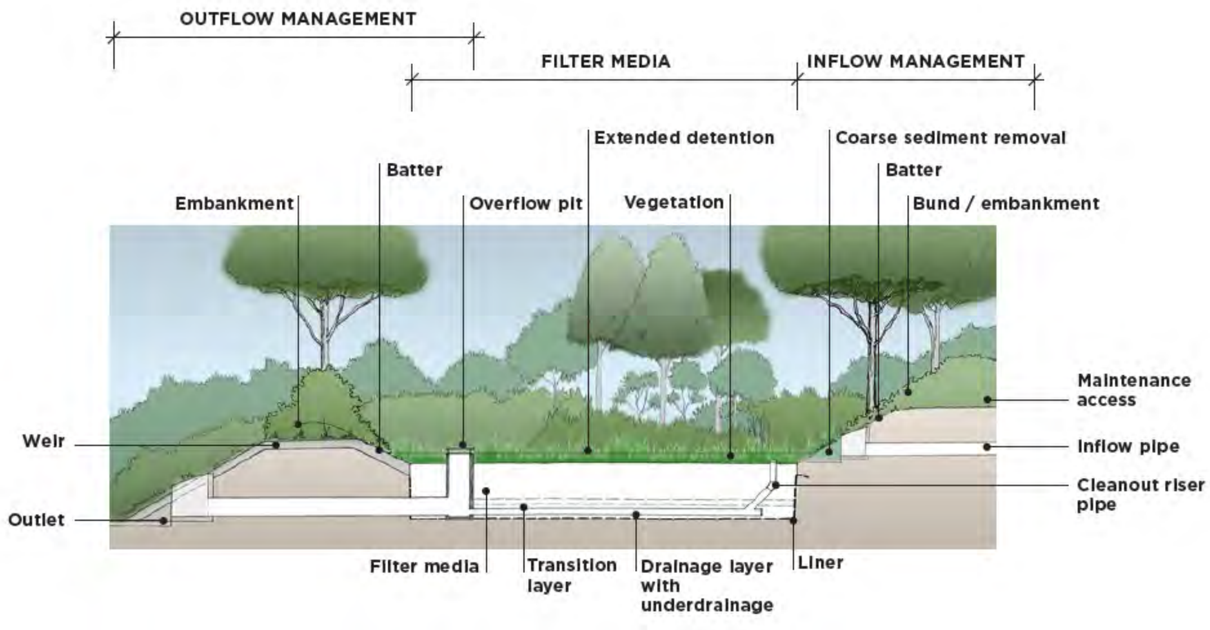
Drainage Type	Materials	Dimensions	Description	Example
Natural drainage				
Natural channels, natural drains	Natural	Various	Ephemeral streams and creeks located within the urban landscape that receive and convey stormwater from the urban environment.	

1. Data from Council's asset register.

Table 7: Stormwater treatment devices

Device	Description/Function	Example
Gross pollutant trap (GPT)	A gross pollutant trap is a sediment trap with a trash rake – usually constructed of vertical steel bars – located on the downstream end of the trap. GPTs are primarily designed to remove litter, debris and coarse sediments. Nutrient loads of receiving waters may be reduced slightly as organic debris is removed in addition to nutrient removal from settling sediments. They generally consist of a large concrete lined wet basin upstream of a weir, with a trash rack located above the weir.	 Gasworks Creek (Keen St)
Detention basin	Detention devices that are designed to capture and temporarily store stormwater from major rainfall events, thereby reducing peak flow rates. Stormwater is then discharged to the drainage system to continue in the hydrological cycle at a controlled rate. Detention devices act to mitigate potential downstream flooding impacts.	 Nesbitt Park (behind South Lismore Bowling Club)

Device	Description/Function	Example
Retention basin	Stormwater is held for relatively long periods for domestic/industrial use and natural processes of infiltration, percolation and evapotranspiration (not via direct discharge to watercourses). Retention or settling basins generally rely on physical settling rather than biological means of pollutant removal which occurs in wetlands. The basins can take the form of a formal tank or less formal pond. Sedimentation occurs when water velocities are reduced to a point where the material drops to the bottom of the structure	 Kookaburra Terrace Goonellabah

Device	Description/Function	Example
Bio-retention systems	A device that is designed to capture and temporarily store stormwater before passing through a filter medium. Filtered runoff is normally collected and returned back to the stormwater system. Bio-retention effectively reduces stormwater pollution and provides some storage for extended detention as part of its retention storage capacity. It is also designed for flood control if associated with additional storage capacity and separate outlet control for this purpose.  Components of a typical bioretention system (Water by Design, 2015)	

Device	Description/Function	Example
	Rain garden – Generally consists of a filter media densely vegetated with suitable plants. As stormwater passes through the media particles and pollutants are captured by filtration, adsorption and biological processes. Once passed through the media the stormwater is conveyed via a slotted pipe to the stormwater system. Rain gardens are typically located street side and in parking lots and used to treat road surface runoff.	 Nesbitt Park carpark South Lismore
	Bio-retention basin – A retention basin (see above) that integrates vegetation, medium-term stormwater retention and sub-surface filtration or infiltration. Vegetation includes both canopy and understorey	 Goonellabah Sports and Aquatic Centre

<table>
<tr><th>Device</th><th>Description/Function</th><th>Example</th></tr>
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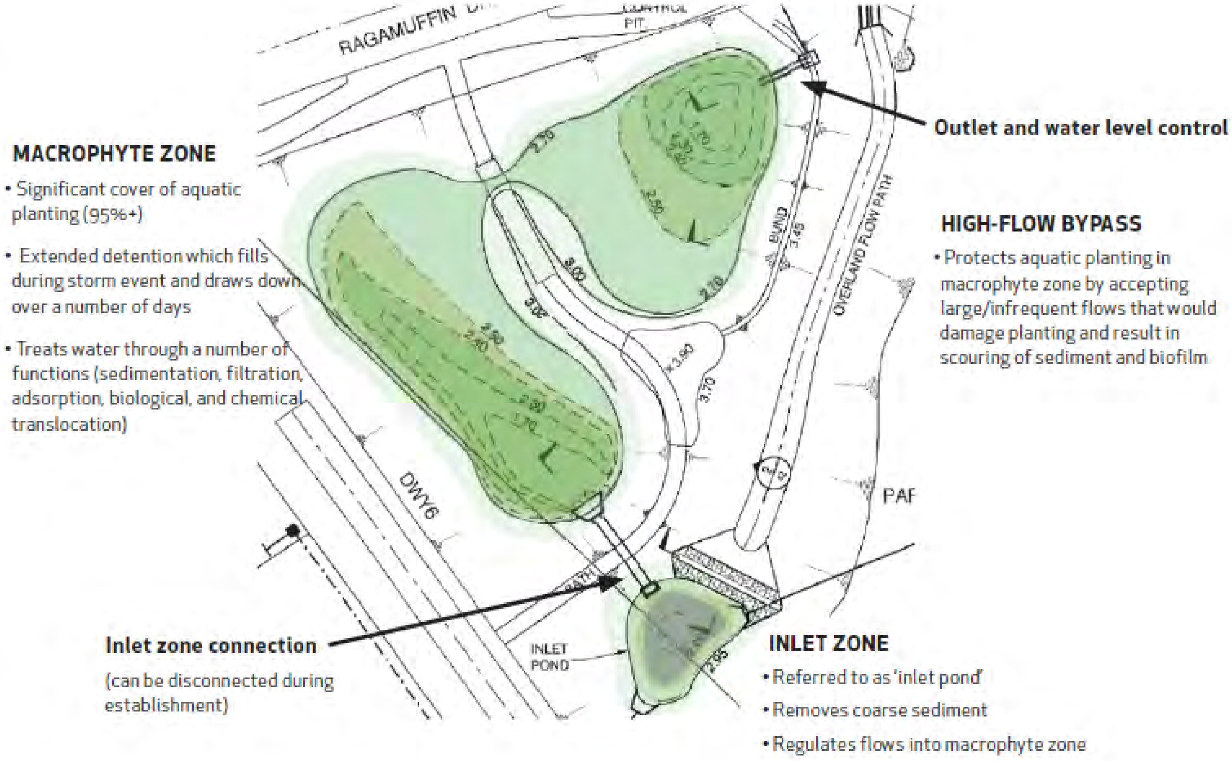
Constructed wetland – shallow, extensively vegetated water bodies that use enhanced sedimentation, fine filtration and biological uptake processes to remove pollutants from stormwater. Water levels rise during rainfall events and outlets are configured to slowly release flows, typically over two to three days, back to dry weather water levels. In addition to treating stormwater, constructed wetlands can also provide habitat, passive recreation, improved landscape amenity and temporary storage of treated water for reuse schemes.
Wetlands generally consist of an inlet zone (sedimentation basin to remove coarse sediments, a macrophyte zone (a shallow heavily vegetated area to remove fine particulates and uptake soluble pollutants) and a high flow bypass channel (to protect the macrophyte zone from scour and vegetation damage).


Components of a constructed wetland (Water by Design, 2012b)
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Slaters Creek constructed wetland North Lismore
(Photo: A. Nguyen)
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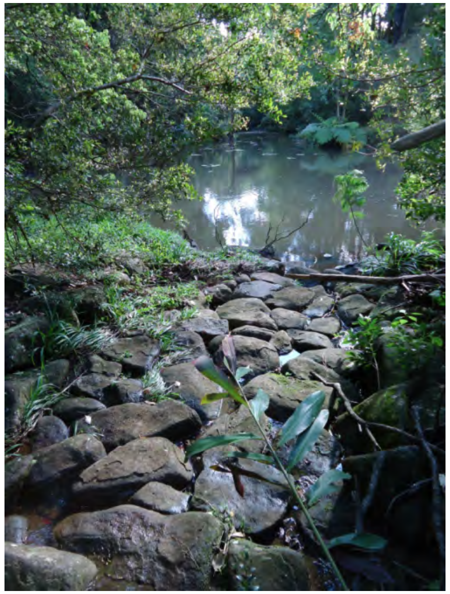
Device	Description/Function	Example
Swales	Grassed open channels that capture and treat stormwater runoff by means of filtering and conveyance during regular rainfall events with an average recurrence interval in the range 3 – 6 months. Grassed swales are less effective than bio-retention systems in treating stormwater pollution but can easily be accommodated in landscape design and are easy to maintain. They do not provide any storage capacity for extended detention or flood control purposes.	
Vegetated channel	Aims to retain, restore and/or rehabilitate the natural features of a watercourse to be compatible with the environment in which it is located. The basic principles are to maintain the hydraulic conveyance requirements of engineered or affected channels, while improving environmental values.	 Nesbitt Park South Lismore

Device	Description/Function	Example
Channel armouring	Armouring of stormwater channel or outlet with rocks to stabilise the drainage path thereby preventing erosion and sedimentation. These are not considered a treatment device as such, however are a preventative measure for erosion and associated stormwater quality issues.	 Channel armouring near Ravenswood Drive, Goonellabah leading in to Tucki Tucki Creek (Photo: A. Nguyen).

Source: adapted from LCC (2007)

4. IMPACTS OF URBAN STORMWATER ON WATERWAYS

Lismore's waterways are under pressure from past and existing development, catchment disturbance and hydrological modification, land use management and large-scale vegetation changes. Urbanisation has affected receiving environments through:

- Changes to the hydrologic characteristics (catchment hardening) of lands making them drain more quickly, partly due to the increased imperviousness, e.g. roads and roofs;
- The use of hydraulically efficient stormwater pipe systems which deliver stormwater to the downstream waterway more quickly; and
- Changing the quality of stormwater runoff due to the use of fertilisers, cars, lawnmowers and domestic animals, etc.

Looking forward, the waterways face continued pressure from future development within the catchment. While urban stormwater can be a significant issue with respect to the health of the waterways, it is necessary to recognise the other major (non-urban stormwater) factors which contribute to degradation of the waterways:

- Wilsons River flood events and poor water quality which are largely attributed to the effects of floodplain vegetation clearing and modification;
- The impacts of floodplain drainage infrastructure including constructed drains, canals, levees and floodgates;
- Sewer overflows and STP discharges;
- Diffuse pollutant loading from agricultural land; and
- The poor condition of the riparian zone.

While the impact of nutrient loads and pollutants from urban runoff may be negligible in comparison to the impact of diffuse loads from the catchment during significant rainfall events, pollutant loads from urban inputs become relatively more important to water quality during the dry season when catchment inputs are low.

On a local scale, there are likely to be direct impacts on receiving environments as a result of urban stormwater. The stormwater impacts on receiving environments are discussed under the broad headings of water quality, modified hydrology and habitat values.

4.1 Urban Stormwater Quality

Water quality is an important determinant of the health of aquatic ecosystems, visual amenity of waterways and the suitability of water for recreational activities involving human contact. Various stormwater pollutants can cause a range of adverse impacts on human health and aquatic ecosystems. Water quality indicators of concern include:

- Visual Water Quality Indicators: Inorganic debris and litter, such as plastics, car tyres, bottles, aluminium cans, cigarette butts and foam boxes are highly visible and often raise community concerns. They can harm wildlife and damage their natural habitats as well as threatening public safety and increasing maintenance of stormwater assets.

  Provision of suitable, highly visible public waste receptacles and education are the key to managing sources of gross pollutants. While litter continues to be an issue, other sources of debris (e.g. due to storm damage, uncovered loads, etc.) also contribute to gross pollutant loads.
- Suspended Solids: Suspended solids generally consist of sediment particles that have been transported from the catchment into waterways via runoff. High suspended solid concentrations in

waterways can also be a result of bank erosion or re-suspension of previously deposited bottom sediments in waterways during high flows. Turbidity from suspended solids reduces water clarity and light penetration in water, affecting the growth of aquatic plants. When silts and clays settle, they may smother bottom dwelling organisms and disrupt their habitats. Since metals, phosphorous and various organics are adsorbed and transported with these particles, sediment deposits may lead to continued release of toxins and nutrients in the waterway. The waterways of the study area, including the Wilsons River, can become highly turbid following significant rainfall. Areas of exposed soil, such as construction sites, are particularly important sources of suspended sediments that can travel to waterways via stormwater systems. Correct management of construction sites will have a large impact on the amount of suspended sediment carried to receiving environments (refer Section 4.1.2).

- Nutrients: Excessive amounts of nutrients, such as nitrogen and phosphorous, can promote rapid growth of aquatic plants, including toxic and non-toxic algae. This excessive growth results in the smothering and/or shading of other plants, deposition of organic sediment and depletion of water column dissolved oxygen. The most effective management of nutrients once in the stormwater system is to trap fine sediments (silt and clay) and organic material and either biologically treat or periodically remove this material from the stormwater system. Up to 85% of phosphorus and 70 - 80% of nitrogen can be isolated as particulate matter. Constructed wetlands, bioretention systems and detention basins have been shown to be effective at slowing stormwater flows and allowing sediment to settle out of solution with the additional function of biological uptake of nutrients, prior to discharge of water to receiving environments.

  Local studies of stormwater quality in Lismore (e.g. McMellon, 2011) have offered insights into the impact of stormwater runoff on nutrient loads to downstream waterways. McMellon found that the three largest nutrient contributors were Lagoons, Browns and Monaltrie Creeks. Sources of the nutrients varied across the creeks with grazing and pasture the likely sources in Lagoons Creek, inorganic fertilisers in Browns Creek and a strong correlation between nutrients and soil particles in Monaltrie Creek.

- Algal Blooms: An algal bloom is caused by the rapid excessive growth of algae, generally caused by high nutrient levels and favourable conditions. Algae are a natural component of aquatic environments and even when algal growth is abundant, it is not necessarily a problem. However, when algal blooms increase in intensity and frequency, the results can cause community concern, health problems, and in some cases can be catastrophic to the environment. Algal blooms can upset the natural balance of plant and animal ecosystems in a waterway or wetland and cause odours, reduction in visual amenity and fish kills. They can also degrade recreation, conservation and scenic values and interfere with economic uses such as fisheries and tourism.

  The Wilsons River CMP reported high nutrient levels and the risk of algal blooms as one of the key issues for the Wilson River. Most strategies to address problems of algal blooms require reduction in the loads of phosphorous entering waterways from runoff. Planning on a catchment basis needs to consider pollutant loads from the various existing land uses and any proposed land uses in the whole catchment.

- Oxygen Demanding Materials: Sources of oxygen-demanding materials include biodegradable organic debris, such as decomposing food and garden wastes and the organic material contained in sewage. Biological and chemical oxygen-depleting substances can give rise to water-borne diseases and present serious health risks. The biological and chemical oxygen demands of sewage overflowing into stormwater systems are high. Management of storm sewer overflows requires managing the sewer hydraulics and redirecting flows to minimise the impact of storms. Education promoting public awareness of correct disposal of garden waste, lawn clippings and other organic materials is also important in managing oxygen demanding pollutants from urban areas.

- Pathogens and micro-organisms: Bacteria and viruses found in soil and decaying vegetation, and faecal bacteria from sewer overflows, septic tank seepage and animal waste are common contaminants in stormwater after heavy rain. Pathogens and micro-organisms, including bacteria, viruses and faecal coliforms, cause water-borne diseases. They can present serious health risks from cholera, typhoid, infectious hepatitis and a range of gastrointestinal diseases.

  Rogers (2008) found that faecal coliform concentrations exceeded ANZECC guidelines for secondary recreation in Browns Creek. Bird faeces, human faecal matter and dog and flying fox faeces were found to be contributors.

  Both LCC and the community have a key role to play in the effective management of this issue. Reducing the occurrence of sewage overflows into the stormwater system should be a key target for Council. Education promoting public awareness of the sources of pathogens to waterways will be important. This would include removal of pet droppings, particularly from impervious surfaces.

- Toxic Organics: These include garden pesticides, industrial chemicals and landfill leachate. They may cause long-term ecological damage and threaten human health. Organochlorine pesticides, herbicides and insecticides can be accumulated in organisms and persist in the environment over long periods. It is not known whether toxic organics are an issue for LCC stormwater as there has not been any targeted monitoring conducted to date. Education focussing on public awareness of stormwater issues such as application of fertilisers, herbicides and pesticides to domestic gardens and disposal of these chemicals will be important in managing this issue.

- Heavy Metals: Industrial chemicals can enter stormwater from a number of sources including sewerage overflows, illegal dumping and accidental spillages. Dust from brake and clutch linings of motor vehicles coupled with waste from degrading roadways and water pipes can inject heavy metals (mercury, cadmium, lead and zinc) into the stormwater system. These metals can also be released from landfills through leaching and by poor agricultural practices. It is not known whether heavy metals are an issue for LCC stormwater, as there has not been any targeted monitoring conducted to date.

- Oils and Surfactants: Rubber from tyres, hydrocarbons and oil and grease washed from road surfaces, domestic and industrial sites, plus surfactants from detergents used for washing vehicles, are common sources of toxic pollutants in stormwater. There are some service stations within the Lismore urban area without grease and oil interceptors (with surface runoff directly discharging to the stormwater system). Education focussing on public awareness of stormwater issues, such as washing cars on the grass and management of oils and other chemicals will be important in minimising these pollutants reaching waterways.

4.1.1 Sewer Overflows

Sewerage systems are designed to overflow at designated locations in the event of system failure (such as electrical outage) or in wet weather when the capacity of the sewerage system is exceeded (surcharged). Wet weather overflows are caused by excessive infiltration and inflow of stormwater and groundwater into the sewerage system through cracks and leaking joints. The locations of sewer overflows within the study area are shown in Figure 12. Many of the overflows discharge into stormwater systems and drainage channels. Dry weather overflows can cause pollution of waterways from undiluted sewage. Wet weather overflows are diluted through stormwater input from other sources.

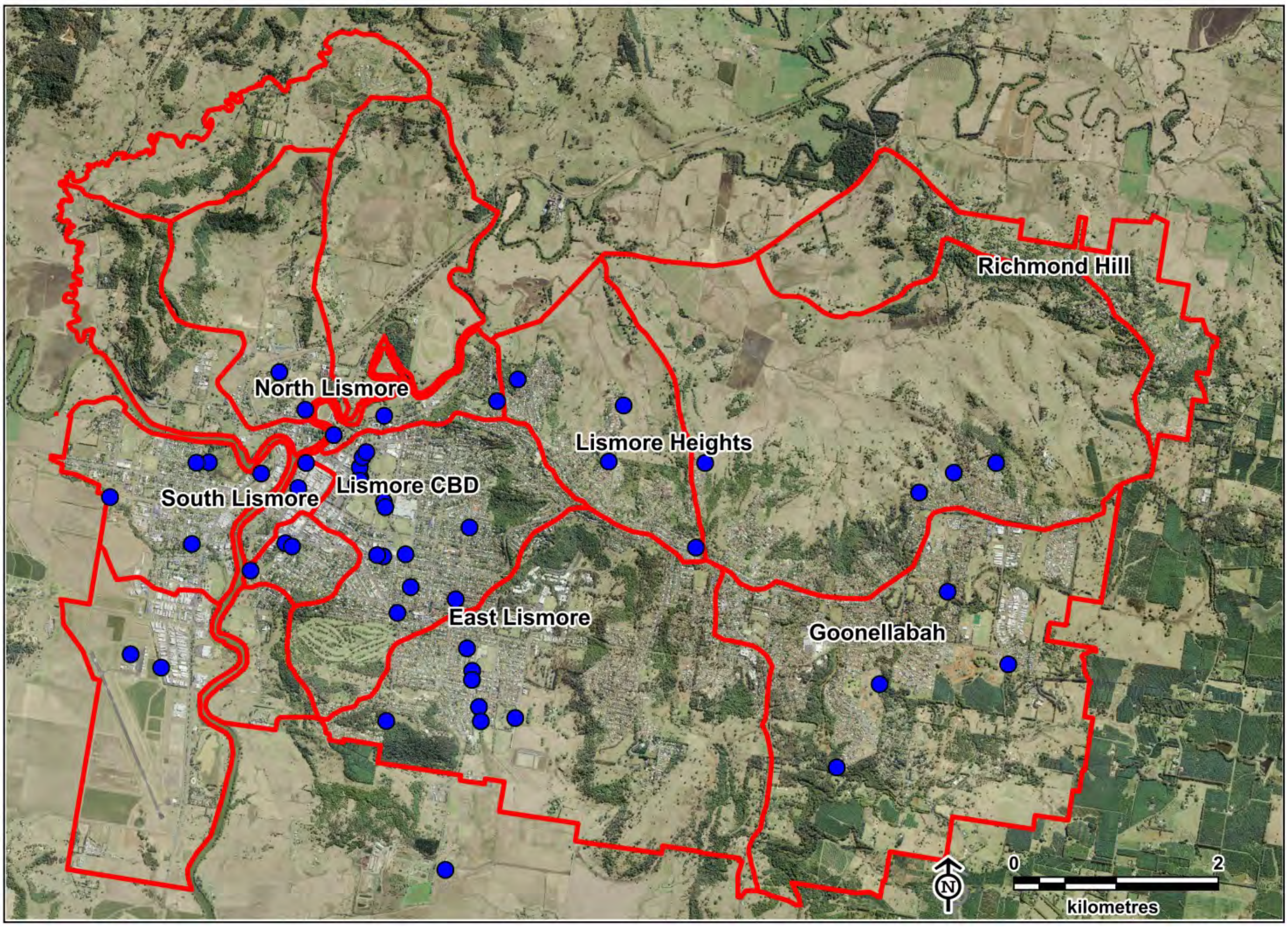


Figure 12: Location of potential sewer overflow points within the study area

4.1.2 Construction Runoff

Building construction, particularly during the wetter months of the year, can exacerbate soil erosion, lead to blocked drains and contribute to stormwater turbidity, stream sedimentation and pollution. When a land parcel is cleared of vegetation, the soil is exposed and is vulnerable to erosion from wind and rainfall events. Eroded sediment becomes entrained in the runoff and transported to receiving waterways resulting in elevated suspended solids and turbidity levels in the discharges from the site (Figure 13). Typically in larger scale developments, site compounds also provide potential stormwater issues in the form of fuel and chemical storage and litter. Many of the water quality complaints received by LCC relate to poor erosion control on building sites.

Figure 13: Exposed soil during housing construction and sediment collected in sedimentation basin downstream of the construction site following significant rainfall (May 2015)

Physical methods of erosion and sediment control, as well as managing the amount of exposed soils at any one time are required to minimise stormwater impacts during constructions phases. Typically, inspection and auditing of construction sites is conducted by Council in response to complaints. In the past, educational programs have targeted builders and developers to assist in awareness and improved implementation of control measures. These programs were well received and further programs are likely to produce improved erosion and sediment controls on building and development sites, including Council managed job sites.

4.2 Modified Hydrology

Urban development alters the natural flow path of water by converting a large percentage of naturally pervious surfaces to impervious surfaces. Instead of infiltrating into soils and percolating to groundwater tables, the amount of stormwater flowing over the land surface is increased by impervious surfaces (roofs, roads, driveways, etc.) and is conveyed at accelerated rates via stormwater drains or pipes to receiving environments. The increase in volume of runoff and reduced delivery time to the receiving environment can cause ponding and/or flash flooding during particularly heavy rainfall.

In the past, the prime objective of urban stormwater management has been mitigation of local flooding and the typical approach was to channel stormwater as rapidly as possible from urban areas to the nearest waterway. In some cases, downstream environments can be permanently altered by changes to hydrology. High velocity stormwater flow has multiple detrimental effects on receiving environments including:

- Scouring of channels and streams;
- Bank undercutting and slumping;
- Increased turbidity of the water column;
- Downstream sedimentation leading to an increased risk of flooding; and
- Potential loss of riparian vegetation and aquatic and wildlife habitat.

Some sites within the study area (e.g. Monaltrie Creek) experience scouring, erosion, gullying and sedimentation from uncontrolled runoff during heavy rainfall events. The nature and severity of these impacts is governed by the intensity of the rain event, the erosive potential of soils and the degree of protection afforded to land surfaces either by vegetation, rock or other built structures. Moderately erodible krasnozem soils occur in the urban areas of Goonellabah. These areas are more susceptible to erosion especially where stream gradients are high (faster flow) or there is minimal overland flow of stormwater before it enters natural drainage channels.

4.3 Habitat Values

Several of the waterways within the Lismore urban area receiving urban stormwater runoff are classed as key fish habitat (See Section 6.1.2). Tucki Tucki Creek in particular is considered to be important habitat as it is known Purple Spotted Gudgeon (Endangered) habitat. There is potential for these environments to be periodically impacted by stormwater through poor water quality events and factors affected by modifications to hydrology. The mechanisms for impact include poor water quality, increased flows with potential to scour downstream habitats and deposition of sediment to smother benthic habitats.

Environmental weeds are an on-going issue throughout the LGA affecting habitat values and in some cases the function of stormwater management systems. The spread of weeds is often assisted by natural factors such as wind and floods, however, there are a number of factors associated with stormwater assets that can accelerate weed encroachment within stormwater infrastructure and receiving environments. The conditions around stormwater discharge areas are often suitable for weed growth as they typically have good water availability and receive nutrient runoff from the upstream catchment. Once weeds are established within the stormwater network, flows can continue to transport weed propagules (seeds, roots, tubers, etc.) further downstream, resulting in on-going weed management issues in receiving waterways and degradation of natural habitats. Community education regarding disposal of garden clippings (particularly weeds) assists in minimising transport of propagules to receiving environments. Regular maintenance and weed removal in vegetated stormwater assets is required to ensure that stormwater assets function correctly and to minimise weed proliferation.

5. URBAN STORMWATER MANAGEMENT AREAS

The study area includes many urban stormwater sub-catchments as shown on Figure 14. The sub-catchments were delineated utilising the latest LiDAR information overlain by 1 m contours, waterways and layouts of stormwater infrastructure. Analysis of the 2007 USMP catchments revealed that the margins of some catchments (particularly those in South Lismore) did not accurately depict what was observed in the LiDAR and watershed mapping and therefore the boundaries were adjusted accordingly. The 2007 plan catchments were defined using coarse topographic information making it difficult to accurately reflect drainage patterns in low relief areas such as in South Lismore. The access to high resolution topographic data has allowed the refinement of the catchment boundaries to accurately depict drainage patterns observed on the ground.

For the purposes of this plan, 16 urban stormwater management areas were developed based on combinations of the urban stormwater catchments. The management areas serve to break the large study area down into smaller units, and to visualise at a suitable scale the location of stormwater assets in relation to receiving environments and any identified problem areas. A total of 16 management areas were identified with reference to hydrological sub-catchments.

The following tables and figures provide a summary of the characteristics of each urban stormwater management area. The tables present relevant information on each area including the location, general description, size, receiving environments, special features/values, land use and LEP zoning, potential stormwater pollutant sources/issues and any recorded stormwater treatment devices. The figures illustrate important features of each management area including stormwater sub-catchments, location of waterways, stormwater infrastructure, treatment devices and future development areas.

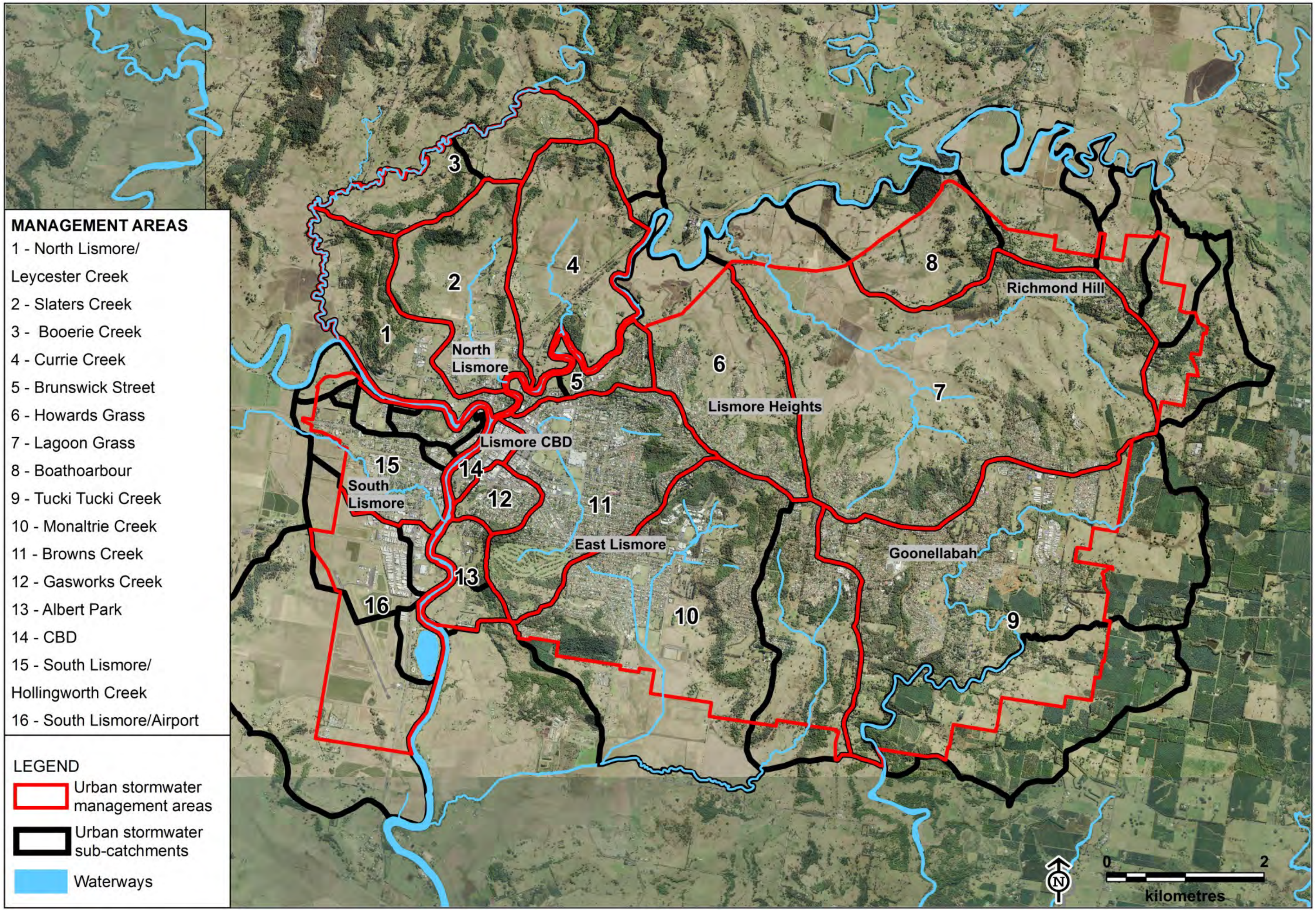


Figure 14: Urban stormwater sub-catchments and management areas

5.1 Stormwater Management Area 1 - North Lismore/Leycester Creek

<table>
<tr><td>Location:</td><td>North Lismore Plateau</td></tr>
<tr><td colspan="2">The North Lismore/Leycester Creek management area encompasses parts of North Lismore that drain into Leycester Creek including light industrial and retail areas in the North Lismore Business precinct and McCauley Street, open space including the Italo Club grounds, several council reserves and parks including Pritchard Park, south and south-west slopes of the North Lismore Plateau (including future development areas) and farmland. Residential properties are located between Crown and Wilsons Street in South Lismore and Bridge and Terania Street in North Lismore.
Roadside drainage consists of grassed swales with a small section of pipes and pits along Terania and Bridge Streets.</td></tr>
<tr><td>Total area:</td><td>248 ha</td></tr>
<tr><td>Receiving environments:</td><td>Leycester Creek</td></tr>
<tr><td>Special features/values:</td><td>Future development area, drinking water catchment</td></tr>
<tr><td>Current % developed to undeveloped land (approx.):</td><td>20% developed, 80% undeveloped</td></tr>
<tr><td>LEP Zoning (%):</td><td>2% Neighbourhood Centre, 7% General Industrial, 1% Light Industrial, 10% General Residential, 2% Low Density Residential, 5% Public Recreation, 3% Private Recreation, 64% Primary Production, 4% Rural Landscape</td></tr>
<tr><td>Main drainage infrastructure:</td><td>Grassed swales in all areas except for Terania and Bridge Street where pipes and pits are used</td></tr>
<tr><td>Stormwater treatment devices:</td><td>1 Bio-detention rain garden</td></tr>
<tr><td>Pressures</td><td>Future development, industrial runoff, urban runoff, road runoff,</td></tr>
</table>

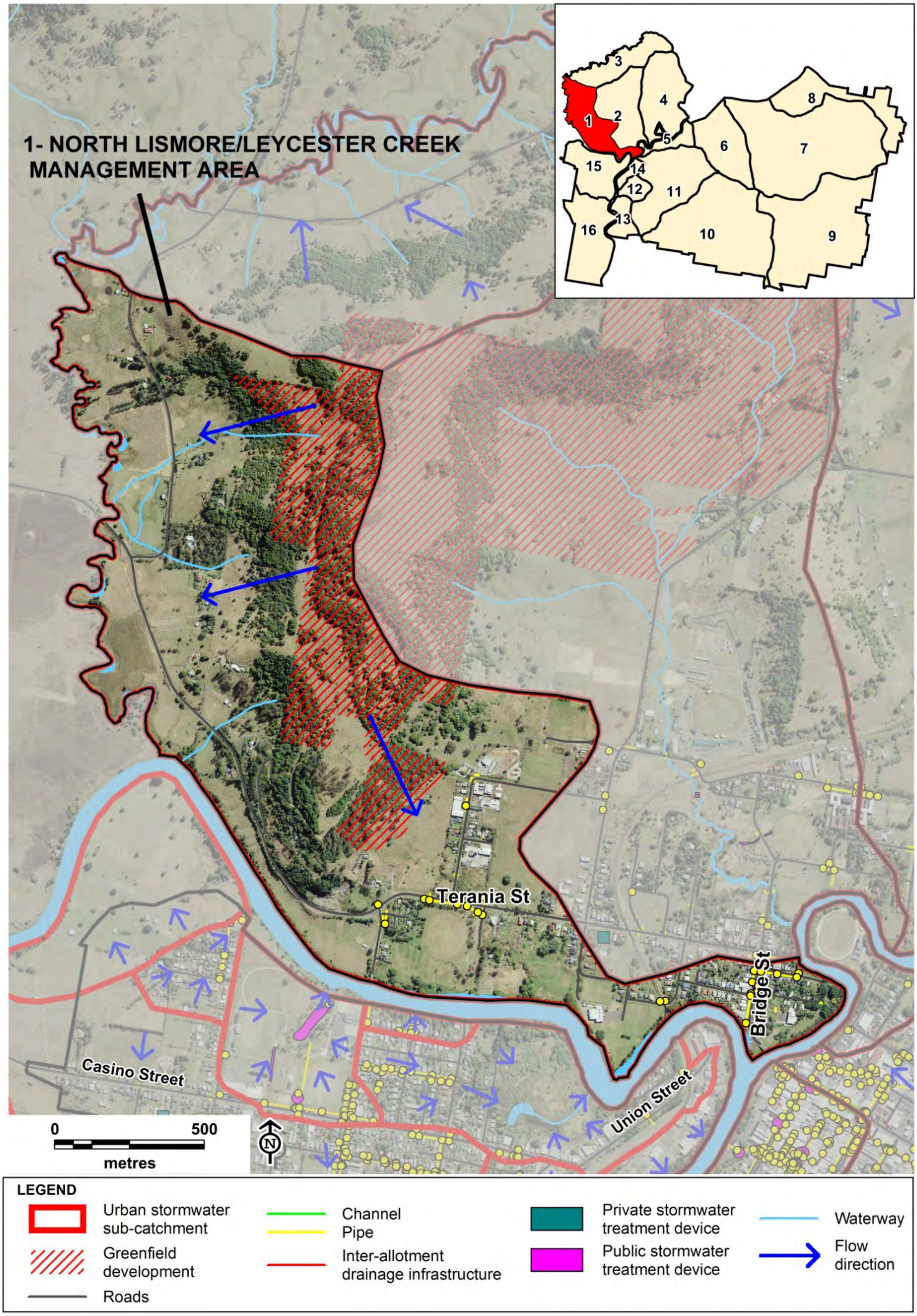


Figure 15: Stormwater Management Area 1 - North Lismore - Leycester Creek

5.2 Stormwater Management Area 2 - Slaters Creek

Location:	North Lismore, North Lismore Plateau
Parts of North Lismore, North Lismore Plateau and the surrounding grazing lands drain to form Slaters Creek, which flows in a south easterly direction to join the Wilsons River opposite the greyhound track. Residential land, domestic livestock paddocks, the Lismore Showgrounds and Saleyards and associated facilities are located in this sub-catchment. All roadside drainage consists of grassed swales apart from a small area along Terania Street. The creek is ephemeral west of Bridge Street with approximately 130m of the lower creek containing permanent water.	
Total area:	305 ha
Receiving environments:	Slaters Creek, Wilsons River
Special features/values:	Slaters Creek, within drinking water catchment
Current % developed to undeveloped land (approx.):	30% developed, 70% undeveloped
LEP Zoning (%):	2% Neighbourhood Centre, 1% General Industrial, 2% Light Industrial, 28% General Residential, 2% Low Density Residential, 8% Public Recreation, 6% Private Recreation, 40% Primary Production, 10% Rural Landscape, 2% Special Uses
Main drainage infrastructure:	Grassed swales and small sections of pipes and pits
Stormwater treatment devices:	Slaters Creek constructed wetland, 2 vegetated natural channels, 1 private detention system
Pressures	Agricultural runoff (grazing), North Lismore Plateau urban development

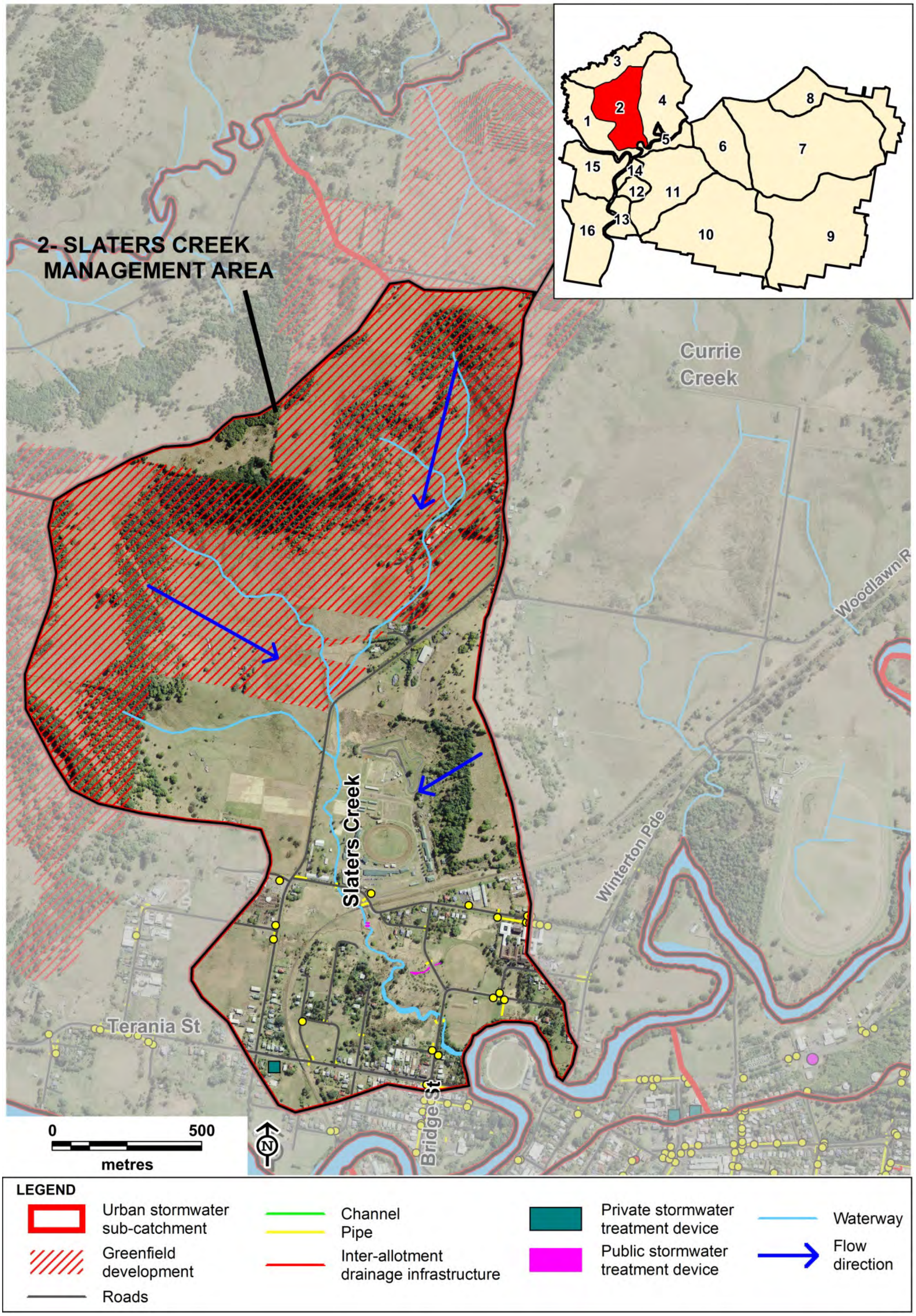


Figure 16: Stormwater Management Area 2 - Slaters Creek

5.3 Stormwater Management Area 3 - Booerie Creek

Location:	North Lismore Plateau
Booerie Creek management area is a new management area used to include parts of the future urban development area of North Lismore Plateau. The area encompasses the north west facing slopes of the plateau including several small tributaries of Booerie Creek. Currently the area is utilised mostly for agriculture with a small residential development in the north east corner of the area. Swales are the dominant drainage infrastructure within the residential area.	
Total area:	235 ha
Receiving environments:	Booerie Creek, Leycester Creek
Special features/values:	Primarily agriculture, future development, fish habitat, within drinking water catchment
Current % developed to undeveloped land (approx.):	10% developed, 90% undeveloped
LEP Zoning (%):	20% General Residential, 12% Low Density Residential, 55% Primary Production, 1% Natural Waterways
Main drainage infrastructure:	N/A
Stormwater treatment devices:	N/A
Pressures	Agricultural runoff, North Lismore Plateau urban development

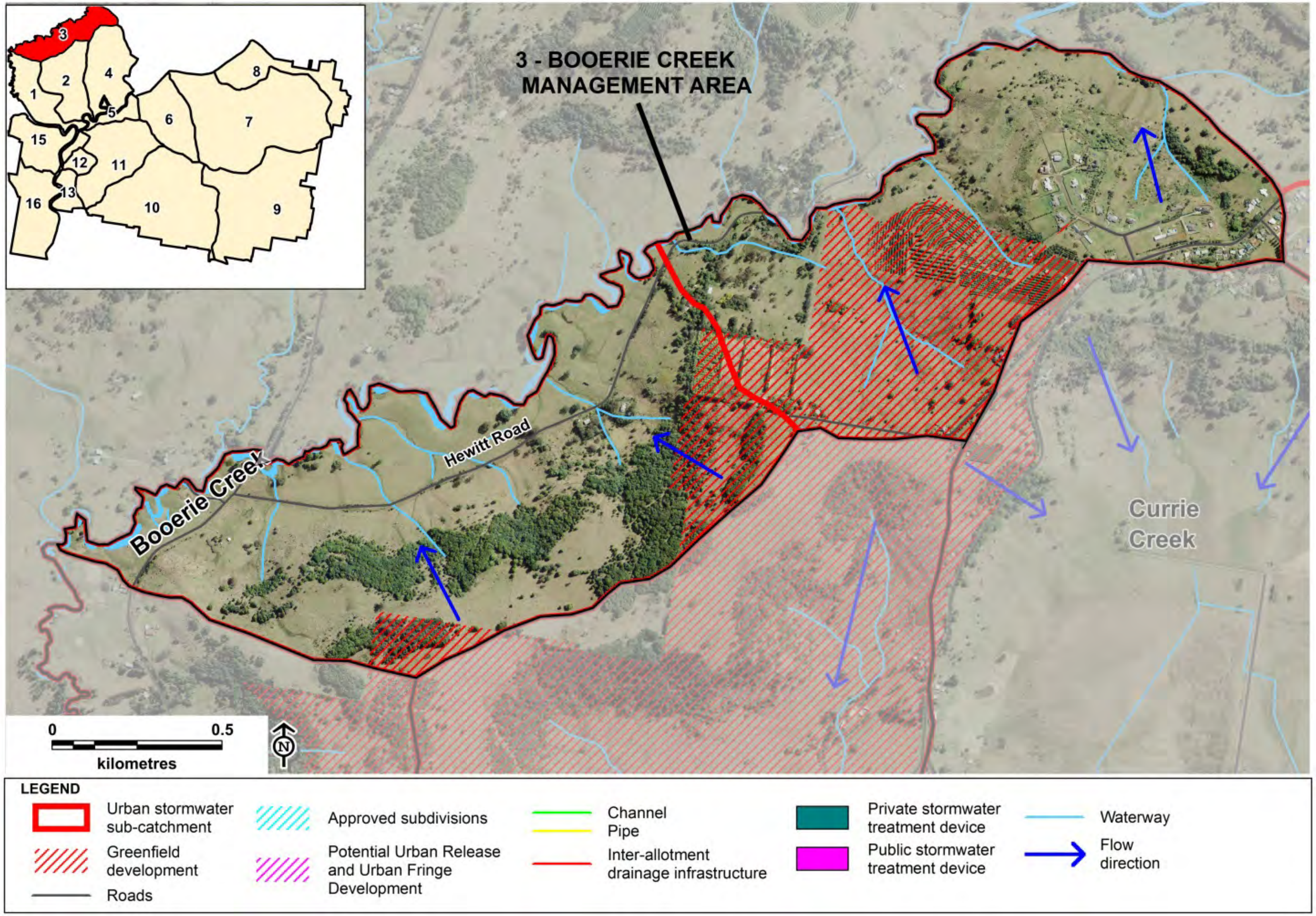


Figure 17: Stormwater Management Area 3 - Booerie Creek

5.4 Stormwater Management Area 4 - Currie Creek

Location:	North Lismore
The Currie Creek management area includes the Currie Creek catchment which drains the area north of Winterton Parade and Woodlawn Road in North Lismore. The ephemeral creek enters the Wilsons River on the western boundary of Currie Park. This area is primarily rural but also contains the Lismore Turf Club, Richmond River High School and a small number of residential properties. Swales are the dominant drainage infrastructure through the management area.	
Total area:	370 ha
Receiving environments:	Currie Creek, Wilsons River
Special features/values:	Within drinking water catchment, primarily rural
Current %developed to undeveloped land (approx.):	20% developed, 80% undeveloped
LEP Zoning (%):	4% Deferred Matter, 3% General Industrial, 4% Low Density Residential, 1% Public recreation, 9% Private Recreation, 72% Primary Production, 4% Rural Landscape, 2% Special Uses
Main drainage infrastructure:	Natural drainage and grassed swales
Stormwater treatment devices:	None
Pressures	Agricultural runoff, racecourse

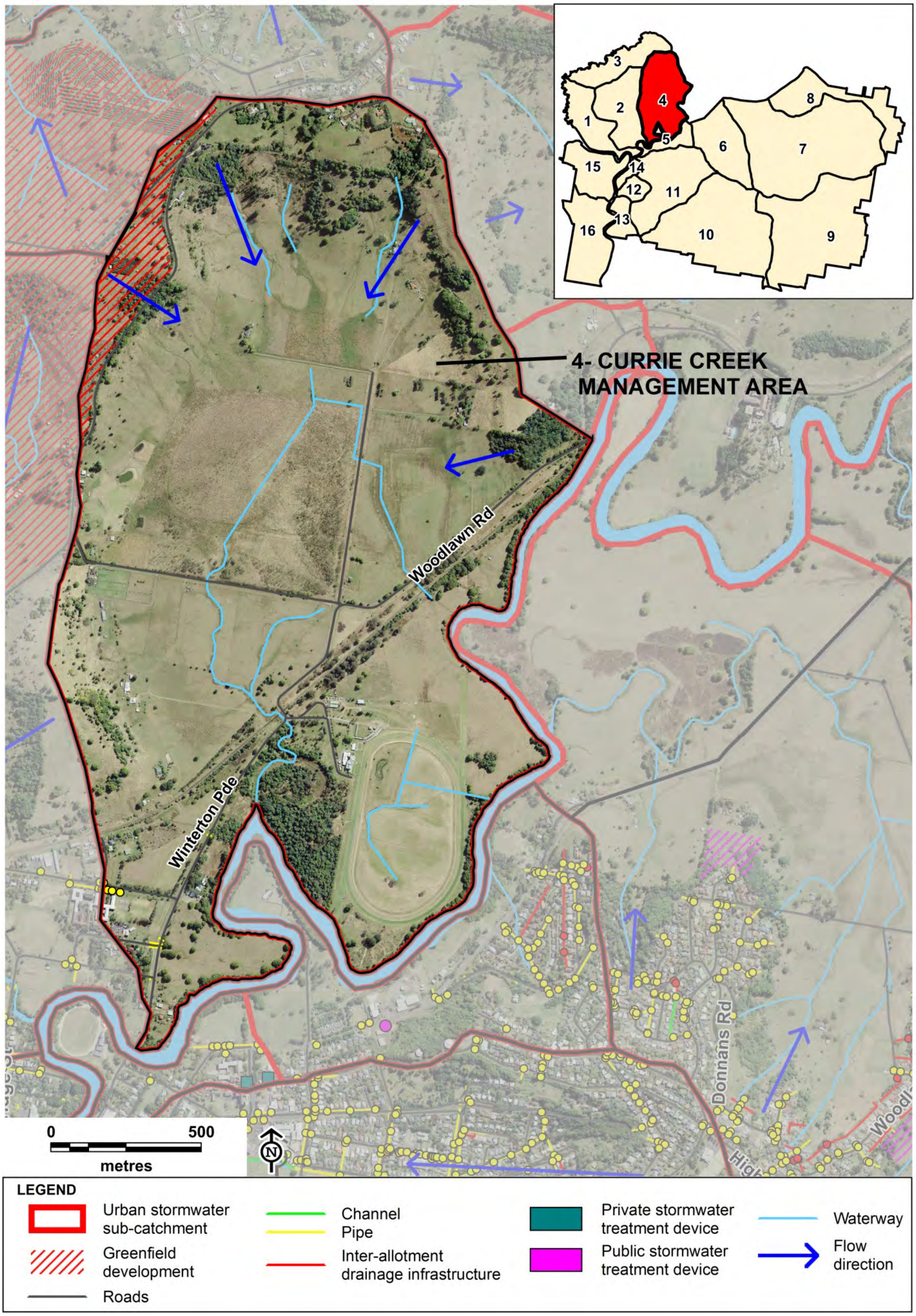


Figure 18: Stormwater Management Area 4 - Currie Creek

5.5 Stormwater Management Area 5 - Brunswick Street

Location:	Brunswick Street
The Brunswick Street sub-catchment lies north of the CBD and Browns Creek and follows the Wilsons River to the urban area boundary. It includes the north facing slope of Lismore Heights and the river flats parallel to Brunswick Street. Land use is residential on the slopes, and open space on the flood prone areas (Trinity High School grounds, greyhound club and the Lismore Rugby Club). The Rescue Helicopter, a caravan park and the council vehicle depot are also located in the sub-catchment. Drainage infrastructure is a mix of concrete curb, gutter and pipe associated with residential areas, and swales on the floodplain.	
Total area:	79 ha
Receiving environments:	Wilsons River
Special features/values:	Fish habitat, large proportion of open grassed areas (sporting fields), within drinking water catchment
Current % developed to undeveloped land (approx.):	80% developed, 20% undeveloped
LEP Zoning (%):	2% Commercial Core, 9% Mixed Use, 4% Light Industrial, 35% General Residential, 1% Public Recreation, 24% Private Recreation, 22% Primary Production, 3% Recreational Waterways
Main drainage infrastructure:	Concrete curb and guttering, pipes and pits in residential area and grassed swales on the lower open areas.
Stormwater treatment devices:	Detention system (private), bio-retention system (private), 2 litter baskets and 1 sediment trap
Pressures	Urban runoff, road runoff (Bangalow Road), sewerage overflows

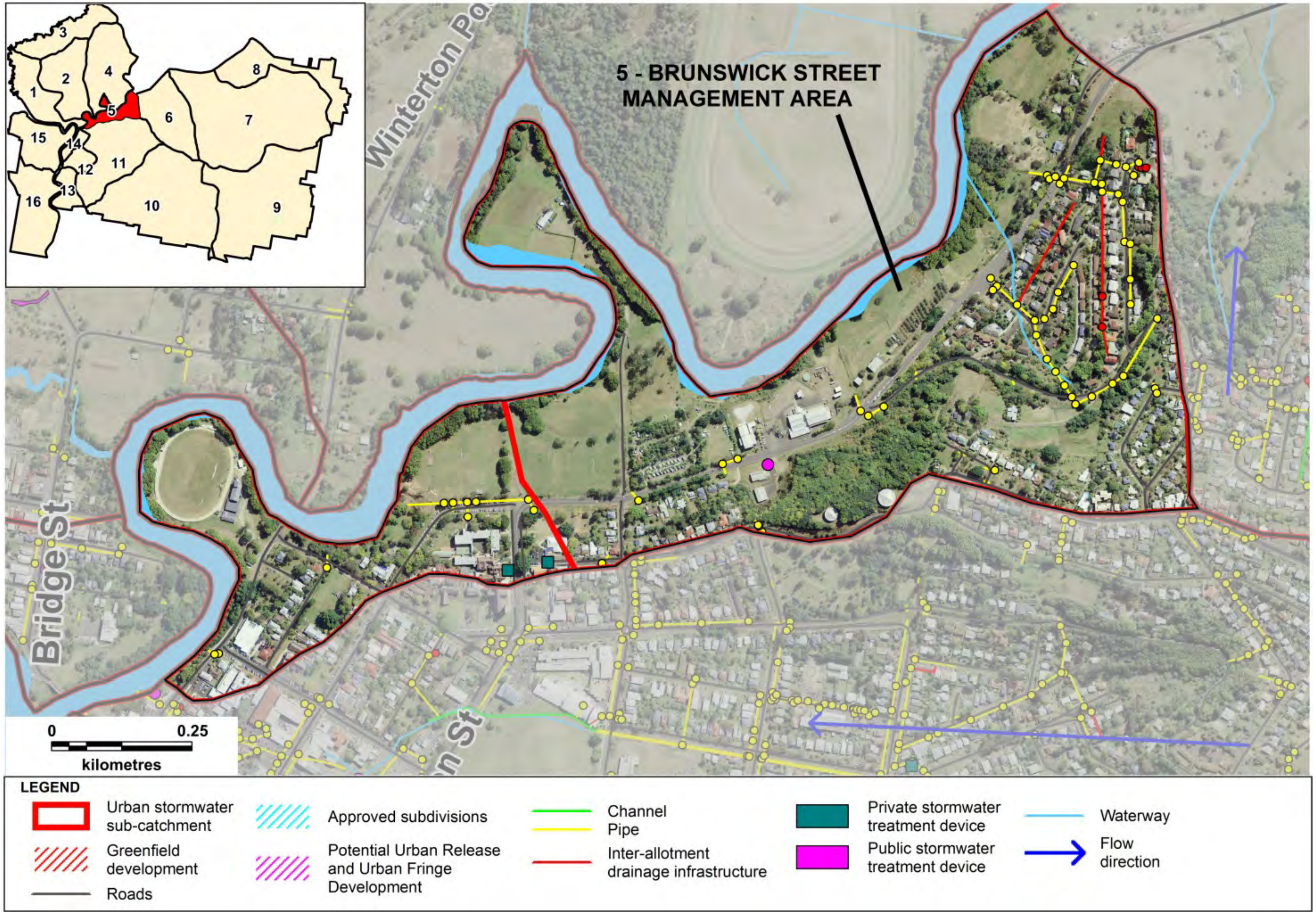


Figure 19: Stormwater Management Area 5 - Brunswick Street

5.6 Stormwater Management Area 6 - Howards Grass

Location:	Lismore Heights/Howards Grass
The Howards Grass management area lies between Ballina Road and the Bangalow Road including parts of Lismore Heights and the Northern Ridges suburbs. Small tributaries drain the slopes then conjoin into an ephemeral stream that flows into the Wilsons River just upstream of the CBD. Land use is rural on the lower slopes and floodplain, and residential on the upper slopes to Ballina Road. Below the residential areas shallow ephemeral tributaries traverse through grazing land before joining the Wilsons River several kilometres upstream of the CBD. Residential development is occurring and will occur into the future along the ridges extending the residential area substantially. Drainage infrastructure includes pipes, pits and inter-allotment drainage.	
Total area:	332 ha
Receiving environments:	Unknown tributary, Wilsons River
Special features/values:	Fish habitat
Current % developed to undeveloped land (approx.):	40% developed, 60% undeveloped
LEP Zoning (%):	61 %Primary Production, 36% General Residential, 3% Deferred Matter
Main drainage infrastructure:	Curb and guttering, pipes and pits and inter allotment drainage in residential areas and natural drainage in lower areas (rural area).
Stormwater treatment devices:	None
Pressures	Future urban development, urban runoff, road runoff, agricultural runoff (grazing), sewerage overflows, gully erosion

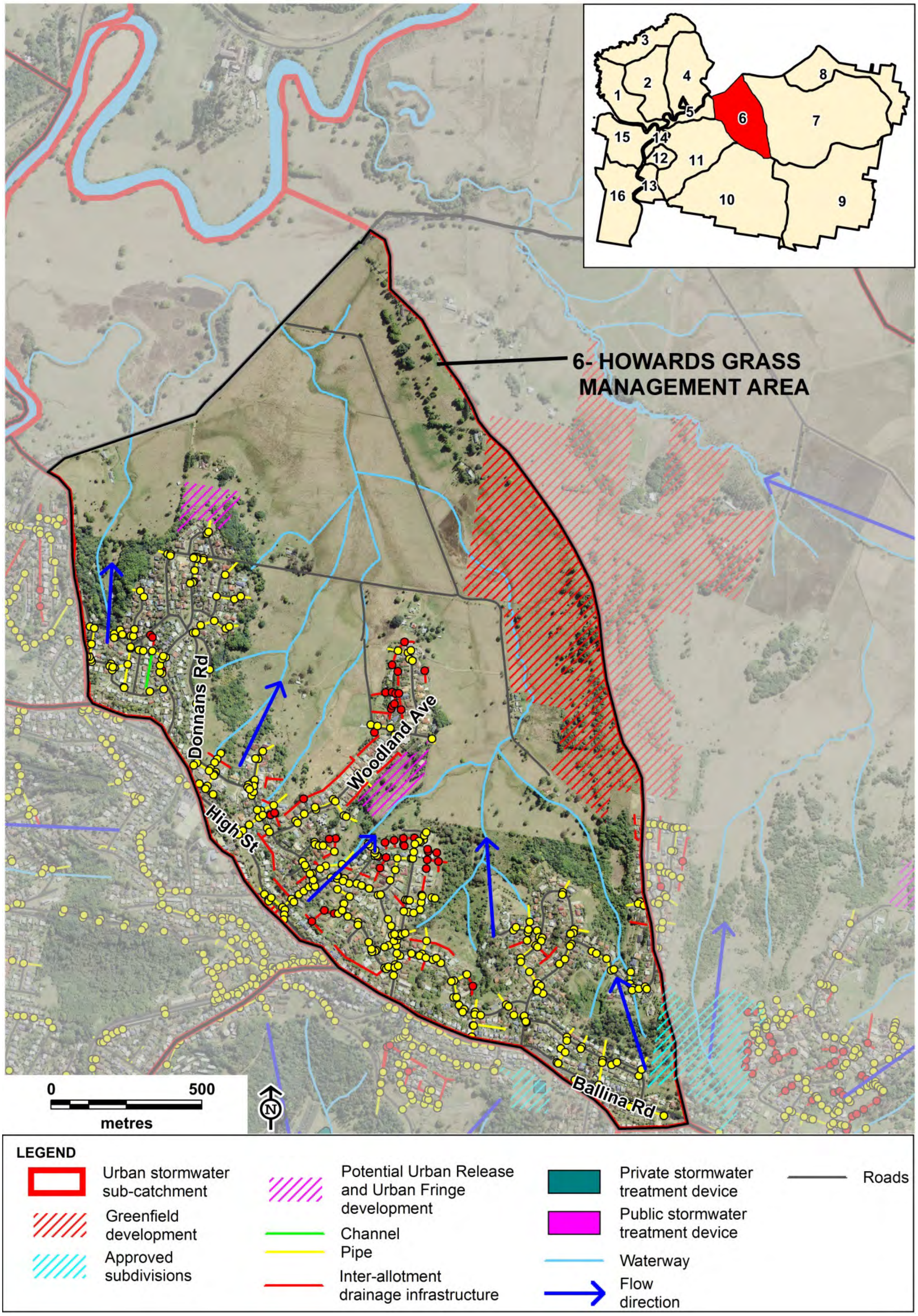


Figure 20: Stormwater Management Area 6 - Howards Grass

5.7 Stormwater Management Area 7 - Lagoon Grass

Location:	Lagoon Grass, Goonellabah, Richmond Hill
The Lagoons Grass management area is located directly east of Howards Grass and has a similar mix of rural and residential land use. It drains the Northern Ridges and Goonellabah north of Ballina Road and Richmond Hill west of Richmond Hill Road. Curb, pit and gutter drainage infrastructure is used throughout the residential areas with stormwater discharge into reserves land on the slopes. Open gullies drain to the floodplain and various unnamed tributaries, most of which join Lagoon Creek. Lagoon Creek flows in a westerly direction through grazing lands to join Wilsons Creek upstream of the CBD. Residential development is focused on the ridges throughout the management area.	
Total area:	1229 ha
Receiving environments:	Lagoon Creek
Special features/values:	Key fish habitat, within drinking water catchment, large areas of future development
Current % developed to undeveloped land (approx.):	20% developed, 80% undeveloped
LEP Zoning (%):	2% Deferred Matter, 15% General Residential, 6% Low Density Residential, 75% Primary Production, 2% Special Uses
Main drainage infrastructure:	Curb, gutter, pipes and pits throughout residential areas and natural drainage channels in lower areas (rural areas).
Stormwater treatment devices/end structures:	Multiple systems (private), retention system (private)
Pressures	New development areas, urban runoff, agricultural runoff (grazing), road runoff (Ballina Road, Richmond Hill Road), sewerage overflows, gully erosion

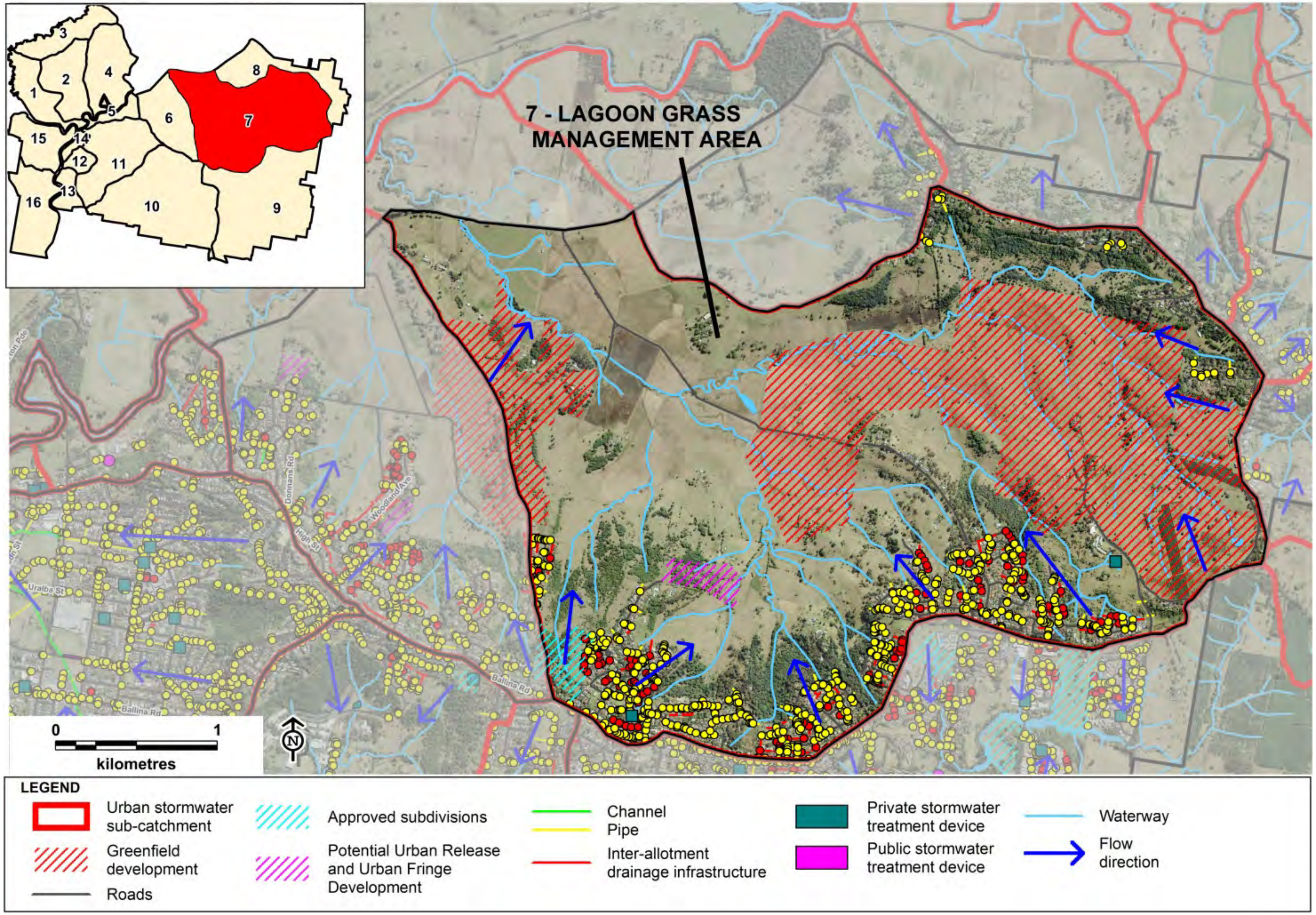


Figure 21: Stormwater Management Area 7 - Lagoon Grass

5.8 Stormwater Management Area 8 - Boatharbour

Location:	Richmond Hill
The Boatharbour management area includes farmland on the floodplain and residential areas on the north eastern edge of the urban area along Richmond Hill Road. Residential areas have curb, pit and gutter drainage infrastructure. Below the residential area stormwater flows to various ephemeral drainage channels before entering the Wilsons River.	
Total area:	362 ha
Receiving environments:	Various ephemeral streams, Wilsons River
Special features/values:	Key fish habitat, drinking water catchment
Current % developed to undeveloped land (approx.):	30% developed, 70% undeveloped
LEP Zoning (%):	45% Low Density Residential, 55% Primary Production, 1% Special Uses
Main drainage infrastructure:	Curb, gutter, pipes and pits in residential area and natural drainage channels below the residential area.
Stormwater treatment devices/end structures:	None
Pressures	Future development, urban runoff, agricultural runoff (grazing and horticulture), road runoff, gully erosion

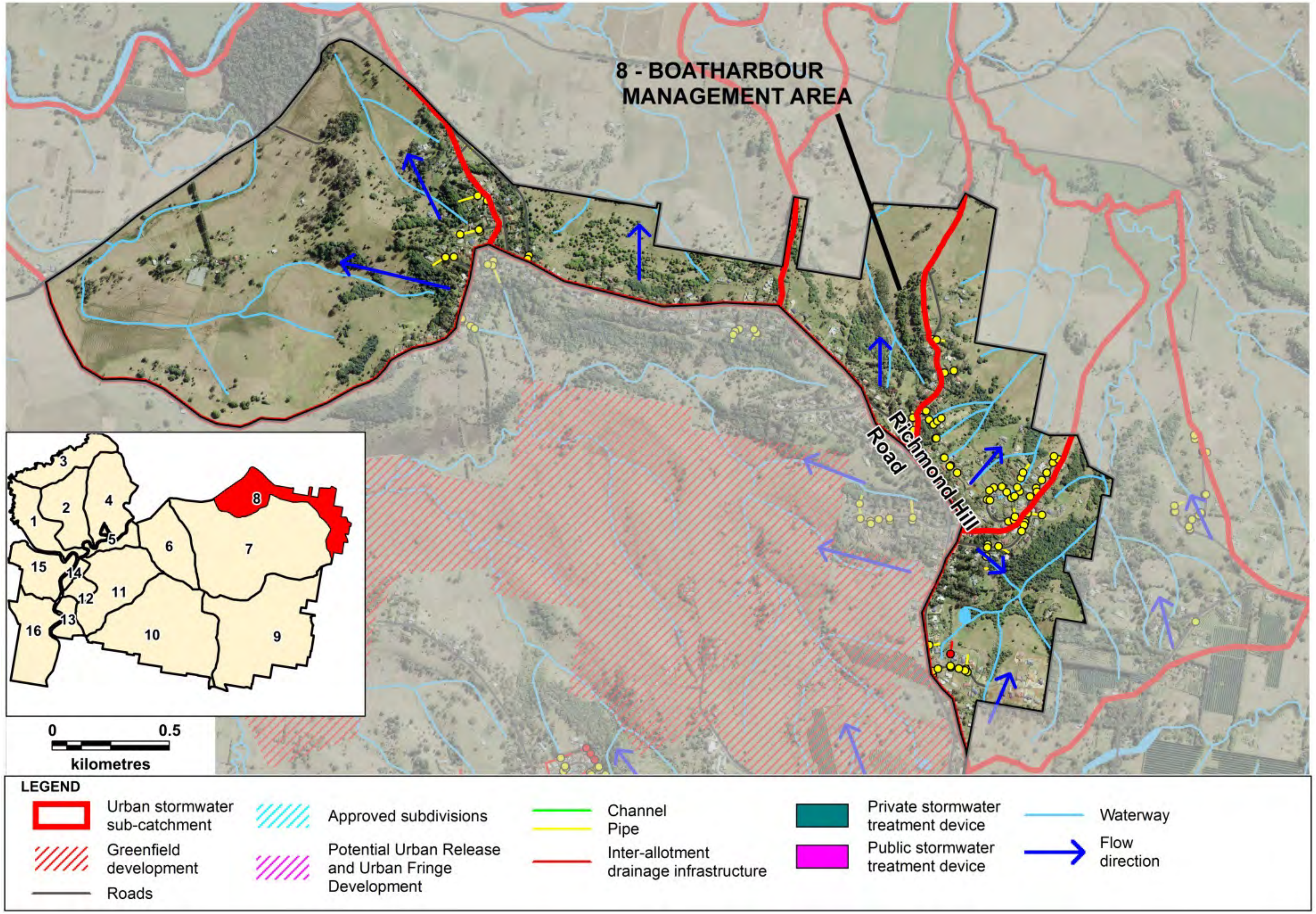


Figure 22: Stormwater Management Area 8 - Boatharbour

5.9 Stormwater Management Area 9 - Tucki Tucki Creek

Location:	Goonellabah, Chilcotts Grass
The Tucki Tucki Creek headwaters rise throughout the suburb of Goonellabah on the southern side of Ballina Road. It is a permanent creek surrounded by residential areas, industrial land and some open space along most of the upper reaches. A few rural properties remain however most of these have been subdivided and redeveloped. Drainage throughout the sub-catchment is concrete curb and gutter with pipes and pits.	
Total area:	968 ha
Receiving environments:	Tucki Tucki Creek
Special features/values:	Tuck Tucki Creek, key fish habitat including threatened fish (*Mogurnda adspersa*), platypus habitat, scenic value
Current % developed to undeveloped land (approx.):	50% developed, 50% undeveloped
LEP Zoning (%):	1% Local Centre, 2% General Industrial, 1% Light Industrial, 38% General Residential, 1% Low Density Residential, 11% Public Recreation, 42% Primary Production, 3% Special Uses
Main drainage infrastructure:	Curb, gutter, pipes and pits and inter-allotment drainage throughout residential areas and natural drainage channels.
Stormwater treatment devices/end structures:	30 recorded treatment devices, private and public, including bio-detention basins, vegetated channels, GPT's etc.
Pressures	Future development, urban runoff (particularly gross pollutants), agricultural runoff (grazing and horticulture), road runoff, industrial runoff, gully erosion

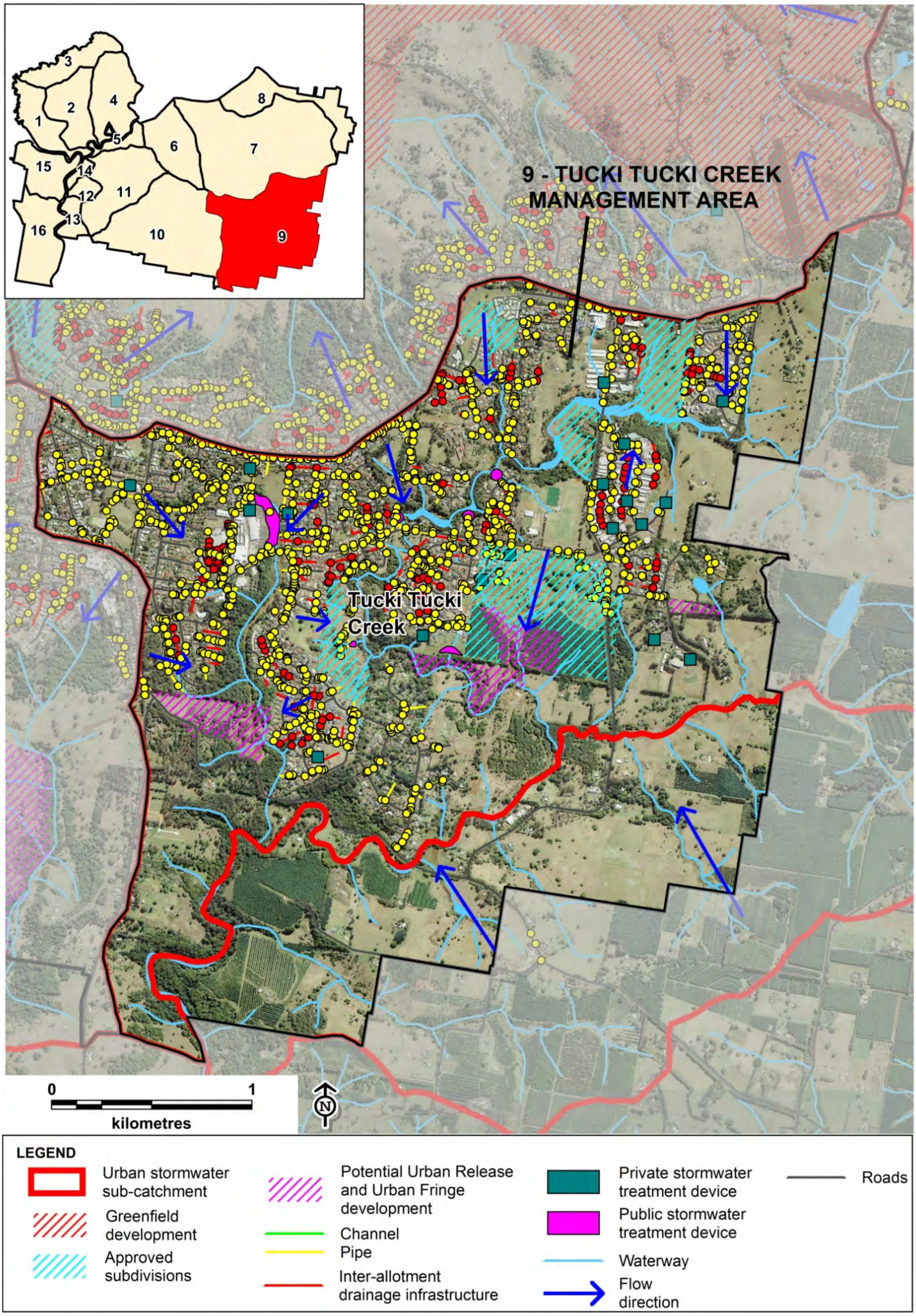


Figure 23: Stormwater Management Area 9 - Tucki Tucki

5.10 Stormwater Management Area 10 - Monaltrie Creek

Location:	East Lismore/ Goonellabah
Most of East Lismore and a section of Goonellabah west from Rous Road, drain to Monaltrie Creek via unnamed tributaries. Land use in the Monaltrie Creek management area is primarily residential and agriculture but includes commercial and light industrial development on Wyrallah Road. Southern Cross University, a hospital and three schools as well as Wilson Park Nature Reserve are also located in this sub-catchment. Some tributaries, particularly those in Goonellabah are ephemeral gullies, while those in East Lismore have been modified (2.5 km of concreted and straightened drains). The remainder of the drainage infrastructure is kerb and gutter with pipes and pits as well as inter-allotment drainage.	
Total area:	921 ha
Receiving environments:	Monaltrie Creek
Special features/values:	Key fish habitat, open concrete canals, university retention ponds
Current % developed to undeveloped land (approx.):	50% urban, 50% non-urban
LEP Zoning (%):	6% Mixed Use, 7% Deferred Matter, 3% National Parks and Reserves, 1% General Industrial, 1% Light Industrial, 48% General Residential, 3% Public Recreation, 20% Primary Production, 11% Special Uses
Main drainage infrastructure:	Curb, gutter, pipes and pits in the elevated residential area (Invercauld Rd ridge), swales and open concrete drains in East Lismore residential area and natural drainage below the residential area.
Stormwater treatment devices/end structures:	4 private bio-retention basins, a gross pollutant trap and detention basin, university retention ponds
Pressures	Future development, urban runoff, agricultural runoff, road runoff (main roads, university carpark), gully erosion, sewerage overflows

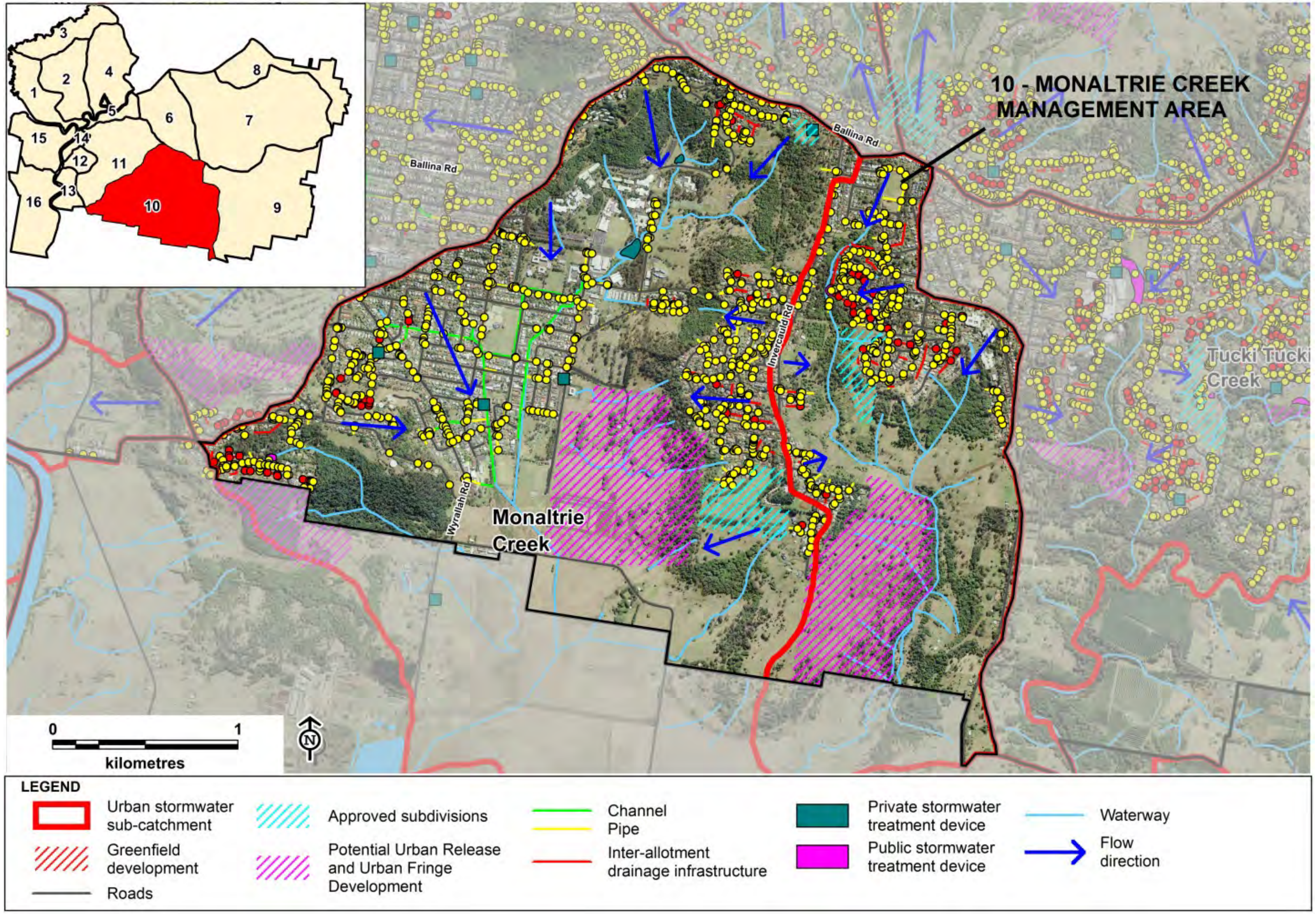


Figure 24: Stormwater Management Area 10 - Monaltrie Creek

5.11 Stormwater Management Area 11 - Browns Creek

<table>
<tr><td>Location:</td><td>East Lismore, Lismore, Lismore Heights</td></tr>
<tr><td colspan="2">The Browns Creek management area encompasses the Browns Creek catchment which drains an area including most of the older fully developed parts of Central Lismore and approximately half of Lismore Heights. While most of the area is residential, a part of the CBD, Lismore Square and some light industrial land use is also contained within the management area. Within Browns Creek semi-permanent flow is sourced from several springs in Lismore Heights and East Lismore. Three of these have been modified to natural vegetated reaches, one of which begins at the upper boundary of a rainforest remnant known as Rotary Park and follows a natural watercourse for approximately 600 metres. On the lower slopes stormwater is conveyed by street drainage infrastructure, a combination of open swales and concrete curb and gutter and pipes. These converge towards the CBD at an open space/floodway area where open canals convey flow. Browns Creek enters the Wilsons River via a tunnel where a pump station and floodgate are used to reduce flooding in the Lismore basin.</td></tr>
<tr><td>Total area:</td><td>455 ha</td></tr>
<tr><td>Receiving environments:</td><td>Browns Creek, Wilsons River</td></tr>
<tr><td>Special features/values:</td><td>CBD, sporting fields, open concrete canals, within drinking water catchment</td></tr>
<tr><td>Current % developed to undeveloped land (approx.):</td><td>95% developed, 5% undeveloped</td></tr>
<tr><td>LEP Zoning (%):</td><td>1% Local Centre, 10% Commercial Core, 4% Deferred Matter, 55% General Residential, 2% Low Density Residential, 21% Public Recreation,4% Primary Production, 2% Special Use</td></tr>
<tr><td>Main drainage infrastructure:</td><td>Combination of open swales and concrete curb, gutter, pipes and pits. Main flow is conveyed by the open concrete channelised tributaries of Browns Creek.</td></tr>
<tr><td>Stormwater treatment devices/end structures:</td><td>10 private systems (retention and bio-retention systems), natural channels, vegetated natural channel, 4 bio detention rain gardens, 1 bio-filter, 1 sediment weir</td></tr>
<tr><td>Pressures</td><td>Urban runoff (particularly, gross pollutants), road runoff (main roads and CBD), sewerage overflows, localised flooding</td></tr>
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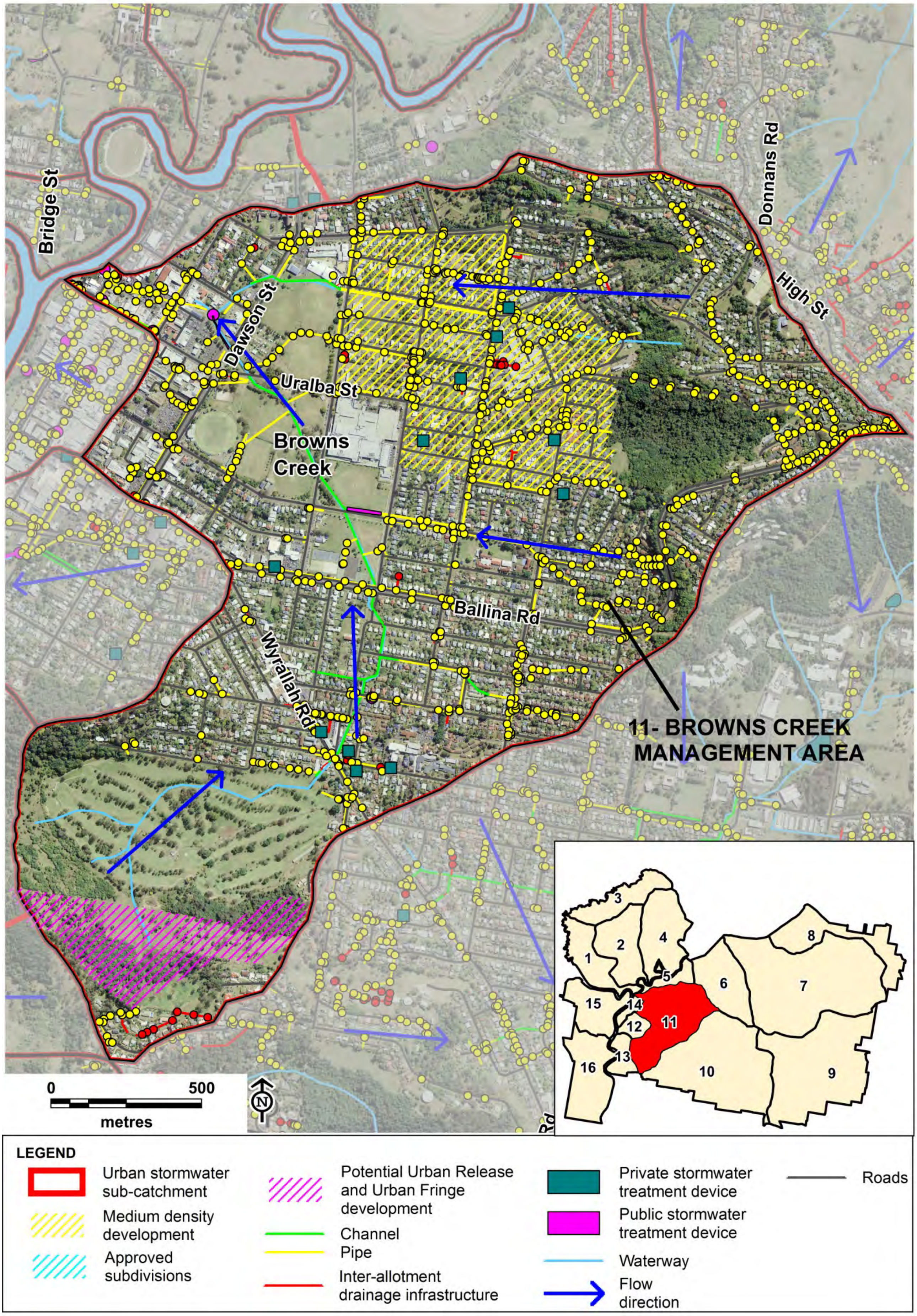


Figure 25: Stormwater Management Area 11 - Browns Creek

5.12 Stormwater Management Area 12 - Gasworks Creek

Location:	Girards Hill, CBD, Lismore
Gas Works Creek management area contains approximately half of the Girards Hill suburb, and the southern edge of the CBD and Central Lismore. Most of this area contains residential and light industrial land use. The creek channel is less than one kilometre in length with the lower section modified and a pump station built to assist with flood mitigation.	
Total area:	62 ha
Receiving environments:	Gasworks Creek, Wilsons River
Special features/values:	Small catchment, highly developed, within drinking water catchment
Current % developed to undeveloped land (approx.):	95% developed, 5% undeveloped
LEP Zoning (%):	24% Commercial Core, 5% Light Industrial, 50% General Residential, 7% Low Density Residential, 8% Public Recreation, 6% Rural Landscape
Main drainage infrastructure:	Combination of open swales in the southern area and concrete curb, gutter, pipes and pits in the north.
Stormwater treatment devices/end structures:	4 private systems, 1 gross pollutant trap, 1 detention pond, 1 natural vegetated channel and vegetated swales
Pressures	Urban runoff (particularly gross pollutants), road runoff (Ballina Road and CBD), industrial runoff

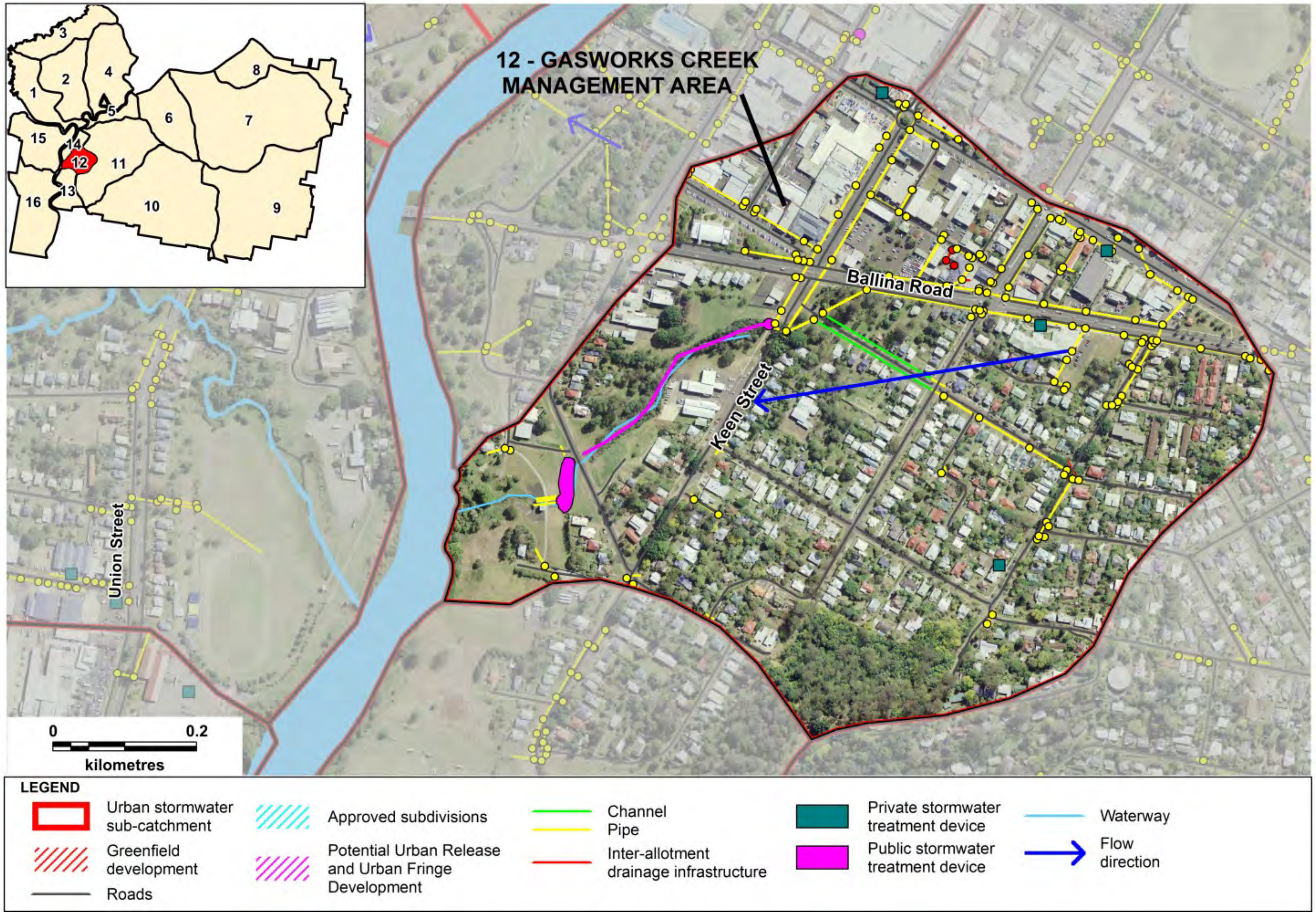


Figure 26: Stormwater Management Area 12 - Gasworks Creek

5.13 Stormwater Management Area 13 - Albert Park

Location:	Albert Park and surrounds
The Albert Park management area is directly south of Gas Works Creek on the Wilsons River floodplain and is dominated by open space and playing fields. It contains approximately 80 domestic dwellings, a unit complex, Albert Park School, indoor basketball facility, the Elgas storage facility, a small industrial area on Trevans Road, and some grazing land. Runoff is conveyed by vegetated swales and on the floodplain these traverse the playing fields and discharge directly to the Wilsons River.	
Total area:	90 ha
Receiving environments:	Wilsons River
Special features/values:	Open space/sporting fields
Current % developed to undeveloped land (approx.):	10% developed, 90% undeveloped
LEP Zoning (%):	1% Light Industrial, 13% General Residential, 1% Low Density Residential, 30% Public recreation, 48% Primary Production, 3% Rural Landscape, 3% Special Uses.
Main drainage infrastructure:	Swales
Stormwater treatment devices:	Natural channel
Pressures	Urban Runoff, agricultural runoff (grazing), industrial runoff

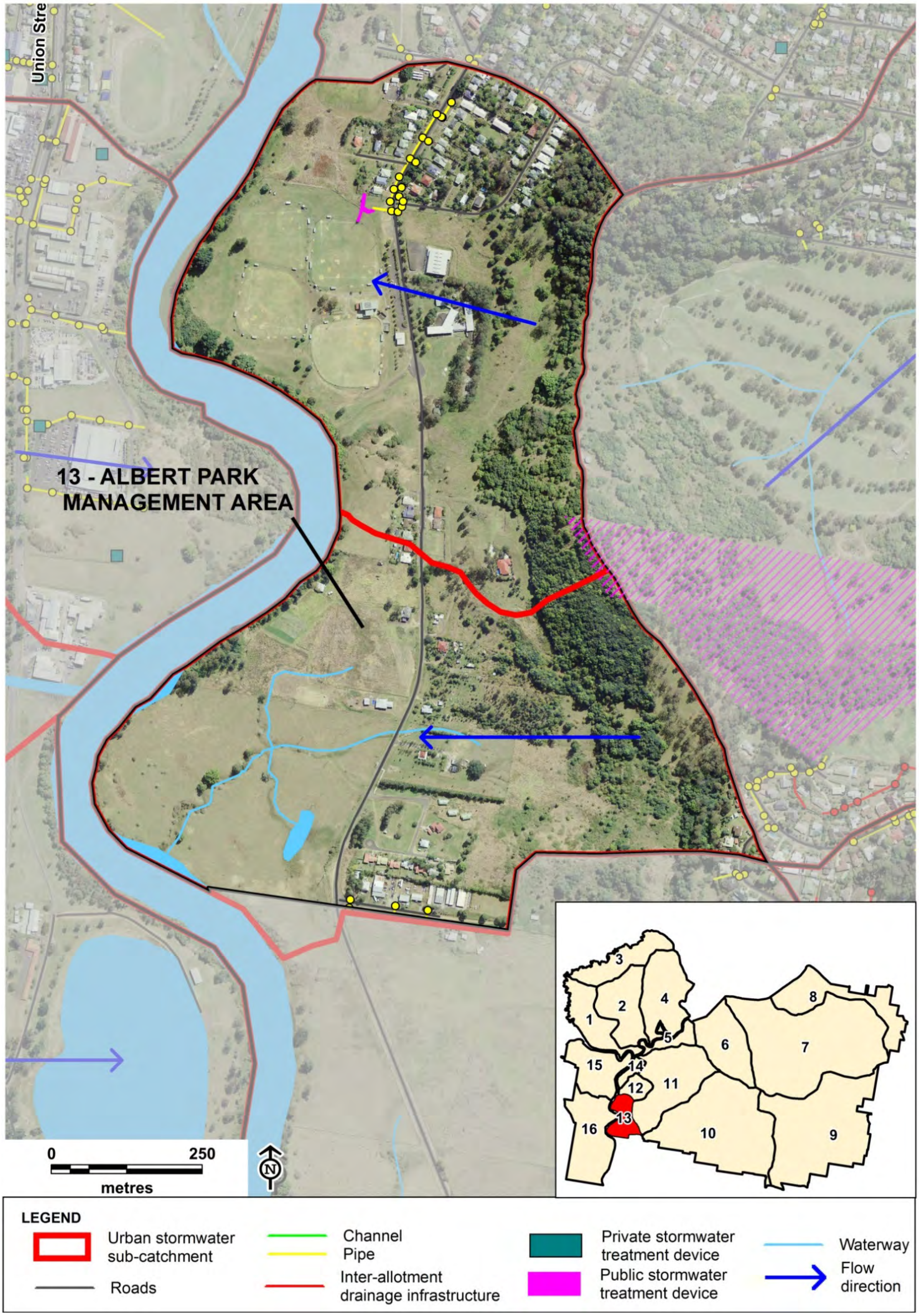


Figure 27: Stormwater Management Area 13 – Albert Park

5.14 Stormwater Management Area 14 - CBD

Location:	Lismore CBD
The CBD management area encompasses the majority of the CBD which is situated on the floodplain and is largely impervious. The area is bordered by the Wilsons River on the western boundary which is dominated by public open spaces and car parks. The constructed levee bank runs along this border. The stormwater infrastructure is made up of roadside kerb and guttering, pits, pipes and closed drains. Stormwater from the CBD discharges directly into the river at several points.	
Total area:	36 ha
Receiving environments:	Wilsons River
Special features/values:	Small catchment, high impervious area, within drinking water catchment
Current % urban to non-urban land (approx.):	100% developed
LEP Zoning (%):	54% Commercial Core, 3% Light Industrial, 3% Low Density Residential, 39% Public Recreation,
Potential pollution sources/issues:	Urban runoff (litter, nutrients, hydrocarbons), localised flooding
Stormwater treatment devices:	6 bio-detention rain gardens, 5 litter baskets
Pressures	Concrete curb, gutter, pipes and pits

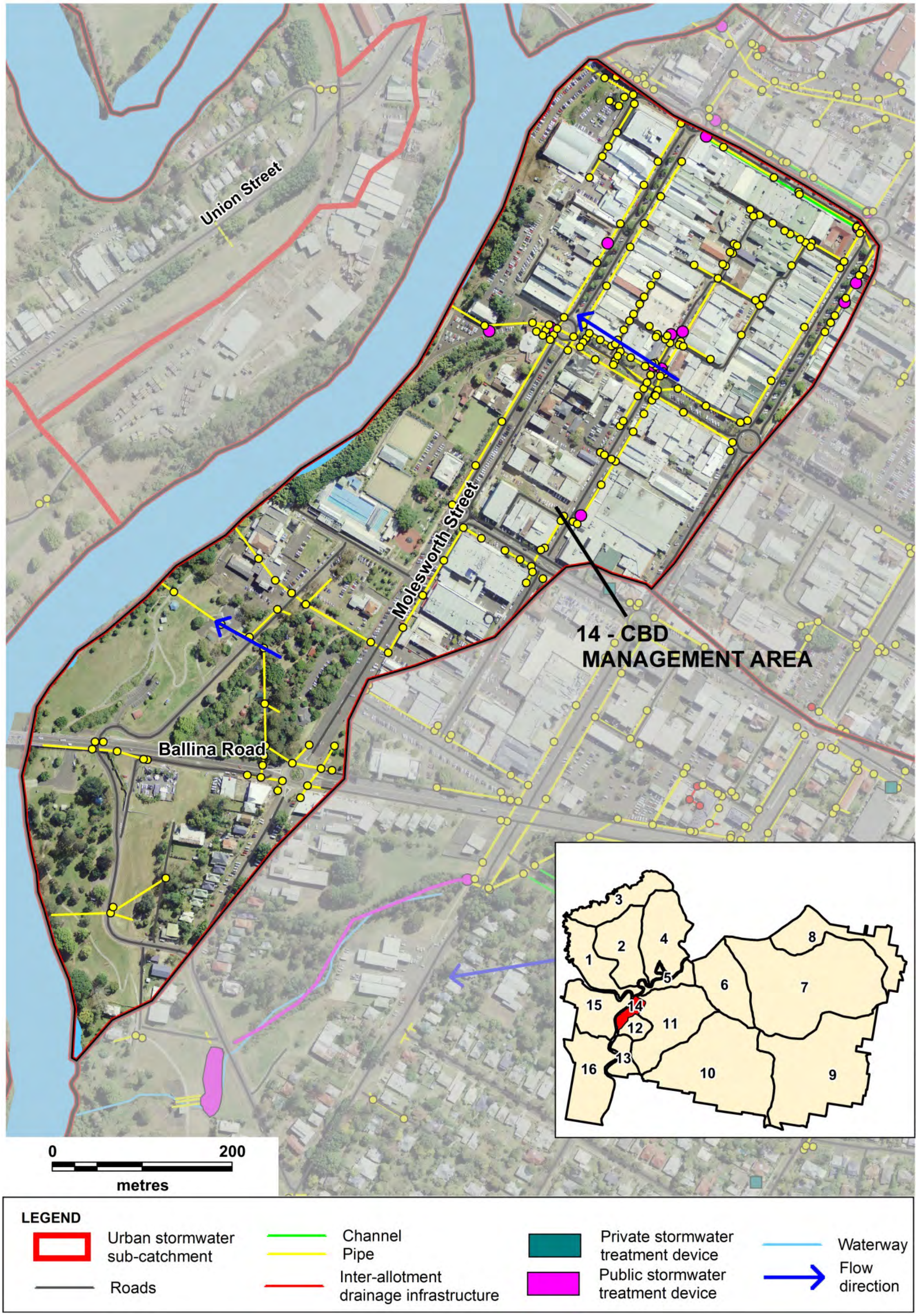


Figure 28: Stormwater Management Area 14 – CBD

5.15 Stormwater Management Area 15 – South Lismore – Hollingworth Creek

Location:	South Lismore
The South Lismore- Hollingworth Creek management area encompasses the urban catchment of Hollingworth Creek and the parts of South Lismore that drain into Leycester Creek. The majority of the management area drains into Hollingworth Creek (which receives effluent from the Lismore STP) and flows from west to east through South Lismore via swales and pipes discharging into the Wilsons River at Riverside Park. The entire area is situated on the Leycester Creek and Wilsons River floodplain and contains varied land uses including residential, industrial and agricultural uses.	
Total area:	247 ha
Receiving environments:	Hollingworth Creek, 'Duck Pond', Leycester Creek, Wilsons River
Special features/values:	Within drinking water catchment, large industrial proportion
Current % developed to undeveloped land (approx.):	60% developed, 40% undeveloped
LEP Zoning (%):	2% Neighbourhood Centre, 3% Enterprise Corridor, 33% General Industrial, 6% Light Industrial, 30% Low Density Residential, 115 Public Recreation, 1% Private Recreation, 8% Primary Production, 5% Rural Landscape
Main drainage infrastructure:	Swales, pipes and pits
Stormwater treatment devices:	9 private systems including bio-retention systems, 1 bio-retention rain garden, 1 detention basin, 1 vegetated channel
Pressures	Industrial runoff (including several service stations), urban runoff, road runoff, agricultural runoff, upstream sewerage treatment plant, sewerage overflows

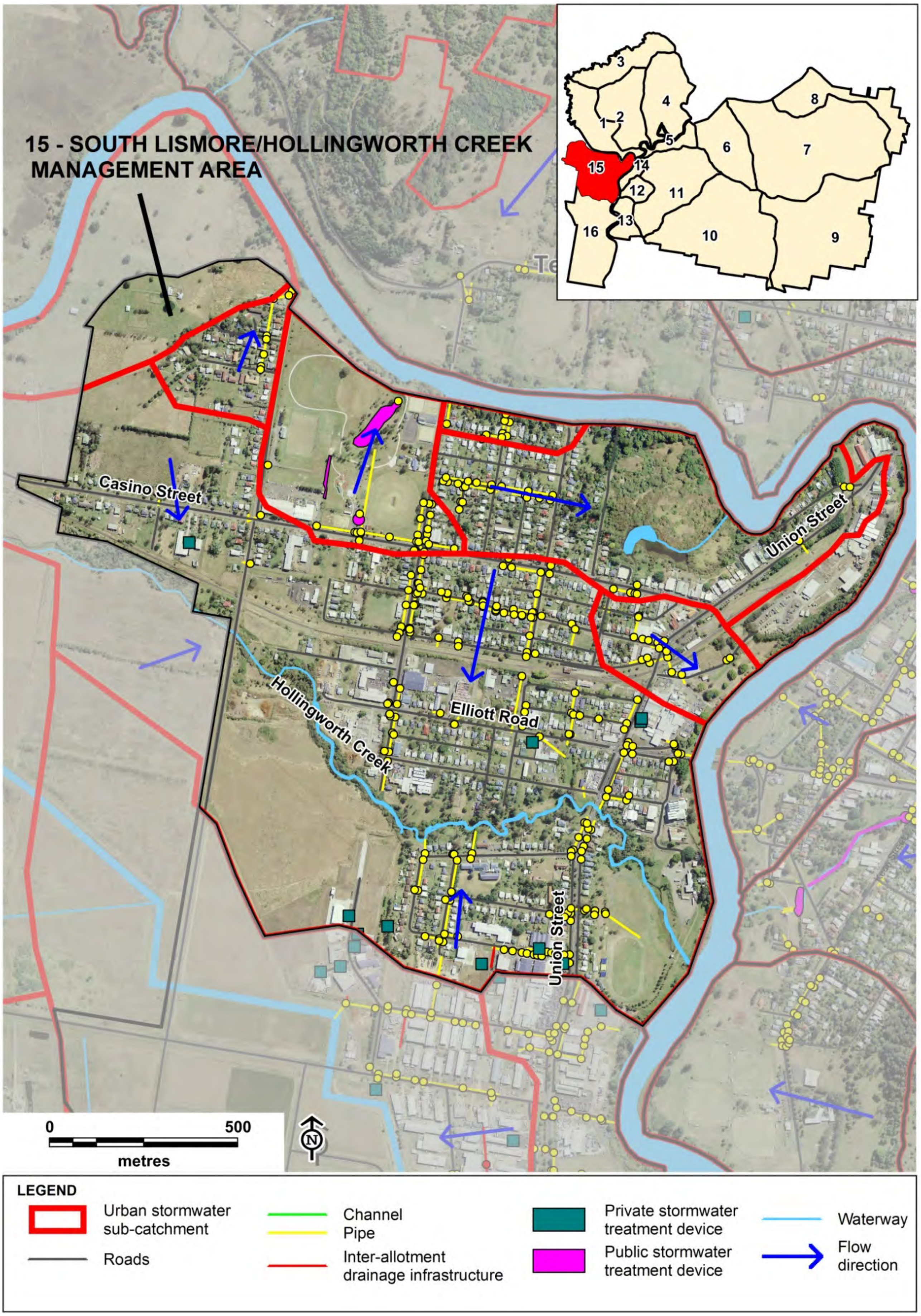


Figure 29: Stormwater Management Area 15 –South Lismore – Hollingworth Creek

5.16 Stormwater Management Area 16 – South Lismore – Airport

Location:	South Lismore
This management area incorporates the southern part of South Lismore that drains into the drain along the flood levee, Loftville Creek, Lismore Lake or the Wilsons River. The management area contains industrial areas that generally drain into the flood levee drain or directly into the Wilsons River. Parts of the tea tree plantations and the airport also drain into the levee drain with the remainder draining into Loftville Creek. Lismore Lake receives stormwater from a small catchment including a small industrial area and the Bruxner Highway. Two caravan parks are situated in the southern end of the management area.	
Total area:	383 ha
Receiving environments:	Loftville Creek, Lismore Lake, Wilsons River
Special features/values:	Airport, Lismore Lake
Current % developed to undeveloped land (approx.):	30% developed, 70% undeveloped
LEP Zoning (%):	14% Enterprise Corridor, 8% General Residential, 7% Public Recreation, 40% Primary Production, 2% Rural; Landscape, 28% Special Uses
Main drainage infrastructure	Swales in residential area and curb, gutter, pipes and pits in newer industrial areas.
Stormwater treatment devices:	11 private devices including bio-retention systems, detention systems, swales and buffer strips.
Pressures	Industrial runoff (including airport) road runoff (Bruxner highway), urban runoff, sewerage overflows , agricultural runoff (tea-tree plantations- effluent re-use, herbicides, sediments)

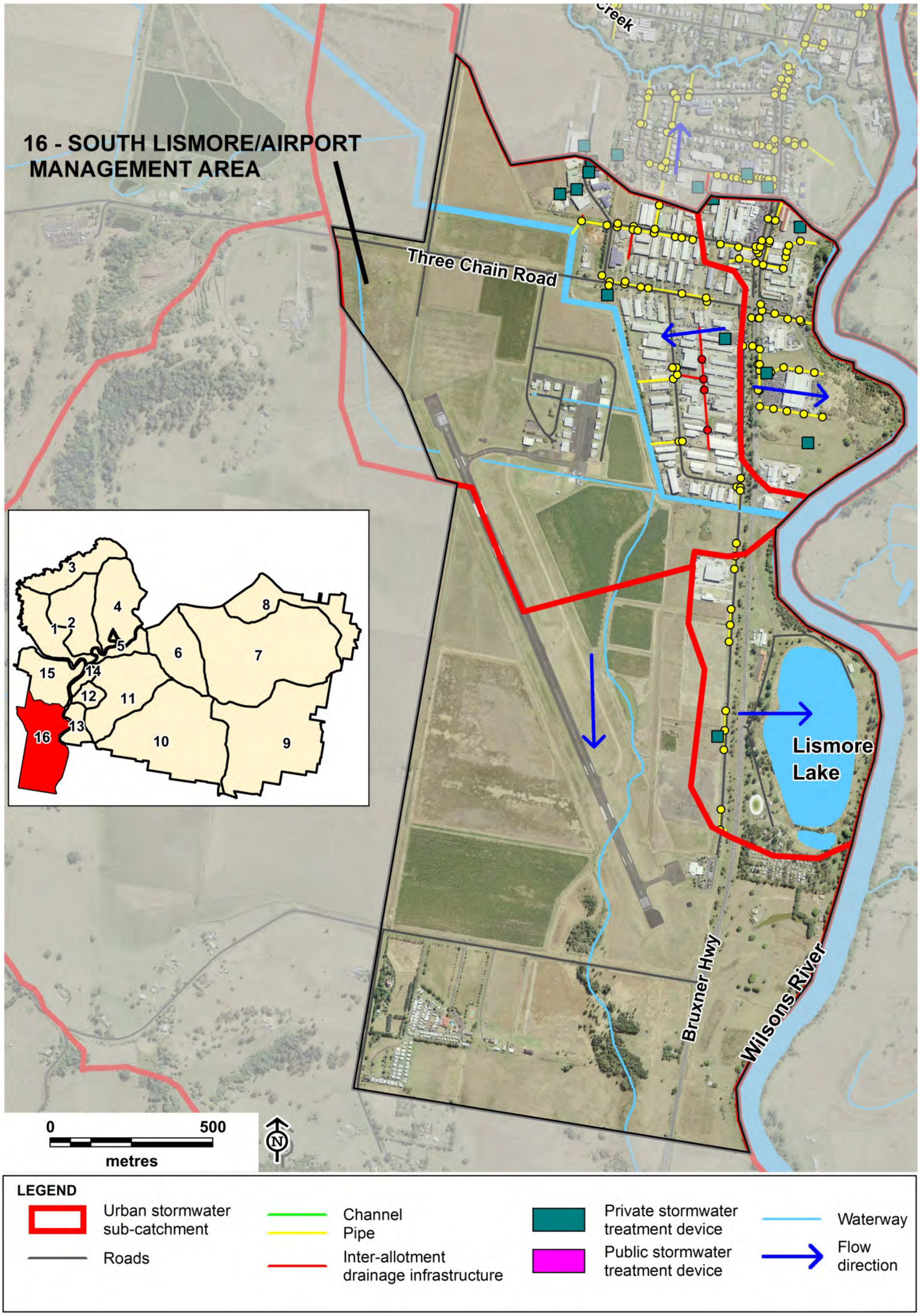


Figure 30: Stormwater Management Area 16 –South Lismore – Airport

6. EXISTING MANAGEMENT FRAMEWORK

6.1 Planning Context

The national and state government planning for urban stormwater management is discussed in Appendix 3.

6.1.1 Local Government Responsibilities

Together with other government agencies and authorities, councils act as an interface between the community and state authorities. Local government is responsible for good governance and the care and protection of local communities within a framework of sustainable development. As managers of public land and land use planners, local government is responsible for policy development and implementation of land use planning as well as regulating a wide range of activities that may impact upon natural resource management. Local government also has a key role to play in translating the policies of Commonwealth and State governments into on-ground projects.

LEPs guide planning decisions for local government areas. Through zoning and development controls, they allow councils to supervise the ways in which land is used. The Lismore LEP contains land-use zones, development standards and other matters to consider when assessing potential development. There are also a range of provisions relating to flooding, heritage, subdivision, vegetation removal etc. The LEP 2012 applies to all land in the LGA excluding areas affected by the Ministerial review into Environmental Protection Zones E2 and E3. The *Lismore LEP 2000* will continue to apply in these (deferred matter) areas until the review is complete.

Development control plans, prepared in accordance with the *EP&A Act*, are also used to help achieve the objectives of the local plan by providing specific, comprehensive requirements for certain types of development or locations, e.g. for urban design, and heritage precincts and properties.

Local Government functions, powers and responsibilities related to urban stormwater management include:

- Strategic planning through land use zoning and statutory controls on all freehold land and locally managed public open space;
- Development control of activities and works on land as specified by council's LEP;
- Enforcement powers for development consent conditions, waste management and unauthorised land uses (e.g. land clearing, drainage and filling);
- Administrative responsibility for state agency coordination through integrated planning, licensing and development concurrence;
- Stormwater management and control, sewerage, drainage works and flood control;
- Pest, plant and animal risk control measures; and
- Management of local open space to restore remnant vegetation and recreate habitat.

Councils are also the primary advocate for and coordinator of local community groups and interests.

6.1.2 Other Stormwater Management Responsibilities

Rous Water

Rous Water supplies bulk water to several Councils in the Northern Rivers, including LCC. Rous Water extracts water from a number of sources including Rocky Creek Dam, Emigrant Creek Dam and the Wilsons River according to current demand and conditions. The Wilsons River source extraction point is located on the Wilsons River approximately 5 km upstream from the Lismore CBD. The catchment for this extraction point encompasses a large area including parts of the Lismore/Goonellabah urban area. Waterways located within the drinking water catchment include (Figure 31):

- Wilsons River;
- Lagoon Creek;
- Currie Creek;
- Slaters Creek;
- Booerie Creek;
- Leycester Creek;
- Browns Creek;
- Gasworks Creek and;
- Hollingworth Creek.

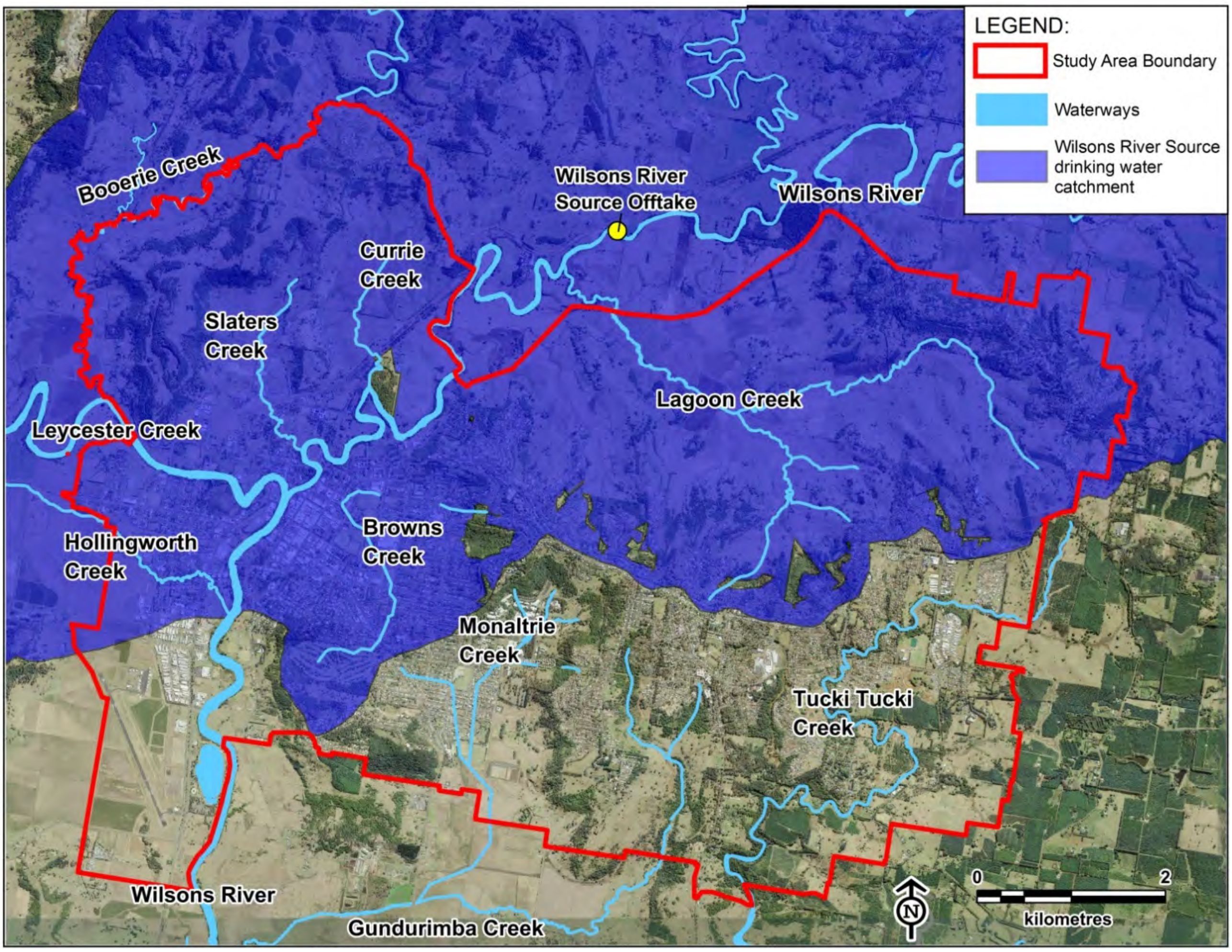


Figure 31: Wilsons River Source drinking water catchment within the study area as mapped in Lismore LEP 2012

NSW Office of Water

The NSW Office of Water (NOW) is responsible for the management of the state's surface and groundwater resources and administers the *Water Management Act 2000*. NOW ensures that the geomorphic integrity of waterways is not impacted/modified by catchment use changes. Under the Act, NOW is required to assess the impact of any proposed activity carried out in, on or under waterfront land (all land within 40 metres of the highest bank of the river, lake or estuary). This is discussed further in Section 6.5.7.

NSW Roads and Maritime Services

The Roads and Maritime Services (RMS) is responsible for stormwater and land management in the designated state highway corridors within the LGA, including Bruxner Highway and Bangalow Road. Responsibility for management stormwater assets on these roads within the Lismore urban area is divided between RMS and LCC. Sections of road within the urban area with stormwater assets under RMS responsibility include (Figure 32):

- Bruxner Highway south of Masters roundabout in South Lismore;
- A small section of Bruxner Highway between Kellas Street roundabout and Nielson Street;
- Bruxner Highway east of Pineapple Road intersection in Goonellabah; and
- Bangalow Road east of Hindmarsh Street intersection (approximately).

Stormwater assets along these sections of road under RMS responsibility include culverts and pits. RMS is also responsible for the culvert under Dawson Street.

RMS conducts an annual inspection with LCC of all highway assets in Lismore to plan future maintenance activities.

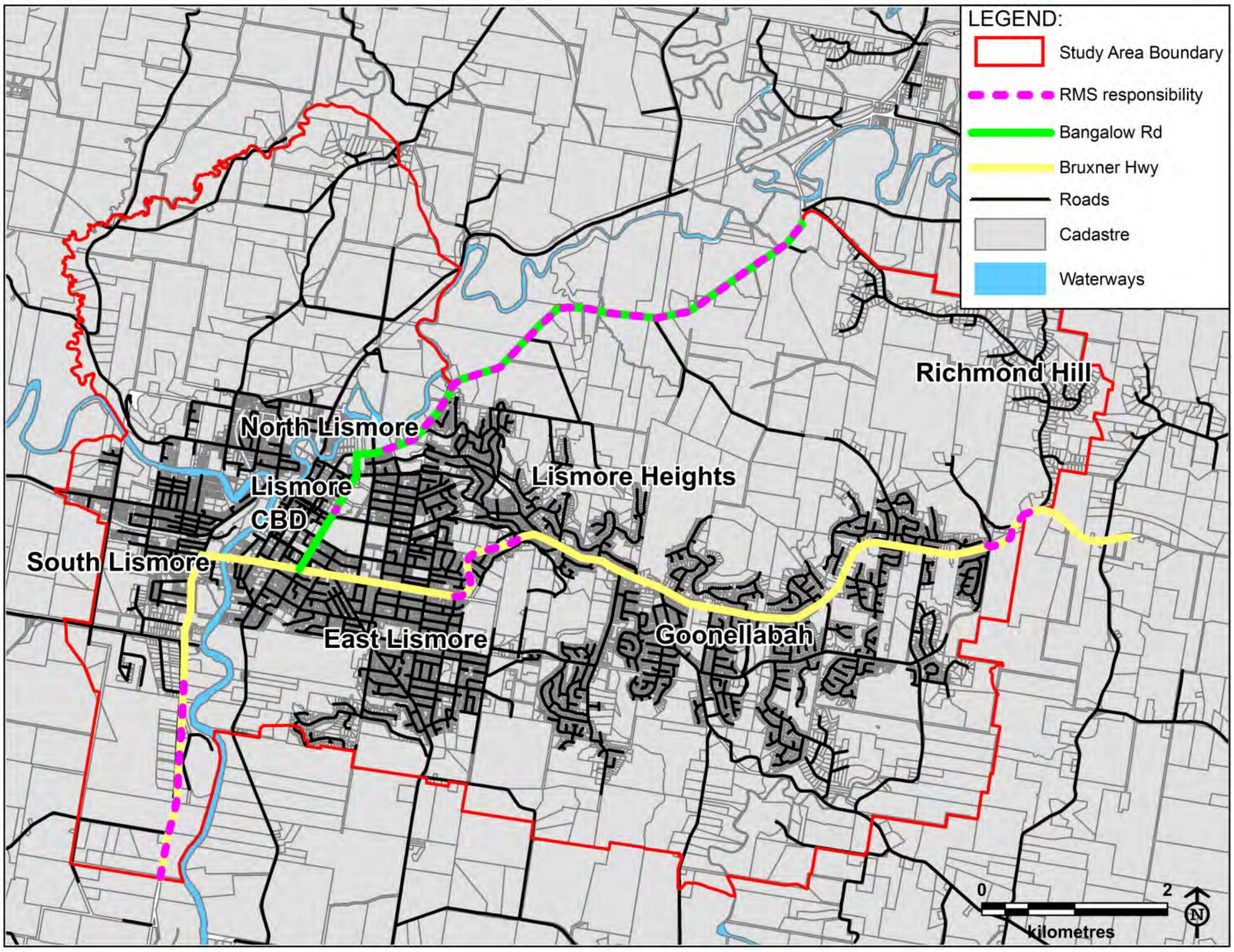


Figure 32: Sections of road within the study area with stormwater assets under the responsibility of NSW Roads and Maritime Services

Fisheries NSW

Fisheries NSW is responsible for ensuring that fish stocks are conserved and that there is “no net loss” of key fish habitats upon which they depend. To achieve this, the Aquaculture and Aquatic Ecosystems Unit assesses activities under various Acts (*Fisheries Management Act 1994*) and guidelines. In addition Fisheries NSW is responsible for ensuring the sustainable management of commercial, quality recreational fishing and viable aquaculture within NSW.

The objectives of the *Fisheries Management Act 1994* are to conserve, develop and share the fishery resources of NSW for the benefit of present and future generations. Part 7 of the Act deals with the protection of aquatic habitats and Part 7A deals with threatened species conservation.

Under the 'integrated development' provisions of the *NSW Environmental Planning and Assessment Act 1979*, the NSW Department of Primary Industries (DPI) is an 'approval body' for local development that requires permits under the *Fisheries Management Act*. Relevant permits include:

- A permit is required for a local government authority to undertake dredging and/or reclamation works (s200); and
- A permit is required for all works that may obstruct the free passage of fish whether permanently or temporarily in TYPE 1-3 habitats (s218-220).

Richmond River County Council

Richmond River County Council (RRCC) has been delegated the responsibility for flood mitigation activities within Ballina Shire, Lismore and Richmond Valley Councils. RRCC provides a coordination role in floodplain management, working with the constituent councils, State and Commonwealth agencies, university researchers, and floodplain industries to develop long-term natural resource management strategies for the Richmond River floodplain and estuary.

RRCC has undertaken riparian management works within the Lismore urban area involvement in the Gasworks Creek restoration project.

Figure 33 shows the flood management infrastructure (including drainage) under the control of RRCC.

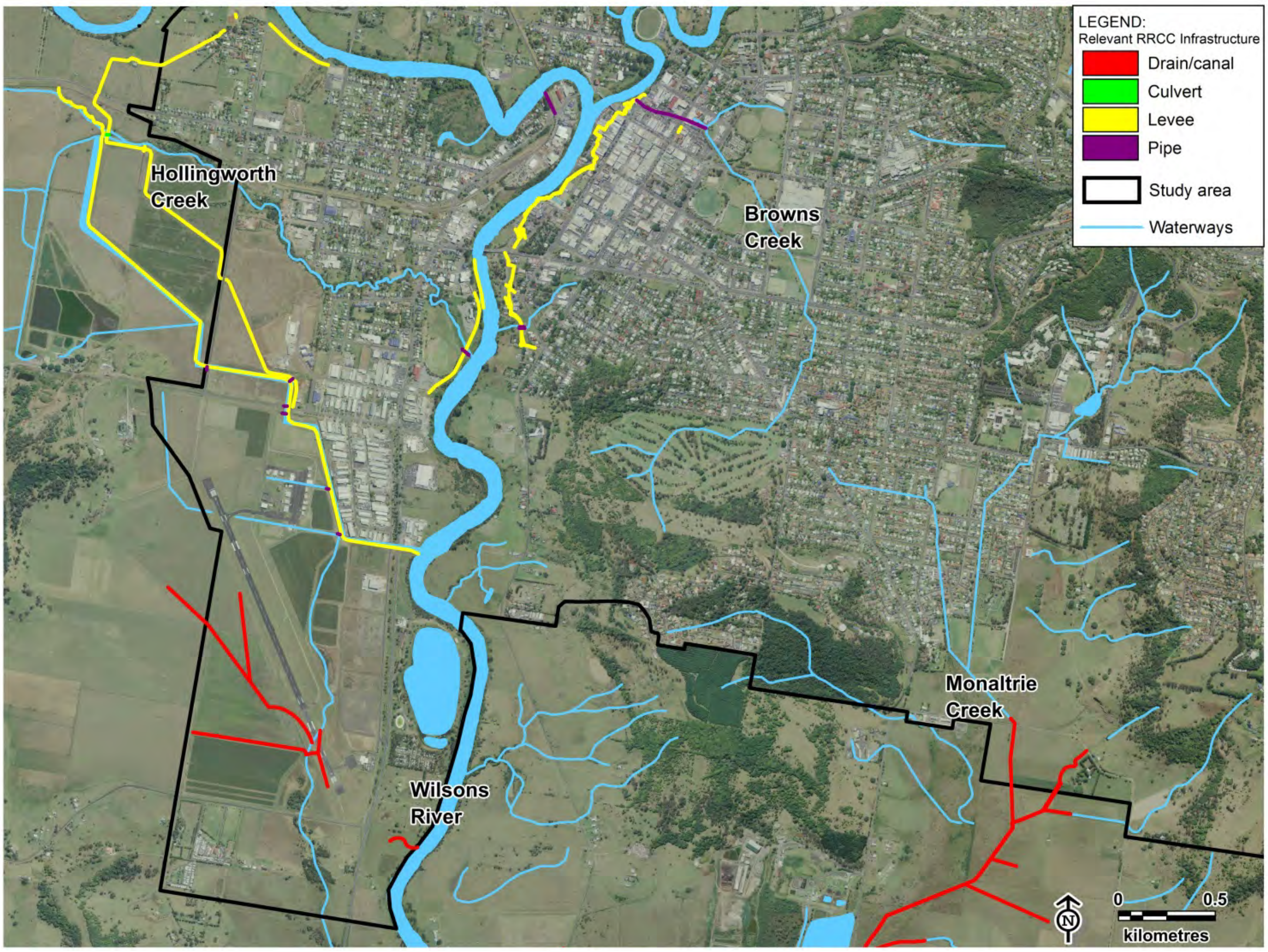


Figure 33: Flood management infrastructure under the control of RRCC

6.2 Council's Urban Stormwater Management Activities

6.2.1 Organisation Structure

Council's current organisation structure comprises three groups - General Manager's Group, Sustainable Development Group and Infrastructure Services Group. The responsibilities of each group that include aspects of urban stormwater management are shown below.

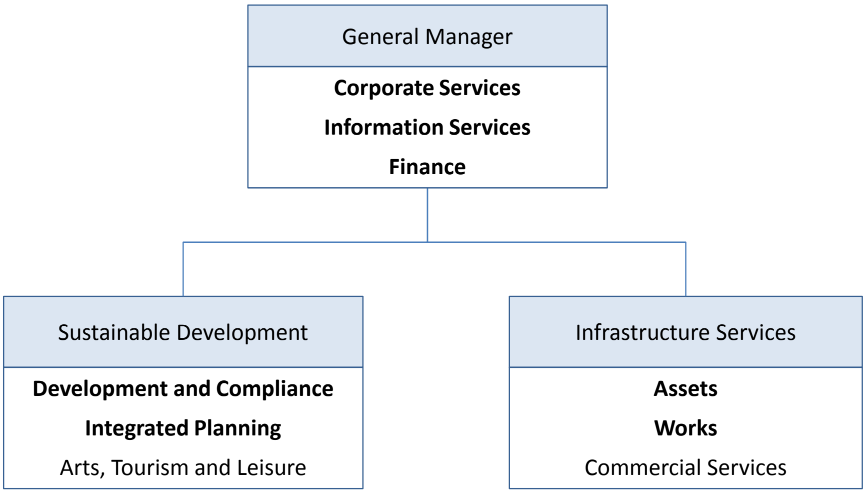


Figure 34: Council structure and responsibilities

In the second half of 2013 a series of workshops were held and facilitated by an external consultant, Morrison Low, to discuss and resolve responsibilities across LCC for the various asset management related tasks that form the basis of sound asset management practice. The approach adopted by Morrison Low was to identify an Asset Owner, Asset Custodian, Service Manager and Asset Maintainer for each asset class. The review found that there are a range of staff across Council with interests in particular asset groups and Council's organisation structure does not easily permit these four roles and their responsibilities to be allocated to the same person/section of Council for different asset classes. Some changes to these responsibilities in relation to stormwater management have been implemented following the workshops facilitated by Morrison Low. Further information is provided in Appendix 4.

6.2.2 Integrated Planning and Reporting (IPR) Framework

The Imagine Lismore 10 Year Plan is a key element of the new IPR framework. The Plan is supported by other more detailed plans and strategies, including the Imagine Lismore Four Year Plan and One Year Plan. The 10 Year Plan is supported by a Resourcing Strategy comprising a Long Term Financial Plan (10-year outlook), a Workforce Management Plan (four-year outlook) and an Asset Management Plan (10-year outlook). The 10 Year Plan also influences Council's LEP as it sets the high-level objectives that inform land-use planning. The Imagine Lismore 10 Year Plan identifies the community's priorities and aspirations. The Imagine Lismore Four Year Plan details specific project costs and delivery timelines to achieve the goals and aspirations of Imagine Lismore. The Imagine Lismore One Year Plan shows how the budget is changing to align with the community's vision each financial year.

The One Year Plan outlines the principal activities to be provided each year, along with the key measures that are recorded to identify whether the actions identified in the 10 Year Plan and the Four Year Plan are being achieved. Urban stormwater management responsibilities are spread across a number of activity areas within each of the services groups.

One of the Community Visions (10: A Vibrant CBD) relates to improvement in the revitalisation of the CBD and the Wilsons River (CBD/Riverbank Master Plan). A major initiative in Imagine Lismore is the Riverbank Restoration and River Walk project. This project will include work by Council and Landcare groups and assist landowners with the regeneration of riverbank on their land. Other activities identified in the four year plan relating to stormwater management are a review of the application of Council's Stormwater Management Service Charge and a review of the Stormwater Management Plan.

The key functions within each of Council's principal activity areas relevant to stormwater management are shown in Table 8.

Table 8: Council Programs relevant to stormwater management

Directorate	Programs	Stormwater Management Functions
Infrastructure Services	Asset management and support services	Asset management planning, GIS mapping
	Parks and Recreation	Maintenance of stormwater treatment devices (weed removal, mowing etc.)
	Roads Urban	Maintenance of drainage infrastructure Construction of new/upgraded drainage infrastructure
	Survey and Design	Design of new/upgraded drainage infrastructure
	Roads and Maritime Services	Maintenance of State Roads

Directorate	Programs	Stormwater Management Functions
Sustainable Development	Integrated Planning	Planning and management of stormwater treatment devices Environmental strategies Strategic environmental planning
	Development and Compliance	Inspection and compliance assessments for new developments Inspection and compliance assessments for existing private stormwater treatment systems Development assessment and approval

6.2.3 2007 Urban Stormwater Management Plan

LCC prepared its original Urban Stormwater Management Plan (USMP) in 2000 with a review in 2007 (LCC, 2007) with the aim of facilitating the coordinated and integrated catchment based management of stormwater quality and quantity and maximise the ecological sustainability of the creek and river systems. The focus of the plan was environmental protection through improved understanding, awareness and cooperation, with an emphasis on developing strategies for the expenditure of the Stormwater Management Service (SMS) charge (refer Section 6.4.2). The 2007 USMP utilises a catchment-based assessment and identifies community values, threats to stormwater, management objectives and management strategies.

This 2007 USMP adopted a hierarchy for stormwater management based on the principles of ESD to ensure the preservation of valuable features of the waterways while promoting cost effective stormwater management by controlling stormwater at the source:

- *Preserve and Restore* – (if required) the existing valuable elements of the water environment (natural watercourses, wetlands, riparian vegetation)
- *Manage the Quantity and Quality of Stormwater at or near the Source* – this may involve a significant component of public education and community involvement,
- *Install 'Structural' Stormwater Management Devices* – such as stormwater treatment measures and retarding basins for water quality and stream flow control.

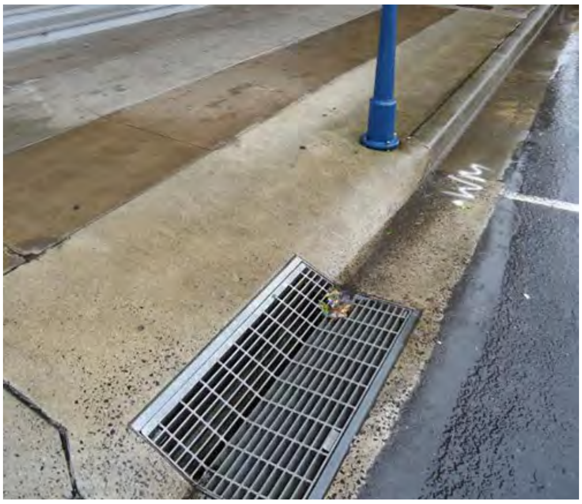
Since the introduction of the SMS Charge, some of the initiatives have been implemented and some have been funded through other Council programs (e.g. waste management and STP effluent management). These include stormwater treatment devices installed under the Cleaner Waterways Program (Figure 35), education initiatives (discussed in Section 6.6) and some trunk drainage upgrades in South Lismore. In addition, the following strategies from the 2007 USMP have been implemented:

- WSUD initiatives have been incorporated into Council's strategic planning (Imagine Lismore);
- Staff have been appointed to stormwater education and stormwater management roles;
- A Service Level Agreement for maintenance of stormwater treatment devices has been developed and formalised between Council's Works and Environmental Strategies Sections;
- Rainwater tanks were installed in public facilities in the CBD (Neighbourhood Centre, Adult Community Education Centre, Council Customer Service Office and Lismore Library) as part of the CBD Greenovation project;
- Landcare groups were established for the Duckpond (South Lismore and Duck Pond Landcare), Slaters Creek (Banyam/Baigham Landcare) and Browns Creek;

- Alternatives to herbicide/pesticide use in grass swales have been implemented (mulching and planting);
- Water quality data was reported in State of the Environment reports and Richmond River EcoHealth report card;
- Rainwater harvesting is promoted through partnerships with Rous Water;
- Riparian weed control and planting (Wilsons River Landcare); and
- Riparian regeneration at Slaters Creek (Reconnecting to Country).

Many of the strategies identified in the 2007 USMP have not been implemented due to a range of factors, namely:

- The 2007 USMP did not identify a prioritised forward works program;
- There have been changes in Council's management structure which have stalled the implementation of some components of the Plan;
- Many strategies were too ambitious given Council's financial capacity;
- The Plan focussed on stormwater quality improvements with little consideration of stormwater quantity requirements; and
- The need to improve water quality within Browns Creek led to the development of the Browns Creek Master Plan involving significant stormwater quality improvements combined with recreational elements. The development of the Master Plan has absorbed substantial staff and external resources and many projects within the Browns Creek catchment were put on hold until the Master Plan was developed (refer Appendix 5).



CBD litter baskets

Bio-retention system at Nesbitt Park carpark, South Lismore. Runoff from the new carpark drains into gardens where the soil microbes and plants treat pollutants including hydro-carbons. Source: LCC website

Gas Works Creek – restoration, head wall reconstruction and installation of litter cages

Ecosol raingarden installed on Avondale Avenue, East Lismore - a small vegetated filter designed to provide biological treatment of stormwater run-off at the road kerb side

GPT replacement at Campbell Crescent, Goonellabah

Slaters Creek Wetland - stormwater treatment wetland in North Lismore to improve water quality flowing from the Slaters Creek catchment into the Wilsons River.

Figure 35: Stormwater treatment – examples of devices installed under the Cleaner Waterways Program

6.3 Asset Management Framework

6.3.1 Council's Asset Management Planning

The objective of asset management is to meet a required level of service, in the most cost effective way, through the management of assets for present and future residents. Lifecycle asset management encompasses all practices associated with considering management strategies as part of the asset lifecycle. The preferred principle is to look at lowest long-term cost (rather than short-term savings) when making decisions.

6.3.2 Stormwater Asset Data

LCC's existing stormwater assets are summarised in Table 9 and the age profile of the assets is shown in Figure 36. These data are based on preliminary asset data and mapping. Further work is required to provide confidence in the asset data, particularly the size, construction details, age and condition. The asset valuation is based on the estimated age. Council has commenced a CCTV inspection program to provide a targeted sample condition assessment of the older stormwater assets and validate the estimated renewal cost. Note that the stormwater treatment assets included in Table 9 are significantly undervalued.

Table 9: Stormwater asset values (2014$)

Asset Category	Current Replacement Cost	Written Down Value
Box Conduits	$1,454,164	$436,160
Channel Conduits	$11,244,204	$7,384,887
Pipe Conduits	$53,333,791	$36,206,190
Pits	$8,820,671	$5,102,131
Bio-Detention Basin	$8,000	$6,080
Bio-Detention System	$22,000	$20,920
Detention Basin	$8,000	$6,260
Detention Pond	$2,000	$1,520
Gross Pollutant Trap	$28,000	$26,880
Sediment Basin	$2,000	$1,720
Sediment Trap	$2,000	$1,780
Vegetated Channels and Bio-Detention basins	$2,000	$1,900
Weir	$2,000	$1,520
Total stormwater drainage	**$74,928,831**	**$49,197,948**

Source: JRA (2014)

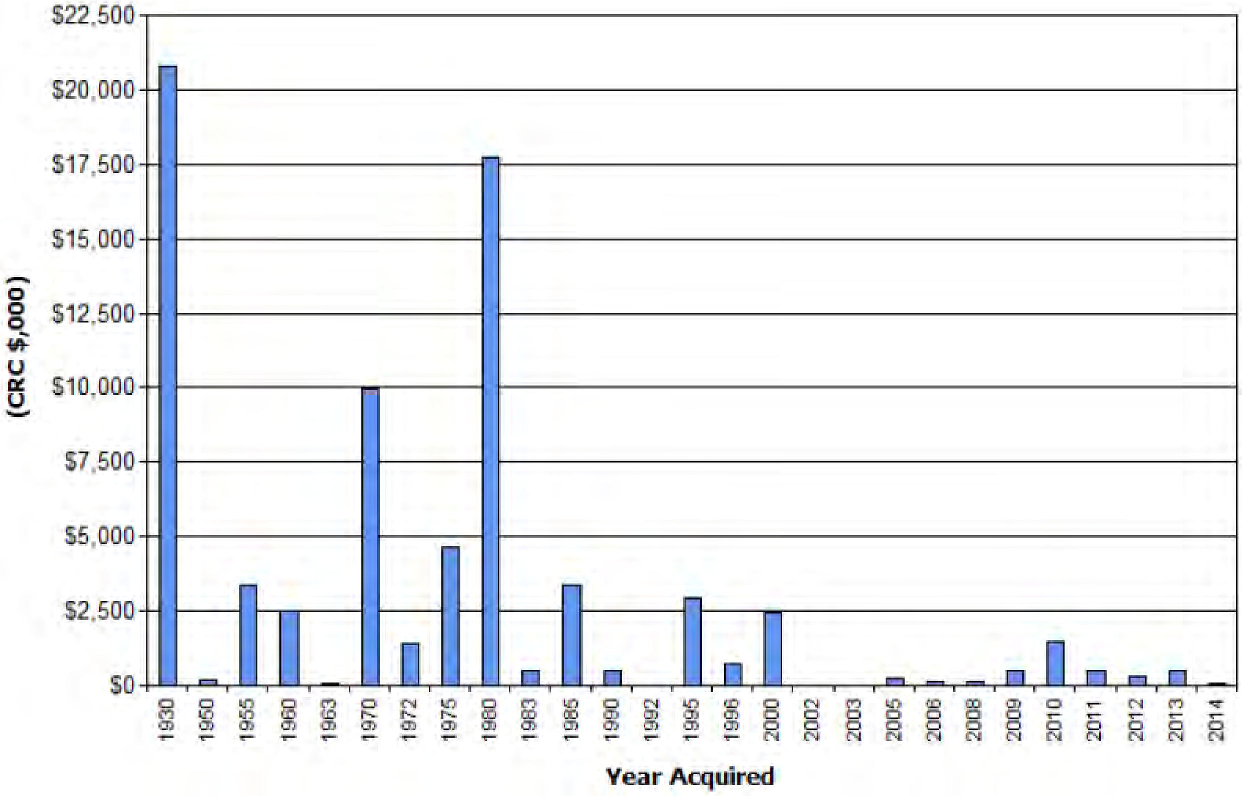


Figure 36: Stormwater asset age profile

Source: LCC (2015b)

6.3.3 Stormwater Service Delivery

Information on the impact of demand drivers that may affect future service delivery and utilisation of assets is summarised below.

Table 10: Demand drivers, projections and impact on urban stormwater services

Demand Drivers	Present Position	Projection	Impact on Services
Development	Population increase and higher density development is not significant	No significant change anticipated	Minimal increase in demand due to development
Community expectations	There is a strong desire from the community for a high level of flood protection and environmental management for the stormwater and road network	Expectations will continue to increase	Existing networks are not suitable for the purpose
Increasing costs	The cost to construct, maintain and renew infrastructure is increasing at a rate greater than council's revenue	Anticipated to continue. Cost of renewing stormwater systems is increasing	The need to carefully target and plan infrastructure is increasing in importance as maximising the service that can be delivered within the funding limitations will be under pressure.

Demand Drivers	Present Position	Projection	Impact on Services
Environment and climate change	It is widely accepted that climate is changing	Future is uncertain but is likely that climate change will impact on the delivery of the services provided by infrastructure. Weather extremes and rising sea levels will have significant impact on stormwater and flood management infrastructure	The stormwater network may be impacted by climate/rainfall and severe events. Higher frequency and larger flood events. Additional costs will be imposed to fund environmental initiatives e.g. retrofitting of water quality infrastructure
Property Protection	There is a need to expand the network to provide broader protection from flood impacts	Anticipated to continue or increase	The impact of flooding in regional NSW in recent years will likely increase the demand for expanding the flood management systems

Source: LCC (2015b)

The Stormwater AMP identifies technical service levels required to meet community levels of service (customer expectations). The current and future technical service levels for stormwater services are shown in Table 11. The required expenditure is based on estimated costs to maintain current service levels. The AMP highlights the following funding issues:

- Council's current spending on stormwater pits and conduits will keep the system in its current condition (“fair”: significant maintenance is required) but not to the service levels desired by the community. Also with the current level of service, the network may degrade to “poor” condition (significant renewal/rehabilitation required) within 5-10 years;
- Current maintenance funding does not address all customer requests;
- Large concrete channels are currently not being maintained due to budget constraints; and
- Renewal of stormwater infrastructure is not currently funded.

The estimated expenditure required to achieve the desired service levels in future is based on preliminary estimates of asset renewal and upgrade requirements. Further investigation including condition assessments are required to confirm the future expenditure requirements.

Table 11: Current funded levels of service

Budget Area	Current (2015) Service		Required to close the Gap and Sustain Current Service Levels	
	Stormwater Pits and Conduits	Stormwater Treatment Devices	Stormwater Pits and Conduits	Stormwater Treatment Devices
Operations	Requirements have not been fully assessed. Further assessment is required to inform future revisions of the AMP.		Requires further assessment to identify and determine whether basic service level expectations would be met.	
Operations Expenditure	$182,000 per year	$128,000 per year	Will need to increase over the next 10 years for the additional assets being created	Will need to increase over the next 10 years for the additional assets being created
Maintenance	Requirements have not been fully assessed. Further assessment is required to inform future revisions of the AMP.		Regular Inspections and Planned Maintenance	
Maintenance Expenditure	$188,000 per year	$46,000 per year	Additional $120,000 per year. Will need to increase over the next 10 years for the additional assets being created. Maintenance requirements will be reviewed following a condition audit of the older sections of the stormwater network.	Will need to increase over the next 10 years for the additional assets being created.
Renewals	Renewal cycle is not fully met. The drainage network appears in relatively good condition although aging. Stormwater treatment systems have not yet reached their design age. Increasing renewal required in medium to longer term, due to the age and condition of the network.		Current network condition would be sustained.	
Renewals expenditure	nil	nil	$865,000 per year [1]	Unknown. Further assessment is required to identify renewal requirements.
Upgrade/new works	Achieved by a combination of Council and Contract works. The augmentation of stormwater infrastructure to meet appropriate service and risk outcomes is not fully funded.		The augmentation of Infrastructure systems to meet appropriate service and risk outcomes would be funded.	
Upgrade/new expenditure	$62,000 per year	$218,000 per year	Additional $290,000 per year	Additional $7,000 per year

Source: adapted from LCC (2015b)

1. Validation of this estimate is required and targeted condition assessments are required to confirm future expenditure requirements.

6.3.4 Maintenance Activities

Drainage Infrastructure

Maintenance of drainage infrastructure (conduits, pits and grass swales) is undertaken by the Council Roads department. Maintenance activities are reactive in response to customer requests and complaints, usually following heavy rain. The maintenance crew inspects the site and applies a target rectification date based on standard intervention levels (e.g. road classification, degree of problem, properties affected and potential damage to public and private infrastructure). Due to limited internal resourcing and funding and a focus on capital works such as road widening, roundabouts and road rehabilitation, maintenance crews have not been available to undertake all maintenance requirements. Many customer requests have not been addressed.

Treatment Devices

An Internal Service Level Agreement for general maintenance has been implemented since 2012/13 to manage and maintain all Council owned/public stormwater treatment devices within the Lismore urban area. The agreement provides a register of Council owned devices and general maintenance responsibilities and requirements (activities to be performed and frequency). The agreement also specifies requirements for facilitating potential capital or renewal works on a case by case basis.

Street Sweeping

Removal of litter and debris from CBD roads is undertaken by Council on a daily to weekly basis depending on the location. Street sweepers also suction waste collected in the CBD litter traps.

6.4 Urban Stormwater Management Revenue and Expenditure

6.4.1 Long-Term Financial Plan

Council has developed a Long-Term Financial Plan (LTFP) in conjunction with Council's Imagine Lismore 10 Year Plan, AMPs and Workforce Management Plan to ensure the maximum integration of Council's strategic planning and the creation of community expectations that are deliverable. The LTFP is a financial assessment of the activities and projects that Council proposes to undertake in the short, medium and long term. The LTFP objectives relating to stormwater management are:

- Progressive increases to asset maintenance and renewal funding in order to maintain current asset service levels and conditions;
- Commitment to identifying and implementing initiatives which reduce expenditure and/or increase income and therefore improve Council's bottom line and/or its capacity to deliver services; and
- Eliminate borrowings as a funding source for asset renewals, as opposed to major new projects, where inter-generational equity issues justify borrowing.

The LTFP is reviewed each year. Annual capital and operating expenditure for stormwater asset management (not including non-asset expenditure such as staff costs or loan repayments) identified in the 2015/16 LTFP are shown below. Stormwater treatment expenditure is funded from the SMS Charges revenue (refer Section 6.4.2) and expenditure for stormwater conduits and pits is funded through General Revenue. As discussed in Section 6.3.3, asset renewal requirements are not currently funded.

Table 12: 10 year (LTFP) stormwater asset expenditure program

Program Area/Expenditure ($k p.a.)	Operations	Maintenance	Capital Renewal	Capital Upgrade New	Total
Asset Management: Stormwater Conduits and Pits	31.1	-	-	-	31.1
Asset Management: Stormwater Treatment Devices	31.1	-	-	-	31.1
Survey and Design: Stormwater Conduits and Pits	56.0	-	-	-	56.0
Survey and Design: Stormwater Treatment Devices	5.6	-	-	-	5.6
Roads – Urban: Stormwater Conduits and Pits	94.3	188.3	-	62.1 (note 1)	344.7
Integrated Planning – Stormwater Treatment	91.2	46.2	-	218.0	355.4
Totals	*309.5*	*234.4*	-	*280.1*	*824.0*

Note 1. Money set aside for reconstruction of roads is used to fund new drainage works when these roads are re-constructed.

6.4.2 Stormwater Management Service Charge

In accordance with Section 96A of *the Local Government Act, 1993* a council may, in accordance with the regulations, make and levy an annual charge for the provision of stormwater management services for each parcel of rateable land for which the service is available. This Stormwater Management Service (SMS) Charge is independent of rate pegging and can be utilised on a wide range of activities.

LCC resolved to introduce the SMS charge from the 2006/2007 financial year. The SMS charge is applied to rateable land within the Lismore urban area. In recent years, LCC has resolved to charge the maximum allowable residential stormwater charge on residential properties ($25 per property and $12.50 for residential strata and company titled land). For business properties the charge is area based with a minimum charge of $25.00 for properties up to 350m² and an additional $25.00 for each unit of 350m² or part thereof. This represents an annual charge levied on all developed urban properties in the LGA. Exemptions to the charge are vacant and crown land (including Department of Housing).

The SMS Charge Guidelines (DLG, 2006) specify that the income from the charge can be spent on both capital projects and recurrent expenditure relating to new/additional stormwater management services such as:

- Planning, construction and maintenance of drainage systems, including pipes, channels, retarding basins and waterways receiving urban stormwater;
- Planning, construction and maintenance of stormwater treatment measures, including gross pollutant traps and constructed wetlands;
- Planning, construction and maintenance of stormwater harvesting and reuse projects;
- Planning and undertaking of community and industry stormwater pollution education campaigns;
- Inspection of commercial and industrial premises for stormwater pollution prevention;
- Cleaning up of stormwater pollution incidents (charge can fund a proportion);

- Water quality and aquatic ecosystem health monitoring of waterways, to assess the effectiveness of stormwater pollution controls (charge can fund a proportion);
- Monitoring of flows in drains and creeks, to assess the effectiveness for flow management (flooding) controls (charge can fund a proportion); and
- Staff specifically appointed to provide the stormwater management service associated with the charge (e.g. temporary project staff).

As a rule of thumb, approximately 10 – 15% of the costs associated with stormwater capital project works should be allocated for continued maintenance of the project (DLG, 2006).

Funding from the charge cannot be spent on activities for which the primary purpose does not relate to providing stormwater management services to parcels of land eligible to be charged. These include:

- Parks and garden activities;
- Riparian restoration or management;
- Bush care (unless proposed activity specifically relates to stormwater impacts on bushland);
- Street sweeping; and
- Kerb and guttering (unless dealing with flooding from private land).

The 2007 USMP included a framework for the expenditure of the SMS Charge delineating the broad categories for expenditure (Figure 37).

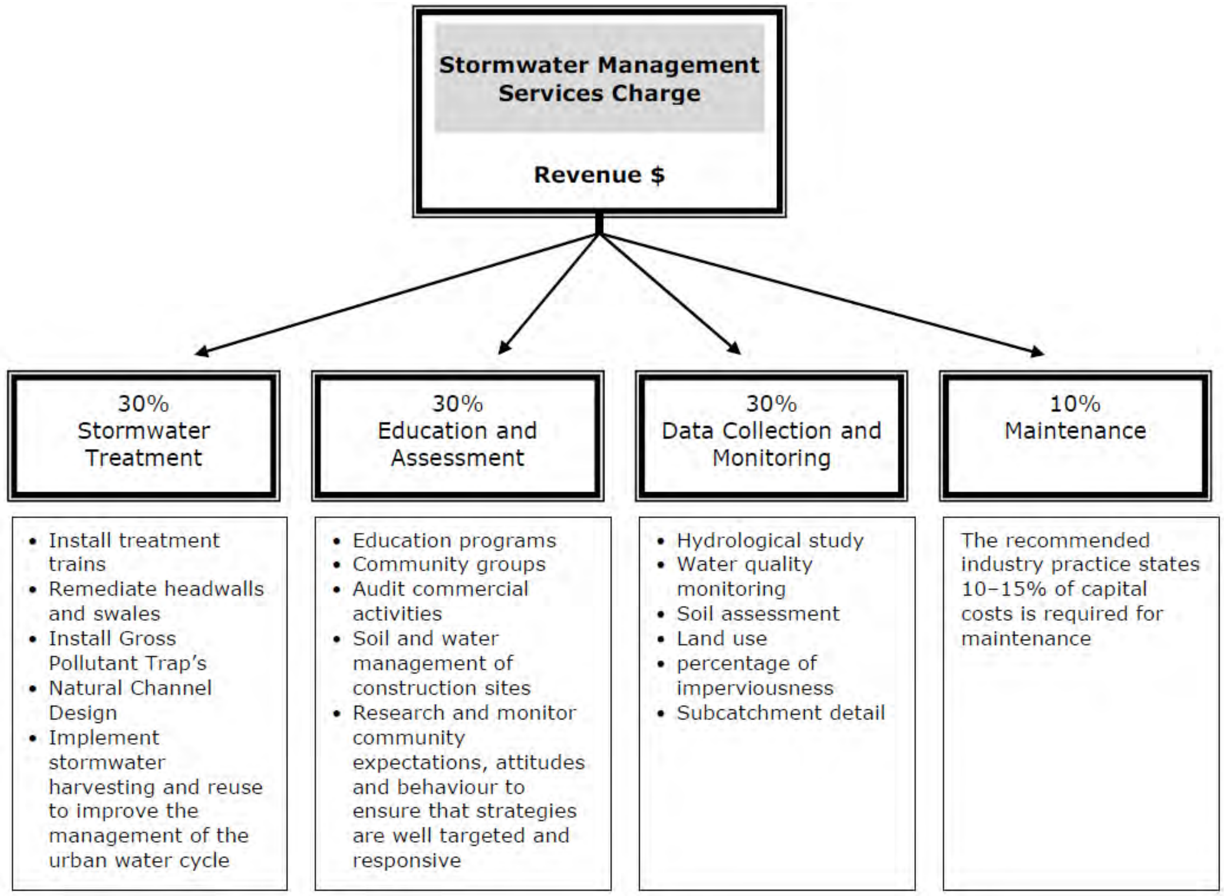


Figure 37: 2007 USMP framework for expenditure of SMS charge revenue

Source: LCC (2007)

A summary of the SMS expenditure program is shown in Table 13 and Figure 38. The accumulated reserve for 2015/16 from the SMS revenue (since 2006/07) was $1.06 million. The planned expenditure for 2015/16 ($175,000) is less than the budget allowance, expected to result in a reserve opening balance of approximately $1.26 million for 2016/17.

Table 13: SMS charge revenue and expenditure since 2011/12

SMS	**Actual ($k)**					**Budget ($k)**
	2011/12	**2012/13**	**2013/14**	**2014/15**	**2007-2015**	**2015/16**
Reserve Opening Balance	574.7	700.9	836.3	791.3	-	1,057.3
SMS Charge Revenue	368.7	371.8	373.5	371.5	3,187.1	378.7
Expenses						
Administration	-54.7	-15.6	-16.5	-16.5	-319.7	-54.6
Data collection and monitoring	-11.7	0.0	0.0	0.0	-44.6	0.0
Education and training	-26.8	-20.0	-22.4	-25.7	-140.7	-25.9
Stormwater treatment - Tucki Tucki	-16.9	-13.1	0.0	0.0	-265.7	-34.1
Stormwater treatment - Wilsons	-81.5	-134.2	-334.2	0.0	-1,064.9	-179.7
Maintenance - Wilsons	-12.7	-19.4	-27.9	-31.9	-135.1	-43.4
Maintenance - Tucki Tucki	-6.4	-3.6	-9.1	-5.3	-25.5	-10.8
Trunk drainage [1]	-31.8	-30.5	-30.3	-26.0	-173.5	-30.2
Interest on Reserve			21.8		39.8	
Net result (accumulated for future expenditure)	*126.2*	*135.4*	*-45.1*	*266.0*	-	-

1. Trunk Drainage funding is for servicing of two loans ($100,000 and $250,000) used to fund the trunk drainage program.

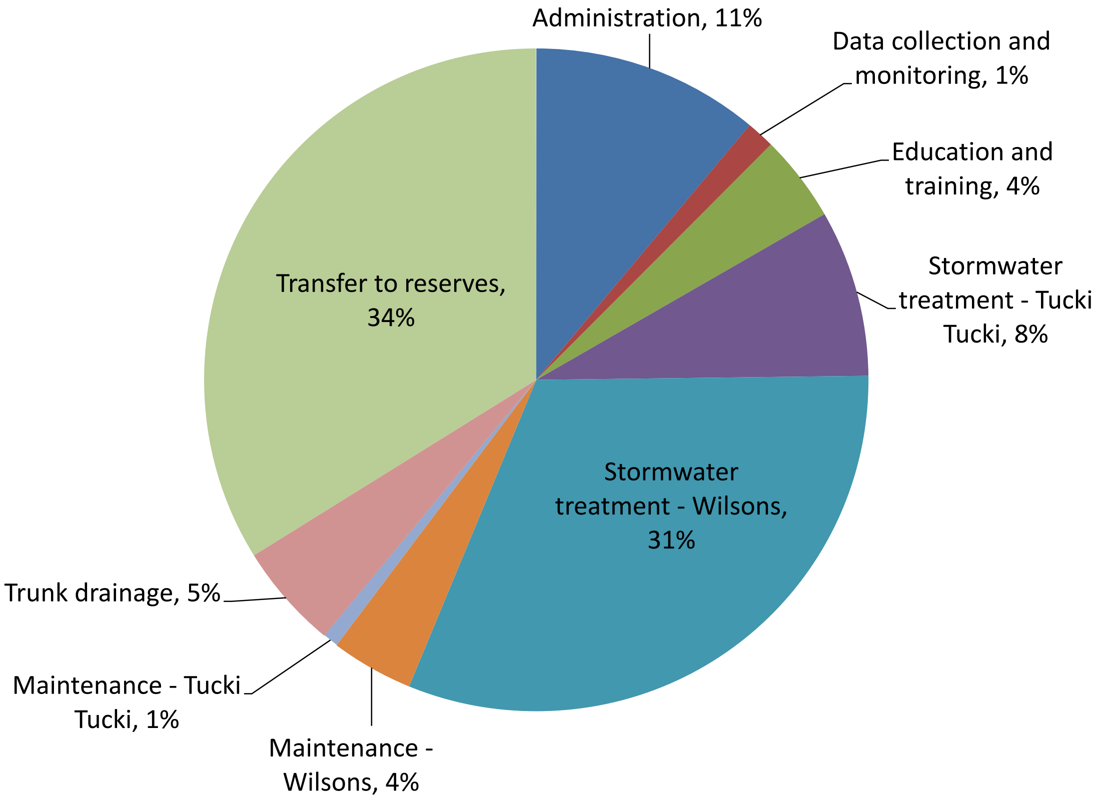


Figure 38: Summary of SMS expenditure and transfers to reserves (average between 2006/07 and 2014/15)

6.4.3 Special Rate for Stormwater Management

LCC also has the option of levying a special rate for stormwater management. Where a council determines that the revenue needed to address local stormwater issues is above the amount that could be raised through levying the SMS charge, the council could apply to the Minister for Local Government for a special variation as an alternative to levying the SMS charge. The variation application would need to justify why higher revenue is required than the amount that could be received from levying the SMS charge. Should the variation be approved, the council cannot also levy the SMS charge. This is to avoid perceptions of ‘double charging’.

The differences between a special rate for stormwater management and the SMS charge are shown below.

Table 14: SMS charge compared to special rate

Item	Special rate for stormwater management	SMS Charge
Calculation method	Structure must include an *ad valorem* component	The lower of a specified cap ($25 for residential lots) or the anticipated cost per lot of providing new/additional services
Payees	Specific group of ratepayers who benefit from , contribute to the need for, or have access to service	All eligible rate payers in the LGA receiving the stormwater service
Rate pegged	Yes	No
Approval/consultation process	Ministerial approval required if special rate causes council to exceed permissible general income limit	Community consultation through draft management process
Reporting process	In annual report if subject to special variation approval	In annual report.

Source: DLG (2006)

6.4.4 Developer Contributions

Section 94 Developer Contributions

Section 94 of the *EP&A Act* 1979 permits councils to require developers to pay monetary contributions and/or dedicate land in order to fund the increased demand for public amenities and public services generated by the carrying out of development. LCC's 2014 Section 94 Contributions Plan authorises the collection of monetary contributions from residential, commercial and industrial developments towards the preparation of this USMP. No other urban stormwater projects are funded from Section 94 contributions.

The introduction of Section 94 contributions for stormwater works would ensure the full cost of developments is recovered at the development approval stage. The three general principles to be satisfied in validly requiring section 94 contributions are:

- The contribution must be for, or relate to, a planning purpose;
- The contribution must fairly and reasonable relate to the subject development; and
- The contribution must be such that a reasonable planning authority, duly appreciating its statutory duties, could have properly imposed the contribution.

Council may require a contribution by way of the payment of monies and/or either or both of the following methods:

- The dedication of land, free of cost to Council; or
- The carrying out of works approved by and free of cost to Council, where such contribution is for the carrying out of public works and/or provision of public facilities which are reasonably required by the particular development.

Internal drainage in subdivisions and other developments is normally accepted as part of the works associated with the development. This work will generally be wholly provided by the developer, and no section 94 contribution will be required. However recovery of trunk drainage costs may include:

- Studies;
- Acquisition of land;
- Construction of drainage facilities;

- Pipelines;
- Culverts;
- Pollution control measures;
- Formation of detention and retention basins;
- All ancillary works; and
- Topdressing and grassing.

In determining a reasonable trunk drainage contribution, the necessary land reservation and construction costs need to be identified. Ecological mechanisms which help drainage, such as appropriate planting and measures to reduce potential downstream impacts, may also be incorporated when assessing the contribution. The application of Section 94 contributions need to be assessed to determine which components are applicable to future development.

In 2010, the NSW Government introduced reforms to increase housing development including a limit on the amount of development contributions ($20,000 per residential lot for established areas and $30,000 per lot for green field areas). The development contributions cap has not been reached in Lismore. The Section 94 Contributions Plan will be reviewed once the USMP works schedule is adopted.

Section 64 Developer Charges

Developer charges are up-front charges that a Council can levy under section 64 of the *Local Government Act 1993* to recover part of the infrastructure costs incurred in servicing new development or additions and changes to existing development. Developer charges provide a source of funding for infrastructure and provide signals to the community regarding the cost of urban development. The NSW Office of Water has issued *Developer Charges Guidelines for Water Supply, Sewerage and Stormwater*, December 2002 pursuant to section 306 (3)(C) of the *Water Management Act 2000*. NSW local water utilities are required to prepare a Development Servicing Plan (DSP) and to levy developer charges in accordance with these guidelines. A DSP documents all the relevant information used to calculate the developer charges per lot.

Council has adopted DSPs for water supply and sewerage services. The preparation of a DSP for stormwater services would also facilitate recovery of costs associated with stormwater management for new developments. This would replace the need for section 94 stormwater contributions.

Voluntary Planning Agreements

A voluntary planning agreement (VPA) is an agreement entered into by a planning authority (such as a council) and a developer. Under the agreement a developer agrees to provide or fund infrastructure. Contributions can be made through dedication of land, monetary contributions, construction of infrastructure or provision of materials for public benefit and/or use. Planning agreements provide a facility for planning authorities and developers to negotiate flexible outcomes in respect of development contributions

6.4.5 External Grants

LCC received funding under the Stormwater Trust grants scheme for various projects including urban drainage and bushland reserve remediation and education and installation of a GPT.

6.5 Development Requirements

6.5.1 Development Control Plan

In assessing a development application, Council must have regard to the matters listed in Section 79C of the *Environmental Planning and Assessment Act 1979*. Under Section 79C(1)(a)(iii) of the Act, Council is required to consider any development control plan that applies to the land to which the development application relates. The aim of the Lismore Development Control Plan (DCP) is to provide controls and guidelines for new development that will assist in achieving the aims and objectives of the Lismore LEP 2012. The DCP is comprised of two parts – Part A and Part B. Part A contains controls that apply to particular forms or aspects of development generally throughout Lismore. Part B contains more specific controls that are applicable to specific areas. The DCP covers a range of matters that are addressed as individual Chapters in the Plan.

DCP chapters relevant to stormwater management in the Lismore urban area are:

- DCP Part A Chapter 1 – Residential Development: specifies stormwater drainage requirements for residential developments;
- DCP Part A Chapter 4 - Subdivision and Infrastructure General Requirements: identifies application documentation required for stormwater management for subdivisions;
- DCP Part A Chapter 5 – Urban Subdivision: specifies stormwater drainage and water quality management requirements for subdivisions;
- DCP Part A Chapter 22 – Water Sensitive Design: contains Council's requirements for the application of Water Sensitive Design (WSUD) principles to developments in the Lismore LGA (refer below);
- DCP Part B Chapter 2 – Land at West Goonellabah: sets out the minimum requirements that should be addressed in a subdivision development application for this land;
- DCP Part B Chapter 4 Airport Industrial Estate: applies to land located on the western side of the Bruxner Highway in South Lismore between the Lismore Airport terminal and Krauss Ave;
- DCP Part B Chapter 5 Wyrallah Road Industrial Estate: applies to development on land in Wyrallah Road, East Lismore;
- DCP Part B Chapter 9 North Lismore Industrial Estate: applies to land bounded by Bouyon, Terania, Tweed and Lake Streets, North Lismore; and
- DCP Part B Chapter 10 - North Lismore Plateau Urban Release Area: provides the coordination, urban design principles and an overall structure for future development of the urban release area.

DCP Chapter 22 – Water Sensitive Design

The main emphasis of this Chapter is stormwater management and water supply. This Chapter sets bench marks for design and performance outcomes at the subdivision, street and lot scales. The provisions are designed to be applied to all developments and to be compatible with the Building Sustainability Index (BASIX).

The objectives of this Chapter relating to stormwater management are:

1. To ensure that WSUD techniques are incorporated in new developments;
2. To ensure that stormwater discharged from new development minimises adverse impacts on the environment and receiving waters;
3. To utilise natural surfaces and landforms as stormwater flow paths and to allow for on-site treatment where suitable;
4. To ensure that water management is a key consideration in the urban design process to maximise opportunities for water reuse and ensure stormwater management infrastructure, in particular, is appropriately integrated with the site design;
5. To protect and restore aquatic ecosystems within the development site and downstream; and

6. To ensure the function of the stormwater drainage and flood protection elements of designs are not compromised by incompatible or inappropriate WSUD designs.

Stormwater performance criteria for developments and subdivisions are shown in Table 15.

Table 15: DCP Chapter 22 WSUD performance criteria

Component	Performance Criteria [1]	Intent
Stormwater Quality		
Total Suspended Solids	75% reduction in the mean annual load compared to baseline	Minimise the risk of water quality degradation in downstream waterways and thereby protect aquatic ecosystems
Total Phosphorus	65% reduction in the mean annual load compared to baseline	
Total Nitrogen	40% reduction in the mean annual load compared to baseline	
Gross Pollutants	90% reduction in the mean annual load compared to baseline	
Stormwater Quantity		
Flow rates (environmental protection)	Limit the post-development peak 1 year average recurrence interval (ARI) discharge from the site to the pre-development peak 1 year ARI discharge.	Reduce the likelihood of increased rates of bed and bank erosion and damage to benthic habitat in waterways
Flow rates (infrastructure protection)	Limit the post-development peak 10 year average recurrence interval (ARI) discharge from the site to the pre-development peak discharge for the same ARI and assess the capacity of existing flow paths to accommodate the post development 100 year average diversion of stormwater to a discharge location where the increased frequency of discharge will not have a detrimental impact on aquatic ecosystems. Reduce discharge from the site and provide necessary attenuation / infrastructure upgrade to ensure flow paths can accommodate anticipated flows.	Ensure that the development does not result in increased stormwater flows that exceed the capacity of the external stormwater drainage infrastructure and or exacerbate overland flow problems.

1. Baseline refers to outcomes from a development scenario where no water sensitive design measures are implemented to improve or mitigate potential impacts of the development. The baseline is the “do nothing” or “business as usual” scenario.

Minor developments (development site area less than 2,500 m² and impervious area greater than 300 m²) are required to satisfy the performance criteria in Table 15 by either implementing the ‘Deemed to Comply’ solutions or preparing a Water Management Plan that demonstrates how the development satisfies the performance criteria and objectives of DCP Chapter 22. Major developments (development site area greater than 2,500 m² and impervious area greater than 300 m²) are required to prepare a Water Management Plan that demonstrates how the development will meet the performance criteria. Subdivisions are required to be designed in accordance with the Northern Rivers Local Government Development and Design Manual (refer Section 6.5.2) and meet the objectives and performance criteria of DCP Chapter 22.

The South East Queensland guidelines for WSUD (refer Section 6.5.9) are referred to in relation to guidance on the selection of appropriate WSUD measures and their subsequent design, construction and establishment. LCC has developed WSUD Technical Guidelines for Minor Development to assist designers to ensure that development proposals meet Council’s WSUD requirements.

Due to public safety, maintenance and operational issues arising from some treatment solutions DCP Chapter 22 limits the array of treatment options that will be accepted as public infrastructure.

6.5.2 Northern Rivers Local Government Development Design and Construction Manual

The *Northern Rivers Local Government Development Design and Construction Manual* has been adopted by Council to provide uniform design and construction standards for new infrastructure associated with developments within the LGA. The development industry is encouraged to utilise these guidelines before planning begins, enabling faster and more effective processing of developments through Council. The specifications are derived from the AUS-SPEC generic Development Specification Series – Design Manual and include amendments required by the Northern Rivers Councils.

Relevant design components include:

- Guidelines for Development and Subdivision of Land;
- D5 – Stormwater Drainage Design and supplement - Handbook of Stormwater Drainage Design;
- D6 – Site Regrading;
- D7 – Erosion Control and Stormwater Management;
- D8 – Waterfront Development; and
- D10 – Handbook of Stormwater Drainage Design.

Standard drawings are also provided for stormwater components.

6.5.3 Construction Manual

Council has developed specifications for development construction based on AUS-SPEC generic specifications. Specifications relevant to stormwater management are:

- C211 – Control of Erosion and Sedimentation
- C213 – Earthworks
- C220 – Stormwater Drainage - General
- C221 – Pipe Drainage
- C222 – Precast Box Culverts
- C223 – Drainage Structures
- C224 – Open Drains (including Kerb and Gutter (Channel))
- C230 – Subsurface Drainage – General
- C233 – Drainage Mats
- C273 – Landscaping

There are no Council construction guidelines specifically for post-construction stormwater treatment systems.

Requirements for control of erosion and sediment during construction and for permanent erosion and sedimentation controls are provided in C211. C211 requires the preparation of a Soil and Water Management Plan (SWMP) prepared in accordance with the requirements of the NSW Department of Housing Blue Book *Managing Urban Stormwater – Soil and Conservation*.

6.5.4 Securities and Maintenance Bonds

DCP Part A Chapter 4 - Subdivision and Infrastructure General Requirements identifies requirements for securities and maintenance bonds. Where works are in compliance with Council's design and construction standards, a bonded maintenance period of 6 months applies from the date the bond is lodged with Council (usually at the time the linen plan is released). Where works are not in compliance, the maintenance period is a minimum of 12 months. The bond is to cover the repair of any defects (faulty material or workmanship) which may arise in the period, if not rectified to the satisfaction of Council. The bond or unexpended funds are refunded after the maintenance period.

The bond is accompanied by a legal agreement nominating the applicant/developer as the responsible person/s. The value of the bond is a minimum of 5% of the total cost of the completed works, or $1,000, whichever is the greater, as calculated by Council. While bonds are not specifically intended to cover the satisfactory construction of operational phase stormwater treatment infrastructure, the maintenance bond is taken to cover works and public items that may be directly affected as a result of the development:

- Additional works undertaken by the applicant;
- Damage to the existing road network;
- Damage to street furniture and trees to be retained in the road reserve; and
- Damage to water, sewer or drainage services.

6.5.5 Landscape Guideline

Council has prepared guidelines for preparation of landscape plans which include recommendations on planting near or over easements and pipes to prevent root intrusion and species selection for street trees to prevent debris falling into the stormwater drains.

6.5.6 Development within Water Supply Catchments

The majority of the area being considered as part of the USMP is located within the Wilsons River drinking water catchment area, as designated in the mapping included in the *Lismore Local Environmental Plan 2012* (Figure 31). Of key significance is the clause in the Lismore LEP that addresses the issue of development control in water supply catchments: Clause 6.4 of the *Lismore Local Environmental Plan 2012* was established *"to protect drinking water catchments by minimising the adverse impacts of development on the quality and quantity of water"*. Clause 6.4 should be addressed early in the design process for any significant development that is proposed.

> *6.4 Drinking water catchments*
>
> *(1) The objective of this clause is to protect drinking water catchments by minimising the adverse impacts of development on the quality and quantity of water entering drinking water storages.*
>
> *(2) This clause applies to land identified as "Drinking water catchment" on the Drinking Water Catchment Map.*
>
> *(3) Before determining a development application for development on land to which this clause applies, the consent authority must consider the following:*
>
> > *(a) whether the development is likely to have any adverse impact on the quality and quantity of water entering the drinking water storage, having regard to the following:*
> >
> > > *(i) the distance between the development and any waterway that feeds into the drinking water storage,*
> > >
> > > *(ii) the on-site use, storage and disposal of any chemicals on the land,*
> > >
> > > *(iii) the treatment, storage and disposal of waste water and solid waste generated or used by the development,*

> *(b) any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.*

(4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:

> *(a) the development is designed, sited and will be managed to avoid any significant adverse impact on water quality and flows, or*
>
> *(b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or*
>
> *(c) if that impact cannot be minimised—the development will be managed to mitigate that impact.*

In order to assist LCC and consultants/developers to meet this clause (Clause 6.4) in designated water catchment areas, Rous Water has provided guidance to LCC that establishes the requirements of Rous Water in relation to significant developments in drinking water catchment areas such as residential subdivisions and associated development and assessment processes:

- *Development Control in the Rous Water Supply Catchment Areas*: This report addresses key issues of significance for the regional water supply catchments including development guidelines and implementation protocols; and
- *Development Control Plan for Development within the Rous Water Catchments*: This report provides guidance to consultants and developers in preparing urban and rural residential subdivision designs and other forms of development, and to Council in its assessment of such developments. The document also identifies a range of water sensitive planning and development principles, practices and solutions that are consistent with the requirements for achieving sustainable catchment health outcomes while still achieving a Neutral or Beneficial Effect on Water Quality (NorBE).

6.5.7 Development within Waterfront Land

Under the *Water Management Act 2000,* an approval is required to undertake controlled activities on waterfront land, unless that activity is otherwise exempt (section 91E). Controlled activities include the carrying out of building work, such as erecting buildings and other structures, and the installation of infrastructure. They also include excavating or depositing material. Under the Act a public authority (including Council) is exempt from the need to obtain a controlled activity approval for any controlled activities that it carries out in, on or under waterfront land. However, the Minister may, if necessary, require a person to take measures to protect the waterfront land, or any river, lake or estuary to which that land has frontage, when carrying out an exempt controlled activity.

NSW Office of Water requires a riparian corridor to be maintained around all waterways with the width of the corridor dependent on the order of the stream. Stormwater outlet structures are a controlled activity under the Act and are permitted (with approval) in the riparian corridor. NOW has prepared guidelines for outlet structures on waterfront land relating to the design of stormwater outlets and spillways from infrastructure including roads, buildings, constructed basins/wetlands, swales or other drainage works into a watercourse or waterfront land (NSW Office of Water, 2012a). The design and construction of stormwater outlets should aim to be natural, yet provide a stable transition from a constructed drainage system to a natural flow regime (Figure 39).

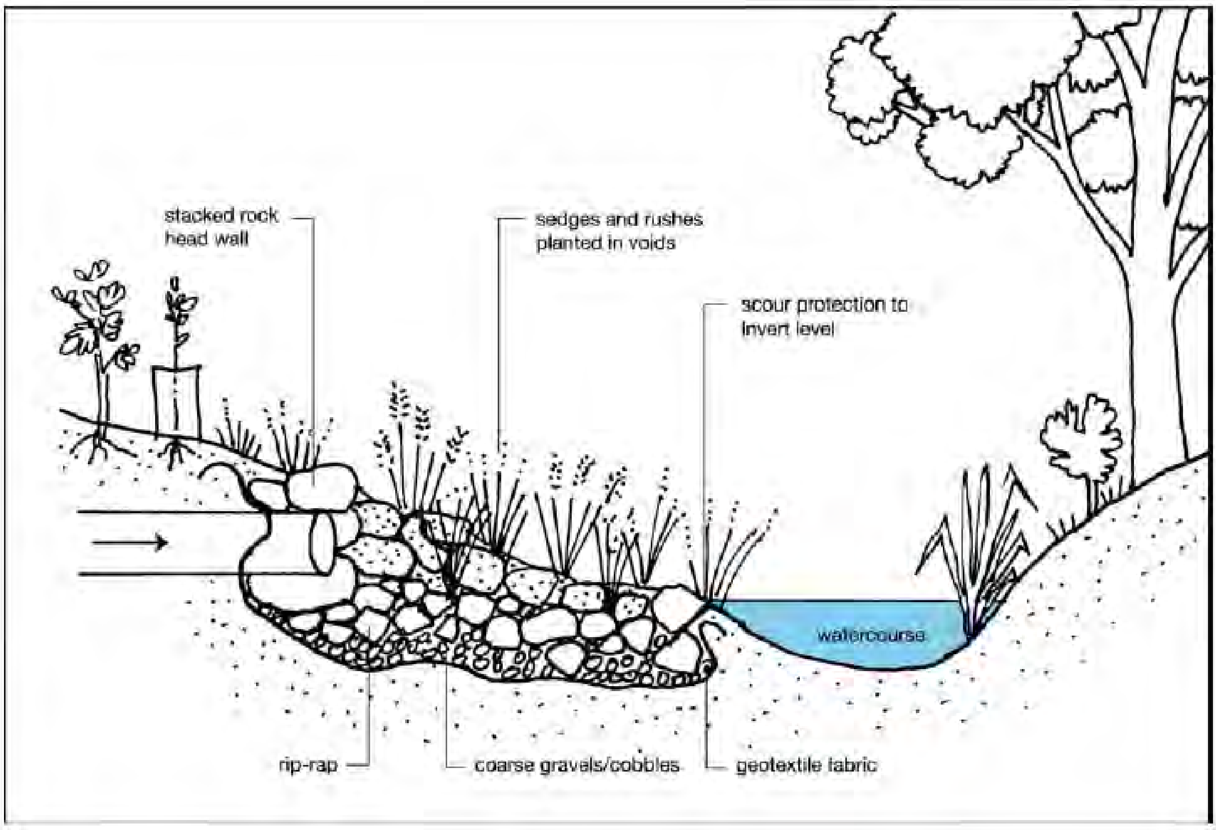


Figure 39: Natural outlet structure

Source: NSW Office of Water (2012a)

All ancillary drainage infrastructure, such as oil or grease interceptors, sediment and litter traps, constructed wetland, detention basins or any works requiring on-going access or maintenance should be located outside the riparian corridor or in accordance with the NSW Office of Water guidelines for riparian corridors. Water run-off from the site should be of appropriate quality and quantity before being discharged into a riparian corridor or watercourse (NSW Office of Water, 2012b).

Appropriate rehabilitation of disturbed areas following the installation of outlet structures should adequately restore the integrity of the riparian corridor. A riparian corridor (RC) forms a transition zone between the land, also known as the terrestrial environment, and the river or watercourse or aquatic environment. The riparian corridor consists of (Figure 40):

- The channel which comprises the bed and banks of the watercourse (to the highest bank) and
- The vegetated riparian zone (VRZ) adjoining the channel.

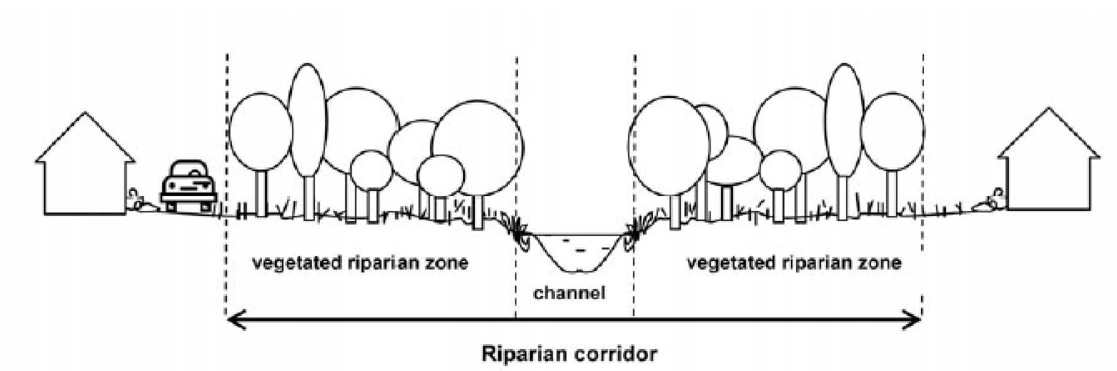
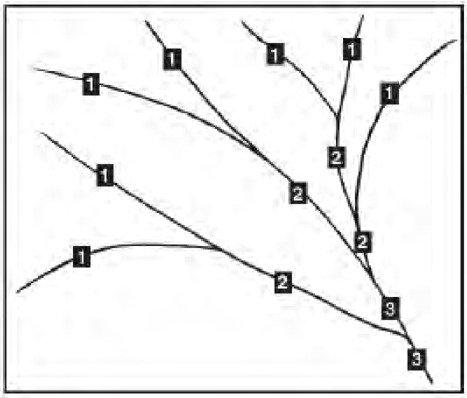


Figure 40: The riparian corridor

Source: NSW Office of Water (2012b)

The Officer of Water recommends a VRZ width based on watercourse order as classified under the Strahler System of ordering watercourses and using current 1:25 000 topographic maps (Figure 41). The width of the VRZ should be measured from the top of the highest bank on both sides of the watercourse.



Watercourse type	VRZ width (each side of watercourse)	Total RC width
1st order	10 metres	20 m + channel width
2nd order	20 metres	40 m + channel width
3rd order	30 metres	60 m + channel width
4th order and greater (includes estuaries, wetlands and any parts of rivers influenced by tidal waters)	40 metres	80 m + channel width

Figure 41: The Strahler system of watercourse ordering and recommended riparian corridor widths

Source: NSW Office of Water (2012b)

6.5.8 Protection of Key Fish Habitat

Fisheries NSW supports water sensitive urban design contingent upon ensuring that those features are appropriately sited to provide treatment prior to entry into waterways mapped as Key Fish Habitats. Key fish habitats are those habitats that are important to the sustainability of the recreational and commercial fishing industries, the maintenance of fish populations generally and the survival and recovery of threatened aquatic species. Within Lismore urban area, key fish habitats include:

- Estuarine habitats up to the level defined by High High Water Solstice Spring tides (so called 'King tides' or Highest Astronomical Tide);
- Permanently flowing rivers and creeks including those where the flow is modified by upstream dam(s), up to the top of the natural bank regardless of whether the channel has been physically modified;
- Intermittently flowing rivers and creeks that retain water in a series of disconnected pools after flow ceases including those where the flow is modified by upstream dam(s), up to the top of the natural bank regardless of whether the channel has been physically modified;
- Billabongs, lakes, lagoons, wetlands associated with other permanent fish habitats (e.g. permanent rivers and creeks, estuaries, etc.);
- Flood channels or flood runners that may normally be dry but would be used by fish to move/migrate across or along floodplains between habitats during high flow events; and
- Any waterbody, if it is known to support or could be confidently expected (based on predictive modelling) to support threatened species, threatened populations or threatened communities listed under the provisions of Part 7A of the *Fisheries Management Act 1994*.

Examples of habitats that are not considered to be key fish habitat (except if they are found to be habitat of a listed threatened species, population or ecological community or 'critical habitat') include:

- First and second order streams on gaining streams (based on the Strahler method of stream ordering);

- Farm dams on first and second order streams or unmapped gullies;
- Agricultural and urban drains;
- Urban or other artificial ponds (e.g. evaporation basins, aquaculture ponds); and
- Sections of stream that have been concrete-lined or piped (not including a waterway crossing).

Key fish habitat is classed as Type 1, Type 2 or Type 3 according to the sensitivity of the habitat.

- Type 1 - highly sensitive key fish habitat (e.g. freshwater habitats that contain in-stream gravel beds, rocks greater than 500 mm in two dimensions, snags greater than 300 mm in diameter or 3 metres in length, or native aquatic plants. Any known or expected protected or threatened species habitat);
- Type 2 – moderately sensitive key fish habitat (e.g. Freshwater habitats and brackish wetlands, lakes and lagoons other than those defined in Type 1; and
- Type 3 – minimally sensitive key fish habitat (e.g. Ephemeral aquatic habitat not supporting native aquatic or wetland vegetation).

Several waterways within the study area are classified as key fish habitats including Wilsons River, Leycester Creek, Lagoon Creek, Booerie Creek, Monaltrie Creek and Tucki Tucki Creek (Figure 42).

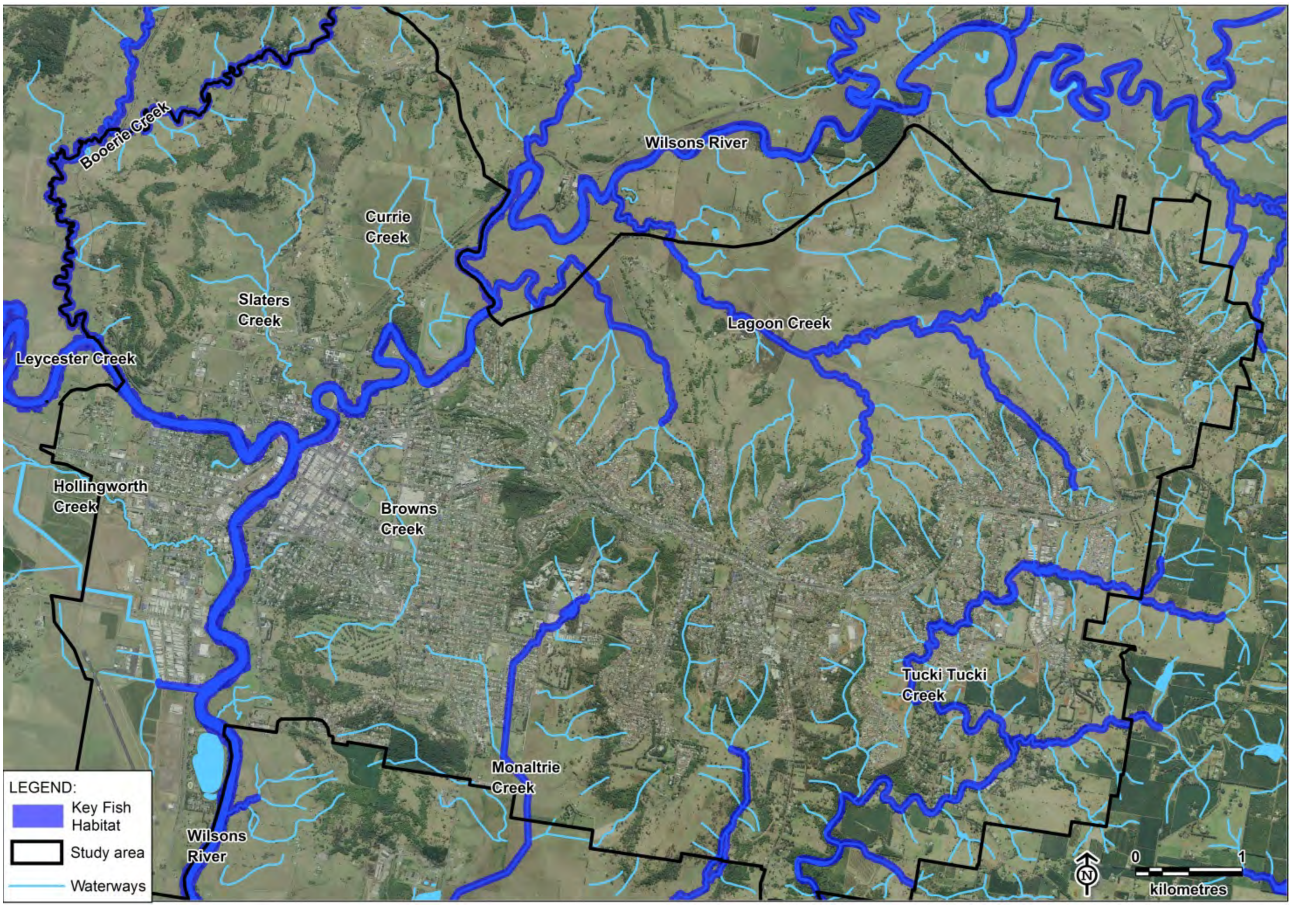


Figure 42: Mapped key fish habitat within the study area

The *NSW Policy and guidelines for fish habitat conservation and management (Fairfull, 2013)* provides policies and guidance on for fish habitat conservation and management under the *Fisheries Management Act 1994*.

6.5.9 South-East Queensland Healthy Waterways Partnership

The Water by Design program is part of the Healthy Waterways Partnership in south-east Queensland. Most local councils in the region are members of the partnership including Gold Coast City Council, Brisbane City Council and Sunshine Coast Regional Council. The program supports the management of the whole urban water cycle in order to achieve sustainable development, including protecting and restoring the natural water cycle. A number of tools and resources to assist practitioners design, construct and implement water sensitive urban design have been or are being developed by the Water by Design Program. The suite of tools, resources and guidelines represent one of the most comprehensive and integrated management approaches to urban stormwater management in Australia. While these tools and resources have been tailored to South East Queensland, they are relevant to the Far North Coast of NSW in terms of an effective overall management approach.

6.6 Community Involvement

6.6.1 Community Education

Community education was a key non-structural component of the 2007 USMP. Education activities undertaken since 2007 are:

- The Catchment Activity Model (Figure 43) is used to demonstrate the water cycle including urban and rural runoff issues. The Richmond River catchment is described in an historical context so learners understand the basic hydrology, e.g. large floodplain to catchment ratio, clearing of 99% of the Big Scrub, drainage of over 90% of wetlands, climate/rainfall and soils e.g. highly erodible red soils in the north, acid sulphate and pug soils on the floodplain. These topics set the scene for demonstrating the major water quality issues affecting the Richmond River. The main stormwater pollution issues discussed are soil erosion, organic matter, litter, hydrocarbons, the spread of weeds, animal wastes, septic systems, pesticides, and paints and solvents. Ways to prevent pollution are discussed and the model includes innovative WSUD features i.e. an artificial wetland/bio-detention system in industrial area.

  The model has been used extensively for the past 5 years at major events annually e.g. North Coast National, NAIDOC day celebrations, Lismore Careers EXPO, Big Scrub Day, Arts VS Science Festival. It has also attended many school events throughout the North Coast LGAs.

Figure 43: Richmond River Catchment Activity Model (photo: V. Tallon)

- The mobile *Litter – it's in our hands* education display is also used and personal ashtrays are given away free, targeting smokers to dispose of cigarette butts correctly e.g. NAIDOC day and the annual Tropical Fruits events. Council rangers also gave out personal ashtrays prior to the smoking ban being implemented in the Lismore CBD. The ashtrays ("binya butts") are available all year round at the Council Chambers and Administration Centre front desk;
- The CBD 'River Poles' is a static education feature with a simple anti-litter message about drains leading to the rivers/aquatic ecosystems;
- The Kadina Park Healthy Creek Path (Figure 44) includes a footpath mural to educate kids and adults on ways to care for our waterways. The footpath mimics a meandering creek with platypus, insects and other animals found in Tucki Tucki creek.

Figure 44: Kadina Healthy Creeks Path

- From 2007 to 2013 a Weedbuster Week education and information display was held at the Lismore Shopping Square. A "what does your garden grow?" workshop was also presented at the Lismore Workers Club;
- Council's Environmental Strategies Officer – Education presented to the Southern Cross University Questacon Careers Expo in 2014 on stormwater management;
- An industry Stormwater Education Project was undertaken in 2008 including audits and advice given to non-residential customers on best-practice stormwater management;
- The Wilsons River Catchment Schools Education and Restoration Project (refer Section 2.9) has involved schools and young people in restoring waterways; and
- Information on the location, purpose and function of stormwater treatment systems is included on Council's website.

As part of the 2015 Arts Vs Science Festival, Council together with Rous Water, Southern Cross University, Big Scrub Landcare and other partners promoted Landscaping for Water Quality through information stalls and workshop presentations including "Costa's Backyard Big Scrub Makeover' (Figure 45). A Landscaping for Water Quality Design Competition was also conducted.

Figure 45: Costa's Backyard Big Scrub Makeover (August 2015, photo: T. Sword)

6.6.2 Partnerships

LCC has recently partnered with EnviTE employment work experience participants to deliver on-ground stormwater improvements including weeding, mulching and revegetation of natural stormwater treatment devices such as Gasworks Creek, Magellan Street and Nesbitt Park (refer Figure 46, Figure 47, Figure 48 and Figure 49). Council recognises that internal resources and funding are not sufficient to undertake the required level of maintenance and that partnerships such as these are an efficient way to maximise resources and engage the community.

Figure 46: Gasworks Creek site – creek rehabilitation undertaken Work for the Dole team (photo: A. Nguyen)

Figure 47: Swale adjacent Gasworks Creek site – weeding, mulching and planting undertaken by Work for the Dole team (photo: A. Nguyen)

Figure 48: Swale at Rous Road/Oliver Avenue roundabout – weeding, mulching and planting undertaken by Work for the Dole team (photo: A. Nguyen)

Figure 49: Nesbitt Park natural channel – weeding, mulching and planting undertaken by Work for the Dole team (photo: A. Nguyen)

7. STAKEHOLDER CONSULTATION

7.1 Council Staff

Council established a Steering Committee and Working Group to oversee the preparation of this USMP. Interviews were held with members of the Working Group and other relevant staff to establish issues and concerns in relation to Council's management of urban stormwater. Meetings were also held with the Steering Committee and Working Group to present and discuss project findings.

Workshops were also held with the LCC Infrastructure Asset Panel, the Sustainable Environment Panel and the Councillor Steering Group.

7.2 Community Consultation

The draft USMP was placed on public exhibition from 25 November 2015 to 22 January 2016. Four submissions were received during the public exhibition phase. The Submissions Report is included in Appendix 11.

7.3 Agency Consultation

Consultation with state agencies was undertaken to identify issues and concerns and obtain information relevant to the USMP development.

7.3.1 NSW DPI – Fisheries

Water sensitive urban design is supported contingent upon ensuring that those features are appropriately sited to provide treatment prior to entry into waterways mapped as Key Fish Habitats. Information on policy and guidelines and requirements proponents need to fulfil to enable assessments of proposals was provided (refer Sections 2.8 and 6.1.2). A key concern is the habitat of the purple spotted gudgeon. The correspondence from NSW Fisheries is included in Appendix 6.

7.3.2 NSW Office of Water

The Office of Water is concerned when the geomorphic integrity of waterways are impacted/modified by catchment changes. The main concern is works within proximity of a waterway. Policy and guidelines are discussed in Section 6.5.7.

7.3.3 Rous Water

The *Public Health Act 2010* requires Rous Water to maintain a quality assurance program that is consistent with the Framework for the Management of Drinking Water Quality (as set out in the Australian Drinking Water Guidelines). As part of Rous Water's approach to these requirements, Rous Water needs to be satisfied that major urban development undertaken within water catchment areas is consistent with water catchment values and does not pose a risk to drinking water quality or catchment health/biodiversity values.

A key issue of concern for Rous Water with respect to urban stormwater management is to establish a planning process that ensures that outcomes from development are clearly consistent with the drinking water catchment status of the development, and so that the requirements of Rous Water can be systematically addressed and demonstrated by the proponents as part of rezoning and/or development processes

Rous Water does not support the comparison to the baseline scenario required by DCP Chapter 22 Water Sensitive Design. Rous Water does not consider this approach appropriate for the catchment context of the majority of major developments or subdivisions. The reason for this is that it is still possible for developments to satisfy these DCP requirements, and yet still provide for deterioration in stormwater quality.

Although it is recognised that in such circumstances any proposed treatment train would have a beneficial result when compared to undertaking the development with no treatment train, it is not clear in such an approach as to whether proposed developments or treatment trains can be considered to have a neutral or beneficial impact upon storm water quality when applied to the existing land use. The only situation where Rous Water would consider that the baseline approach may be appropriate is where there is urban renewal of a very degraded site, where percentage reductions of contamination loading compared to the ‘do nothing’ baseline would deliver a higher standard of mitigation than a neutral or beneficial test.

Rous Water considers that for major development and subdivisions, that in order to demonstrate that the development is “sited and will be managed to avoid any significant adverse impact on water quality and flows” (as required by Clause 6.4 of the Lismore Local Environmental Plan 2012), then a ‘neutral or beneficial effect on water quality’ approach and assessment criteria should be applied to significant developments being undertaken within drinking water catchment areas.

In order to demonstrate that urban development projects achieve a neutral or beneficial effect on water quality, the quality of runoff from the pre-development site should be compared with that from the post-development site including proposed stormwater treatment measures (such as water sensitive design elements) that may be needed to mitigate pollutant loads and concentrations resulting from the proposed land use change.

Rous Water considers that the Wilsons River catchment, being a compromised catchment, additional development, albeit potentially small, may be considered to represent an unacceptable incremental risk if the development does not demonstrate direct or indirect net equality or reduction in risk from the perspective of the water supply and/or other environmental values.

Rous Water recommends that in renewing the USMP, that a ‘neutral or beneficial effect on water quality’ test be applied to any proposed stormwater management approach. This is consistent with Clause 6.4 of the LEP which requires Council to consider “whether the development is likely to have any adverse impact on the quality and quantity of water.”

Rous Water considers it critical that the USMP provide for an integrated approach to the management of stormwater that:

- Protects and enhances the drinking water catchment values of receiving waters;
- Requires the application of water sensitive urban design principles;
- Maximises the use of natural waterway corridors and natural channel design principles;
- Achieves a neutral or beneficial effect on water quality; and
- Prevents the discharge of sediment laden stormwater direct to surface waters.

The correspondence from Rous Water is included in Appendix 6.

7.3.4 Richmond River County Council (RRCC)

RRCC provided information on its floodplain management responsibilities as well as the EcoHealth monitoring program (Section 2.6.4) and riparian condition (Section 2.9).

7.3.5 Roads and Maritime Services (RMS)

RMS provided information on its responsibilities for stormwater infrastructure management and RMS maintenance activities.

7.3.6 NSW Environment Protection Authority (EPA)

Stormwater infiltration into the sewer system and sewer overflows are the EPA's key concerns. These are briefly covered by this USMP and addressed in Council's sewerage strategic planning.

8. URBAN STORMWATER MANAGEMENT GOALS AND OBJECTIVES

The values and objectives have been developed from Council's adopted strategic direction (Imagine Lismore 10 Year Plan, 2013-2023) and stakeholder feedback.

8.1 Council's Strategic Objectives

The 2007 USMP provided the following objective for urban stormwater management in Lismore:

> *'improve and maintain the quality of urban runoff in order to protect the natural, ecological and aesthetic values of Lismore's waterways while enhancing the recreational and economic opportunities for our community'*

The primary goal in preparing the SMP 2007 was to assist Council to improve its management activities and respond to priority threats. Council has progressively implemented a number of stormwater treatment devices aimed at improving water quality in the waterways as discussed in Section 6.2.3.

Guiding principles for urban stormwater management are provided in Council's strategic plans (Imagine Lismore, the Asset Management Strategy, LEP and Development Control Plans). The guiding principles for stormwater management in Lismore are given in Table 16.

Table 16: Guiding principles for Council's stormwater management

Focus Area	Guiding Principles
Asset management	The objective of asset management is to ensure assets are maintained and renewed in a systematic way to ensure present and future residents of Lismore and our surrounding villages have adequate services and facilities.
Financial sustainability	Council's overriding objective over the last few years has been to work towards financial sustainability. This includes addressing the fact that for many years Council has been under-funding its infrastructure assets. Council needs to ensure it is maintaining and renewing its assets appropriately.
Affordability	To ensure the long-term financial sustainability of Council, it is essential to balance the community's expectations for services with their ability to pay for the infrastructure assets used to provide the services.
Asset life cycle	Maintenance of service levels for infrastructure services requires appropriate investment over the whole of the asset life cycle.
Water Sensitive Design	A multidisciplinary approach for integrating land use and water management (water supply, stormwater, wastewater and groundwater) planning, with the aim of minimising the impacts of development on the natural water cycle.
Development control in water supply catchments	Clause 6.4 of the Lismore LEP 2012 was established "*to protect drinking water catchments by minimising the adverse impacts of development on the quality and quantity of water entering drinking water storages*". Refer Section 8.2.
Revitalising the CBD	Community Vision #10 in the Delivery Plan relates to improvement in the revitalisation of the CBD and the Wilsons River (CBD/Riverbank Master Plan).

8.2 Water Sensitive Design

Water Sensitive Urban Design (WSUD) is an internationally recognised concept that offers an alternative to traditional development practices. WSUD is a holistic approach to the planning and design of urban development that aims to minimise negative impacts on the natural water cycle and protect the health of aquatic ecosystems (Healthy Waterways Partnership, 2006). WSUD considers ways in which urban infrastructure and the built form can be integrated with a site's natural features. In addition, WSUD seeks to optimise the use of water as a resource.

The key principles of WSUD are to:

- Protect existing natural features and ecological processes;
- Maintain the natural hydrologic behaviour of catchments;
- Protect water quality of surface and ground waters;
- Minimise demand on the reticulated water supply system;
- Minimise sewage discharges to the natural environment; and
- Integrate water into the landscape to enhance visual, social, cultural and ecological values.

WSUD aims to consider the whole water cycle when planning and implementing urban development as well as the community's needs and aspirations. While Council urban stormwater management is geographically limited to the urban areas of the Shire, the outcomes are intrinsically linked to the health of the Shire's waterways. Similarly, a holistic consideration of waterway health must consider other, often dominating, influences such as catchment management and point source pollution (such as treated sewage discharges). In addition urban development within the Shire must consider floodplain management and the implications of climate change. Increased consideration of runoff water quality, erosion and sedimentation control and hydrological impacts at the land use planning and development stages provide better outcomes for future asset management and ecosystem health.

In Lismore, population growth, environmental impacts, community values, climate change and the increased consideration of stormwater and wastewater as a resource are key drivers of a water sensitive urban design approach. This approach recognises that all elements of the water cycle are interdependent and all aspects of land use and infrastructure planning should be integrated with the water cycle considerations . The principles of WSUD were adopted by Council in 2005. Council's management group has resolved to promote the principles of WSUD, and incorporate those principles throughout Council's management plans including all operational areas of Council. Chapter 22 of the Development Control Plan describe the current requirements for the application of WSUD principles to developments in the Lismore LGA and sets bench marks for design and performance outcomes at the subdivision, street and lot scales.

8.3 Protection of the Wilsons River Source Drinking Water Catchment

Rous Water extracts water from the Wilsons River at Howards Grass near Lismore for the purposes of providing the bulk urban water supply for this region. The majority of Lismore's urban stormwater catchments discharge into the mapped drinking water catchment area (Section 6.1.2) and due to the tidal nature of the Wilsons River at Lismore, all activities in the catchment can influence the water quality. Of particular significance is the Lagoon Creek sub-catchment which discharges to the Wilsons River within 300 m of the water offtake. As such, the quantity and quality of stormwater delivered from the Lagoon Creek sub-catchment can have a significant influence on the quality of the raw water extracted for regional water supply purposes. Other areas of particular sensitivity due to the proximity to the source include Brunswick Street, Howards Grass and Boatharbour. Nevertheless, Rous Water is concerned to ensure that the water quality and catchment health outcomes from all urban areas within sub-catchments draining to the Wilsons River catchment are consistent with the drinking water catchment values of this location.

8.4 Urban Stormwater Management Objectives

With the increased focus on asset management, Council has recognised the need for consideration of the whole asset lifecycle and wider consideration of stormwater impacts. Whereas the 2007 USMP focussed on the quality of runoff, this USMP will extend Council's stormwater management planning to include management of quantity issues as well as quality within the asset management framework.

The overall goal for this USMP is therefore:

To provide a balanced, whole of life cycle approach to management of urban stormwater to:

- ***Reduce the occurrence of localised flooding to protect public and private property;***
- ***Improve the quality of urban runoff in order to protect the natural, ecological and aesthetic values of Lismore's waterways;***
- ***Minimise adverse impacts of stormwater runoff within the Wilsons River Source drinking water catchment; and***
- ***Incorporate opportunities to enhance the recreational opportunities and amenity of Lismore's urban area, particularly the CBD and Wilsons riverbank.***

The principles applied to stormwater management within the Lismore urban area (adapted from the *Queensland Urban Drainage Manual* (DEWS, 2013)) are:

Principle 1 - Protect and/or enhance downstream environments, including recognised social, environmental and economic values, by appropriately managing the quality and quantity of stormwater runoff:

- Ensure that the water quality and catchment health outcomes from all urban areas within sub-catchments draining to the Wilsons River catchment are consistent with the drinking water catchment values of this location;
- Minimise changes to the quality and quantity of the natural flow regime of urban waterways;
- Identify and control the primary sources of stormwater pollution;
- Develop stormwater systems based on a preferred management hierarchy - the preferred hierarchy for the selection of stormwater management practices is:
    1. Retain and restore (if degraded) existing valuable elements of the natural drainage system, such as natural channels, wetlands and riparian vegetation;
    2. Implement source control measures using non-structural techniques to limit changes to the quality and quantity of stormwater at the source of change;
    3. Implement source control measures using structural techniques to limit changes to the quality and quantity of stormwater at or near the source of change; and
    4. Install in-system constructed management techniques within stormwater systems to manage stormwater quality and quantity prior to discharge into receiving waters.
- Develop robust stormwater treatment systems that do not rely on a single treatment system or focus on a single target pollutant.

Principle 2 - Limit flooding of public and private property to acceptable or designated levels

- Limit the frequency and severity of flooding to appropriate levels given the community's expectations and the community's ability and willingness to afford such flood protection;
- Take all reasonable and practicable measures to enhance resilience to all floods, including those that exceed specified design standards; and
- Preserve the alignment and capacity of major drainage corridors such as waterways and major overland flow paths.

Principle 3 - Ensure stormwater and its associated drainage systems are planned, designed and managed with appropriate consideration and protection of community health and safety standards, including potential impacts on pedestrian and vehicular traffic:

- Establish and maintain a safe, affordable and socially equitable and acceptable level of urban drainage and flood control including:
  - Designing urban drainage systems to minimise the existence of dangerous waters and the risk of people entering or being trapped within such waters;
  - Minimising the risk of injury to the public and maintenance personnel resulting from the operation and maintenance of stormwater systems; and
  - Minimising public risks associated with such things as mosquitoes and water-borne diseases.

Principle 4 - Adopt and promote water sensitive design principles, including appropriately managing stormwater as an integral part of the total water cycle, protecting natural features and ecological processes within urban waterways:

- Ensure water sensitive design features are appropriately sited to provide treatment prior to entry into waterways mapped as Key Fish Habitats;
- Minimise the quantity of directly connected impervious surface area; and
- Maintain and protect natural drainage systems and their ecological health.

Principle 5 - Appropriately integrate stormwater systems into the natural and built environments while optimising the potential uses of drainage corridors:

- Ensure adopted stormwater management systems are appropriate for the site constraints, land use and catchment conditions; and
- Appropriately integrate both wildlife and community land use activities within urban waterway and drainage corridors.

Principle 6 - Ensure stormwater is managed at a social, environmental and economic cost that is acceptable to the community as a whole, and that the levels of service and the contributions to costs are equitable:

- Assess the economics of stormwater management systems on the basis of their full lifecycle costs (i.e. capital and operational costs);
- Ensure adopted stormwater management systems are sustainable; and
- Ensure appropriate protection of stormwater treatment measures during the construction phase.

Principle 7 - Enhance community awareness of, and participation in, the appropriate management of stormwater:

- Engage the community in the development of parameters for the development and evaluation of stormwater management solutions.

It is intended that these principles apply to the full cycle of stormwater management activities including land use planning, development controls, stormwater asset and system design, construction, operation and maintenance. To achieve these objectives, the following supporting principles are required:

- Council Commitment – Appropriate policy development to ensure the success of the USMP. The urban stormwater management objectives will be integrated into all relevant Council groups/functional areas;

- Resources and Funding – An appropriate level of funding and resources (Council and external contributions) is required to ensure successful implementation of the USMP; and
- Community Awareness – Council programs and actions will aim to increase public awareness and education on the impacts of stormwater pollution and the implementation of improved stormwater management practices.

9. STORMWATER MANAGEMENT ISSUES

9.1 Administration and Governance Issues

Due to the diverse nature of stormwater management activities and responsibilities, which affect and are affected by many aspects of Council's decision making, Council management and responsibilities related to urban stormwater have evolved in an *ad hoc* manner. Historically, as with other natural resource management considerations, the impacts of urban stormwater have not been a key consideration for local councils. Early land use planning and development did not address future stormwater management requirements and many of the land developments have resulted in a legacy of asset management issues (e.g. poor drainage, water quality impacts, lack of access for maintenance and poor asset function). These issues are exacerbated by the climatic conditions and topographical constraints in Lismore.

With increasing urbanisation and community understanding of the water quality and hydrological impacts of stormwater systems, increasing emphasis is being placed on the consideration of stormwater assets and their function. Urban stormwater considerations are now receiving more emphasis in the planning, development and operational responsibilities of local government (and the complementary roles of the State Government). Within LCC, there is increasing recognition of the need for a management approach that covers the full asset life cycle and involves decision making across many different Council functions. However, the skills, resources and funding available within Council are not adequate to address the range of issues and services required. The current management structure creates a distinct separation between engineering (civil) and environmental (water quality and vegetation) responsibilities for approval of developer provided stormwater assets and management of stormwater quality and quantity asset requirements. Some staff members with responsibility for stormwater management have minimal training in the function of stormwater systems and the management of these assets over the whole life cycle.

9.1.1 Funding

The current funding for stormwater management activities is sourced from general purpose income allocated to the relevant Council functions and the SMS charge. The level of Council resourcing and funding has historically been insufficient to adequately maintain the existing stormwater systems, implement asset renewals and resolve issues with poor function of the existing systems. Similarly, there is a shortfall in future funding identified to adequately service the existing systems. This is largely due to competition for funds for other Council services and the lack of forward planning for stormwater asset management.

A summary of the 2015/16 budget and sources of funding for stormwater management activities is provided below. While budget has been allocated for new stormwater treatment systems, these projects are not likely to occur in 2015/16, with any remaining budget held in reserves.

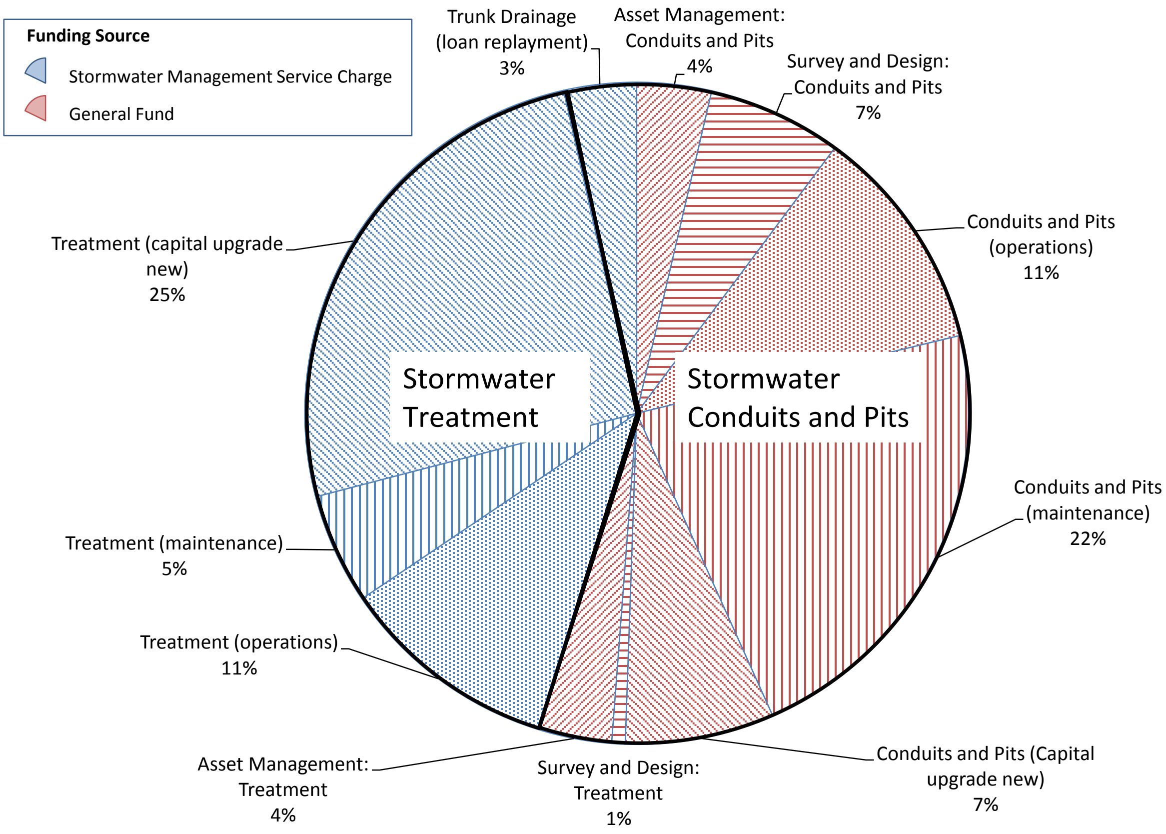


Figure 50: 2015/16 stormwater activities budget and funding sources

Particular issues are:

- Council's Works Section is responsible for maintenance of drainage infrastructure although funding and resources have historically been inadequate to address all maintenance requirements. Local flooding issues raised by customers are not being addressed due to this lack of funding;
- Renewal of drainage infrastructure has not been undertaken and future funding source have not been identified. There is low confidence in the extent of renewals required and more investigation (condition assessment, etc.) is required;
- New drainage infrastructure or upgrades to existing infrastructure are minor projects undertaken as part of road upgrades on an opportunistic basis when funding permits. Funding for drainage upgrades has not been sufficient to complete all works identified;
- The SMS charge has largely been used to fund new stormwater treatment devices and their maintenance. While procedures and funding arrangements are in place for ongoing maintenance of these devices, the SMS charge is not sufficient to fund all works associated with management of these assets (new/upgrades, maintenance and renewal); and
- Developer contributions that cover the full nexus between future development and stormwater requirements have not been imposed.

The funding of stormwater asset management is a significant challenge for Council.

9.1.2 Skills and Knowledge

Currently construction and maintenance of stormwater treatment systems and drainage swales are undertaken by Council Parks and Recreation or Roads maintenance crews who do not necessarily have training in stormwater management. Vegetated stormwater assets have a number of different components which are important for achieving the primary functions of stormwater quality improvement and visual amenity. The effective management of vegetated stormwater assets requires a team of people with skills in engineering, landscaping and ecology or horticulture. Civil components (structural and erosion control) require a basic understanding of hydrological and hydraulic processes as well as structural engineering and geomechanics while vegetation components requires understanding of plants, weeds and weed eradication. Increased understanding of the purpose and function of the assets is required for effective design, construction and ongoing maintenance (Water by Design, 2012b).

Council’s assessment of stormwater management components as part of development applications and at asset handover stage is also limited by the capability and/or capacity of staff. Current development controls provide general requirements for construction phase erosion and sediment controls, however the available resources are not sufficient to ensure these controls are properly enforced. Similarly, consideration of asset management requirements following handover of assets to Council is generally required as part of development controls. However, consideration of the post-construction phase function of the assets and ongoing maintenance requirements are not well considered during the planning and design stages or enforced as part of asset handover.

9.1.3 Asset Management

Asset Data

Council has been progressively documenting the type and location of its stormwater assets. The current stormwater asset register includes stormwater conduits (channels, box culverts and pipes), pits and treatment devices although asset data such as construction date, size, depths have not been ground-truthed. Asset condition data are not currently included in the asset register. Accurate condition assessment relies on documentation of existing condition and establishing performance indicators related to function in wet and dry conditions and regular inspection of assets. A small sample of stormwater conduits have been inspected using CCTV and this information has been used inform asset valuations. To obtain accurate asset details and condition data to inform the maintenance and renewal programs, additional CCTV inspection of the network is required. Survey of the assets is also required to ground-truth the location, size and depth of assets.

Natural assets such as streams, wetlands and riparian open space are also integral components of the urban stormwater system but there is limited detail included in Council’s asset management system. A large component of the stormwater drainage system includes grass swales which are not mapped as stormwater assets. Natural waterways are considered as the 'receiving environment' for stormwater and the role that natural waterways provides to convey stormwater has received less consideration in the management of the stormwater assets. It should be recognised that natural systems also require maintenance to achieve adequate functioning.

Asset Construction

Urban construction practices are largely self-regulated (by the developer) with Council undertaking audits and inspections for major developments and responding to community complaints when resources permit. Construction practices and erosion and sedimentation controls are likely to have improved with the implementation of State government and Council guidelines although resources for Council inspections are limited. As a consequence, the adequacy of construction-phase erosion and sedimentation controls and geomorphic modification of waterways remains a key concern. Examples of poor construction phase practices include inlets constructed at inappropriate elevation, lack of access for maintenance and incorporate selection of technologies. For example, sedimentation basins along Kookaburra Terrace are designed for construction phase sediment and erosion control and do not function well as operational phase treatment systems. Improved planning, education and enforcement are required to address this.

The key construction phase issues appear to be related to handover of assets to Council, including compliance, completion and operational requirements of the assets. This has resulted from the lack of clear guidelines and connection between the design, construction and operational phases as well as the lack of co-ordination between the different Council functions. Systems and processes that ensure stormwater assets are designed, constructed and established properly are not consistently applied, often resulting in Council receiving assets at the wrong time or that are inappropriate for the development or are in poor condition. Council should inherit donated assets that are functioning properly and meet the design intent in order to protect receiving environments and avoid unnecessary maintenance burdens. Due to the nature of vegetated systems, being a combination of civil infrastructure and landscape elements, and the separate Council responsibilities managing the two elements, the process of asset handover is not being captured well.

Asset Maintenance

Current Council maintenance activities include:

- Treatment devices – in accordance with the maintenance schedule included in the Internal Service Level Agreement (regular or scheduled activities such as weeding, mowing or removing sediment and litter). Recent devices (Slaters Creek wetland and Avondale Avenue raingarden) are not included in the agreement; and
- Drainage assets – clearing of concrete drains and grass swales as resources permit.

The 2007 USMP recognised that the correct maintenance of stormwater treatment devices is crucial for the efficient treatment of stormwater and to provide the hydraulic benefits required for flood control. While programs have been implemented to improve maintenance of treatment devices, some maintenance issues are still current. These are:

- Due to limited internal resourcing and funding and a focus on capital works such as road widening, roundabouts and road rehabilitation, maintenance crews have not been available to address the maintenance requirements for stormwater drainage assets. This has contributed to risks of localised flooding in many areas;
- Grass swales are a significant concern during rain events as the lack of maintenance has resulted in siltation and loss of capacity. In addition, many swales are located in areas of low grade and are not designed with capacity suitable for local storm conditions. Many grass swales within the Shire have very low grade and do not drain adequately, often being water logged and unable to be mowed. Many driveway culverts are not correctly aligned with swales causing scouring of road verges, trapping of debris and localised flooding;
- The vegetated drainage assets are not well documented in Council’s Asset Management System, resulting in a lack of easily accessible information for maintenance planning;
- Similarly, the register of public stormwater treatment devices and Internal Service Level Agreement requires review and update to ensure completeness and to identify appropriate action for those assets requiring maintenance, renewal or upgrade to improve performance including associated costs and priority. The majority of Council’s stormwater treatment devices are maintained as part of the Internal Service Level Agreement (Section 6.3.4). Maintenance activities at Slater’s Creek wetland are not yet undertaken. Costs are estimated at $10,000 - $15,000 p.a. for wetlands of a similar size (EWater, 2009). Similarly the new rain garden on Avondale Avenue, East Lismore will require annual maintenance of $500 p.a. (Water by Design, 2015). An annual review of the Internal Service Level Agreement is required to ensure adequate servicing of infrastructure and cost-effective services are provided; and
- Privately owned treatment devices and inter-allotment drainage are maintained by the property owner in accordance with property management plans, however, there are limited Council resources to ensure appropriate maintenance is undertaken.

A large component of the urban stormwater system consists of vegetated assets and these can be effective in reducing impacts of pollutants if they are well planned, designed, constructed and maintained. Inadequate maintenance has resulted in ongoing issues such as:

- Assets that fail to manage stormwater quality. This is potentially more serious when the value of downstream waterways is high (e.g. drinking water catchment, key fish habitat);
- Poor amenity due to weed intrusion and pest species;
- Litter and weeds accumulating in open drains which are difficult to remove as the site is always wet;
- Health and safety problems such as mosquitoes and odours;
- High cost of rectification to a functional state; and
- Reduced asset value.

Previously, maintenance of grass swales has involved spraying rather than brushcutting, slashing or mowing. The result was a lack of turfing within the swales to protect against erosion and to minimise weed growth. The excessive use of herbicide in table drains, swales and canals is a major issue for stormwater quality in and around Lismore. This is partly due to limited staff resources to implement remediation and drainage upgrades and repairs such as failing or eroding flow paths. In contrast, grassed swales in residential areas that are regularly maintained (mown) by local residents are generally well covered with turf, efficient as a part of a treatment device and aesthetically pleasing.

As discussed in Section 6.3.4, many customer complaints and requests for maintenance of drainage infrastructure have not been addressed due to lack of resources and funding. The current annual budget is $188,000 and this is spent on reactive maintenance based on preliminary inspections and complaint follow-up. A more targeted maintenance program is required based on prioritisation of drainage issues according to key concerns such as safety, damage to private property or Council assets, road classification/level of traffic. As part of the maintenance activities the need for additional trunk drainage upgrades should be identified.

Council receives complaints about inter-allotment drainage (private mains) that are not Council assets. This arises from the land owner's lack of understanding about the function of the drainage system and their responsibilities for maintenance. Although these are not Council assets, in the past Council has fixed these problems as 'good-will' gestures. Council should ensure private assets are adequately maintained through education, maintenance agreements attached to planning approvals, property covenants and creation of easements.

Capital Renewals/Rectification

Limited rectification of poorly performing or ageing assets has occurred due to limited funding and renewals planning. A cost-effective renewal program relies on accurate asset condition data and review of functional needs.

The LCC Stormwater AMP estimates the annual renewal cost for pits and conduits as $865,000 p.a. (although confidence levels for the data are low) with no estimate available for renewal of treatment devices.

9.1.4 Development Controls within the Drinking Water Catchment

In the Lismore urban area, there are potential impacts on the drinking water catchment from all sub-catchments discharging into the Wilsons River with the highest risk in the areas that are close to the extraction point and without adequate buffer from the river. Some rezoning for large residential developments is proposed in these higher risk areas. In addition the replacement of natural ground surfaces and vegetation cover with roads, buildings and other impermeable surfaces may increase the volume of runoff from the site and the potential for pollutants to be transported off site during rainfall events.

In operating the regional water supply system, the previous approach to development control was for Rous Water to review any development proposal. To protect the water supply, Rous Water took a multiple barrier approach from encouraging protection of catchment ecology through to consideration of the water treatment process and distribution system. However, recent changes in the approach taken by the state government to reduce the complexity of the planning system and to reduce referrals by councils resulted in Local Environmental Plans being prepared without referral clauses. Therefore, councils must take on the role of protecting the water supply without reference to Rous Water. To achieve this, provisions within local planning instruments must be appropriate to give a council the power to ensure new development does not negatively impact on drinking water quality. Rous Water will still provide an advisory service to councils on development applications if desired by a council.

It is important that the drinking water catchment health outcomes are considered at the rezoning stage of a development with appropriate development controls applied at the development application stage. Rous Water considers that development consent should not be granted unless the proposed development would have a Neutral or Beneficial Effect (NorBE) on water quality. Although LCC has specific stormwater management requirements and objectives, these requirements and objectives are not designed to protect water quality for drinking water supply purposes. A development complying under the Lismore DCP may still have the potential to introduce greater quantities and a broader variety of pollutants to the site (refer Section 6.5.1). Therefore, whilst Rous Water recognises that it may be possible to demonstrate that a certain development proposal (incorporating a stormwater treatment train) will have a beneficial result when compared to undertaking the development with no treatment train, Rous Water does not consider that this alone meets the requirement of a neutral or beneficial impact upon stormwater quality.

The draft *Development Control Plan for Development within the Rous Water Catchments* (Innovation Planning Australia, 2009) provides guidance to consultants and developers in preparing rural residential subdivision designs and other forms of development, and to councils in its assessment of such developments. The document also identifies a range of water sensitive planning and development principles, practices and solutions that are consistent with the requirements for achieving sustainable catchment health outcomes while still satisfying the NorBE test. While guidance is available from Rous Water with regard to developments within drinking water catchments, the Lismore DCP does not specifically require these drinking water catchment health outcomes.

9.1.5 Council Developments

Where Council is the developer of a site, design and construction processes are not governed by the same arrangements as for private developers. Where development consent is not required, Part 5 of the *Environmental Planning and Assessment Act, 1979* applies and Council is required to assess environmental impacts of the proposal through a Review of Environmental Factors. Whereas a private developer is required to comply with Council's DCP, there are no development or design guidelines applicable to Council developments that do not require consent. In the past, there has been limited consideration of stormwater treatment requirements as part of these developments. For example, a road rehabilitation project or public carpark development would typically be undertaken without stormwater treatment components. In some cases, stormwater treatment is implemented retrospectively at higher cost and disruption than if it were included at the initial construction stage.

9.2 Site-Based Issues

Site-based management issues identified through stakeholder consultation, data collection and site inspections are detailed in the following tables and are shown on Figure 51. The issues identified during this study are generally:

- Significant stormwater management issues which are expensive to address;
- A legacy of an ageing stormwater system;

- Largely a result of local climatic conditions and topography;
- Related to assets that have been transferred to Council's control following private development;
- A result of underfunding of asset management activities (such as maintenance and renewal); and/or
- Minor in nature, but occur throughout the Shire and will require a coordinated approach to achieve the best outcome for stakeholders.

As shown in Figure 51, the site-based issues have been categorised as relating to:

- Poor quality of urban stormwater;
- Gross pollutants;
- Sedimentation;
- Localised flooding;
- Weeds (restricted stormwater conveyance);
- Inadequate drainage;
- Water logging; and/or
- Poor riparian condition.

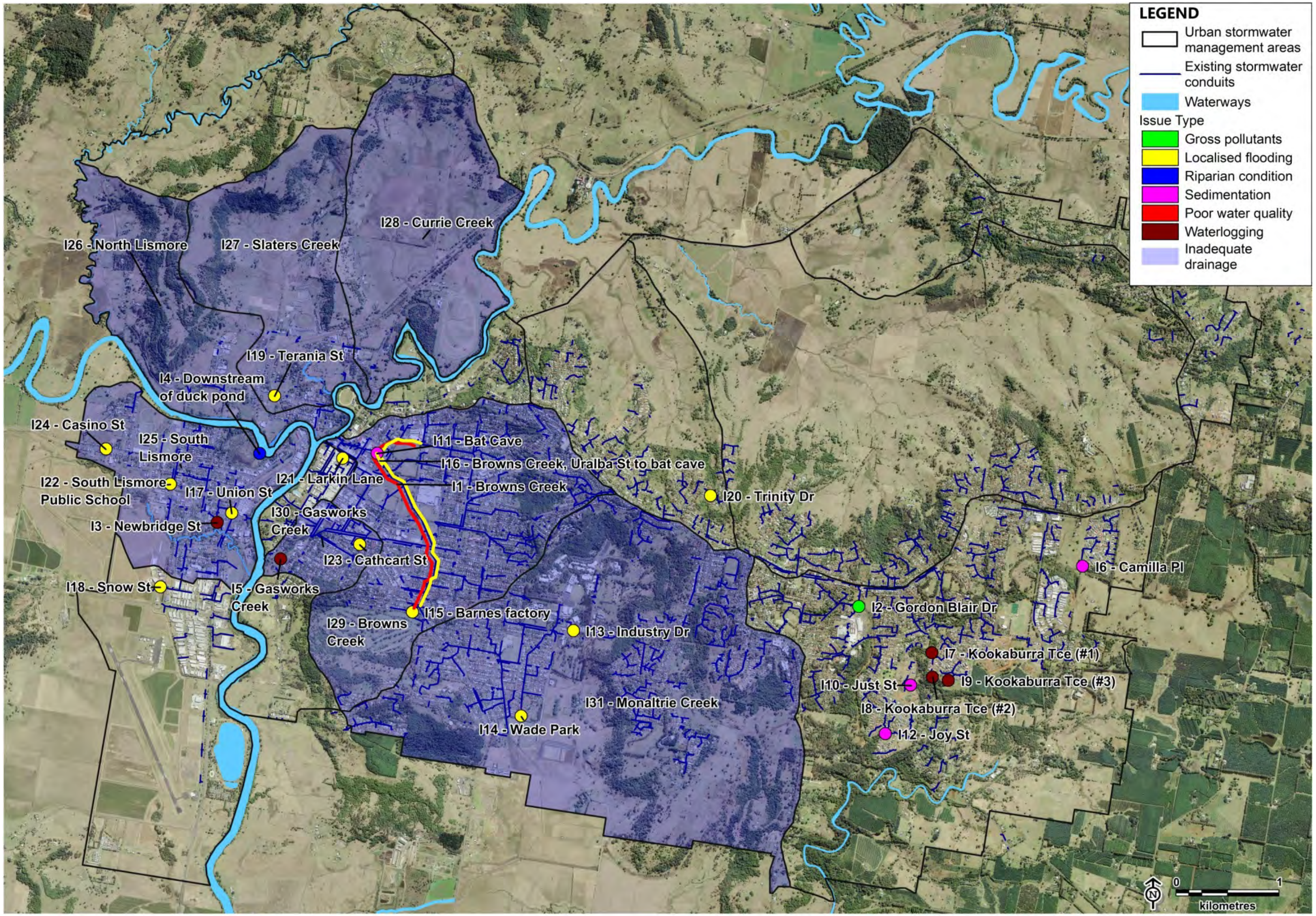


Figure 51: Locations of site-based issues

<table>
<tr><td>Issue</td><td colspan="2">I1 - Poor water quality in Browns Creek, localised flooding</td></tr>
<tr><td>Location</td><td colspan="2">Lismore Park, CBD</td></tr>
<tr><td>Management Area</td><td colspan="2">11 – Lismore CBD</td></tr>
<tr><td colspan="2">
Removal of shopping trolleys from Browns Creek, significant weed growth, July 2015</td><td>
Browns Creek near netball courts, May 2015</td></tr>
<tr><td colspan="2">
Browns Creek near Lismore Square, July 2015</td><td>
Browns Creek, Magellan Street, May 2015</td></tr>
<tr><td>Catchment area (approx.)</td><td colspan="2">304 ha</td></tr>
<tr><td>Existing treatment devices</td><td colspan="2">2 public (raingarden and vegetated channel), 7 private (various)</td></tr>
<tr><td>Extent of Issue/s</td><td colspan="2">Poor water quality – Browns Creek channel is a significant source of nutrients to Wilsons River with limited treatment provided in this large catchment. Gross pollutants are collected in the channel, requiring extensive ongoing maintenance.
Localised flooding – overtopping of the channel occurs in high rainfall.</td></tr>
</table>

Issue	I2 – Gross pollutants entering Tucki Tucki Creek	
Location	Gordon Blair Drive, Goonellabah	
Management Area	9 - Tucki Tucki Creek	
 Headwall to Tucki Tucki Creek at Gordon Blair Drive		 Gross pollutants in Tucki Tucki Creek
Catchment area (approx.)	62 ha	
Existing treatment devices	Vegetated channel downstream	
Extent of Issue/s	High gross pollutant load enters Tucki Tucki Creek from the large upstream catchment (large mixed use catchment) with no existing upstream treatment	

Issue	I3 – Water logging of swale
Location	Newbridge Street, South Lismore
Management Area	15 – South Lismore/Hollingsworth Creek
	Waterlogged swale (May 2015)
Catchment area (approx.)	20 ha
Existing treatment devices	None.
Extent of Issue/s	Area is difficult to maintain as it is waterlogged. Weed growth inhibits stormwater conveyance. Old petrol stations also contribute hydrocarbon load to this sub-catchment.

Project	I4 - Poor condition of riparian vegetation along Leycester Creek
Location	‘Duck Pond’ South Lismore
Management Area	15 – South Lismore/Hollingsworth Creek
	Riparian zone of Leycester Creek (adjacent Landcare site)
Catchment area (approx.)	29.7 ha
Existing treatment devices	None
Extent of Issue/s	The small parcel of land adjacent to the river bank and an existing Landcare rehabilitation site is in poor condition (weeds).

Issue	I5 - Gasworks Creek detention pond is silted up reducing capacity and effectiveness
Location	Gasworks Creek floodgates
Management Area	12 - Gasworks Creek
 Gasworks Creek channel	 Flood pumping station at end of channel
Catchment area (approx.)	59 ha
Existing treatment devices	GPT and several vegetated channels.
Extent of Issue/s	Current detention pond is silted up reducing capacity and effectiveness. Coral trees are present, area is difficult to maintain and generally aesthetically displeasing.

Issue	I6 - Camilla Place retention basin is silted up and ineffective
Location	Camilla Place, Goonellabah
Management Area	9 - Tucki Tucki Creek
	Camilla Place retention basin
Catchment area (approx.)	11 ha
Existing treatment devices	No others upstream or downstream
Extent of Issue/s	Retention basin is silted up and ineffective, suspected tertiary pollutants (hydrocarbons, nutrients) entering waterway. The upper bank has bare soil and rocks are being undermined.

<table>
<tr><td>Issue</td><td colspan="2">I7 - Kookaburra Terrace sedimentation basin (#1) is waterlogged and provides low water quality improvement</td></tr>
<tr><td>Location</td><td colspan="2">Kookaburra Terrace Goonellabah (between 37 and 41 Kookaburra Terrace)</td></tr>
<tr><td>Management Area</td><td colspan="2">9 - Tucki Tucki Creek</td></tr>
<tr><td colspan="2">
Inlet headwall to basin</td><td>
Basin and high level inlet pit</td></tr>
<tr><td>Catchment area (approx.)</td><td colspan="2">3 ha</td></tr>
<tr><td>Existing treatment devices</td><td colspan="2">No others upstream or downstream</td></tr>
<tr><td>Extent of Issue/s</td><td colspan="2">Requires regular mowing maintenance, very damp, provides low water quality improvement. It appears that the system operates as a sediment basin with no subsoil drainage or low flow discharge. Potential flooding of neighbouring property.</td></tr>
</table>

Issue	I8 - Kookaburra Terrace sedimentation basin (#2) is waterlogged and provides low water quality improvement
Location	Kookaburra Terrace Goonellabah (between 47 and 53 Kookaburra Terrace)
Management Area	9 - Tucki Tucki Creek
	Inlet headwall and basin
Catchment area (approx.)	1 ha
Existing treatment devices	No others upstream or downstream
Extent of Issue/s	Requires regular mowing maintenance, provides low water quality improvement. It appears that the system operates as a sediment basin with no subsoil drainage or outlet (outflow over top of bank to grassed area and creek).

Project	I9 – Kookaburra Terrace sedimentation basin (#3) is waterlogged and provides low water quality improvement
Location	Kookaburra Terrace Goonellabah (63 Kookaburra Terrace)
Management Area	9 - Tucki Tucki Creek
 Inlet headwall to basin	 Surcharge pit
Catchment area (approx.)	4 ha
Existing treatment devices	No others upstream or downstream
Extent of Issue/s	Requires regular mowing maintenance, difficult to mow, low water quality improvement.

Issue	I10 - Large amounts of silt in Just Street bioretention basin
Location	Just Street (Bio-retention basin #1)
Management Area	9 - Tucki Tucki Creek
	Silt and weeds in bioretention basin
Catchment area (approx.)	3.6 ha
Existing treatment devices	No others upstream or downstream
Extent of Issue/s	Large amounts of silt from construction site runoff reducing capacity and function.

Issue	I11 - Bat Cave sediment weir is not accessible for maintenance and has become ineffective
Location	Confluence of tributary and Browns Creek at the 'Bat Cave'.
Management Area	11 - Browns Creek
	Location of Bat Cave sediment weir
Catchment area (approx.)	102 ha
Existing treatment devices	No others upstream or downstream
Extent of Issue/s	The sediment weir is not accessible for maintenance and has become ineffective. Pollutants from urban runoff from the northern section of the catchment entering Browns Creek and Wilsons River

Issue	I12 - Sediment basin is silted up reducing capacity and effectiveness
Location	Joy Street
Management Area	9 - Tucki Tucki Creek
	Sediment basin (Photo: A. Nguyen)
Catchment area (approx.)	7 ha
Existing treatment devices	No others upstream or downstream
Extent of Issue/s	Sediment basin is silted up reducing capacity and effectiveness of the system. Sediment is bypassing the system and dispersing downstream during high flows. Structure is difficult to access due to surrounding vegetation.

Issue	I13 - Localised flooding of storage sheds and surrounding area
Location	Industry Drive, East Lismore
Management Area	10 – Monaltrie Creek

Drain is full during heavy rain, May 2015

Culvert under road is blocked with debris, July 2015

High flow behind storage sheds during heavy rain, May 2015

Erosion of drainage line downstream of storage shed

Inlet to stormwater system behind Martin Drive residences (draining gully along Cynthia Wilson Drive from Fig Tree Drive and surrounding residential development), July 2015

Weed growth and erosion of Creek along Airforce Drive

Catchment area (approx.)	33 ha
Existing drainage infrastructure	Open channels
Extent of Issue/s	Sediment has collected along the drainage line at the rear of the storage sheds causing a build-up of weeds and restriction in flow. The drainage line has three 90 degree bends upstream along the open channel and culvert under Industry Drive. This culvert becomes blocked with debris, further restricting the flow. There is a large amount of siltation and weed growth resulting in flow diversions and scouring of banks. Some stilling ponds exist behind Martin Drive properties although they appear too small to be effective in normal flows. The source of sediment appears to be the gully adjacent to Cynthia Wilson Drive, commencing at Fig Tree Drive. Stormwater from the Fig Tree Drive residential area flows through the steep gully which is unstable until it reaches thicker forest approximately 50 m downhill. Trees are largely cleared after this point and the creek is channelised through a section of concrete lined bed with rock inlaid (Bush Boss, undated). There is a large deposition of rock and soil at the base of the gully and the creek flows into the stormwater system at the rear of Martin Drive. A soil bed replaces the concrete and is quite badly eroded in parts till bedrock surfaces just before Martin Drive culvert. After the culvert gully erosion becomes severe to a depth up to 2.5 metres over approximately 200 metres (Bush Boss, undated). After this the creek becomes a wide flat channel with extensive weed cover behind the industrial sheds.

Issue	I14 - Localised flooding adjacent to Wade Park and East Lismore Community Preschool
Location	Wade Park, East Lismore
Management Area	10 - Monaltrie Creek
 Concrete channel and natural drainage line looking south, July 2015	 Channel and drainage line during high rainfall, May 2015
Catchment area (approx.)	255 ha
Existing drainage infrastructure	Trunk drainage, open channels and swales. Two upstream detention basins (Southern Cross University)
Extent of Issue/s	High sediment load causes localised flooding adjacent to Wade Park and East Lismore Community Preschool. Sediment accumulates at the end of the open concrete channel. Approximately 80 m^3 of sediment is excavated from the area every 18 months. Access to the area is difficult due to wet surface and access arrangements through the pre-school.

Issue	I15 - Stormwater from the golf course backs up underneath the Barnes property
Location	Lismore Workers Golf Course and Wyrallah Road
Management Area	11 - Browns Creek

Golf course drainage, July 2015

Drainage under Barnes property from golf course, July 2015

Existing swales annd open drains flowing towards Barnes property

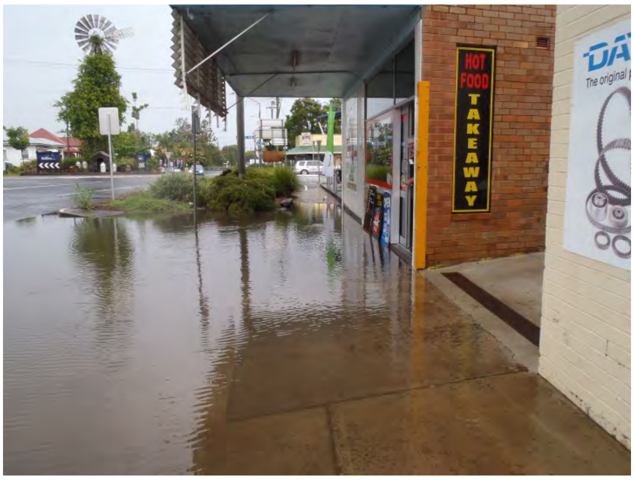
Drain from Barnes property (Wyrallah Road)

Open channel downstream of Barnes property

Catchment area (approx.)	88 ha
Existing drainage infrastructure	Open swales through golf course, concrete channel under Barnes property, Wyrallah road and behind shopping centre.
Extent of Issue/s	There are well-maintained swales in the golf course and neighbouring properties that discharge into a concrete channel under Barnes property. The size of the open channel downstream of the golf course is limited by available space. Stormwater from the golf course backs up underneath the Barnes property

Issue	I16 - The northern section of Browns Creek channel is overgrown with weeds, restricting conveyance of flows to Bat Cave
Location	Uralba Street to Bat Cave
Management Area	11 - Browns Creek
 Drainage channel upstream of Bat Cave	 Drainage channel to Bat Cave
 Entrance to Bat Cave	
Catchment area (approx.)	445 ha
Existing drainage infrastructure	Open channels
Extent of Issue/s	The channel is overgrown with weeds, restricting conveyance of flows to Bat Cave. The Dawson Street culvert may be undersized.

Issue	I17 - Localised flooding on Union Street
Location	Union Street, South Lismore
Management Area	15 – South Lismore/Hollingsworth Creek



Flooding outside of Butchers on Union Street, May 2015

Stormwater pit, 121 Union Street

Catchment area (approx.)	<0.05 ha
Existing drainage infrastructure	Open swales and trunk drainage
Extent of Issue/s	Existing stormwater does not extend to intersection of Elliot Road and Union Street. Very low longitudinal grade in kerb and gutter. Flooding of parking area and shopfronts during heavy rainfall.

<table>
<tr><td>Issue</td><td colspan="2">I18 - Localised flooding of Snow Street drainage channel</td></tr>
<tr><td>Location</td><td colspan="2">Snow Street, South Lismore</td></tr>
<tr><td>Management Area</td><td colspan="2">16 – South Lismore/Airport</td></tr>
<tr><td colspan="2">
Inundation of drainage channel, 21 February 2015. Weeds and debris (to surcharge pit) were recently removed (Photo: D. Baldwin)</td><td>
Flood gate at stormwater outlet to levee, July 2015</td></tr>
<tr><td>Catchment area (approx.)</td><td colspan="2">11 ha</td></tr>
<tr><td>Existing drainage infrastructure</td><td colspan="2">Pipes draining Snow Street industrial properties to flood diversion channel with flood gate at channel. Surcharge (letter box) pit into stormwater channel. Kerb inlet from intersection drains to stormwater channel.</td></tr>
<tr><td>Extent of Issue/s</td><td colspan="2">Stormwater is designed to surcharge from a pit along the drainage channel when flood gate is closed. Due to standing water level in levee channel, flood gate may not fully open even in dry times. Weed growth limits capacity for detention when pipe is surcharging.</td></tr>
</table>

Issue	I19 - Localised flooding of Terania Street	
Location	Terania Street Railway Underpass	
Management Area	2 – Slaters Creek	
 Flooding of Terania Street near railway underpass, May 2015	 Discharge at headwall in paddock on Peate Street.	
Catchment area (approx.)	6 ha	
Existing drainage infrastructure	Grass swales, piped under Terania and Peate Streets and discharging into adjacent paddock. This appears to be part of the original drainage line to Slaters Creek.	
Extent of Issue	The area is flat and low in the catchment, grass swales are not adequate to convey high flows and discharge location (on private land) is overgrown. Headwalls at road crossings are blocked with weeds.	

Issue	I20 - Localised flooding of Trinity Drive
Location	Trinity Drive, Goonellabah
Management Area	6 – Howards Grass
 Trinity Drive stormwater inlet (draining ridge line from South)	 12 Trinity Drive
 Stormwater outlet adjacent to 12 Trinity Drive	
Catchment area (approx.)	9 ha
Existing drainage infrastructure	The catchment for this location commences on the top side of the Bruxner Highway, includes properties in Bruxner Crescent and the Neighbourhood Park, which includes the open drain to the Trinity Drive road crossing.
Extent of Issue/s	A large amount of water flows to the headwall at the Trinity Drive road crossing and surcharges over the road and into the opposite residential property. The culvert and stormwater outlet may be undersized for the flows. The outlet also is blocked with weeds and rubbish.

Issue	I21 - Localised flooding of Larkin Lane
Location	Larkin Lane, CBD
Management Area	14 - CBD
 Alleyway that is inundated during heavy rainfall	 Drainage is half full of sediment
Catchment area (approx.)	<0.5 ha
Existing drainage infrastructure	Pits and pipes
Potential Cause	The road surface in Larkin Lane is a patchwork of surfaces and levels which may contribute to ponding/flooding of shop fronts and alleyway. Access ramps to shops restrict flows in gutters. Large amount of sediment and debris in drains.

Issue	I22 - Localised flooding adjacent to South Lismore Public School
Location	South Lismore Public School
Management Area	15 – South Lismore/Hollingsworth Creek
Catchment area (approx.)	6 ha
Existing drainage infrastructure	Pipes, open swales
Extent of Issue/s	Localised flooding in school yard potentially caused by high level of swale/outlet within railway corridor. The underpass under the railway near the school may be blocked by a downstream development.

Issue	I23 - Localised flooding on Cathcart Street
Location	Cathcart Street, Girards Hill
Management Area	12 – Gasworks Creek

Houses on Cathcart Street are lower than the road

Swale drain along Cathcart Street is full of sediment and debris.

Capacity of culvert inlet is reduced due to tree roots and debris. Sandbags have been placed in an attempt to contain stormwater flows.

Catchment area (approx.)	0.5 ha
Existing drainage infrastructure	Pipes, open swales
Extent of Issue/s	Localised flooding of 37-41 Cathcart Street potentially caused by inadequate upstream drainage (blocked pipes and sediment in swales). Runoff appears to flow from the road to the pathway in front of 41 Cathcart Street and drains to Ballina Road along the footpath.

Issue	I24 - Localised flooding on Casino Street
Location	Casino Street, South Lismore
Management Area	15 – South Lismore/Hollingsworth Creek
Catchment area (approx.)	5 ha
Existing drainage infrastructure	Pipes, open swales
Extent of Issue/s	Localised flooding of residences on Casino Street potentially caused by inadequate swale drainage (low grade, overgrown swales) and blocked pipes crossing to Hanlon Street and the east side of Caniaba Street.

There are many locations where the existing grass swales in flat, low-lying areas do not provide adequate stormwater conveyance resulting in flooding of roads, residential properties and businesses. The issues in these areas have been grouped by Management Area as follows:

- I25 – Localised flooding in South Lismore/Hollingsworth Creek (Management Area 15);
- I26 – Localised flooding in North Lismore/Leycester Creek (Management Area 1);
- I27 - Localised flooding in Slaters Creek (Management Area 2);
- I28 - Localised flooding in Currie Creek (Management Area 4);
- I29 - Localised flooding in Browns Creek (Management Area 11);
- I30 - Localised flooding in Gasworks Creek (Management Area 12); and
- I31 - Localised flooding in Monaltrie Creek (Management Area 10).

The extent of the localised flooding in these areas will require large-scale, catchment-wide solutions to address the issue.

9.2.1 Prioritisation of Site-Based Issues

The site-based management issues have been prioritised according to the risk of not achieving the stormwater management objectives (Section 8) as well as the urgency of developing a solution to the problem. The prioritisation matrix is included in Appendix 7 and the priority ranking is provided in Table 17.

The stormwater management objectives include both quantity and quality objectives as well as reducing impacts on amenity. The priority is assessed as high, medium, low or no risk in relation to:

- Quantity (flooding) related risks to public safety (contact with pathogens, drowning or injury), flooding of private property or public infrastructure and the risk of nuisance flooding. Some issues potentially cause flooding of private property (e.g. Cathcart Street, Girards Hill and Casino Street, South Lismore). Although these do not rank as highly as more widespread issues which also include water quality concerns, these are considered to be a high priority;
- Quality related risks - urban stormwater quality (contributor of pollutants to receiving waters either due to land use or lack of treatment systems), degradation of high value ecology/sensitive receiving environments (Key Fish Habitat, valuable aquatic habitat) and risks to Wilsons River Source drinking water catchment. To assess the risks to the drinking water catchment, the risks were assessed according to the distance to the Wilsons River Source extraction point at Howards Grass. Urban Stormwater Management Areas 4, 5, 6, 7 and 8 consequently receive the highest risk ranking in this regard, whilst Areas 3, 9 and 10 are outside of the Wilsons River Source catchment and pose little risk to the raw water quality; and

- Risk to amenity of high usage areas – where the area is used for recreation and/or sensitive land uses such as hospitals and schools or where there is high usage/traffic.

Table 17: Priority ranking of site-based issues

Issue Category	No.	Issue/s	Location	Management Area	Issue Score[1]	Priority
Poor water quality	I1	Poor water quality in Browns Creek, localised flooding	Browns Creek	11 - Browns Creek	16	High
Sedimentation	I14	Localised flooding adjacent to Wade Park and East Lismore Community Preschool	Wade Park	10 - Monaltrie Creek	15	
Localised flooding	I22	Localised flooding adjacent to South Lismore Public School	South Lismore Public School	15 - South Lismore/ Hollingworth Creek	12	
Localised flooding	I16	The northern section of Browns Creek channel is overgrown with weeds, restricting conveyance of flows to Bat Cave	Browns Creek, Uralba Street to Bat Cave	11 - Browns Creek	11	
Localised flooding	I15	Stormwater from the golf course backs up underneath the Barnes property	Barnes factory	11 - Browns Creek	10	
Inadequate drainage	I30	CBD grass swales (Gasworks Creek) do not provide adequate stormwater conveyance	CBD	12 - Gasworks Creek	9	
Inadequate drainage	I31	East Lismore grass swales (Monaltrie Creek) do not provide adequate stormwater conveyance	East Lismore	10 - Monaltrie Creek	9	
Inadequate drainage	I29	CBD grass swales (Browns Creek) do not provide adequate stormwater conveyance	CBD	11 - Browns Creek	9	
Localised flooding	I13	Localised flooding of Industry Drive storage sheds and surrounding area	Industry Drive	10 - Monaltrie Creek	9	

Issue Category	No.	Issue/s	Location	Management Area	Issue Score[1]	Priority
Localised flooding	I23	Localised flooding of Cathcart Street	Cathcart Street, Girards Hill	12 - Gasworks Creek	8	Medium
Localised flooding	I24	Localised flooding of Casino Street	Casino Street, South Lismore	15 - South Lismore/ Hollingworth Creek	8	
Sedimentation	I11	Bat Cave sediment weir is not accessible for maintenance and has become ineffective	Browns Creek near Bat Cave	11 - Browns Creek	8	
Localised flooding	I21	Localised flooding of Larkin Lane	Larkin Lane	14 - CBD	8	
Localised flooding	I17	Localised flooding on Union Street	Union Street	15 - South Lismore/ Hollingworth Creek	8	
Inadequate drainage	I26	North Lismore grass swales (Leycester Creek) do not provide adequate stormwater conveyance	North Lismore	1 - North Lismore/ Leycester Creek	7	
Inadequate drainage	I27	North Lismore grass swales (Slaters Creek) do not provide adequate stormwater conveyance	North Lismore	2 - Slaters Creek	7	
Inadequate drainage	I28	North Lismore grass swales (Currie Creek) do not provide adequate stormwater conveyance	North Lismore	4 - Currie Creek	7	
Inadequate drainage	I25	South Lismore grass swales (Hollingworth Creek) do not provide adequate stormwater conveyance	South Lismore	15 - South Lismore/ Hollingworth Creek	7	
Localised flooding	I19	Localised flooding of Terania Street	Terania Street	2 - Slaters Creek	7	
Water logging	I7	Kookaburra Terrace sedimentation basin (#3) is waterlogged and provides low water quality improvement	Kookaburra Terrace (#1)	9 - Tucki Tucki	7	
Water logging	I5	Gasworks Creek detention pond is silted up reducing capacity and effectiveness	Gasworks Creek	12 - Gasworks Creek	7	

Issue Category	No.	Issue/s	Location	Management Area	Issue Score[1]	Priority
Water logging	I9	Kookaburra Terrace sedimentation basin (#3) is waterlogged and provides low water quality improvement	Kookaburra Terrace (#3)	9 - Tucki Tucki	6	Low
Water logging	I3	Waterlogging of swale	Newbridge Street	15 - South Lismore/ Hollingworth Creek	6	
Water logging	I8	Kookaburra Terrace sedimentation basin (#2) is waterlogged and provides low water quality improvement	Kookaburra Terrace (#2)	9 - Tucki Tucki	6	
Gross pollutants	I2	Gross pollutants entering Tucki Tucki Creek	Gordon Blair Drive channel	9 - Tucki Tucki	6	
Localised flooding	I20	Localised flooding of Trinity Drive	Trinity Drive	6 - Howards Grass	5	
Localised flooding	I18	Localised flooding of Snow Street drainage channel	Snow Street	16 - South Lismore/ Airport	5	
Sedimentation	I6	Camilla Place retention basin is silted up and ineffective	Camilla Place	9 - Tucki Tucki	5	
Sedimentation	I10	Large amounts of silt in Just Street bioretention basin	Just Street	9 - Tucki Tucki	4	
Sedimentation	I12	Sediment basin is silted up reducing capacity and effectiveness	Joy Street	9 - Tucki Tucki	3	
Riparian condition	I4	Poor condition of riparian vegetation along Leycester Creek	Downstream duck pond	15 - South Lismore/ Hollingworth Creek	2	

1. The maximum possible issues score is 24.

9.3 Future Development Areas

Council adopted its Growth Management Strategy in 2015 to ensure that the community continues to have access to affordable and appropriate housing and employment options in locations that can be serviced by infrastructure and that protect prime agricultural and other resources, the natural environment and important landscape features. The Growth Management Strategy provides for new housing and other development to be located in or adjacent to Lismore's main urban area, which contains the majority of the LGA's services and jobs, in or in close proximity to villages that provide a range of services or in and adjacent to existing rural residential estates. It is anticipated that around 70% of new dwellings in the LGA will be in the urban area of Lismore (LCC, 2015d).

North Lismore Plateau is a new urban release area located approximately 1.5 kilometres north-west of the Lismore CBD. The area is identified in various regional planning strategies as land potentiality suitable for future urban development. The majority of North Lismore Plateau development area has been rezoned to General Residential under the Lismore City Council LEP 2012. There are expected to be approximately 1,500 dwellings once the development is complete (TTM Consulting, 2012). Other greenfield release areas are proposed to provide for anticipated population and employment growth and different housing markets. Urban infill and fringe sites have also been identified to maximise and support existing infrastructure and services and respond to identified demand for alternative housing options. A 'Medium Housing Precinct' is proposed for the area close to the Lismore Base Hospital located within the vicinity of Lismore Base Hospital.

Potential future development sites are shown on Figure 52. The anticipated development timing, description of each site and existing stormwater issues are detailed in Appendix 8.

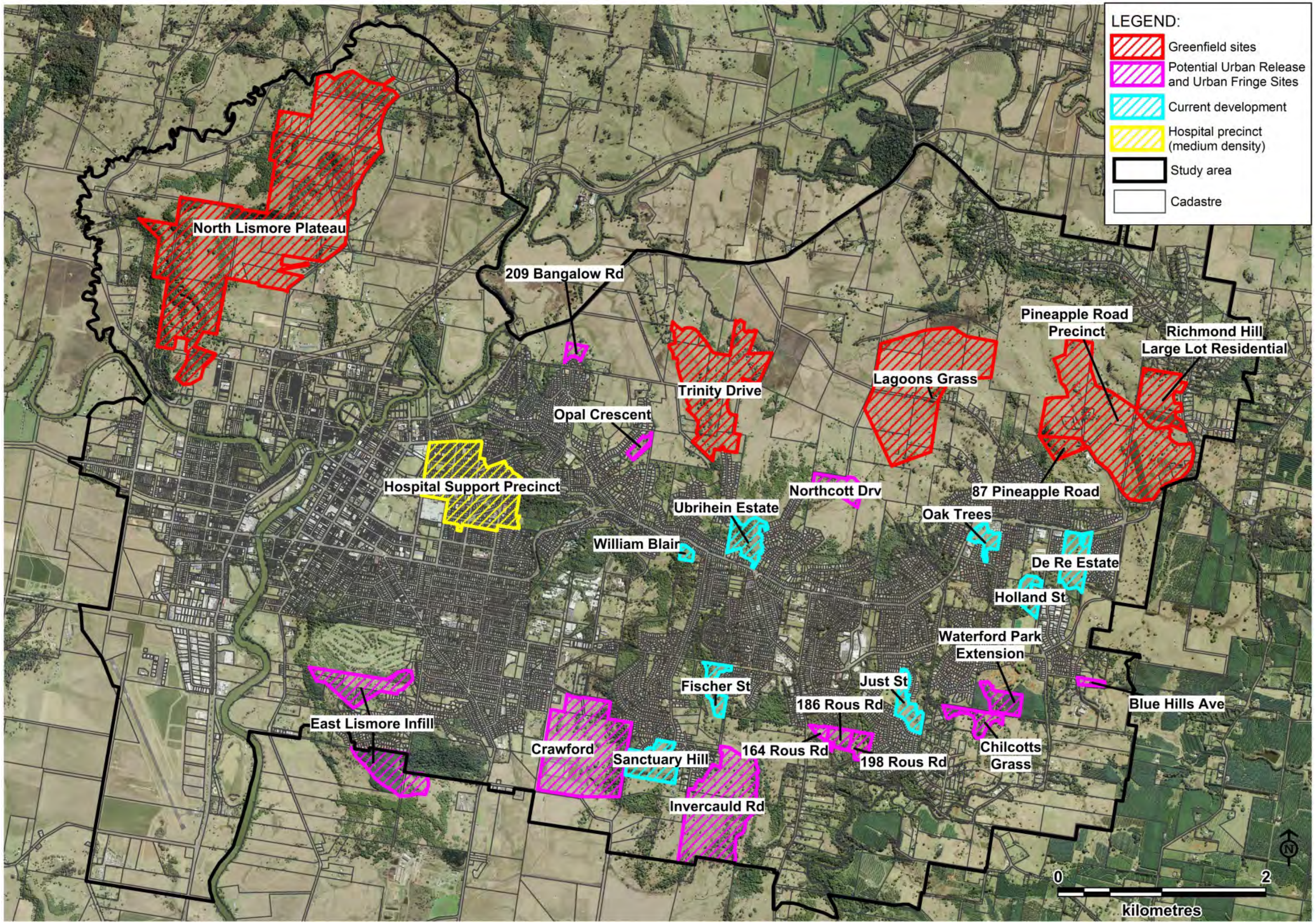


Figure 52: Potential future development sites

10. STORMWATER MANAGEMENT APPROACHES

Management approaches are briefly discussed in this section including prioritisation of on-ground improvement projects. Prioritised actions that are funded in this USMP are discussed in more detail in Volume 1.

10.1 Administration and Governance Actions

Council's urban stormwater management should be enhanced through improved administration and governance and increased emphasis on planning and asset management, consistent with Council's strategic direction and policies. More strategic consideration of stormwater management requirements is required through the whole asset lifecycle including allocation of internal Council responsibilities and ensuring adequate skills, funding and supporting policies are in place. Desired outcomes are:

- Consideration of how stormwater infrastructure will be designed to suit local circumstances and funded through the whole asset life cycle during the land use planning stage;
- Improved management of stormwater assets through design, construction and operational phases to ensure Council inherits assets that are functioning properly and that meet the design intent as well as any Council requirements for technology and resource requirements. Council needs to have a clear understanding and funding commitment (and also minimise the burden) for ongoing maintenance of the assets;
- Increased construction phase compliance enforcement to ensure adequate operation of erosion/sediment controls. Increased funding for regulatory compliance officers is required, with clear policies and support mechanisms;
- Asset handover should be undertaken over a staged process with appropriate inspections to progressively transfer ownership and responsibility to Council;
- Details of all existing stormwater infrastructure (including vegetated assets) is required with sufficient accuracy to allow identification of future maintenance, upgrade and renewal requirements;
- Function and performance requirements should be identified for all asset types and maintenance should be undertaken to these desired standards; and
- Increased focus on compliance of private treatment systems through self-regulation with spot checks by Council or compulsory compliance inspections by Council.

10.2 On-Ground Improvement Projects

Strategies for stormwater quality and quantity improvement have been developed for the purposes of this Plan based on the review of background data and identified management issues and collation of suggestions from Council staff. These include:

- Water quality improvement;
- Treatment system upgrade/renewal;
- Maintenance of existing treatment devices;
- Improving stormwater conveyance;
- Modifications to existing drainage infrastructure; and
- Provision of new trunk drainage.

The current management approach, possible alternative new approaches and the preferred approach to address the site-based issues are given in Table 18.

A catchment-based approach has been used to develop the preferred approach but this does not preclude staged implementation of individual components.

Table 18: Preferred management approaches to address site-based issues

	ID	Site-Based Issue	Management Area	Issue Score	Current management approach	Alternative Approaches	Other Considerations	Preferred Approach
High Priority	I1	Poor water quality in Browns Creek, localised flooding	11 - Browns Creek	16	Ongoing maintenance of channels (gross pollutant and sediment removal)	Browns Creek naturalisation project was developed in 2013 to address recreational and stormwater management objectives. A Master Plan of stormwater quality improvements within Bruxner Highway/Diadem Street to Uralba Street precincts has been documented to concept level.	The Browns Creek naturalisation project would address the precincts from Bruxner Highway/Diadem Street to Uralba Street. The section of channel from Uralba Street to the Bat Cave is currently overgrown with weeds, restricting conveyance of flows. Other catchments also drain into this channel and the Bat Cave.	Review of catchment-wide options to provide stormwater quality and localised flooding improvements within the Browns Creek CBD area, with consideration of staged implementation of components of Browns Creek naturalisation project, drainage improvements between Uralba Street and the Bat Cave and Zadoc Street to Bat Cave as well as treatment provided to sub-catchments not included in the naturalisation precincts. Potential collection of contributions from Hospital Precinct developments for centralised treatment systems on Little Keen Street, Gloria Mortimer Oval and for Browns Creek naturalisation (in lieu of on-site treatment).
	I14	Localised flooding adjacent to Wade Park and East Lismore Community Preschool	10 - Monaltrie Creek	15	Sediment is excavated from the area approximately every 18 months where approximately 80 m3 of sediment is removed	Construction of a sediment collection system and wetland system at the end of the concrete channel designed to reduce turbidity and other contaminants.	The trunk drainage program includes 3 concrete channels at the bottom of this catchment (refer below). The proposed wetland system is an alternative to the 90m of concrete channel included in the trunk drainage program. The open concrete channel is expected to be significantly cheaper. An alternative treatment system is a system constructed lower in the catchment to treat the entire Monaltrie Creek sub-catchment. This could also tie-in with the development of Crawford land and the concrete channels in the trunk drainage program. The sources of sediment are expected to be the drainage swales within this catchment, the drainage line commencing at the gully adjacent to Cynthia Wilson Drive and other urban runoff within the catchment. This sedimentation also causes localised flooding at Industry Drive (refer below).	Staged construction of concrete channels at bottom of urban catchment (to Crawfords development area) with a treatment system constructed at the end of the three channels potentially within Crawfords land. Potential use of wetland for treatment of Crawfords development runoff (with associated developer contributions). Implementation of upstream sediment controls (refer Industry Drive) is expected to reduce sediment load in the lower catchment and should be implemented prior to downstream treatment measures.
	I22	Localised flooding adjacent to South Lismore Public School	15 - South Lismore/ Hollingworth Creek	12	Weed removal		Council has replaced five metres of drainage pipe and unblocked the culvert that runs under Caniaba Street, south of the railway crossing	Ongoing maintenance of swale to remove sediment and debris.
	I16	The northern section of Browns Creek channel is overgrown with weeds, restricting conveyance of flows to Bat Cave	11 - Browns Creek	11	Slashing and litter collection along the edge and banks	Trunk drainage from Dawson Street to the bat cave would improve conveyance of flows and allow provision of additional parking areas. Modification of road culverts may be required.	-	As above
	I15	Stormwater from the golf course backs up underneath the Barnes property	11 - Browns Creek	10	Mowing of swales	Detention within golf course	The East Lismore infill area is upstream of the site and downslope of the Tanelawn subdivision. The stormwater detention for this development area may be oversized to partially minimise downstream flooding. Council may purchase the factory and convert the site into a detention basin.	Initiate negotiations wth the golf club for the construction of a detention basin in the lower portion of the golf course to retain stormwater from the upper reaches of the catchment (Tanelawn Subdivision) and enable slow release to the trouble point. Potential collection of contributions from East Lismore infill developments for centralised treatment as part of the detention basin (in lieu of on-site treatment)

	ID	Site-Based Issue	Management Area	Issue Score	Current management approach	Alternative Approaches	Other Considerations	Preferred Approach
High Priority	I30	CBD grass swales (Gasworks Creek) do not provide adequate stormwater conveyance	12 - Gasworks Creek	9	Ongoing maintenance of drainage swales	Trunk drainage program	Scour control at waterways and treatment systems should be included.	Trunk drainage program (part TD17). Include outlet structures for discharge to waterways (in accordance with NOW requirements). Include in-line treatment devices (such as CDS units) where no other treatment is provided in the catchment. Additional treatment may also be required (subject to detailed investigations).
	I31	East Lismore grass swales (Monaltrie Creek) do not provide adequate stormwater conveyance	10 - Monaltrie Creek	9	Ongoing maintenance of drainage swales	Trunk drainage program	Scour control at waterways and treatment systems should be included.	Trunk drainage program (part TD20, TD21). Include outlet structures for discharge to waterways (in accordance with NOW requirements). Include in-line treatment devices (such as CDS units) where no other treatment is provided in the catchment. Additional treatment may also be required (subject to detailed investigations).
	I29	CBD grass swales (Browns Creek) do not provide adequate stormwater conveyance	11 - Browns Creek	9	Ongoing maintenance of drainage swales	Trunk drainage program	Scour control at waterways and treatment systems should be included.	Trunk drainage program (TD13, part TD14, TD16, TD18, part TD19). Include outlet structures for discharge to waterways (in accordance with NOW requirements). Include in-line treatment devices (such as CDS units) where no other treatment is provided in the catchment. Additional treatment may also be required (subject to detailed investigations).
	I13	Localised flooding of Industry Drive storage sheds and surrounding area	10 - Monaltrie Creek	9	Removal of debris from road culvert	Sediment containment in the upper catchment, maintenance of drainage pathways.	Sediment containment in the upper catchment is also expected to restrict sediment deposition at Wade Park. Conditional consent has been provided for a subdivision to create 13 new lots on Airforce Road. This could potentially exacerbate the sediment deposition and flooding problem. Depending on the status of the development application, stormwater works for the subdivision may incorporate components of these works	Construct a series of sediment containment structures (at the top of the gully at the intersection of Fig Tree and Cynthia Wilson Drives and at the rear of the Martin Drive properties). Ongoing maintenance and rehabilitation of the drainage lines is required to remove sediment and weeds and clear culvert blockages. Access to the drainage line at the rear of the industrial sheds (either though private property or the Airforce land) will be required.

	ID	Site-Based Issue	Management Area	Issue Score	Current management approach	Alternative Approaches	Other Considerations	Preferred Approach
Medium Priority	I23	Localised flooding of Cathcart Street	12 - Gasworks Creek	8	Ongoing maintenance of drainage swales	Removal of sediment and debris from swale and culverts. Enlargement of culvert entry swale and realignment of driveway crossing (no. 41). Potential enlargement of road culvert to east side of Cathcart Street.	-	Removal of sediment and debris from swale and culverts. Enlargement of culvert entry swale and realignment of driveway crossing (no. 41). If flooding still occurs, enlarge road culvert to east side of Cathcart Street.
	I24	Localised flooding of Casino Street	15 - South Lismore/ Hollingworth Creek	8	Ongoing maintenance of drainage swales	Removal of sediment and debris from swale and downstream culverts. Potential enlargement and regrading of swale and realignment of driveway crossings. Construction of road culverts to Hanlon and Caniaba Streets.	Road rehabilitation is proposed in 2015/16 for Casino Street to Hanlon Street.	Council will construct a culvert under Casino Street to Hanlon Street as part of the road rehabilitation work to be undertaken in 2015.
	I26	North Lismore grass swales (Leycester Creek) do not provide adequate stormwater conveyance	1 - North Lismore/ Leycester Creek	7	Ongoing maintenance of drainage swales	Trunk drainage program	Scour control at waterways and treatment systems should be included.	Trunk drainage program (part TD10, part TD11). Include outlet structures for discharge to waterways (in accordance with NOW requirements). Include in-line treatment devices (such as CDS units) where no other treatment is provided in the catchment. Additional treatment may also be required (subject to detailed investigations).
	I27	North Lismore grass swales (Slaters Creek) do not provide adequate stormwater conveyance	2 - Slaters Creek	7	Ongoing maintenance of drainage swales	Trunk drainage program	Scour control at waterways and treatment systems should be included.	Trunk drainage program (part TD10, part TD11, part TD12). Include outlet structures for discharge to waterways (in accordance with NOW requirements). Include in-line treatment devices (such as CDS units) where no other treatment is provided in the catchment. Additional treatment may also be required (subject to detailed investigations).
	I28	North Lismore grass swales (Currie Creek) do not provide adequate stormwater conveyance	4 - Currie Creek	7	Ongoing maintenance of drainage swales and headwalls	Trunk drainage program	Scour control at waterways and treatment systems should be included.	Trunk drainage program (part TD12). Include outlet structures for discharge to waterways (in accordance with NOW requirements). Include in-line treatment devices (such as CDS units) where no other treatment is provided in the catchment. Additional treatment may also be required (subject to detailed investigations).
	I11	Bat Cave sediment weir is not accessible for maintenance and has become ineffective	11 - Browns Creek	8	None	Restore access to the structure/vegetation clearance, excavation of sediment and replanting.	Piping of the section of drainage line from Zadoc Street to the bat cave would negate the need for upgrade of the sediment weir. The northern section of the proposed medium density hospital precinct drains to this weir. Developers may contibute to a centralised treatment system in this location in lieu of on-site treatment measures.	Refer approach for I1.

	ID	Site-Based Issue	Management Area	Issue Score	Current management approach	Alternative Approaches	Other Considerations	Preferred Approach
Medium Priority	I21	Localised flooding of Larkin Lane	14 - CBD	8	None	Removal of sediment and debris from drains. If flooding still occurs, the crossfall of the road could be regraded away from the shops.	-	The drains should be cleared of sediment and debris to improve conveyance. If flooding still occurs, the crossfall of the road could be regraded away from the shops. Detailed survey is required. Road surface towards Keen Street has been re-laid with pavers. Extension of the resurfacing to the full length of the lane including regrading would reduce flood risk.
	I25	South Lismore grass swales (Hollingworth Creek) do not provide adequate stormwater conveyance	15 - South Lismore/ Hollingworth Creek	7	Ongoing maintenance of drainage swales	Trunk drainage program	Scour control at waterways and treatment systems should be included.	Trunk drainage program (TD1, TD2, TD3, TD4, TD5, TD6, TD9, TD15). Include outlet structures for discharge to waterways (in accordance with NOW requirements). Include in-line treatment devices (such as CDS units) where no other treatment is provided in the catchment. Additional treatment may also be required (subject to detailed investigations).
	I17	Localised flooding on Union Street	15 - South Lismore/ Hollingworth Creek	8	None	Inspect and clean out stormwater system downstream. If flooding still occurs, extend drainage to intersection	-	Inspect and clean out stormwater system downstream. If flooding still occurs, another pit could be installed in front of the shop with very efficient inlet grate (class D - traffic loading) and an oversize pipe discharging to the existing pit. This may hold excess water below ground rather than ponding outside shop, but relies upon all downstream pits and pipes being clear of sediment / obstructions. An alternative is to construct a raingarden from the intersection with Elliot Road without impeding pedestrian access and existing parking bays on Union Street.
	I19	Localised flooding of Terania Street	2 - Slaters Creek	7	Ongoing maintenance of drainage swales and headwalls	Trunk drainage extension, creation of easement through private land	-	Trunk drainage extension to Pine Street, creation of easement through private land where existing stormwater discharges
	I7	Kookaburra Terrace sedimentation basin (#3) is waterlogged and provides low water quality improvement	9 - Tucki Tucki	7	Litter and debris removal, slashing and mowing when dry	Upgrade sedimentation basin to a bioretention system	Tucki Tucki creek contains high value aquatic habitat.	Excavation for subsoil drainage and modification of surcharge pit, scour control at headwall, re-vegetation with suitable species to increase water quality improvement, increase general amenity of the area and reduce long-term maintenance.
	I5	Gasworks Creek detention pond is silted up reducing capacity and effectiveness	12 - Gasworks Creek	7	Weed removal	Upgrade detention pond to a bioretention system	-	Desilting of current pond and re-contouring of pond and channel directly upstream to include a sediment drop-out structure that can be regularly maintained. The banks would be graded and revegetated similar to rehabilitated upstream channel.

	ID	Site-Based Issue	Management Area	Issue Score	Current management approach	Alternative Approaches	Other Considerations	Preferred Approach
Low Priority	I9	Kookaburra Terrace sedimentation basin (#3) is waterlogged and provides low water quality improvement	9 - Tucki Tucki	6	litter and debris removal, slashing and mowing when dry	Upgrade sedimentation basin to a bioretention system	-	Re-vegetation with suitable species to increase water quality improvement, increase general amenity of the area and to reduce long-term mowing maintenance
	I3	Waterlogging of swale	15 - South Lismore/ Hollingworth Creek	6	Slashing and mowing when dry	Upgrade swale to a bioretention system or wetland	-	Establishment of wetland or bioretention system
	I8	Kookaburra Terrace sedimentation basin (#2) is waterlogged and provides low water quality improvement	9 - Tucki Tucki	6	litter and debris removal, slashing and mowing when dry	Upgrade sedimentation basin to a bioretention system	-	Re-vegetation with suitable species to increase water quality improvement, increase general amenity of the area and to reduce long-term mowing maintenance
	I2	Gross pollutants entering Tucki Tucki Creek	9 - Tucki Tucki	6	Litter collection	Collection of gross pollutants	-	Installation of GPT at Gordon Blair Drive headwall
	I20	Localised flooding of Trinity Drive	6 - Howards Grass	5	Removal of weeds and debris from upstream channel	Maintenance of drainage system and/or increase capacity of culvert.	This catchment drains to the Wilsons River near to the drinking water extraction point which may warrant additional treatment at the outlet.	Inspection of the collection pit on Trinity Drive to ensure no blockages. Maintenance of the outlet drain (weed, silt and rubbish removal). If the pit and pipes are clear, an additional pipeline within the road crossing or box culvert combined with regrading and scour control at the outlet may be required. Additional treatment may also be required (subject to detailed investigations).
	I18	Localised flooding of Snow Street drainage channel	16 - South Lismore/ Airport	5	Removal of weeds and debris	Enlarge and reshape channel to improve conveyance	-	Enlarge and reshape channel to improve conveyance (including downstream of surcharge pit). Maintenance should extend north as far as possible beyond surcharge pit.
	I6	Camilla Place retention basin is silted up and ineffective	9 - Tucki Tucki	5	Maintained by resident	Maintenance of retention basin	-	Excavation of silt, re-contouring, reinstatement of subsoil drainage and re-vegetation.
	I10	Large amounts of silt in Just Street bioretention basin	9 - Tucki Tucki	4	Litter collection within the basin and along the concrete overflow	Maintenance of bioretention basin	-	Excavation of silt and re-instatement as a bioretention system to provide tertiary treatment
	I12	Sediment basin is silted up reducing capacity and effectiveness	9 - Tucki Tucki	3	Litter and debris removal	Maintenance of sediment basin	-	The basin requires removal of accumulated sediment by excavation. Several trees would need to be removed to allow access. Restoration of vegetation and allowance for permanent access.
	I4	Poor condition of riparian vegetation along Leycester Creek	15 - South Lismore/ Hollingworth Creek	2	None	Riparian restoration	-	Investigate grant opportunities for revegetation and maintenance of the riparian zone along the small stream from the duck pond to Leycester Creek

10.3 Trunk Drainage Program

LCC commenced planning for upgrades to trunk drainage in 2009/10. The target area for the upgrade of stormwater trunk drainage was within the South Lismore area. This area has a very old drainage system, with several low lying and flat areas which do not permit stormwater flows to drain effectively, resulting in Council receiving a large number of complaints/ requests from local residents. Council's Design Services team undertook extensive field surveys of the existing stormwater systems within the South Lismore area and identified drainage lines that require upgrading to cater for a 1-in-20-year storm for the main drainage lines and 1-in-10-year storm for side lines. The catchments areas were also split into sub-catchments areas to allow more detailed designs to be undertaken, indicating where upgrades in capacity are required. At the time, a priority rating system was developed to help prioritise this work. In 2009/10, the trunk drainage upgrade budget was $440,000 consisting of $190,000 reserve funding and a $250,000 loan serviced through the SMS Charge (refer Section 6.4.2). This was used to fund upgrades in Webster Street, Phyllis Street and Brewster Street, South Lismore. Since then, no funding has been available for the trunk drainage program.

LCC has reviewed the trunk drainage upgrade requirements for this USMP and developed a schedule of upgrades which will be progressively implemented as funding permits. Cost estimates are based on recent construction work undertaken by Council including 30% contingency. There may be efficiencies if the program is packaged in large components. Where required, costs include outlet structures for discharge to waterways (in accordance with NOW requirements as discussed in Section 6.5.7). The trunk drainage program should also include in-line treatment devices (such as CDS units) where no other treatment is provided in the catchment. Additional treatment may also be required (subject to detailed investigations).

Details of the trunk drainage program are provided in Appendix 9.

10.4 Sealed Road Rehabilitation Program

Council has developed a forward works program for sealed road rehabilitation. Many of the proposed trunk drainage upgrades and some of the site-based issues are located in the same roads as the rehabilitation projects. There is an opportunity to construct trunk drainage at the time of road rehabilitation, depending on the prioritisation and proposed timing of trunk drainage works. Appendix 10 lists the relevant trunk drainage upgrades and road rehabilitation program.

Council's road upgrade program should also include stormwater treatment as follows:

- Priority given to the treatment of road runoff from areas where there is a high concentration of vehicle braking and turning (i.e. roundabouts, intersections and off-ramps);
- Incorporation of water treatment systems into roadway features such as bio-retention filters into traffic calming devices;
- Incorporation of litter collection systems into the car parks and surrounding roadways of shopping centres, takeaway food centres, community areas, entertainment facilities and sporting fields; and
- Incorporation of public education messages onto the face of stormwater inlet lintels (e.g. PROTECT OUR WATERWAYS – FLOWS TO CREEK).

10.5 Stormwater Servicing for Future Growth Areas

The anticipated development timing, description of each site, existing stormwater issues and potential opportunities for future stormwater management are detailed in Appendix 8.

The rezoning of identified urban greenfield release areas will occur by way of landowner initiated planning proposals prepared in accordance with Council and Department of Planning and Environment's requirements and will address any site specific issues identified in the LCC Growth Management Strategy. Planning Proposals will be required to include Structure Plans that address infrastructure servicing including stormwater management. The Structure Plans will either be incorporated into a site specific DCP or the Urban Residential Subdivision DCP prior to or in conjunction with the amendment to the LEP being made.

A DCP has been adopted for North Lismore Plateau development. Council also intends to develop a separate section 94 contributions plan for this development.

Many of the larger development sites are located within the Wilson's River drinking water catchment and within close proximity to the extraction point (North Lismore Plateau, Trinity Drive, Lagoons Grass, Pineapple Road and the Hospital Support Precinct). Rous Water requires that development in these areas is designed to have a neutral or beneficial impact on water quality (refer to Section 7.3.3).

Potential opportunities for optimising stormwater management are:

- Hospital Support Precinct (refer Figure 53): Developer contributions could be collected and utilised to provide centralised downstream stormwater treatment (in lieu of on-site stormwater quality controls). There are four drainage catchments within the precinct flowing to Browns Creek at Magellan Street, Uralba Street, via Laurel Avenue and Gloria Mortimer Oval and via Orion Street and Jim Roder Oval. As part of the proposed Browns Creek naturalisation, GPTs are proposed for the Magellan Street and Uralba Street catchments. The other two catchments flow into concrete channels with no treatment. Under the existing DCP, all developments within the precinct would be required to provide on-site treatment systems that provide the specified reduction in stormwater pollutants (refer Section 6.5.1). Provision of centralised downstream treatment systems would provide advantages including reduced maintenance burden, increased space for development and the ability for Council to part-fund systems that treat the entire catchment where none currently exist. A Planning Agreement between Council and developers may be established to facilitate this. Improvements to the stormwater drainage system (trunk drainage program refer Section 10.3) are likely to be required prior to development proceeding and would also provide increased/improved roadside parking;
- East Lismore Infill (north site): Stormwater detention, larger than that required by the DCP, could be implemented at the development site to assist with resolving the flooding issue at the AK Barnes truss factory as well as mitigating issues related with new development. An alternative to this approach, which may yield a better overall solution, is to instead provide a detention system in the lower golf course which could treat a greater proportion of the catchment (Figure 54);
- Crawford: A treatment system for the Monaltrie Creek catchment could be included as part of Crawfords development to treat the upstream catchment as well as stormwater from the development (Figure 55). The proposed trunk drainage program includes extension of three concrete channels to the boundary with Crawfords land. This combined with the stormwater treatment system would address sedimentation and localised flooding issues at Wade Park as well as provide downstream treatment for the entire catchment. Sediment capture systems may also be required in upper areas of the catchment to capture the large sediment load;
- Waterford Park Extension: Existing farm dam north of site could potentially be reconfigured (and possibly expanded) to manage stormwater from this development site.

- Northern Front: Stormwater management could be combined for the adjacent development sites (Richmond Hill Large Lot Residential, Pineapple Road Precinct, 87 Pineapple Road, Trinity Drive, Lagoons Grass). There may be economic benefits due to increased scale, or opportunities for more efficient treatment, however, it may be difficult to find a site for a large centralised system (due to land ownership and use). Provision of a large centralised system would be difficult to time with development of the sites and receipt of developer contributions. There is potential for retention and restoration of existing gullies and creeks within and downstream of the sites to provide environmental benefits;
- Due to the timing of the Northern Front developments, it would be appropriate to review development controls to consider the need to protect the drinking water catchment including inclusion of Rous Water's requirements for application of a NorBE test and risk-based assessment of the impacts on drinking water quality (refer Section 6.5.6). Figure 56 shows the potential new developments discharging into the Wilsons River Source catchment; and
- In areas with limited existing urban development (e.g. Trinity Drive, Opal Crescent and 209 Bangalow Road), there is the potential for retention and restoration of existing gullies and creeks within site.

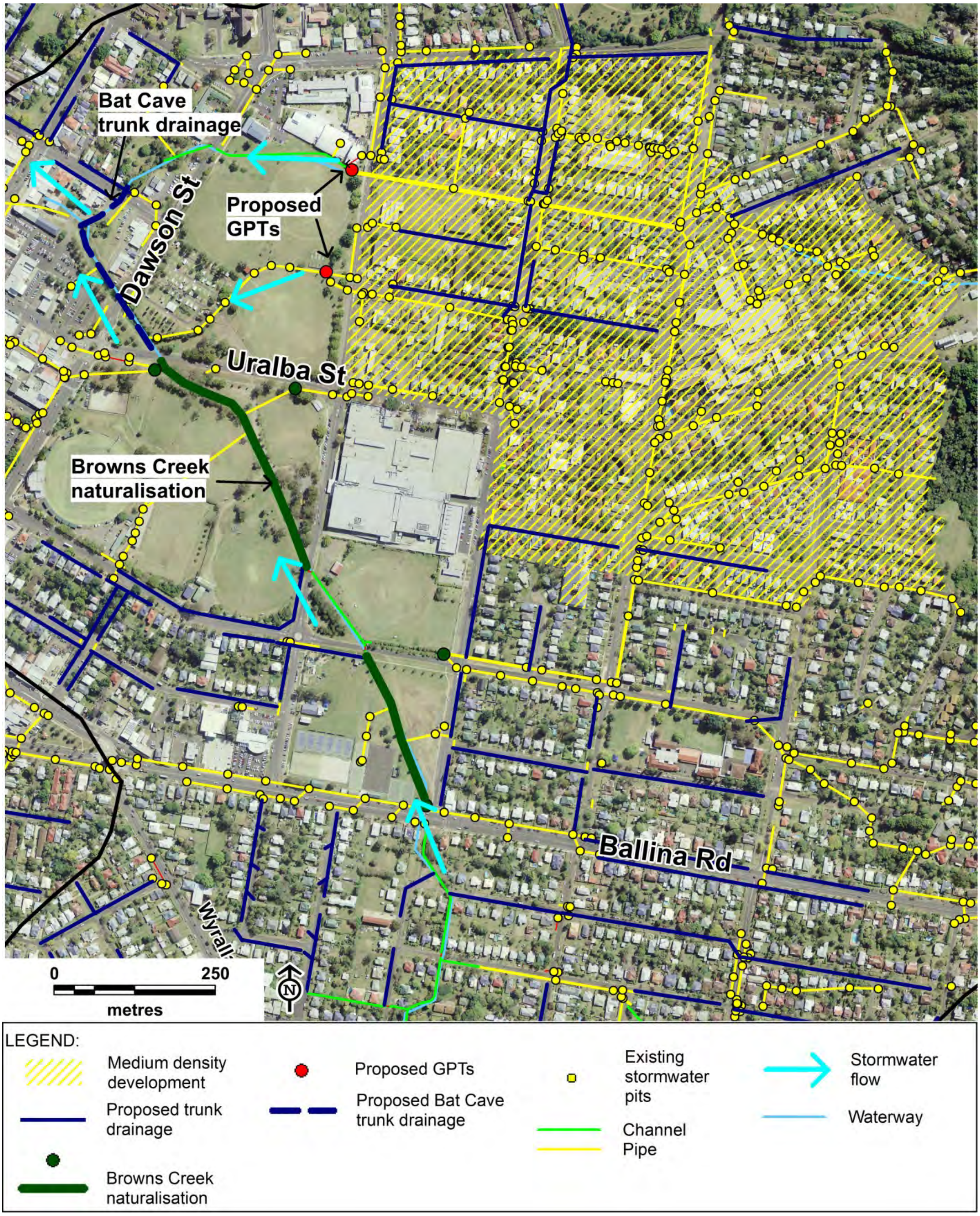


Figure 53: Potential downstream centralised stormwater quality controls for the Hospital Support Precinct

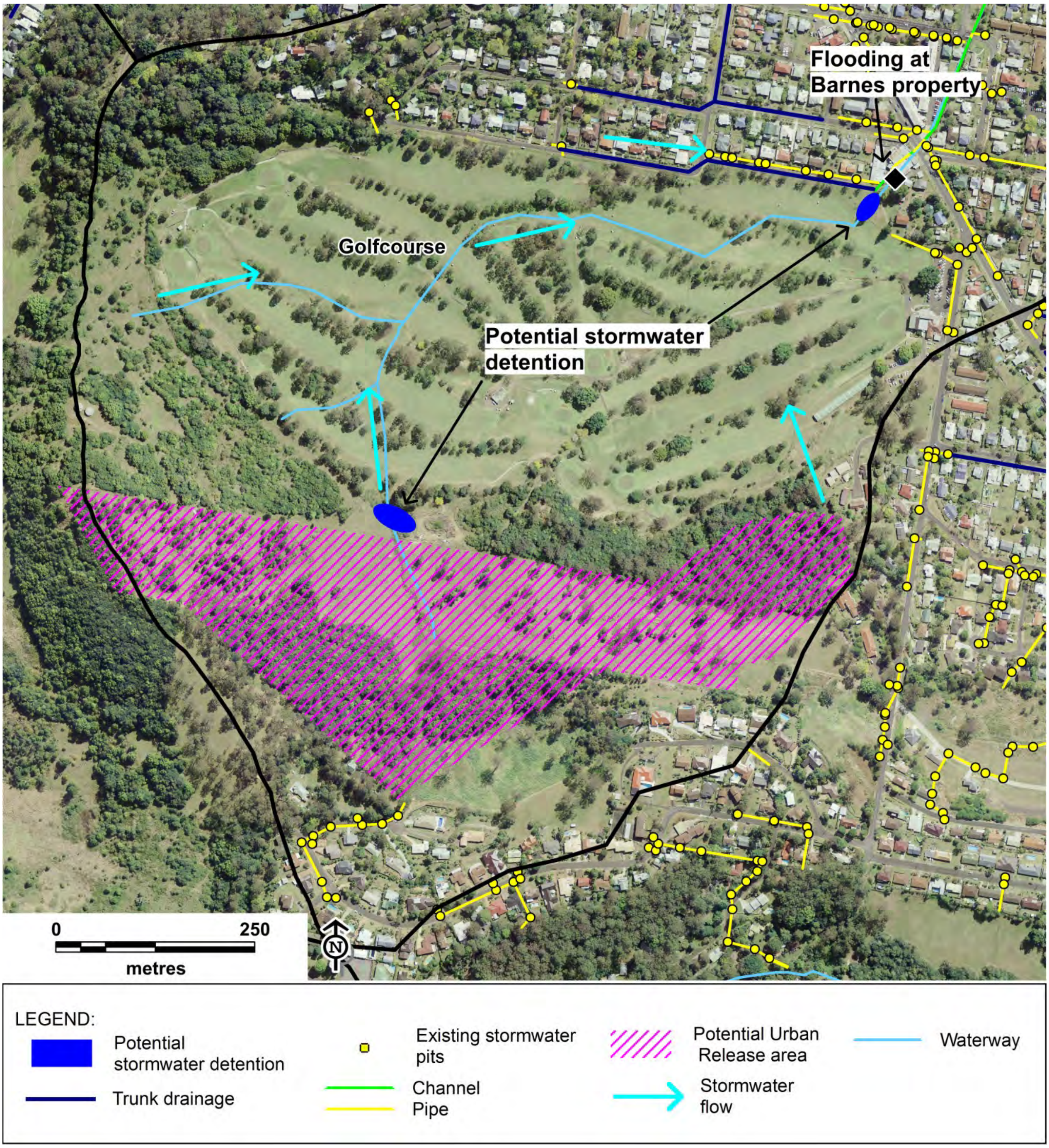


Figure 54: Potential on-site detention as part of East Lismore infill development

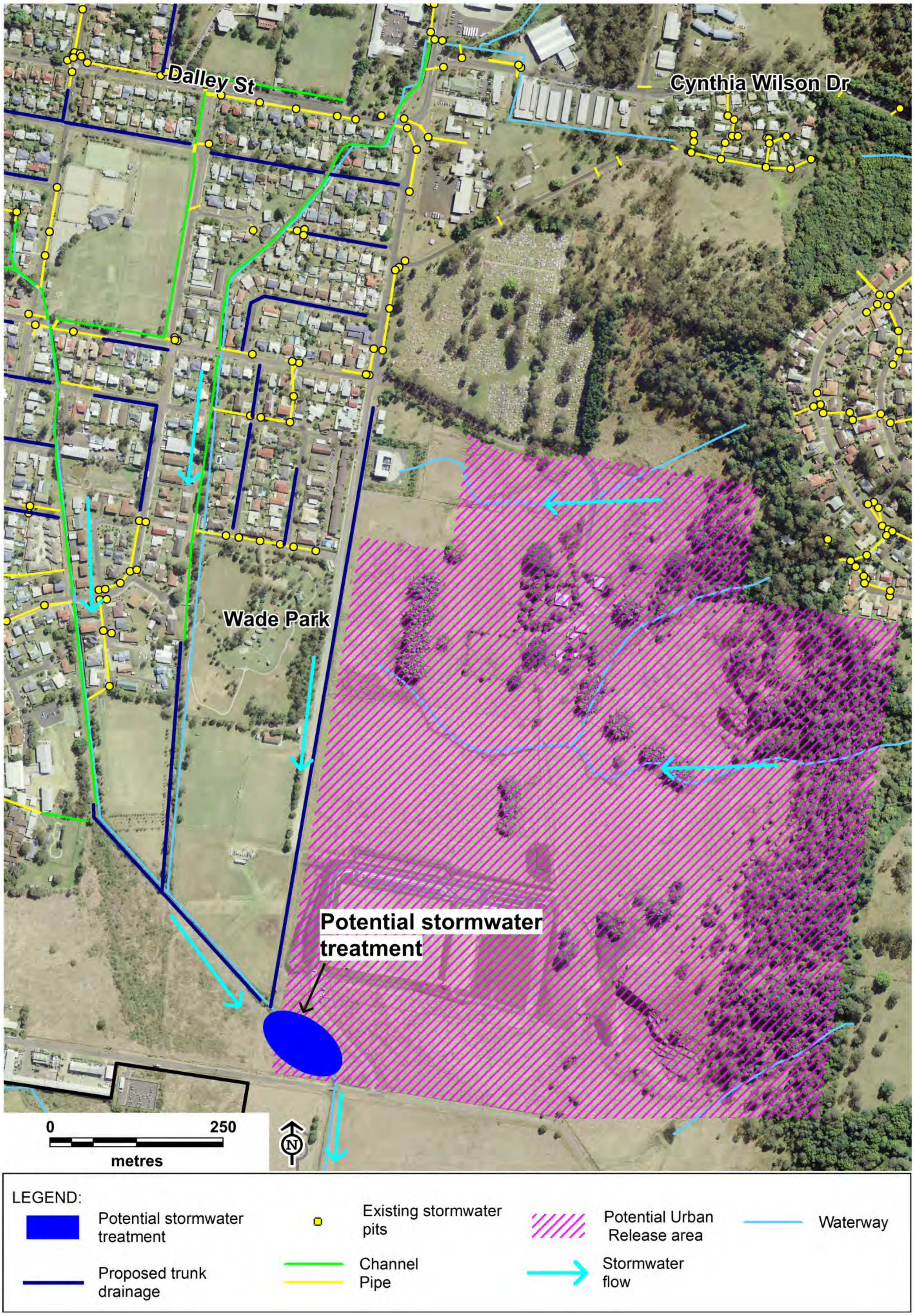


Figure 55: Potential Monaltrie Creek stormwater treatment system

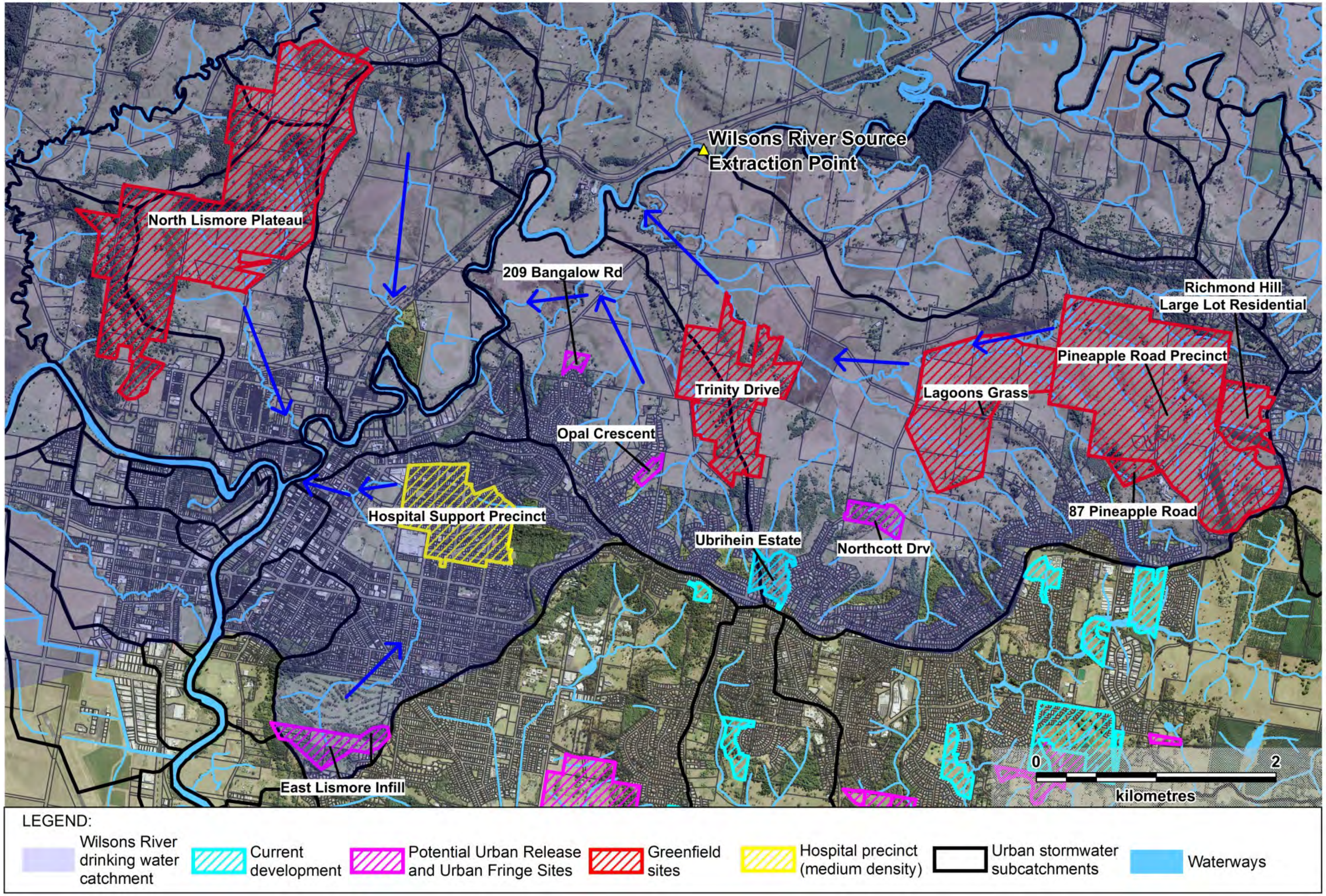


Figure 56: Potential future developments discharging into the Wilsons River drinking water catchment

11. DEVELOPMENT OF THE USMP IMPLEMENTATION PROGRAM

Based on the urban stormwater management issues identified in the previous sections and the level of funding available, a prioritised schedule for implementing the proposed management strategies is presented in the USMP Implementation Program (Volume 1 of this USMP).

The Implementation Program includes the recommended management strategies based on the issues raised in this document compiled into a ten-year schedule of actions. The implementation of the USMP will be supported by a process for reviewing the effectiveness of the plan and adapting it as required.

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GLOSSARY AND ABBREVIATIONS

AHD	Australian Height Datum is a geodetic datum for altitude measurement in Australia. According to Geoscience Australia, "In 1971 the mean sea level for 1966-1968 was assigned the value of 0.000m on the Australian Height Datum at thirty tide gauges around the coast of the Australian continent".
Amenity	A desirable or useful feature or facility of a building or place
Aquatic	Relating to water
Bioretention	Process whereby substances are removed from stormwater by biological processes
CBD	Central Business District
Chlorophyll a	The green pigment in plants used to capture and use energy from sunlight to form organic matter (see photosynthesis). Concentrations of chlorophyll a in the water column are used as an indicator for phytoplankton and benthic algae biomass. It provides a useful proxy indicator of the amount of nutrients incorporated into phytoplankton biomass, because phytoplankton have predictable nutrient-to-chlorophyll ratios.
Cadastre	Register of property lot boundaries
Catchment	An area drained by a river or watercourse
CZMP	Coastal Zone Management Plan
DECCW	Former (NSW) Department of Environment, Climate Change and Water (now OEH)
DCP	Developer Control Plan
DPI	(NSW) Department of Primary Industries
EEC	Endangered Ecological Community
Ecology	The interactions between organisms and their environment
Ecosystem	Refers to all the biological and physical parts of a biological unit (e.g. an estuary, forest, or planet) and their interconnections.
EPA	Environment Protection Authority
Estuarine	Part of the river channel with a mix of fresh water and salt (tidal) water
Greenfield	Previously undeveloped area.
GPT	Gross Pollutant Trap
Groundwater	Water underneath the earth's surface stored in soil pore space and rock fractures.
Habitat	Home or environment of an animal, plant, or other organism.
Hydrology	The study of water and its properties, including precipitation onto land and returning to oceans
Infrastructure	The basic physical and organisational structures and facilities needed for operation.
Inter-allotment drainage (IAD)	Stormwater systems installed by developer within dedicated easement to facilitate the draining of stormwater from lots that are enable to drain to the street. Responsibility of lot owner, not Council.
LCC	Lismore City Council
LEP	Local Environmental Plan
LGA	Local Government Area
Macrophyte	An aquatic plant large enough to be seen by the naked eye
OEH	Office of Environment and Heritage
Physico-chemical	Physical properties dependent on and influencing chemical structure, properties and reactions
Point Source Pollution	A single point of pollutant discharge. For example, effluent from a sewage treatment plant.
Riparian	Of, on or relating to the banks of a watercourse
Rous Water	Local water supply authority

RMS	NSW Roads and Maritime Services
RRCC	Richmond River County Council – responsible for flood mitigation activities for Ballina, Lismore and Richmond Valley councils.
Salinity	The level of salt dissolved in the water
Sedimentation	The deposition or accumulation of sediment
SEPP	State Environmental Planning Policy
SMS	Stormwater Management Service (Charge)
STP	Sewage Treatment Plant. Raw sewage is collected from homes and businesses and transported via a network of pipes and pump stations to the sewage treatment plant, a centralised system for treatment and disposal.
Terrestrial	Living or growing on land (not aquatic)
Threatened species	Species at risk of extinction listed under the *Threatened Species Conservation Act 1995*
Turbidity	A measure of the amount of light-attenuating particles in a water body.

Appendix 1: Rainfall Data

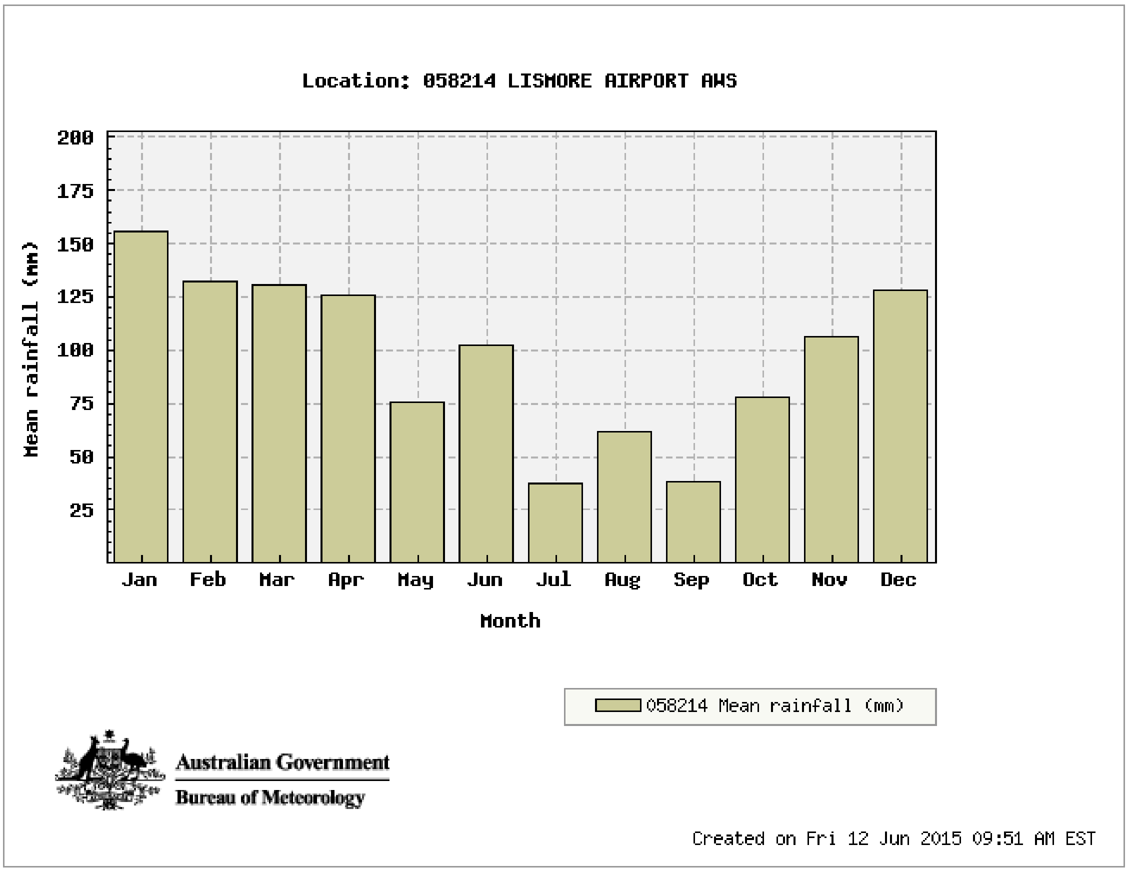


Figure 57: Lismore airport mean monthly rainfall

Source: BOM (2015a)

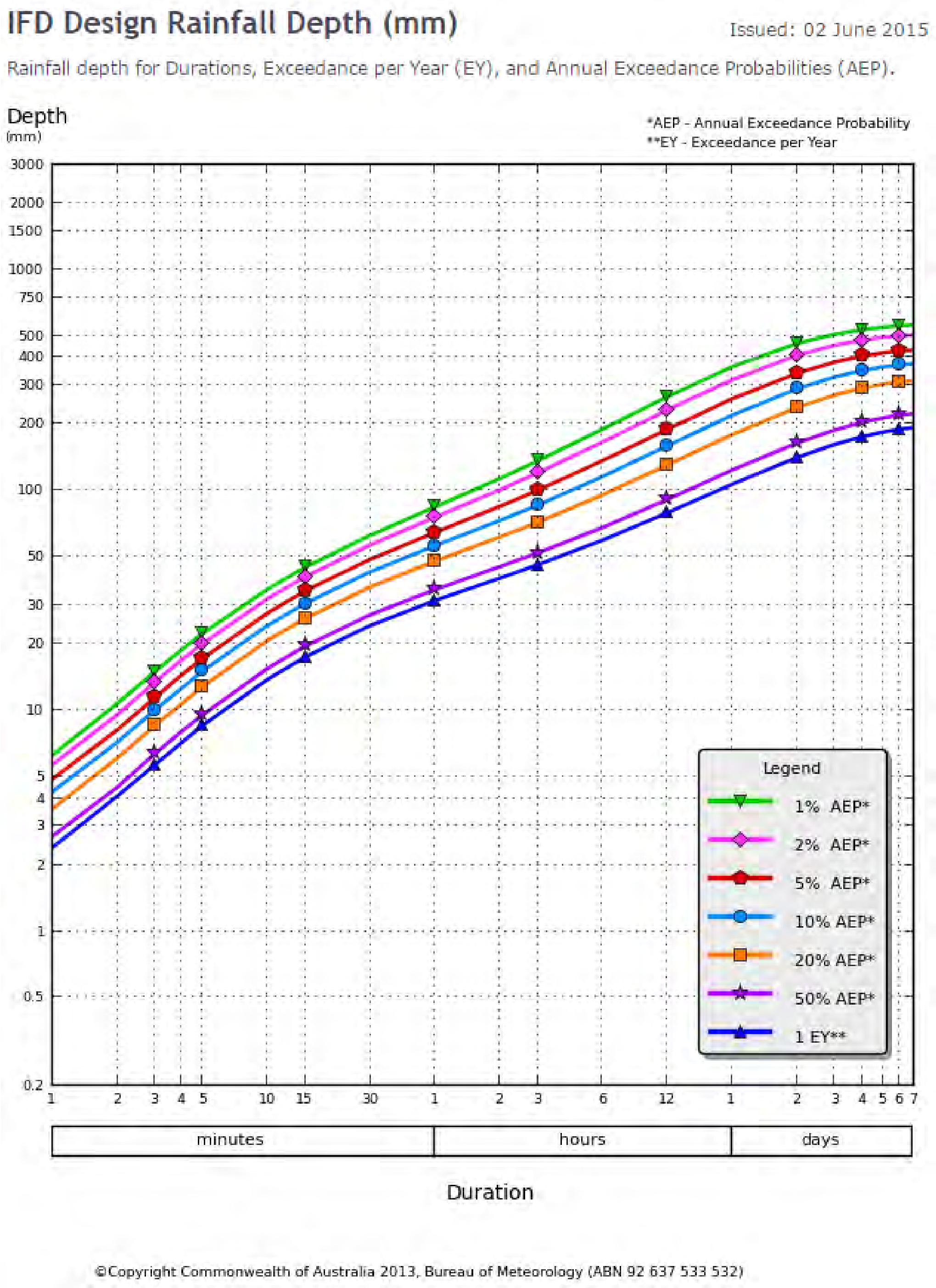


Figure 58: Intensity, frequency, duration analysis of rainfall – Lismore

Source: BOM (2015b)

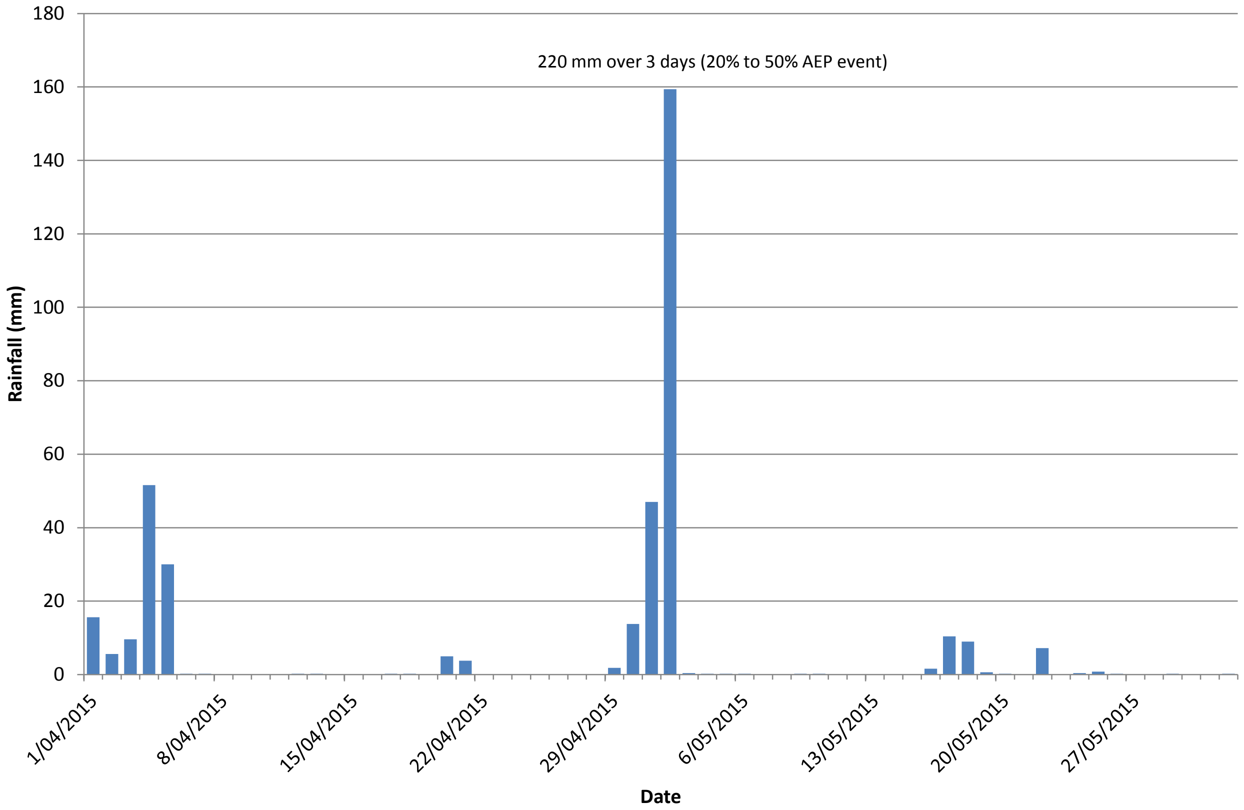


Figure 59: Lismore Airport rainfall data during April-May 2015

Source: BOM (2015b)

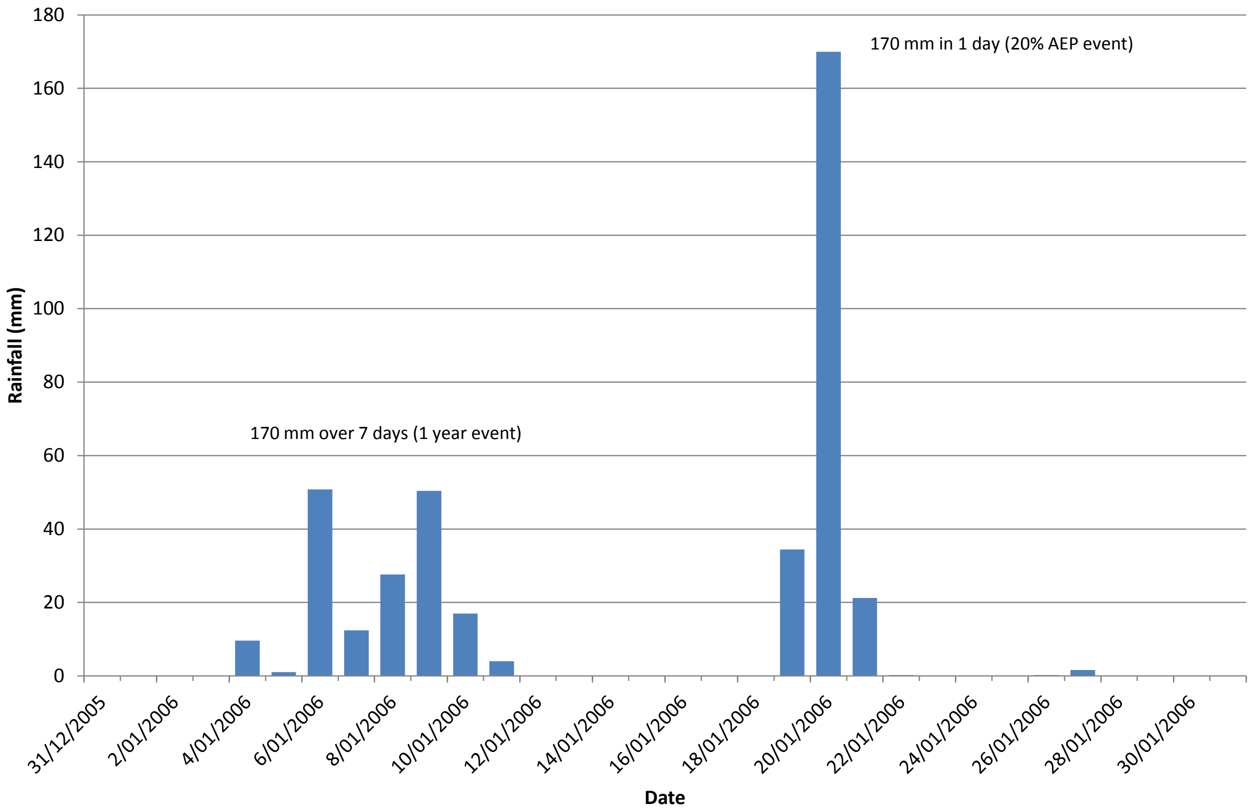


Figure 60: Lismore Airport rainfall data during January 2006

Source: BOM (2015b)

Appendix 2: Water Quality Data – Rous Water

Rous Water – Water Quality Monitoring within Lismore Urban Area

Rous Water monitors water quality at a number of sites in the Wilson River as shown in Figure 61 to assess catchment health and risks to drinking water supply. A comprehensive water quality dataset has been supplied by Rous Water for sites around Lismore spanning the last nine years from 2004 to 2015. Samples are collected weekly at catchment sites and analysed for several parameters. Box plots have been prepared for key water quality indicators for the period of record (Figure 63). The median, minimum, maximum, upper and lower quartiles and outliers are shown on box plots (refer to box plot explanation Figure 62). Water quality objectives for the Richmond River Catchment (OEH, 2015) have also been plotted for a visual assessment of compliance with recommended values for ecosystem health (the median of values at each site is compared to the guideline). Compliance was assessed for a key range of indicators against the objectives for aquatic ecosystem health (pH, turbidity, DO, EC, TN, TP and Chlorophyll a) and human health (*E.coli*).The sites have been ordered from upstream to downstream to provide an overview of spatial trends.

In general the physico-chemical indicators (pH, turbidity, DO and EC) were within recommended guidelines for ecosystem health at all sites. The maximum recommended guideline for median turbidity (50 NTU) was not exceeded at any site over the monitoring period indicating good overall water clarity under average flow conditions. There were occasional high turbidity readings at several sites, indicating the waterways do experience turbid conditions at times and this is likely to be associated with rainfall/runoff events. Similar to what was found in the LCC Waterways monitoring, overall turbidity levels were slightly higher at the sites in Leycester Creek (WR06) and downstream of Lismore CBD (WR01), compared to sites further upstream on the Wilson River. Dissolved oxygen levels were good at all sites with median values of between 8mg/L and 9.5 mg/L. pH fluctuated with some occasional values below pH 6.5 which is considered to be consistent with natural variation. Sites on Leycester Creek and downstream of Lismore showed slightly elevated pH levels on average compared to the upstream sites. Similarly EC showed a greater range of values and typically higher levels at these sites compared to upstream.

Both nutrients (TN and TP) and faecal indicator bacteria (*E.coli*) were in excess of water quality objectives at all sites indicating nutrient and pathogen sources are present in the catchment both upstream and downstream of Lismore, and are having a negative impact on water quality. A similar spatial trend to turbidity was observed for both nutrient and *E.coli* concentrations which were higher at WR06 and WR01 compared to the sites further upstream. Despite elevated nutrient concentrations, median Chlorophyll *a* values were within guidelines for ecosystem health at all sites, indicating that other factors (e.g. good flow regime) is limiting the growth of algae in the main waterways.

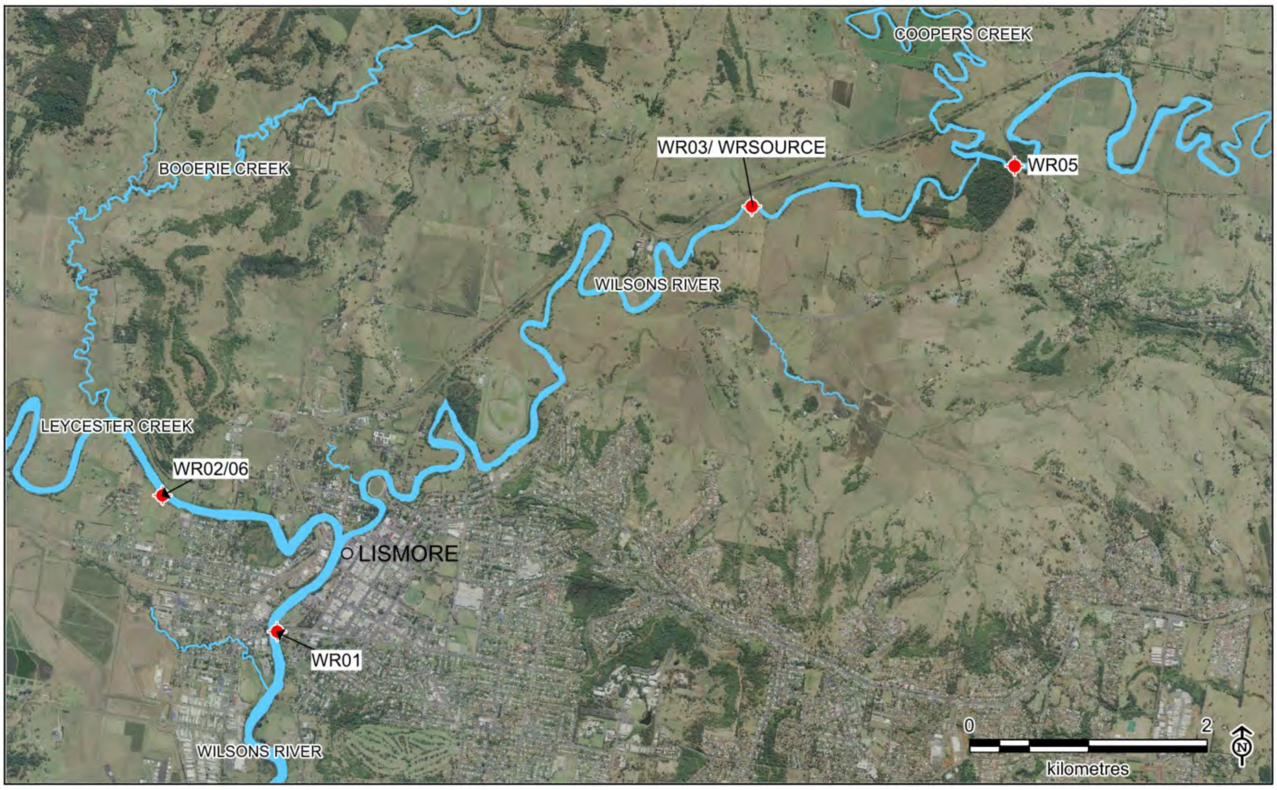


Figure 61: Rous Water monitoring sites

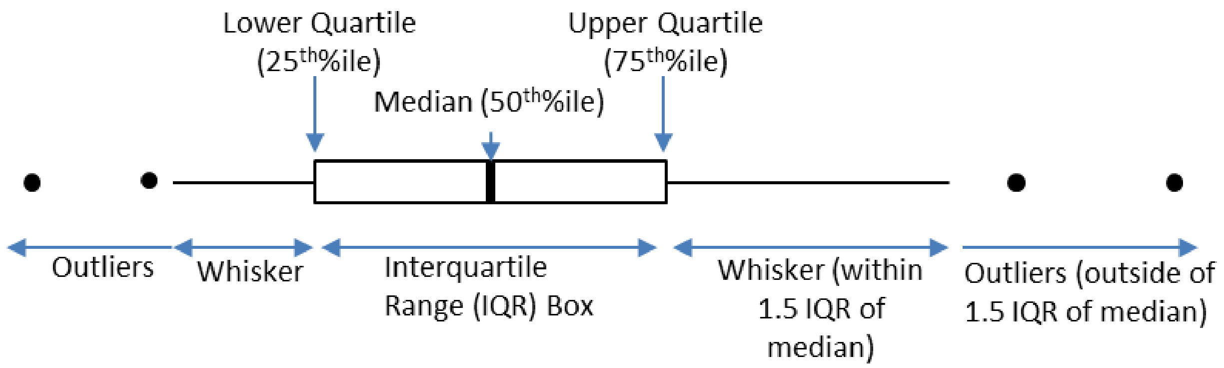
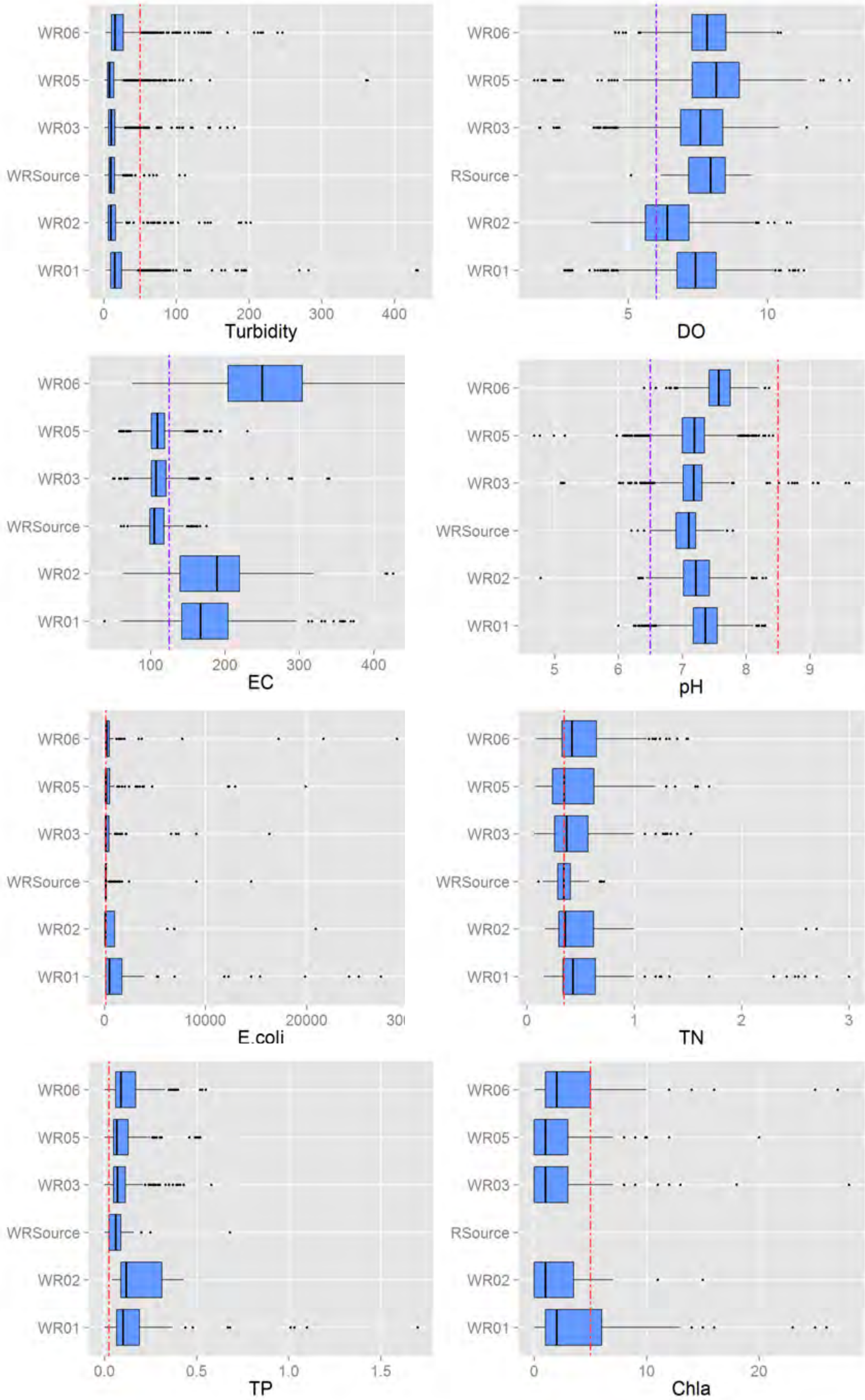


Figure 62: Explanation of box plots



Richmond River Water Quality Objectives (OEH, 2015):

lower guideline limit   upper guideline limit

Figure 63: Box plots for key water quality indicators sampled by Rous Water from 2004-2015

Regression analysis was applied to raw data to identify any statistically significant trends over time. This assessment focused on identifying temporal trends in Chlorophyll *a*, *E.coli*, TN, and TP at WR01. Figure 64 shows the results of this analysis. Water quality variables fluctuated throughout the monitoring period with no long-term temporal trends evident for any of the parameters assessed.

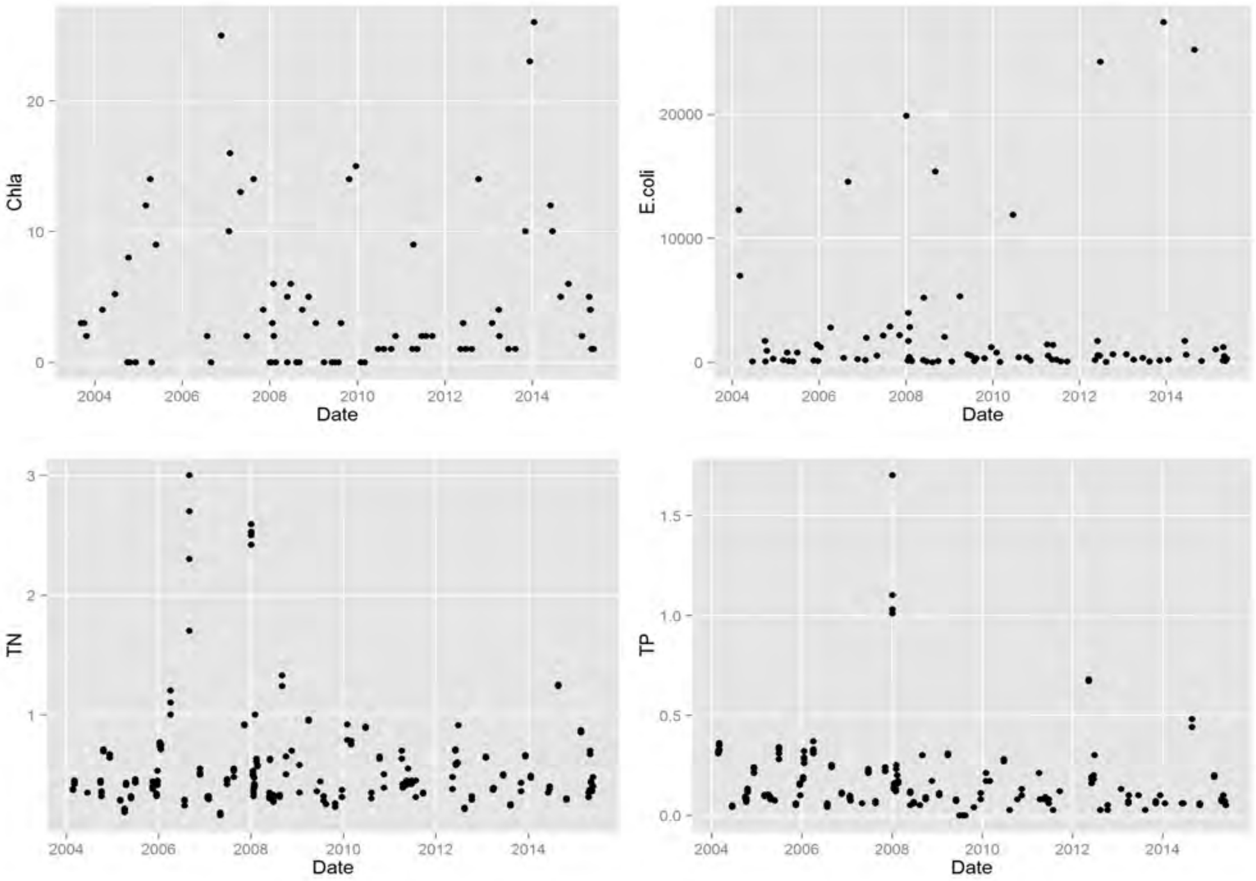


Figure 64: Time series of water quality at site WR01 2004-2015

Appendix 3: Planning Context

National Context

Guidelines prepared as part of the National Water Quality Management Strategy promote nationally consistent approaches to urban stormwater management, based on best practice and the principles of ecologically sustainable development and integrated (or total) catchment management (ANZECC, 2000). The national guidelines recognise the shift of focus from traditional flood management to also include stormwater quality and ecosystem health considerations. The best-practice approaches focus on managing stormwater in the catchment, including Water Sensitive Urban Design (WSUD) approaches but also require consideration of community values, water quality objectives, public health and safety and economic sustainability.

The national WSUD Guidelines (JSCWSC, 2009) provide guidance on evaluating WSUD projects in Australia to promote the uptake of more sustainable urban water management.

Commonwealth legislation relevant to stormwater management includes the *Environment Protection and Biodiversity Conservation (EPBC) Act, 1999*, which provides a legal framework to protect and manage nationally and internationally important flora, fauna, ecological communities and heritage places, defined in the *EPBC Act* as matters of national environmental significance.

Senate Stormwater Enquiry

The Senate Standing Committee on Environment and Communications has commenced an enquiry into stormwater resources in Australia including:

a. the quantum of stormwater resource in Australia and impact and potential of optimal management practices in areas of flooding, environmental impacts, waterway management and water resource planning;

b. the role of scientific advances in improving stormwater management outcomes and integrating these into policy at all levels of government to unlock the full suite of economic benefits;

c. the role of stormwater as a positive contributor to resilient and desirable communities into the future, including 'public good' and productivity outcomes;

d. model frameworks to develop economic and policy incentives for stormwater management;

e. model land use planning and building controls to maximise benefits and minimise impacts in both new and legacy situations;

f. funding models and incentives to support strategic planning and investment in desirable stormwater management, including local prioritisation;

g. asset management and operations to encourage efficient investments and longevity of benefit;

h. the role of innovation in supporting desirable outcomes and transparent decision-making, including access to information and novel technologies for planning, design and implementation; and

i. any related matters.

The Committee is due to report on the enquiry in October 2015.

NSW Context

In 1998 the NSW Environment Protection Authority (EPA) issued a legal direction under section 12 of the *Protection of the Environment Administration Act, 1991* requiring councils to prepare stormwater management plans as part of the State Government Waterways Package. Lismore City Council (LCC or "Council") prepared its Urban Stormwater Management Strategy (USMS) in 2000 and updated it in 2007 (refer Section 6.2.3).

The Stormwater Trust Scheme was implemented in 1997 to support projects that cost-effectively address common issues, knowledge gaps or impediments that councils face while implementing sustainable stormwater practices. Since the Stormwater Trust closed in 2003/04, the State government has prepared guidelines (Managing Urban Stormwater Series) for stormwater managers including stormwater harvesting and reuse, erosion and sediment control on construction sites, stormwater education and environmental management on the urban fringe.

NSW Legislation

The key NSW legislation relevant to urban stormwater management is discussed below.

The *Local Government Act, 1993* gives local councils specific duties regarding natural resource management, land use allocation and development. Councils also have significant planning and development powers as a consent authority under the *Environmental Planning and Assessment Act (EP&A), 1979*. The *EP&A Act* sets out the NSW system of land zoning and future planning through environmental planning instruments. It determines the requirements for development and use consents and gives the relevant authorities rights of enforcement to ensure compliance with the provisions of the Act. The Act also gives councils responsibility for considering conservation of biodiversity through the protection of ecological communities and threatened species through reference to the *Threatened Species Conservation Act, 1995*.

The *Protection of the Environment Operations (POEO) Act 1997* covers all forms of pollution. The EPA is the appropriate regulatory authority for the activities specified in Schedule 1 of the *POEO Act* (scheduled activities). In general, local councils can regulate non-scheduled activities through notice and enforcement powers. However, the EPA can issue a licence to regulate water pollution from a non-scheduled activity. If it does, it becomes the regulator for all environmental impacts from the activity under the *POEO Act* instead of the local council. The legislation also imposes a duty to notify 'relevant authorities' as specified in section 148(8) of the *POEO Act* (the EPA, local authority, Ministry of Health, WorkCover Authority and Fire and Rescue NSW) of pollution incidents where material harm to the environment is caused or threatened.

The *Fisheries Management Act, 1994* aims to conserve, develop and share the fishery resources of the State for the benefit of present and future generations. In relation to stormwater management, the Act provides for the protection of aquatic habitats.

The *Soil Conservation Act, 1938* controls conservation of the soil resources of the State, mitigation of soil erosion and land degradation, and the conservation of water resources.

The *Local Government Act, 1993* was amended in 2005 to allow councils the option to levy a stormwater management service charge on eligible residential or business rateable land for improved stormwater management. This change was made in recognition of councils' key role in stormwater management and their need for a sustainable funding source to support their stormwater services. Councils are now able to fund stormwater management actions which would otherwise be required to be funded from general revenue or loan funded (refer Section 6.4.2).

State Government Policies and Guidelines

Relevant environmental planning instruments under the *Environment Planning and Assessment Act, 1979* are summarised in the following table.

Table 19: State Environmental Planning Policies

Policy	Application to this Plan
North Coast REP, deemed SEPP (1988)	This plan covers all of the North Coast LGAs. It identifies environmental features that are important to the region and provides a basis for new urban and rural development. The plan sets requirements for, and guides, the preparation and processing of local environmental plans and some forms of development.
State and Regional Development SEPP 2011	The State significant assessment system establishes two separate assessment pathways known as State significant development (SSD) and State significant infrastructure (SSI). Projects that fall into these categories are assessed by the Department of Planning and Infrastructure. The SEPP defines which projects come into the system. The SSD assessment system has been established to guide planning decisions on large-scale industrial, resource and other proposals and development in precincts identified as important for the State by the NSW Government.
SEPP 1 (Development Standards) 1980	The aim of SEPP 1 is to provide councils with the flexibility to vary development standards contained within gazetted environmental planning instruments where it can be demonstrated that compliance with the development standard, in the particular circumstances of an individual development application, is unreasonable or unnecessary.
SEPP (Exempt and Complying Development Codes) 2008	Streamlines assessment processes for development that complies with specified development standards. The policy provides exempt and complying development codes that have State-wide application, identifying, in the General Exempt Development Code, types of development that are of minimal environmental impact that may be carried out without the need for development consent; and, in the General Housing Code, types of complying development that may be carried out in accordance with a complying development certificate as defined in the Environmental Planning and Assessment Act 1979.
SEPP No. 4 - Development without Consent and Miscellaneous Complying Development	This policy allows relatively simple or minor changes of land or building use and certain types of development without the need for formal development applications.
SEPP Remediation of Land, 1998	Councils must ensure contaminated land undergoes remediation before it is developed through the application of land remediation guidelines. The appropriate management and remediation of contaminated sites will minimise the risk of contamination of waterways.
SEPP Building Sustainability Index (BASIX), 2004	This SEPP operates in conjunction with Environmental Planning and Assessment Amendment (Building Sustainability Index: BASIX) Regulation 2004 to ensure the effective introduction of BASIX in NSW. The SEPP ensures consistency in the implementation of BASIX throughout the State by overriding competing provisions in other environmental planning instruments and development control plans, and specifying that SEPP 1 does not apply in relation to any development standard arising under BASIX. BASIX was mandatory for regional NSW from 2005/06. All new residential development, as well as residential alterations and additions, are required to meet targets for water and energy efficiency.
SEPP Infrastructure, 2007	Provides a consistent planning regime for infrastructure and the provision of services across NSW, along with providing for consultation with relevant public authorities during the assessment process. The SEPP supports greater flexibility in the location of infrastructure and service facilities along with improved regulatory certainty and efficiency The policy consolidates and updates 20 previous State planning instruments which included infrastructure provisions. It also includes specific planning provisions and development controls for 25 types of infrastructure works or facilities.
SEPP 19 Bushland in Urban Areas, 1986	Protects and preserves bushland within certain urban areas, as part of the natural heritage or for recreational, educational and scientific purposes. The policy is designed to protect bushland in public open space zones and reservations, and to ensure that bush preservation is given a high priority when local environmental plans for urban development are prepared.

NSW Diffuse Source Water Pollution Strategy

The NSW Diffuse Source Water Pollution Strategy provides a framework for coordinating efforts in reducing diffuse source water pollution across NSW. The Strategy promotes partnerships, provides a guide for investment, and provides a means to share information on projects and their outcomes across the State. Developing and implementing this Strategy is a joint initiative by the State's natural resource managers (at State, regional and local government levels), building on and supporting a range of existing diffuse source water pollution management actions.

The main aim of the Strategy is to reduce diffuse source water pollution inputs into all NSW surface and ground water and contribute towards the community agreed NSW water quality objectives and State-wide Natural Resource Management targets listed in the State Plan - A new direction for NSW.

A Priority Action Plan has been developed as part of the NSW Diffuse Source Water Pollution Strategy. It identifies agreed projects that will be progressed across NSW to help improve management of priority diffuse source water pollution problems. The first NSW Diffuse Source Water Pollution Strategy Annual Report was published in November 2010. It reports on the implementation of the individual actions identified it the Priority Action Plan.

Case studies implemented as part of the strategy include retrofitting an existing concrete channel with a GPT upstream of a constructed multi-cell wetland to prevent pollutants being transported to Lake Macquarie and riparian improvements, stormwater treatment and reuse. The strategy can be used to support bids for project funding and to encourage collaboration between organisations to achieve cost efficiencies.

Water Quality and River Flow Objectives

The ANZECC Guidelines for Fresh and Marine Water Quality (2000) provide a framework for conserving ambient water quality in rivers, lakes, estuaries and marine waters. This framework is used to develop water quality and river flow objectives.

The EPA has developed water quality and river flow objectives for the Richmond River Catchment. Each objective aims to improve river health by recognising the importance of natural river flow patterns. Councils are required to consider these environmental values and long-term goals when assessing and managing the likely impact of its activities on waterways.

The objectives were developed in a whole of government process lead by DECCW. Objectives were developed through extensive community consultation and are intended to assist resource managers in assessing and setting targets for environmental values with associated water quality indicators defined by ANZECC.

There are eleven WQOs that provide reference levels to guide water quality planning and management. The objectives consist of three parts, environmental values, their indicators, and their numerical criteria. Environmental values outline values and beneficial uses of the environment that are important to a community. The primary contact recreation environmental value for example, includes swimming or any activity with a likelihood of water being swallowed. The indicators provide a measurement of specific environmental trends while the criteria provide the framework for measuring how close current water quality is to meeting the desired levels.

Floodplain Management Plans

The Floodplain Development Manual published in 2005 was prepared in accordance with the NSW Government's Flood Prone Land Policy. It guides councils in the development and implementation of detailed local floodplain risk management plans to produce robust and effective floodplain risk management outcomes.

The floodplain risk management process consists of the following steps:

- Flood Study: Defines the nature and extent of the flood problem, in technical rather than map form.

- Floodplain Risk Management Study (FRMS): Determines options in consideration of social, ecological and economic factors relating to flood risk.
- Floodplain Risk Management Plan (FRMP): Preferred options publicly exhibited and subject to revision in light of responses. Formally approved by the council after public exhibition and any necessary revisions due to public comments.
- Plan Implementation: Implementation of flood, response and property modification measures (including mitigation works, planning controls, flood warnings, flood readiness and response plans, environmental rehabilitation, ongoing data collection and monitoring) by council.

LCC has prepared a FRMP for Lismore aims to minimise the community's exposure to flood hazard in Lismore's developed areas and ensure that new development is compatible with the flood hazard and does not create additional flooding problems. Controls that apply to new development in the flood-prone urban areas of Lismore are in Chapter 8 of the Lismore DCP.

Richmond River CZMP

The Coastal Zone Management Plan (CZMP) for the Richmond River Estuary provides a ten-year strategic plan for the implementation of key actions to address identified estuary issues. The primary goal is to achieve integrated, balanced, responsible methods to restore and maintain the ecological sustainability of the estuary as well as the recreational and commercial activities associated with it.

The CZMP is the culmination of the coastal zone management process for the Richmond River estuary. The Plan has been developed from the recommendations and outcomes reported in the Richmond River Estuary Management Study (EMS, Volume 2) and is supported by the scientific knowledge from the Estuary Processes Study (Hydrosphere Consulting, 2011).

The CZMP reported that the impact of urban stormwater to overall estuarine water quality is a significant issue for the public and councils. The importance of managing urban stormwater will also become increasingly important as the extent of urban development increases to accommodate the increase in population within the study area.

The reduction of urban pollution such as nutrients and faecal coliforms is consistent with the aims of the estuary management program. The desired outcome of stormwater management actions is on-going improvements in stormwater management resulting in reduction of contaminants transported to the estuary. Tasks include:

- On-going review and update of council stormwater management plans;
- On-going review and update of Development Control Plans and development guidelines;
- Community education;
- Incorporating water sensitive urban design in new developments;
- Retrofitting stormwater/water quality controls to existing urban developments; and
- The State Government BASIX program.

Appendix 4: Morrison Low Review

Morrison Low Review - Clarification of Roles and Responsibilities in Asset Management

In the second half of 2013 a series of workshops were held and facilitated by an external consultant, Morrison Low, to discuss and resolve responsibilities across LCC for the various asset management related tasks that form the basis of sound asset management practice. The approach adopted by Morrison Low was to identify an Asset Owner, Asset Custodian, Service Manager and Asset Maintainer for each asset class. The review found that there are a range of staff across Council with interests in particular asset groups and Council's organisation structure does not easily permit these four roles and their responsibilities to be allocated to the same person/section of Council for different asset classes. The following table shows the section/manager at Council responsible for each role as it has existed to date and the proposed changes to these responsibilities following the workshops facilitated by Morrison Low.

Table 20: Proposed allocation of stormwater management roles and responsibilities

Task	**Currently Responsibility /delegation**	**Proposed Responsibility /delegation**	**Comments**
Asset Owner - Executive Director Infrastructure Services			
Establish long term Policy/Strategy	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Establish future demand for assets (type and standard) – Utilise interdepartmental resources	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Establish long term community expectation – Utilise interdepartmental resources	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Implement Policy/Strategy for existing assets	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Establish community expectation and service outcomes – Utilise interdepartmental resources	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Ensure integration of asset management into Council's community, delivery and operational plans	Manager Assets	Manager Assets	
Asset systems and reporting	Manager Assets	Manager Assets	
Asset accounting	Manager Assets	Manager Assets	
Capital works prioritisation system	Manager Assets	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Asset Custodian – Manager Assets			
Establish existing demand for assets	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality

Task	Currently Responsibility /delegation	Proposed Responsibility /delegation	Comments
Planning for new projects	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Monitor capital works programs	Manager Works/ Manager Integrated Planning	Manager Assets	
Handover and documentation	Manager Works/ Manager Integrated Planning	Manager Assets	
Detailed design	Manager Works/ Manager Integrated Planning	Manager Assets	
Budget oversight	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Commissions improvements	Manager Works/ Manager Integrated Planning	Manager Assets	
Develop asset plans	Manager Assets	Manager Assets	
Specifies service levels (i.e. accessibility, responsiveness, condition rating)	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Asset management data and data collection (condition rating for network) – new maintenance activity	Manager Assets	Manager Assets	
Asset condition rating	Manager Assets	Manager Assets	
Strategic risk management	Manager Assets	Manager Assets	
Data custodian – strategic data	Manager Assets	Manager Assets	
Funding strategies	Manager Works/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	Shared responsibility – quantity vs. quality
Service Manager Accountable for Tasks listed – Manager Integrated Planning/ Manager Assets			
Service delivery	Manager Assets/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	
Manages all service delivery functions	Manager Assets/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	
Manages service user expectations	Manager Assets/ Manager Integrated Planning	Manager Assets/ Manager Integrated Planning	
Asset Maintainer Accountable for Tasks listed – Manager Works			
Controls asset use in line with policy	Manager Works/ Manager Integrated Planning	Manager Works	
Deliver programmed and reactive maintenance	Manager Works/ Manager Integrated Planning	Manager Works	

Task	Currently Responsibility /delegation	Proposed Responsibility /delegation	Comments
Use Internal/ external resources to deliver projects and services	Manager Works/ Manager Integrated Planning	Manager Works	
Risk management	Manager Works/ Manager Integrated Planning	Manager Works	
Recommendation of asset disposal and renewal, i.e. resurfacing, resealing programs	Manager Works/ Manager Integrated Planning	Manager Works	

Source: LCC (2015d)

The recommendations of the review relating to stormwater management and their current status are:

- The USMP working group consisting of internal stakeholders will oversee this review of the 2007 USMP taking into consideration water quality and quantity concerns, customer requests, and asset sustainability considerations;
- The USMP will assist Council to establish long term policy/strategy, establish existing and future demand for assets, develop a capital works prioritisation system, identify funding strategies and establish a process for planning of new projects;
- A process for handover and as-constructed documentation for new or upgraded assets, including donated assets will be established;
- All capital budgets and reporting requirements to be transferred from works and environmental teams to assets team. Discussion is required on how the budget is managed and who has overall responsibility. Current shared responsibility will create issues in the longer term;
- The Assets Team will undertake and coordinate all investigation, design and other pre-construction activities for capital projects with relevant input from Environmental Strategies staff;
- Service levels (i.e. accessibility, responsiveness, condition rating) to be specified;
- Risk management processes will be incorporated into operations; and

Asset disposal and renewal requirements to be reported to asset/owner/custodian as required.

Appendix 5: Browns Creek Master Plan

Browns Creek was once a large wetland covering what is now Lismore Park which provided habitat to wading birds. It was filled and raised while the tributaries were concreted and straightened (Figure 65). Browns Creek is the largest of the fully urbanised creek catchments in Lismore, measuring 460 ha. The catchment collects stormwater from the residential areas of Lismore Heights and East Lismore and culminates in a 900m concrete channel running through Lismore Park, before entering the Wilsons River at the Browns Creek pump station (refer Section 4, Stormwater Management Area 11).

Figure 65: Browns Creek precincts

Source: Storm Consulting *et al.* (2012)

The poor quality of the urban stormwater which passes through this channel has previously been identified as a major pollutant of the Wilsons River (refer Section 2.6). The primary goal of this project is water quality improvement. A water 'treatment train' is proposed within the creek as part of 'naturalisation' of the creek through the replacement of the open channel.

During the development of Council's 2011-2021 Sport and Recreation Plan an upgrade of Lismore Park was identified as a high priority for recreation development within the City. To support the redevelopment of the park the Sport and Recreation Plan also recommended that, to the extent possible, the concept planning for storm water improvements at Browns Creek incorporates recreational elements in the design.

A Master Plan (Storm Consulting *et. al.*, 2012) was prepared for the naturalisation of Browns Creek through Lismore Park including integration of the creek with the surrounding parkland and land uses. The intent is to create a destination park with the naturalised Browns Creek as a centrepiece feature and which is surrounded by and integrated with a range of new passive recreation opportunities to balance the already strong active recreation activities within Lismore Park. The vision for the Browns Creek Lismore Park Master Plan is to:

- Utilise the waterway in an innovative fashion to produce substantial environmental and recreational improvements while recognising and responding to the necessary hydraulic function of the creek;
- Demonstrate creativity in sustainable use and management;
- Create a destination park that is different and exciting – a place for people of all ages to relax, play, socialise or be active;
- Provide a showcase for educational outcomes in terms of environment, recreation, sustainability and hydraulic engineering; and
- Provide pedestrian and cycle connections that contribute to greater and safer access and mobility within central Lismore.

The draft of the Master Plan was endorsed by Council and went on exhibition in April 2013. There was an overwhelming positive response to the idea of creating a destination park in the centre of Lismore with the majority of elements within the plan being well supported. Community consultation continued during the exhibition period and an additional review of the Browns Creek (stormwater treatment) component of the plan was conducted by a working party of local stormwater specialists. This review recommended removal of stormwater treatment ponds in Precinct 1 (Blair and Humbley Ponds) due to safety concerns and limited treatment value and inclusion of additional treatment in Precinct 2. The revised stormwater treatment system for Browns Creek incorporates:

- Primary Treatment – removal of 100% gross pollutants (>1mm) using Gross Pollutants Traps on the upper reaches of both channels entering Lismore Park;
- Secondary Treatment – removal of heavy sediment and nutrients using a sediment pond behind the netball courts and an additional sediment pond on the channel that runs along Magellan Street (both in Precinct 2).
- Tertiary Treatment – removal of fine sediments and nutrients by converting the concrete channel within Precinct 1 to a naturalised creek and incorporating ephemeral wetlands imitating what would have originally existed on the site.

The Master Plan and stormwater concept are shown on Figure 66 and Figure 67.

The proposed design aims to maintain or improve the hydraulic capacity of Browns Creek and does not intend to modify existing flood regimes, but operate within them. It is likely that the hydraulic capacity of Browns Creek will improve as an outcome of the naturalisation process, because the channel will be made wider than the existing concrete channel. The installation of gross pollutant traps in the upper reaches of the park (Precinct 2) will also trap litter and reduce the risk of litter blocking the pump station on the levee wall (LCC, 2013).

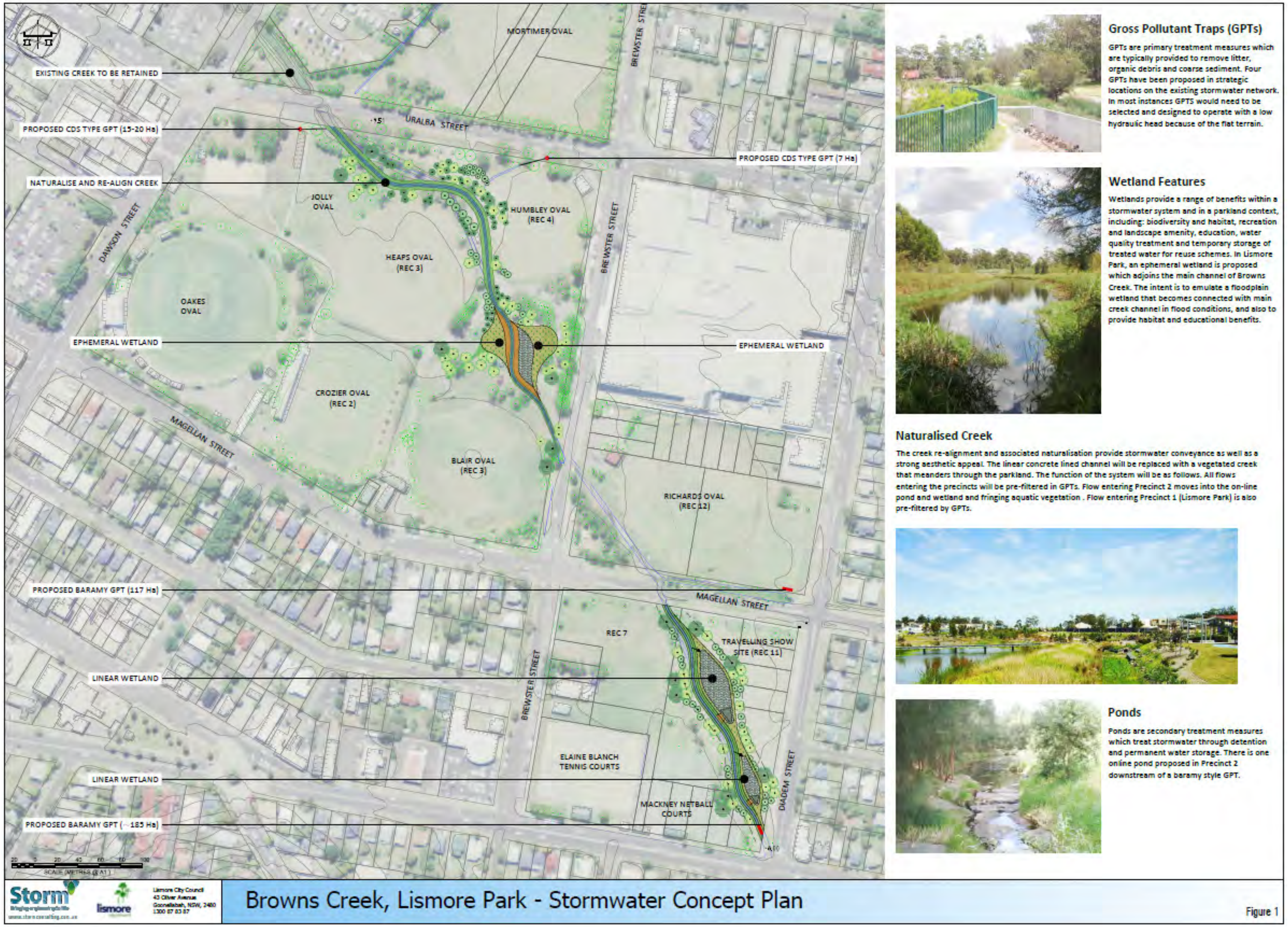


Figure 66: Revised stormwater concept plan – Browns Creek

Figure 67: Adopted Browns Creek Master Plan

The development of Lismore Park is a key component of revitalising the Central Business District (CBD) (Community Vision #10 in the Delivery Plan). The project is also a key objective of Council's Sports and Recreation Plan (2012) which appears in Imagine Lismore.

The cost estimate developed by Council for the stormwater management components (based on the draft Master Plan, excluding Blair and Humbly Ponds) is summarised in the following table.

Table 21: Budget cost estimate – Browns Creek stormwater improvements (2015$)

Item	**Cost**
Precinct 1 Drainage	
Site preparation	78,000
GPT (East Uralba Street)	125,000
GPT (West Uralba Street)	73,000
Stormwater drainage	31,000
Landscaping	11,000
Weir pool and riffle zones	63,000
Ephemeral wetlands	229,000
Total Precinct 1 Drainage	*610,000*
Precinct 2 Drainage	
GPTs (Diadem and Magellan Street)	417,000
Linear wetland	122,000
Total Precinct 2 Drainage	*539,000*
Contingency (20%)	230,000
Total Budget Estimate	*1,379,000*

The remaining components of the Master Plan relating to recreational facilities would be constructed over 4 stages with a total cost of $4.95 million.

Start-up funding for the stormwater treatment system (generated through the annual Stormwater Management Service (SMS) charge) is currently being held in reserves. Maintenance costs associated with the stormwater treatment system would also be wholly covered by the SMS charge. These have been estimated to be $50,000 in the first 2 years following construction, reducing to $20,000 once earthworks stabilise and vegetation becomes established (LCC, 2013). Funding for the recreational components has not yet been identified.

At the Council meeting 13 August 2013, Council resolved to adopt the revised Lismore Park/ Browns Creek Concept Master Plan to ensure its readiness for future funding opportunities.

Appendix 6: Agency Consultation

From: Patrick Dwyer
To: Katie Pratt
Subject: Re: Lismore Urban Stormwater Management Plan
Date: Tuesday, 9 June 2015 12:30:05 PM

Dear Katie

Thanks for your email. Fisheries NSW is responsible for ensuring that fish stocks are conserved and that there is "no net loss" of key fish habitats upon which they depend. To achieve this, the Aquaculture and Aquatic Ecosystems Unit assesses activities under Part 5 of the *Environmental Planning and Assessment Act* 1979 in accordance with the objectives of the *Fisheries Management Act* 1994, the aquatic habitat protection and threatened species conservation provisions in Parts 7 and 7A of the Act, and the *Policy and Guidelines for Fish Habitat Conservation and Management (2013 Update)*. In addition Fisheries NSW is responsible for ensuring the sustainable management of commercial, quality recreational fishing and viable aquaculture within NSW.

The Department's policy and guidelines (available at: www.dpi.nsw.gov.au/fisheries/habitat/protecting-habitats/toolkit) outline the areas that have been identified as Key Fish Habitats and outlines policies and guidelines for the protection of these habitats and the information requirements proponents need to fulfill to enable assessments of proposals.

With specific regard to Lismore City Council's Urban Stormwater Management Plan water sensitive urban design is supported contingent upon ensuring that those features are appropriately sited to provide treatment prior to entry into waterways mapped as Key Fish Habitats.

Sincerely

PAT

Patrick Dwyer | Regional Assessment Officer (North)|
Aquaculture & Aquatic Environment **|** Primary Industries NSW
T 02 6626 1397 | F 02 6626 1377 | M 0407 264 391 | E patrick.dwyer@dpi.nsw.gov.au
W: www.industry.nsw.gov.au | www.dpi.nsw.gov.au
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PERMIT APPLICATION FORMS & FISH HABITAT POLICIES AVAILABLE AT:
www.dpi.nsw.gov.au/fisheries/habitat/protecting-habitats/toolkit

Submit permit applications via email to: ahp.central@dpi.nsw.gov.au

NB from date of receipt of application please allow:
- 28 days for Permits, Consultations and Land Owner's Consent responses
- 40 days for Integrated Development Applications

On 27 May 2015 at 14:16, Katie Pratt <katie.pratt@hydrosphere.com.au> wrote:

> Dear Pat,
>
> As discussed, Lismore City Council has engaged Hydrosphere Consulting to review and update its urban stormwater management plan. As part of the development of the plan, the project team will consider stakeholder views on urban stormwater management issues and areas for improvement. Council aims to improve the performance and sustainability of Lismore City's urban stormwater infrastructure and to protect the health of the waterways now and

into the future. The aim is to deliver the greatest benefit to the community at least cost.

You are invited to provide input into the development of the plan by raising any issues or areas for improvement you are aware of in relation to stormwater. Note that the study area incorporates Lismore City urban areas only and does not extend to other urban areas in the Lismore LGA (i.e. villages and towns).

Please provide your response by reply email by the end of June 2015.

Thank you for your time.

Regards,

Katie Pratt

Environmental Scientist
Hydrosphere Consulting

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Mob: 0437 018 709

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Robyn Campbell

From:	Anthony Acret <Anthony.Acret@rouswater.nsw.gov.au>
Sent:	Friday, 17 July 2015 4:45 PM
To:	Katie Pratt
Cc:	Records
Subject:	RE: Lismore Urban Stormwater Management Plan review/update
Attachments:	08052.1 v2_Final_Report_dark logo.pdf; Rous Water Draft DCP_Final_dark logo.pdf

[File = 1714]

Hi Katie

Thank you for your email requesting Rous Water's input to Lismore City Council's *Urban Stormwater Management Plan* (USMP).

Rous Water understands the objectives and scope of the review, which is aimed at updating the 2007 USMP with a focus on the 2015-2025 period.

The area that is the subject of the USMP i.e. the urban areas of Lismore are largely located within the Wilsons River catchment, as shown in the *Drinking Water Catchments Map* that forms part of the Lismore Local Environment Plan (LEP) 2012. Rous Water is committed to providing quality drinking water to the region and therefore welcomes the opportunity to be involved in review of this important management plan so as to minimise the risk posed to the public water supply arising from this source.

Rous Water's comments address the following areas:

(i) Broad context of the USMP
(ii) Comments on the 2007 USMP
(iii) Stormwater objectives for drinking water supply protection
(iv) Development control provisions/links
(v) Other

Details are provided below.

1. CONTEXT

1.1 General

Rous Water extracts water from the Wilsons River at Howards Grass near Lismore for the purposes of providing the bulk urban water supply for this region.

One of the key sources of catchment risk for the Wilsons River source relates to urban stormwater impacts. Urban landuses in the Wilsons River catchment currently represent approximately 2.2% of the catchment area, and yet account for over 12% of the annual suspended solids load (Ecos, 2009).

Whilst the majority of Lismore's urban stormwater catchments discharge into the mapped drinking water catchment area, of particular significance is the Lagoon Creek sub-catchment. As Lagoon Creek discharges to the Wilsons River within 300 m of the water offtake, the quantity and quality of stormwater delivered from the Lagoon Creek sub-catchment can have a significant influence on the quality of the raw water extracted for regional water supply purposes. Other subcatchments of particular sensitivity due to the proximity to the source include Brunswick Street, Howards Grass and Boatharbour.

Nevertheless, Rous Water is concerned to ensure that the water quality and catchment health outcomes from all urban areas within subcatchments draining to the Wilsons River catchment are consistent with the drinking water catchment values of this location.

1.2 Planning context

Whilst it is recognised that the current project involves renewal of Lismore's Urban Stormwater Management Plan (USMP), a key aspect of managing stormwater within the urban areas of Lismore City involves planning and development controls and provisions. These provisions, and the way in which they relate to the USMP need to be considered as part of the USMP renewal.

It is noted that the majority of the area being considered as part of the USMP is located within the Wilsons River drinking water catchment area, as designated in the mapping included in the *Lismore Local Environmental Plan 2012*.

Of key significance is the clause in the Lismore LEP that addresses the issue of development control in water supply catchments: Clause 6.4 of the *Lismore Local Environmental Plan 2012* was established *"to protect drinking water catchments by minimising the adverse impacts of development on the quality and quantity of water"*:

It is therefore important that the requirements of Clause 6.4 be addressed early in the design process for any significant development that is proposed. Clause 6.4 is as follows:

6.4 Drinking water catchments

(1) The objective of this clause is to protect drinking water catchments by minimising the adverse impacts of development on the quality and quantity of water entering drinking water storages.

(2) This clause applies to land identified as "Drinking water catchment" on the Drinking Water Catchment Map.

(3) Before determining a development application for development on land to which this clause applies, the consent authority must consider the following:

- (a) whether the development is likely to have any adverse impact on the quality and quantity of water entering the drinking water storage, having regard to the following:
  - (i) the distance between the development and any waterway that feeds into the drinking water storage,
  - (ii) the on-site use, storage and disposal of any chemicals on the land,
  - (iii) the treatment, storage and disposal of waste water and solid waste generated or used by the development,
- (b) any appropriate measures proposed to avoid, minimise or mitigate the impacts of the development.

> (4) Development consent must not be granted to development on land to which this clause applies unless the consent authority is satisfied that:
>
> (a) the development is designed, sited and will be managed to avoid any significant adverse impact on water quality and flows, or
>
> (b) if that impact cannot be reasonably avoided—the development is designed, sited and will be managed to minimise that impact, or
>
> (c) if that impact cannot be minimised—the development will be managed to mitigate that impact.

1.3 Relevant Rous Water documentation – Rous Water Development Control Plan

In order to assist Lismore City Council (LCC) and consultants/developers to meet this clause (Clause 6.4) in designated water catchment areas, Rous Water has previously provided guidance to LCC that clearly establishes the requirements of Rous Water in relation to significant developments in drinking water catchment areas such as residential subdivisions and associated development and assessment processes – and this is applicable and needs to be included or cross-referenced in the USMP. This includes the following documentation:

(i) ***Development Control in the Rous Water Supply Catchment Areas*:** This report addresses key issues of significance for our regional water supply catchments including development guidelines and implementation protocols.

(ii) ***Development Control Plan for Development within the Rous Water Catchments:*** This report provides guidance to consultants and developers in preparing urban and rural residential subdivision designs and other forms of development, and to Council in its assessment of such developments. The document also identifies a range of water sensitive planning and development principles, practices and solutions that are consistent with the requirements for achieving sustainable catchment health outcomes while still achieving a *Neutral or Beneficial Effect on Water Quality (NorBE).*

A copy of these documents is attached for your information.

It is noted that LCC has previously committed to complying with such a systematic approach to development assessment within drinking water catchment areas through the *Water Supply Agreement* established between Rous Water and its Constituent Councils (including LCC) in June 2014.

Therefore, a key issue of concern for Rous Water with respect to urban stormwater management is to establish a planning process that ensures that outcomes from development are clearly consistent with the drinking water catchment status of the development, and so that the requirements of Rous Water can be systematically addressed and demonstrated by the proponents as part of rezoning and/or development processes.

1.4 Relevant Rous Water documentation - the Wilsons River Catchment Management Plan

In recognition of the threat posed by runoff from urban areas, the Wilsons River Catchment Management Plan established an Urban Land Management Program, the goals of which included:

Appropriate water sensitive planning and development across all urban and rural residential zones, including density controls and environmental constraints mapping.

Minimise adverse impacts on waterways through continuous improvement in stormwater and recycled water discharge quality and reduction in contaminants.

Key elements within this program included the following elements that are of relevance to Lismore's USMP:

- Raise awareness amongst catchment residents, government agencies, emergency services and local businesses that they are living in a water supply catchment.
- Rous Water to be involved in the preparation and review of Local Environment Plans (LEP's) and Development Control Plans (DCP's), and major development projects.
- Investigate stormwater run-off as a source of water for irrigation and other uses.
- Investigate the reason for high *E. coli* counts and nitrogen concentrations in Wilsons River at Ballina Street.
- Encourage better drainage at road/waterway crossings (*links to Road Management Program*).
- Encourage use of Water Sensitive Urban Design (WSUD) in urban areas.

Accordingly, Rous Water has an interest in pursuing these actions and is therefore an interested stakeholder and partner in the renewal of Lismore's USMP.

2. COMMENTS ON THE 2007 USMP

Rous Water recognises that it is the intention of LCC to develop a USMP that address both water quality and quantity issues. Whilst recognising the need to address both of these (and other) aspects of stormwater management, and the need for an implementation schedule matched with current LCC requirements, Rous Water considers that the 2007 USMP still provides an excellent coverage of stormwater issues, much of which remains relevant. Clearly Rous Water has a strong interest in water quality issues and so would like to see water quality remain a key focus in the plan renewal. Accordingly, it may be appropriate that components of the current plan be retained in some form.

3. STORMWATER OBJECTIVES

Whilst it is understood that you have requested comments on the USMP, due to the linkages, this means that there also needs to be some consideration of Development Control Plan (DCP) (Chapter 22 – Water Sensitive Urban Design).

In both the USMP and Chapter 22 of the DCP, Rous Water considers that there needs to be a strong emphasis on defining prescriptive stormwater objectives.

The 2007 USMP includes a wide range of objectives and cross-references to development control plans for quantitative objectives. The majority of these are supported.

However Table 1 of the LCC Development Control Plan (DCP) (Chapter 22 – Water Sensitive Urban Design) lists water sensitive performance criteria for major development and subdivisions.

Comparisons to the baseline scenario not supported

Under the LCC DCP, a comparison is made of the outcomes from proposed stormwater management measures associated with a development proposal to the 'baseline scenario'. The 'baseline scenario' is defined in the Chapter 22 of the Lismore DCP *as "outcomes from a development scenario where no water sensitive design measures are implemented to improve or mitigate potential impacts of the development. The baseline is the "do nothing" or "business as usual" scenario.*

Rous Water does not consider this approach appropriate for the catchment context of the majority of major developments or subdivisions. The reason for this is that it is still possible for developments to satisfy these DCP requirements, and yet still provide for deterioration in stormwater quality.

Although it is recognized that in such circumstances any proposed treatment train would have a beneficial result when compared to undertaking the development with no treatment train, it is not clear in such an approach as to whether proposed developments or treatment trains can be considered to have a neutral or beneficial impact upon storm water quality when applied to the existing landuse. The only situation where Rous Water would consider that the baseline approach may be appropriate is where there is a urban renewal of a very degraded site, where %reductions of contamination loading compared to the 'do nothing' baseline would deliver a higher standard of mitigation than the neutral or beneficial test.

Neutral or beneficial test for water quality supported

Whilst Lismore's DCP aims to ensure that water sensitive urban design measures are integrated into new development, it must be recognized that it is not the purpose of this DCP to seek to protect water quality for the purpose of drinking water supply purposes.

However in the mapped drinking water catchment under the LEP, it would seem appropriate that a higher standard should apply.

Rous Water considers that for major development and subdivisions, that in order to demonstrate that the development is "sited and will be managed to avoid any significant adverse impact on water quality and flows" (as required by Clause 6.4 of the *Lismore Local Environmental Plan 2012*), then a <u>'neutral or beneficial effect on water quality' approach and assessment criteria should be applied</u> to significant developments being undertaken within drinking water catchment areas. As stated in the Rous Water DCP documentation:

> *"An issue of concern for Rous Water is that it is possible to achieve stormwater management objectives contained in relevant local and State Government policy documents and yet still provide for deterioration in stormwater quality. Specifically, Rous Water has had situations where development proposals have demonstrated compliance with relevant local and State Government stormwater management objectives and policy documents yet still result in an increase in pollutant loading of key contaminants of concern.*
>
> *Therefore, whilst Rous Water recognises that it may be possible to demonstrate that a certain development proposal (incorporating a stormwater treatment train) will have a beneficial result when compared to undertaking the development with no treatment train, Rous Water does not consider that this meets the requirement to have a neutral or beneficial impact upon storm water quality when applied to the existing landuse.*
>
> *In a working catchment, additional development, of even a modest scale, may be considered to represent an unacceptable incremental risk if the development cannot demonstrate direct or indirect net equality or reduction in risk from the perspective of the water supply and/or other environmental values.*
>
> *Rous Water requires proponents of development to undertake stormwater modelling of the proposed stormwater management approach in order to demonstrate that a 'neutral or beneficial effect' can be achieved in relation to surface water quality."*

In order to demonstrate that urban development projects achieve a neutral or beneficial effect on water quality, the quality of runoff from the pre-development site should be compared with that from the post-development site including proposed stormwater treatment measures (such as water sensitive design elements) that may be needed to mitigate pollutant loads and concentrations resulting from the proposed land use change.

Rous Water considers that the Wilsons River catchment, being a compromised catchment, additional development, albeit potentially small, may be considered to represent an unacceptable incremental risk if the development does not demonstrate direct or indirect net equality or reduction in risk from the perspective of the water supply and/or other environmental values.

Stormwater modelling for urban development projects should be required to demonstrate that there would be no deterioration of stormwater quality arising from development.

Rous Water recommends that in renewing the USMP, that a 'neutral or beneficial effect on water quality' test be applied to any proposed stormwater management approach. This is consistent with Clause 6.4 of the LEP which requires Council to consider "whether the development is likely to have any adverse impact on the quality and quantity of water."

Rous Water requests that consultants prepare MUSIC stormwater quality models to help achieve a neutral or beneficial effect on water quality. MUSIC stands for 'Model for Urban Stormwater Improvement Conceptualisation', which is a decision support system for simulating the performance of stormwater management measures. In order to satisfy this requirement, Rous Water requests that this be undertaken in accordance with the guideline entitled *Using MUSIC in Sydney's Drinking Water Catchment* prepared by the Sydney Catchment Authority, and available at the following link:

http://www.sca.nsw.gov.au/catchment/development

Specifically, the criteria listed in Section 2.4.2 of the abovementioned guide should be addressed so that the proponents/developments can be demonstrated to have a neutral or beneficial effect on water quality.

4. OTHER ROUS WATER ISSUES OF CONCERN

Very broadly, Rous Water considers it critical that the USMP provide for an integrated approach to the management of stormwater that:

(i) protects and enhances the drinking water catchment values of receiving waters;
(ii) requires the application of water sensitive urban design principles;
(iii) maximises the use of natural waterway corridors and natural channel design principles;
(iv) achieves a neutral or beneficial effect on water quality; and
(v) prevents the discharge of sediment laden stormwater direct to surface waters.

5. CONCLUSION

The *Public Health Act 2010* requires Rous Water to maintain a quality assurance program that is consistent with the Framework for the Management of Drinking Water Quality (as set out in the *Australian Drinking Water Guidelines*). As part of Rous Water's approach to these requirements, Rous Water needs to be satisfied that major urban development undertaken within water catchment areas is consistent with water catchment values and does not pose a risk to drinking water quality or catchment health/biodiversity values.

The scope of the USMP clearly applies to lands set within the Wilsons River drinking water catchment area (as mapped in the *Lismore Local Environmental Plan 2012)*. Therefore, in order to demonstrate compliance with contemporary standards for urban development in drinking water catchment areas as well as the water catchments clause in the *Lismore Local Environmental Plan 2012*, it is requested that the issues described above be considered in the scope of the USMP.

Thank you for the opportunity to detail these important issues of concern to Rous Water. Should you require any further information regarding this submission or should you wish to discuss the issues raised further, please contact Anthony Acret on (02) 6621 8055.

Best regards,

Anthony Acret
Catchment Assets Manager
[File = 1714]

Anthony Acret
Catchment Assets Manager
Rous Water
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LISMORE NSW 2480
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From: Katie Pratt [mailto:katie.pratt@hydrosphere.com.au]
Sent: Thursday, 28 May 2015 10:26 AM
To: Anthony Acret <Anthony.Acret@rouswater.nsw.gov.au>
Subject: Lismore Urban Stormwater Management Plan review/update

Anthony,

Thanks for taking time to speak with me today.

As discussed Lismore City Council has engaged Hydrosphere Consulting to review and update its urban stormwater management plan. As part of the development of the plan, the project team will consider stakeholder views on urban stormwater management issues and areas for improvement. Council aims to improve the performance and sustainability of Lismore City's urban stormwater infrastructure and to protect the health of the waterways now and into the future. The aim is to deliver the greatest benefit to the community at least cost.

You are invited to provide input into the development of the plan by raising any issues or areas for improvement you are aware of in relation to stormwater. Note that the study area incorporates Lismore City urban areas only and does not extend to other urban areas in the Lismore LGA (i.e. villages and towns).

We would appreciate if you could provide your response by reply email by the end of June 2015.

Thank you for your time.

Regards,

Katie Pratt
Environmental Scientist
Hydrosphere Consulting

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PO Box 7059
Ballina NSW 2478
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Appendix 7: Site-Based Issues Prioritisation Matrix

3	High risk	Lismore USMP - Issues Prioritisation Matrix	MA 4,5,6,7,8	High	9-24
2	Medium risk		MA 1,2,11	Medium	7-8
1	Low risk		MA 12, 13, 14, 15,16	Low	0-6
0	No risk		MA 3,9,10		

ID	Management Area	Issue Category	Details	Location	Goals and Objectives								Score
				Overall Goal of USMP	***Reduce the occurrence of localised flooding to protect public and private property***				***Improve the quality of urban runoff in order to protect the natural, ecological and aesthetic values of Lismore's waterways.***		***Minimise adverse impacts of stormwater runoff within the Wilsons River Source drinking water catchment***	***Incorporate opportunities to enhance the recreational opportunities and amenity of Lismore's urban area, particularly the CBD and Wilsons riverbank***	
				Risks	**Risk to public safety**	**Risk to private property**	**Risk to public infrastructure**	**Nuisance flooding**	**Poor quality of urban stormwater**	**Degradation of high value ecology/sensitive receiving environments**	**Risk to Wilsons River Source drinking water catchment**	**Risk to amenity of high usage areas**	
				Principles	*3. Ensure stormwater and its associated drainage systems are planned, designed and managed with appropriate consideration and protection of community health and safety standards, including potential impacts on pedestrian and vehicular traffic*	*2. Limit flooding of public and private property to acceptable or designated levels*			*1. Protect and/or enhance downstream environments, including recognised social, environmental and economic values, by appropriately managing the quality and quantity of stormwater runoff.* *4 - Adopt and promote water sensitive design principles, including appropriately managing stormwater as an integral part of the total water cycle, protecting natural features and ecological processes within urban waterways*			*5. Appropriately integrate stormwater systems into the natural and built environments while optimising the potential uses of drainage corridors.* *6. Enhance community awareness of, and participation in, the appropriate management of stormwater*	
				Considerations	*drowning, pathogens, traffic, entrapment, mosquitoes*	*Flooding, damage to driveways*	*Damage to roads*	*Minimise standing water*	*Provide treatment infrastructure in catchments where none currently. Addresses known water quality issues*	*Tucki Tucki KFH*	*Distance from extraction point and proximity to Wilsons River*	*Maintain integrity of road verges, roadside parking, minimise traffic, pedestrian disruptions*	
I1	11 Browns Creek	Poor water quality	Poor water quality in Browns Creek, localised flooding	Browns Creek	The existing open channels provide a risk of traffic/pedestrian accident or drowning during wet weather when drains are full. Sewer overflows are located in the channel. The channels are not fenced. 3	Currently overtopping of this section of the channel does not impact private property. 0	Currently overtopping of this section of the channel does not impact Council infrastructure. There is a risk of litter blocking the culvert under Brewster Street bridge and the pump station on the levee wall. 2	Flooding and water logging in the park areas occurs with high rainfall 3	Stormwater runoff in Browns Creek is a high contributor of nutrient loads. There are no other treatment devices within the Browns Creek catchment upstream of Lismore Park. 3	No impact on high value ecology 0	Browns Creek flows into the Wilsons River downstream of the Wilsons River source extraction point. 2	This is a high usage recreation area with low amenity. 3	**16**
I2	9 Tucki Tucki	Gross pollutants	Gross pollutants entering Tucki Tucki Creek	Gordon Blair Drive channel	No risk 0	No risk 0	No risk 0	No risk 0	This catchment is a significant source of gross pollutants which currently discharge into Tucki Tucki creek. 2	Tucki Tucki creek is mapped as key fish habitat with high aquatic habitat value 3	No risk 0	Litter contributes to poor amenity but this is not a high usage area 1	**6**
I3	15 South Lismore/ Hollingworth Creek	Water logging	Waterlogging of swale	Newbridge Street	The site remains waterlogged following heavy rainfall which provides potential mosquito breeding. Human contact with the water may provide the risk of water-borne diseases 1	No risk. 0	No risk. 0	Water logging of the site occurs with high rainfall 1	This catchment includes residential and industrial stormwater runoff and does not currently include any treatment systems. 2	No impact on high value ecology 0	Hollingworth Creek flows into the Wilsons River downstream of the Wilsons River source extraction point. 1	This is a low usage recreation area with low amenity 1	**6**
I4	15 South Lismore/ Hollingworth Creek	Riparian condition	Poor condition of riparian vegetation along Leycester Creek	Downstream duck pond	No risk 0	No risk 0	No risk 0	No risk 0	The poor condition of the Leycester Creek riparian corridor contributes to water quality issues. Some treatment is provided in the duck pond 1	No impact on high value ecology 0	Leycester Creek flows into the Wilsons River downstream of the Wilsons River source extraction point. 1	The area is not easily accessible by the public 0	**2**
I5	12 Gasworks Creek	Water logging	Gasworks Creek detention pond silted up reducing capacity and effectiveness	Gasworks Creek	Sewer overflows are located in the channel. Human contact with the water may provide the risk of water-borne diseases 1	No risk 0	There is a risk of blockage of the flood pump station 2	Water logging of the site occurs with high rainfall 1	The upstream channel rehabilitation has been completed and therefore significant treatment is already provided in this waterway. 1	No impact on high value ecology 0	Gasworks Creek flows into the Wilsons River downstream of the Wilsons River source extraction point. 1	This is a low usage area with low amenity 1	**7**
I6	9 Tucki Tucki	Sedimentation	Camilla Place retention basin is silted up and ineffective	Camilla Place	No risk 0	No risk 0	No risk 0	No risk 0	This small catchment includes residential stormwater runoff and does not currently include any other treatment systems. 2	Tucki Tucki creek is mapped as key fish habitat with high aquatic habitat value 3	No risk 0	The area is not highly used 0	**5**
I7	9 Tucki Tucki	Water logging	Kookaburra Terrace sedimentation basin (#3) is waterlogged and provides low water quality improvement	Kookaburra Terrace (#1)	The current system operates as a sediment basin with no low flow discharge which provides a risk of mosquito breeding. Human contact with the water may provide the risk of water-borne diseases. 1	There is the potential for flooding of neighbouring backyard 1	No risk 0	Water logging of the site occurs with high rainfall 1	This small catchment includes residential stormwater runoff and does not currently include any other treatment systems. 1	Tucki Tucki creek is mapped as key fish habitat with high aquatic habitat value 3	No risk 0	The area is not highly used 0	**7**

Lismore USMP - Issues Prioritisation Matrix

3	High risk
2	Medium risk
1	Low risk
0	No risk

MA 4,5,6,7,8
MA 1,2,11
MA 12, 13, 14, 15,16
MA 3,9,10

High	9-24
Medium	7-8
Low	0-6

	Goals and Objectives								Score
Overall Goal of USMP	***Reduce the occurrence of localised flooding to protect public and private property***				***Improve the quality of urban runoff in order to protect the natural, ecological and aesthetic values of Lismore's waterways.***		***Minimise adverse impacts of stormwater runoff within the Wilsons River Source drinking water catchment***	***Incorporate opportunities to enhance the recreational opportunities and amenity of Lismore's urban area, particularly the CBD and Wilsons riverbank***	
Risks	**Risk to public safety**	**Risk to private property**	**Risk to public infrastructure**	**Nuisance flooding**	**Poor quality of urban stormwater**	**Degradation of high value ecology/sensitive receiving environments**	**Risk to Wilsons River Source drinking water catchment**	**Risk to amenity of high usage areas**	
Principles	*3. Ensure stormwater and its associated drainage systems are planned, designed and managed with appropriate consideration and protection of community health and safety standards, including potential impacts on pedestrian and vehicular traffic*	*2. Limit flooding of public and private property to acceptable or designated levels*			*1. Protect and/or enhance downstream environments, including recognised social, environmental and economic values, by appropriately managing the quality and quantity of stormwater runoff.* *4 - Adopt and promote water sensitive design principles, including appropriately managing stormwater as an integral part of the total water cycle, protecting natural features and ecological processes within urban waterways*			*5. Appropriately integrate stormwater systems into the natural and built environments while optimising the potential uses of drainage corridors.* *6. Enhance community awareness of, and participation in, the appropriate management of stormwater*	
Considerations	*drowning, pathogens, traffic, entrapment, mosquitoes*	*Flooding, damage to driveways*	*Damage to roads*	*Minimise standing water*	*Provide treatment infrastructure in catchments where none currently. Addresses known water quality issues*	*Tucki Tucki KFH*	*Distance from extraction point and proximity to Wilsons River*	*Maintain integrity of road verges, roadside parking, minimise traffic, pedestrian disruptions*	

ID	Management Area	Issue Category	Details	Location	Risk to public safety	Risk to private property	Risk to public infrastructure	Nuisance flooding	Poor quality of urban stormwater	Degradation of high value ecology/sensitive receiving environments	Risk to Wilsons River Source drinking water catchment	Risk to amenity of high usage areas	Score
I8	9 Tucki Tucki	Water logging	Kookaburra Terrace sedimentation basin (#2) is waterlogged and provides low water quality improvement	Kookaburra Terrace (#2)	The current system operates as a sediment basin with no low flow discharge which provides a risk of mosquito breeding. Human contact with the water may provide the risk of water-borne diseases. 1	No risk 0	No risk 0	Water logging of the site occurs with high rainfall 1	This small catchment includes residential stormwater runoff and does not currently include any other treatment systems. 1	Tucki Tucki creek is mapped as key fish habitat with high aquatic habitat value 3	No risk 0	The area is not highly used 0	6
I9	9 Tucki Tucki	Water logging	Kookaburra Terrace sedimentation basin (#3) is waterlogged and provides low water quality improvement	Kookaburra Terrace (#3)	The current system operates as a sediment basin with no low flow discharge which provides a risk of mosquito breeding. Human contact with the water may provide the risk of water-borne diseases. 1	No risk 0	No risk 0	Water logging of the site occurs with high rainfall 1	This small catchment includes residential stormwater runoff and does not currently include any other treatment systems. 1	Tucki Tucki creek is mapped as key fish habitat with high aquatic habitat value 3	No risk 0	The area is not highly used 0	6
I10	9 Tucki Tucki	Sedimentation	Large amounts of silt in Just Street bioretention basin	Just Street	No risk 0	No risk 0	No risk 0	No risk 0	This small catchment includes residential stormwater runoff and does not currently include any other treatment systems. 1	Tucki Tucki creek is mapped as key fish habitat with high aquatic habitat value 3	No risk 0	The area is not highly used 0	4
I11	11 Browns Creek	Sedimentation	Bat Cave sediment weir is not accessible for maintenance and has become ineffective	Browns Creek near Bat Cave	The site is overgrown with a steep gully and no fencing. 2	No risk 0	No risk 0	No risk 0	This large catchment includes residential and industrial stormwater runoff and does not currently include any treatment systems. 3	No impact on high value ecology 0	Browns Creek flows into the Wilsons River downstream of the Wilsons River source extraction point. 2	The area is part of a high usage industrial/parking area. 1	8
I12	9 Tucki Tucki	Sedimentation	Sediment basin is silted up reducing capacity and effectiveness	Joy Street	No risk 0	No risk 0	No risk 0	No risk 0	This small catchment includes residential stormwater runoff and does not currently include any other treatment systems. 1	Tucki Tucki creek is mapped as key fish habitat with high aquatic habitat value 2	No risk 0	The area is not highly used 0	3
I13	10 Monaltrie Creek	Localised flooding	Localised flooding of Industry Drive storage sheds and surrounding area	Industry Drive	The existing open channels provide a risk of traffic/pedestrian accident during wet weather when drains are full. The channel is not fenced. 2	Flooding of the storage sheds occurs in high rainfall. 3	No risk 0	Flooding and standing water in the channel occurs in high rainfall. 2	Sedimentation contributes to the poor quality of stormwater discharged to Monaltrie Creek and Wilsons River. Some treatment is provided by the vegetated channels 2	No impact on high value ecology 0	No risk 0	The area is not highly used 0	9
I14	10 Monaltrie Creek	Sedimentation	Localised flooding adjacent to Wade Park and East Lismore Community Preschool	Wade Park	The existing open channels provide a risk of traffic/pedestrian accident during wet weather when drains are full. The channel is not fenced. 3	There is a risk of flooding of the preschool. 3	There is a risk of flooding of Wade park 2	Flooding and water logging in the park areas occurs with high rainfall 3	A large amount of sediment currently accumulating in the channel is periodically removed. 1	No impact on high value ecology 0	No risk 0	Water logging of park areas and pedestrian access ways occurs in high rainfall, restricting access and usage. 3	15
I15	11 Browns Creek	Localised flooding	Stormwater from the golf course backs up underneath the Barnes property	Barnes factory	The drain under Barnes property is not grated and presents a safety risk during high rainfall/when flooded 2	There is a risk of flooding of the golf course, Barnes property and neighboruing residences. 3	No risk 0	Flooding and standing water in the lower golf course occurs in high rainfall. 2	This catchment includes residential and golf course stormwater runoff and does not currently include any treatment systems. 1	No impact on high value ecology 0	Browns Creek flows into the Wilsons River downstream of the Wilsons River source extraction point. 2	The area is not highly used 0	10

3	High risk
2	Medium risk
1	Low risk
0	No risk

Lismore USMP - Issues Prioritisation Matrix

MA 4,5,6,7,8
MA 1,2,11
MA 12, 13, 14, 15,16
MA 3,9,10

High	9-24
Medium	7-8
Low	0-6

ID	Management Area	Issue Category	Details	Location	Goals and Objectives								Score
				Overall Goal of USMP	***Reduce the occurrence of localised flooding to protect public and private property***				***Improve the quality of urban runoff in order to protect the natural, ecological and aesthetic values of Lismore's waterways.***		***Minimise adverse impacts of stormwater runoff within the Wilsons River Source drinking water catchment***	***Incorporate opportunities to enhance the recreational opportunities and amenity of Lismore's urban area, particularly the CBD and Wilsons riverbank***	
				Risks	**Risk to public safety**	**Risk to private property**	**Risk to public infrastructure**	**Nuisance flooding**	**Poor quality of urban stormwater**	**Degradation of high value ecology/sensitive receiving environments**	**Risk to Wilsons River Source drinking water catchment**	**Risk to amenity of high usage areas**	
				Principles	*3. Ensure stormwater and its associated drainage systems are planned, designed and managed with appropriate consideration and protection of community health and safety standards, including potential impacts on pedestrian and vehicular traffic*	*2. Limit flooding of public and private property to acceptable or designated levels*			*1. Protect and/or enhance downstream environments, including recognised social, environmental and economic values, by appropriately managing the quality and quantity of stormwater runoff.* *4 - Adopt and promote water sensitive design principles, including appropriately managing stormwater as an integral part of the total water cycle, protecting natural features and ecological processes within urban waterways*			*5. Appropriately integrate stormwater systems into the natural and built environments while optimising the potential uses of drainage corridors.* *6. Enhance community awareness of, and participation in, the appropriate management of stormwater*	
				Considerations	*drowning, pathogens, traffic, entrapment, mosquitoes*	*Flooding, damage to driveways*	*Damage to roads*	*Minimise standing water*	*Provide treatment infrastructure in catchments where none currently. Addresses known water quality issues*	*Tucki Tucki KFH*	*Distance from extraction point and proximity to Wilsons River*	*Maintain integrity of road verges, roadside parking, minimise traffic, pedestrian disruptions*	
I16	11 Browns Creek	Localised flooding	The northern section of Browns Creek channel is overgrown with weeds, restricting conveyance of flows to Bat Cave	Browns Creek, Uralba Street to Bat Cave	The existing open channels provide a risk of pedestrian accident or drowning during wet weather when drains are full. The channel is not fenced. There are sewer overflows discharging into the channel. 3	No risk 0	There is a risk of flooding of the parkland and Dawson and Uralba Streets 2	Flooding and standing water in the park and road areas surrounding the channel occurs in high rainfall. 2	No risk 0	No impact on high value ecology 0	Browns Creek flows into the Wilsons River downstream of the Wilsons River source extraction point. 2	The area is part of a high usage industrial/parking area. 2	**11**
I17	15 South Lismore/ Hollingworth Creek	Localised flooding	Localised flooding on Union Street	Union Street	Flooding on Union Street presents a risk to traffic 1	There is a risk of flooding of the shops on Union Street. 3	There is a risk of flooding of Union Street 1	Flooding and standing water in the area occurs in high rainfall. 2	No risk 0	No impact on high value ecology 0	No risk 0	Flooding of Union Street and pedestrian access ways 1	**8**
I18	16 South Lismore/ Airport	Localised flooding	Localised flooding of Snow Street drainage channel	Snow Street	The existing open channels provide a risk of traffic/pedestrian accident or drowning during wet weather when drains are full. The channel is not fenced. 2	No risk 0	There is a risk of flooding of Snow Street 1	Flooding and standing water in the area occurs in high rainfall. 2	No risk 0	No impact on high value ecology 0	No risk 0	The area is not highly used 0	**5**
I19	2 Slaters Creek	Localised flooding	Localised flooding of Terania Street	Terania Street	The existing swales along a major access road to villages north of the shire provide a risk of traffic/pedestrian accident during wet weather/ flooding. 2	No risk 0	There is a risk of flooding of Terania Street and the railway corridor 2	Flooding and standing water in the area occurs in high rainfall. 2	No risk 0	No impact on high value ecology 0	No risk 0	Flooding of Terania Street and pedestrian access ways. 1	**7**
I20	6 Howards Grass	Localised flooding	Localised flooding of Trinity Drive	Trinity Drive	During heavy rainfall there is a large amount of water at the channel headwall which floods the road which provide a risk of traffic/pedestrian accident. 1	Theres is a risk of flooding of the Trinity Drive residence. 2	There is a risk of flooding of Trinity Drive 1	Flooding and standing water in the area occurs in high rainfall. 1	No risk 0	No impact on high value ecology 0	No risk 0	The area receives local traffic only. 0	**5**
I21	14 CBD	Localised flooding	Localised flooding of Larkin Lane	Larkin Lane	No risk 0	There is a risk of flooding of the Keen Street shops and alleyway 3	There is a risk of flooding of Larkin Lane 1	Flooding and standing water in the area occurs in high rainfall. 2	No risk 0	No impact on high value ecology 0	No risk 0	Flooding of Larkin Lane and pedestrian access ways . 2	**8**
I22	15 South Lismore/ Hollingworth Creek	Localised flooding	Localised flooding adjacent to South Lismore Public School	South Lismore Public School	During heavy rainfall there is a large amount of water on the road verge and school grounds which provide a risk of traffic/pedestrian accident. 3	There is a risk of flooding of the school. 3	There is a risk of flooding of Kyogle and Wilsons Streets 1	Flooding and standing water in the area occurs in high rainfall. 2	The vegetated swales provide some treatment of runoff if appropriately maintained. 0	No impact on high value ecology 0	No risk 0	Flooding of school. 3	**12**
I23	12 Gasworks Creek	Localised flooding	Localised flooding of Cathcart Street	Cathcart Street, Girards Hill	Lack of adequate drainage causes waterlogging and potential mosquito breeding sites and risk of pedestrian/traffic accidents 1	There is a risk of flooding of the residential properties. 3	There is a risk of flooding of Cathcart Street 1	Flooding and standing water in the area occurs in high rainfall. 2	The vegetated swales provide some treatment of runoff if appropriately maintained. 0	No impact on high value ecology 0	Gasworks Creek flows into the Wilsons River downstream of the Wilsons River source extraction point. 1	The area receives local traffic only. 0	**8**
I24	15 South Lismore/ Hollingworth Creek	Localised flooding	Localised flooding of Casino Street	Casino Street, South Lismore	Lack of adequate drainage causes waterlogging and potential mosquito breeding sites and risk of pedestrian/traffic accidents 1	There is a risk of flooding of the residential properties. 3	There is a risk of flooding of Casino Street 1	Flooding and standing water in the area occurs in high rainfall. 2	The vegetated swales provide some treatment of runoff if appropriately maintained. 0	No impact on high value ecology 0	Hollingworth Creek flows into the Wilsons River downstream of the Wilsons River source extraction point. 1	The area receives local traffic only. 0	**8**

3	High risk	MA 4,5,6,7,8	High	9-24
2	Medium risk	MA 1,2,11	Medium	7-8
1	Low risk	MA 12, 13, 14, 15,16	Low	0-6
0	No risk	MA 3,9,10		

Lismore USMP - Issues Prioritisation Matrix

	Goals and Objectives								Score
Overall Goal of USMP	***Reduce the occurrence of localised flooding to protect public and private property***				***Improve the quality of urban runoff in order to protect the natural, ecological and aesthetic values of Lismore's waterways.***		***Minimise adverse impacts of stormwater runoff within the Wilsons River Source drinking water catchment***	***Incorporate opportunities to enhance the recreational opportunities and amenity of Lismore's urban area, particularly the CBD and Wilsons riverbank***	
Risks	**Risk to public safety**	**Risk to private property**	**Risk to public infrastructure**	**Nuisance flooding**	**Poor quality of urban stormwater**	**Degradation of high value ecology/sensitive receiving environments**	**Risk to Wilsons River Source drinking water catchment**	**Risk to amenity of high usage areas**	
Principles	*3. Ensure stormwater and its associated drainage systems are planned, designed and managed with appropriate consideration and protection of community health and safety standards, including potential impacts on pedestrian and vehicular traffic*	*2. Limit flooding of public and private property to acceptable or designated levels*			*1. Protect and/or enhance downstream environments, including recognised social, environmental and economic values, by appropriately managing the quality and quantity of stormwater runoff.* *4 - Adopt and promote water sensitive design principles, including appropriately managing stormwater as an integral part of the total water cycle, protecting natural features and ecological processes within urban waterways*			*5. Appropriately integrate stormwater systems into the natural and built environments while optimising the potential uses of drainage corridors.* *6. Enhance community awareness of, and participation in, the appropriate management of stormwater*	
Considerations	*drowning, pathogens, traffic, entrapment, mosquitoes*	*Flooding, damage to driveways*	*Damage to roads*	*Minimise standing water*	*Provide treatment infrastructure in catchments where none currently. Addresses known water quality issues*	*Tucki Tucki KFH*	*Distance from extraction point and proximity to Wilsons River*	*Maintain integrity of road verges, roadside parking, minimise traffic, pedestrian disruptions*	

ID	Management Area		Issue Category	Details	Location	Risk to public safety	Risk to private property	Risk to public infrastructure	Nuisance flooding	Poor quality of urban stormwater	Degradation of high value ecology	Risk to Wilsons River Source	Risk to amenity	Score
I25	15	South Lismore/ Hollingworth Creek	Inadequate drainage	South Lismore grass swales (Hollingworth Creek) do not provide adequate stormwater conveyance	South Lismore	Lack of adequate drainage causes waterlogging and potential mosquito breeding sites and risk of pedestrian/traffic accidents	Potential damage to residential and commercial properties due to flooding	Potential damage to Council roads due to flooding	Flooding and standing water in the area occurs in high rainfall.	The vegetated swales provide some treatment of runoff if appropriately maintained.	No impact on high value ecology	No risk	The area inlcudes residential, commercial and industrial properties	**7**
						1	2	1	2	0	0	0	1	
I26	1	North Lismore/ Leycester Creek	Inadequate drainage	North Lismore grass swales (Leycester Creek) do not provide adequate stormwater conveyance	North Lismore	Lack of adequate drainage causes waterlogging and potential mosquito breeding sites and risk of pedestrian/traffic accidents	Potential damage to residential and commercial properties due to flooding	Potential damage to Council roads due to flooding	Flooding and standing water in the area occurs in high rainfall.	The vegetated swales provide some treatment of runoff if appropriately maintained.	No impact on high value ecology	No risk	The area inlcudes residential, commercial and industrial properties	**7**
						1	2	1	2	0	0	0	1	
I27	2	Slaters Creek	Inadequate drainage	North Lismore grass swales (Slaters Creek) do not provide adequate stormwater conveyance	North Lismore	Lack of adequate drainage causes waterlogging and potential mosquito breeding sites and risk of pedestrian/traffic accidents	Potential damage to residential and commercial properties due to flooding	Potential damage to Council roads due to flooding	Flooding and standing water in the area occurs in high rainfall.	The vegetated swales provide some treatment of runoff if appropriately maintained.	No impact on high value ecology	No risk	The area inlcudes residential, commercial and industrial properties	**7**
						1	2	1	2	0	0	0	1	
I28	4	Currie Creek	Inadequate drainage	North Lismore grass swales (Currie Creek) do not provide adequate stormwater conveyance	North Lismore	Lack of adequate drainage causes waterlogging and potential mosquito breeding sites and risk of pedestrian/traffic accidents	Potential damage to residential and commercial properties due to flooding	Potential damage to Council roads due to flooding	Flooding and standing water in the area occurs in high rainfall.	The vegetated swales provide some treatment of runoff if appropriately maintained.	No impact on high value ecology	No risk	The area inlcudes residential properties and a high school	**7**
						1	2	1	2	0	0	0	1	
I29	11	Browns Creek	Inadequate drainage	CBD grass swales (Browns Creek) do not provide adequate stormwater conveyance	CBD	Lack of adequate drainage causes waterlogging and potential mosquito breeding sites and risk of pedestrian/traffic accidents in a high traffic area	Potential damage to residential and commercial properties due to flooding	Potential damage to Council roads due to flooding	Flooding and standing water in the area occurs in high rainfall.	The vegetated swales provide some treatment of runoff if appropriately maintained.	No impact on high value ecology	No risk	High vehicle and pedestrian traffic is experienced in the CBD and the hospital precinct.	**9**
						2	2	1	2	0	0	0	2	
I30	12	Gasworks Creek	Inadequate drainage	CBD grass swales (Gasworks Creek) do not provide adequate stormwater conveyance	CBD	Lack of adequate drainage causes waterlogging and potential mosquito breeding sites and risk of pedestrian/traffic accidents in a high traffic area	Potential damage to residential and commercial properties due to flooding	Potential damage to Council roads due to flooding	Flooding and standing water in the area occurs in high rainfall.	The vegetated swales provide some treatment of runoff if appropriately maintained.	No impact on high value ecology	No risk	High vehicle and pedestrian traffic is experienced in the CBD and inner residential areas.	**9**
						2	2	1	2	0	0	0	2	
I31	10	Monaltrie Creek	Inadequate drainage	East Lismore grass swales (Monaltrie Creek) do not provide adequate stormwater conveyance	East Lismore	Lack of adequate drainage causes waterlogging and potential mosquito breeding sites and risk of pedestrian/traffic accidents in a high traffic area	Potential damage to residential and commercial properties due to flooding	Potential damage to Council roads due to flooding	Flooding and standing water in the area occurs in high rainfall.	The vegetated swales provide some treatment of runoff if appropriately maintained.	No impact on high value ecology	No risk	High vehicle and pedestrian traffic is experienced in East Lismore	**9**
						2	2	1	2	0	0	0	2	

Appendix 8: New Development Areas

Table 22: Potential future development sites – timing and total dwellings

Development Area	Area (ha)	Total Anticipated Dwellings					
		2016-2035	2016 -2020	2021 -2025	2026-2030	2031-2035	Total
Potential Urban Release and Urban Fringe development							
East Lismore Infill	35.8	42	5	15	10	12	200
Chilcotts Grass	5.9	25		5	10	10	163
Crawford	66.6	80		25	20	35	269
Invercauld Road	57.0	155	30	45	30	50	232
Northcott Drive	8.5	<5	-	-	<5		<5
164, 186 and 198 Rous Road	10.1	<50	-	-	<50	-	<50
Opal Crescent	2.5	<5	-	-	<5		<5
Waterford Park Extension	7.2	20	-	-	10	10	30
209 Bangalow Road	2.3	2	2		-	-	2
Blue Hills Avenue	1.4	<15	-	-	<15		<15
Greenfield Development							
Pineapple Road Precinct	208.7	360	190	70	40	60	380
Trinity Drive	77.8	100	10	40	30	20	280
North Lismore Plateau	265.0	810	300	200	160	150	1500
Richmond Hill Large Lot Residential	20.1	10-20	-	-	-	10-20	10-20
Lagoons Grass	92.2	35	-	-	-	35	175
87 Pineapple Road	6.0	<30	-	-	<30		<30
Medium Density Development							
Hospital support precinct	58.8	90	20	20	30	20	100

Table 23: Potential future development sites – Browns Creek Management Area 11

Site	Hospital Support Precinct	East Lismore Infill (north site)
Expected Development Timeframe	2016-beyond 2035	2016-beyond 2035
Total Anticipated Dwellings	100	100
Location within broader catchment	Covers a substantial portion of the north-east of Browns Creek Catchment. Located midway along the drainage pathway.	Located at the top of the Browns Creek catchment.
Land use of development site	Urban commercial and residential.	Mix of vegetated, regrowth and cleared.
Land use of upslope area(s)	Nature reserve / park immediately to the east, with urban residential further upslope.	Site is close to top of catchment. Small pocket of urban residential above.
Land use of downstream area(s)	Public open space / sports fields and commercial.	Golf course, then urban residential, then park, then commercial CBD.
Description of downstream waterway(s)	Hard-lined open channels and man-made earth channels prior to Wilsons River.	Grassed swales through golf course (0.5 km), then stormwater pipes and open channels through urban areas (2 km).
Features	Existing urban area, so all development will be redevelopment of existing residential or commercial.	Swales and dams within golf course potentially provide treatment and flow attenuation benefits.
Existing stormwater issues	Open swales in the precinct are not adequate to convey stormwater in high rainfall and localised flooding occurs. Downstream of the development site, there are existing stormwater issues associated with the open channels between Uralba St and the 'bat cave' and the sediment weir at the bat cave. There is poor water quality in Browns Creek.	Stormwater flowing from golf course backs up in channel under the AK Barnes truss factory located to the north-east.
Opportunities	Developer contributions could be collected and utilised to provide centralised downstream stormwater treatment (in lieu of on-site stormwater quality controls). Improvements to the stormwater drainage system (trunk drainage program) are likely to be required prior to development proceeding and would also provide increased/improved roadside parking and amenity.	Stormwater detention, larger than that required by the DCP, could be implemented at the development site to assist with resolving the flooding issue at the AK Barnes truss factory. However, a detention system in the lower golf course would be more effective.

Table 24: Potential future development sites – Monaltrie Creek Management Area 10

Site	East Lismore Infill (sth)	Crawford	Invercauld Rd
Expected Development Timeframe	2016-beyond 2035	2021-beyond 2035	2016-beyond 2035
Total Anticipated Dwellings	100	163	232
Location within broader catchment	Located at the top of a small tributary catchment (1.5 km long) that connects into the middle of the Monaltrie Creek system from the west.	Roughly located in the middle of the Monaltrie Creek catchment.	Roughly located in the middle of the Monaltrie Creek catchment.
Land use of development site	Plantation, with some cleared areas.	Cleared, rural, urban fringe. Vegetation on higher, eastern slopes along edge of existing urban residential.	Cleared, rural on urban fringe. Vegetation on lower slopes along eastern edge, adjacent to creek.
Land use of upslope area(s)	n/a – site is top of catchment.	Urban residential	Western edge of site is a ridge. Small area of urban residential upslope of site in north-western corner.
Land use of downstream area(s)	Forest (Wilson Nature Reserve), then cleared, rural floodplain.	Cleared, rural floodplain.	Cleared, rural floodplain, with some pockets of remnant / regrowth vegetation closer to site.
Description of downstream waterway(s)	Natural gullies through forest (1 km), then man-made / modified drainage channels, with low ecological value and minimal riparian vegetation for approx. 3 km.	Man-made / modified drainage channels, with low ecological value and minimal riparian vegetation for approx. 3 km. Mapped as key fish habitat.	Natural creek with some riparian vegetation for approx. 1 km, followed by creek with minimal riparian vegetation (3 km) and then man-made / modified drainage channel, with low ecological value and minimal riparian vegetation (1.5 km).
Features	-		
Existing stormwater issues	Not in the urban area	Council's trunk drainage program includes extension of the existing channels to Crawfords land. There are sedimentation issues in the Monaltrie creek catchment	-

Site	East Lismore Infill (sth)	Crawford	Invercauld Rd
Opportunities	-	A treatment system for the Monaltrie Creek catchment could be included as part of Crawfords development to treat the upstream catchment as well as stormwater from the development.	-

Table 25: Potential future development sites – Tucki Tucki Creek Management Area 9

Site	164, 186 & 198 Rous Rd	Chilcotts Grass	Waterford Park Extension	Blue Hills Ave
Expected Development Timeframe	2026-2030	2021-beyond 2035	2026-beyond 2035	2026-2035
Total Anticipated Dwellings	<50	163	30	<15
Location within broader catchment	Located at the lower end of a small tributary (2 km long) in the upper reaches of the Tucki Tucki Creek catchment.	Located adjacent to Tucki Tucki Creek in the upper reaches of the catchment.	Located adjacent to a small tributary (0.5 km long) that joins Tucki Tucki Creek in the upper reaches of the catchment.	Located at the top of a small tributary catchment (0.5 km long) that joins a larger tributary (2 km long) of Tucki Tucki Creek in the upper reaches of the catchment.
Land use of development site	Generally cleared, large lot residential on urban fringe. Small plantation / orchard on middle lot, some riparian vegetation adjacent to creek on eastern lot.	Heavily vegetated on western portion. Generally cleared with some plantation on eastern portion.	Plantation, with some riparian vegetation on eastern bank of creek.	Generally cleared rural residential.
Land use of upslope area(s)	Western edge of site is close to ridge. Northern portion of cemetery is located upslope of south-western corner of the site.	Urban residential (including some areas approved for subdivision, but yet to be constructed).	Urban residential – new subdivision.	Large lot urban residential.
Land use of downstream area(s)	Urban fringe, with some residential development, immediately downstream of site, followed by rural land with a mixture of plantations and cleared pasture. Transitions to rural floodplain.			

Site	164, 186 & 198 Rous Rd	Chilcotts Grass	Waterford Park Extension	Blue Hills Ave
Description of downstream waterway(s)	Natural creek with substantial riparian vegetation followed by natural creek with varying amounts of riparian vegetation through floodplain and then man-made / modified drainage channel, with low ecological value and minimal riparian vegetation before joining Richmond River. Mapped as key fish habitat with high aquatic habitat value.			
Features	Upper reaches of Tucki Tucki Creek catchment dominated by urban, plantation and grazing land uses, but creek still retains significant ecological value.			
Existing stormwater issues	-	-	-	-
Opportunities	-	-	Existing farm dam north of site could potentially be reconfigured (and possibly expanded) to manage stormwater from this development site.	-

Table 26: Potential future development sites – Lagoon Grass Management Area 7

Site	Richmond Hill Large Lot Residential	Pineapple Road Precinct	87 Pineapple Road	Lagoons Grass	Northcott Drive	Trinity Drive (part)
Expected Development Timeframe	2031-2035	2016-beyond 2035	2026-2035	2031-beyond 2035	2026-2035	2016-beyond 2035
Total Anticipated Dwellings	10-20	380	<30	175	<5	140
Location within broader catchment	Located at the top of the Lagoon Creek catchment.	Covers a substantial portion of the upper Lagoon Creek catchment.	Located in the upper reaches of a tributary (2 km long) of Lagoon Creek, which joins Lagoon Creek midway along its length.	Covers a substantial portion of the middle of the Lagoon Creek catchment.	Located midway along a tributary (2 km long) of Lagoon Creek, which joins Lagoon Creek midway along its length.	Straddles a ridge that separates the Howards Grass catchment from the Lagoon Creek catchment. Located owards the lower end of the Lagoon Creek catchment.

Site	Richmond Hill Large Lot Residential	Pineapple Road Precinct	87 Pineapple Road	Lagoons Grass	Northcott Drive	Trinity Drive (part)
Land use of development site	Cleared grazing pasture with small area of plantation and minimal vegetation.		Rural hillside, with significant vegetation cover.		Generally cleared rural ridgeline, with some pockets of significant vegetation cover.	
Land use of upslope area(s)	n/a – site is top of catchment.	Small area of existing rural residential to the north-east. 'Richmond Hill Large Lot Residential' future development site to the east.	n/a – site is top of catchment.	Substantial area of urban residential and cleared pasture to the south-east. 'Richmond Hill Large Lot Residential' and 'Pineapple Road Precinct' future development sites to the east.	n/a – site is top of catchment.	n/a – site is top of catchment.
Land use of downstream area(s)	Cleared, rural hill pasture followed by cleared, rural floodplain.			Cleared, rural floodplain.		
Description of downstream waterway(s)	Natural gullies and creeks with minimal riparian vegetation followed by natural creek on cleared floodplain before joining Wilsons River. Lagoon Creek is mapped as key fish habitat.					
Features	Lagoon Creek flows into Wilsons River approximately 300 m from the drinking water source extraction point.					
Existing stormwater issues	-	-	-	-	-	-
Opportunities	Stormwater management could be combined with that required for the adjacent development sites (Richmond Hill Large Lot Residential, Pineapple Road Precinct, 87 Pineapple Road, Trinity Drive, Lagoons Grass). However, it may be difficult to find site for a large centralised system (land ownership, size etc.). Provision of a large centralised system would be difficult to time with development of the sites. Potential for retention and restoration of existing gullies and creeks within site. Development controls should be more stringent due to the need to protect the drinking water catchment (as discussed in Rous Water DCP).					

Table 27: Potential future development sites – Howards Grass Management Area 6

Site	**Trinity Drive (part)**	**Opal Crescent**	**209 Bangalow Road**
Expected Development Timeframe	2016-beyond 2035	2026-2035	2016-2025
Total Anticipated Dwellings	140	<5	2
Location within broader catchment	Straddles a ridge that separates the Howards Grass catchment from the Lagoon Creek catchment. Located midway along the Howards Grass catchment.	Located midway along a small tributary (1 km long) in the upper reaches of the Howards Grass catchment.	Located towards the lower end of the Howards Grass catchment.
Land use of development site	Generally cleared rural ridgeline, with some pockets of significant vegetation cover.	Rural hillside on the urban fringe, with minimal vegetation cover.	Rural hillside on the urban fringe, with some pockets of significant vegetation cover.
Land use of upslope area(s)	n/a – site is top of catchment.	Single row of residential houses along Woodland Ave upslope of site.	Residential development.
Land use of downstream area(s)	Cleared, rural floodplain.		
Description of downstream waterway(s)	Natural creeks, with some modified sections on cleared floodplain before joining Wilsons River.		
Features	The tributary flows into Wilsons River downstream of the drinking water source extraction point. The tributary is mapped as key fish habitat.		
Existing stormwater issues	-		
Opportunities	Potential for retention and restoration of existing gullies and creeks within site. Development controls should be more stringent due to the need to protect the drinking water catchment (as discussed in Rous Water DCP).		

Appendix 9: Proposed Trunk Drainage Program

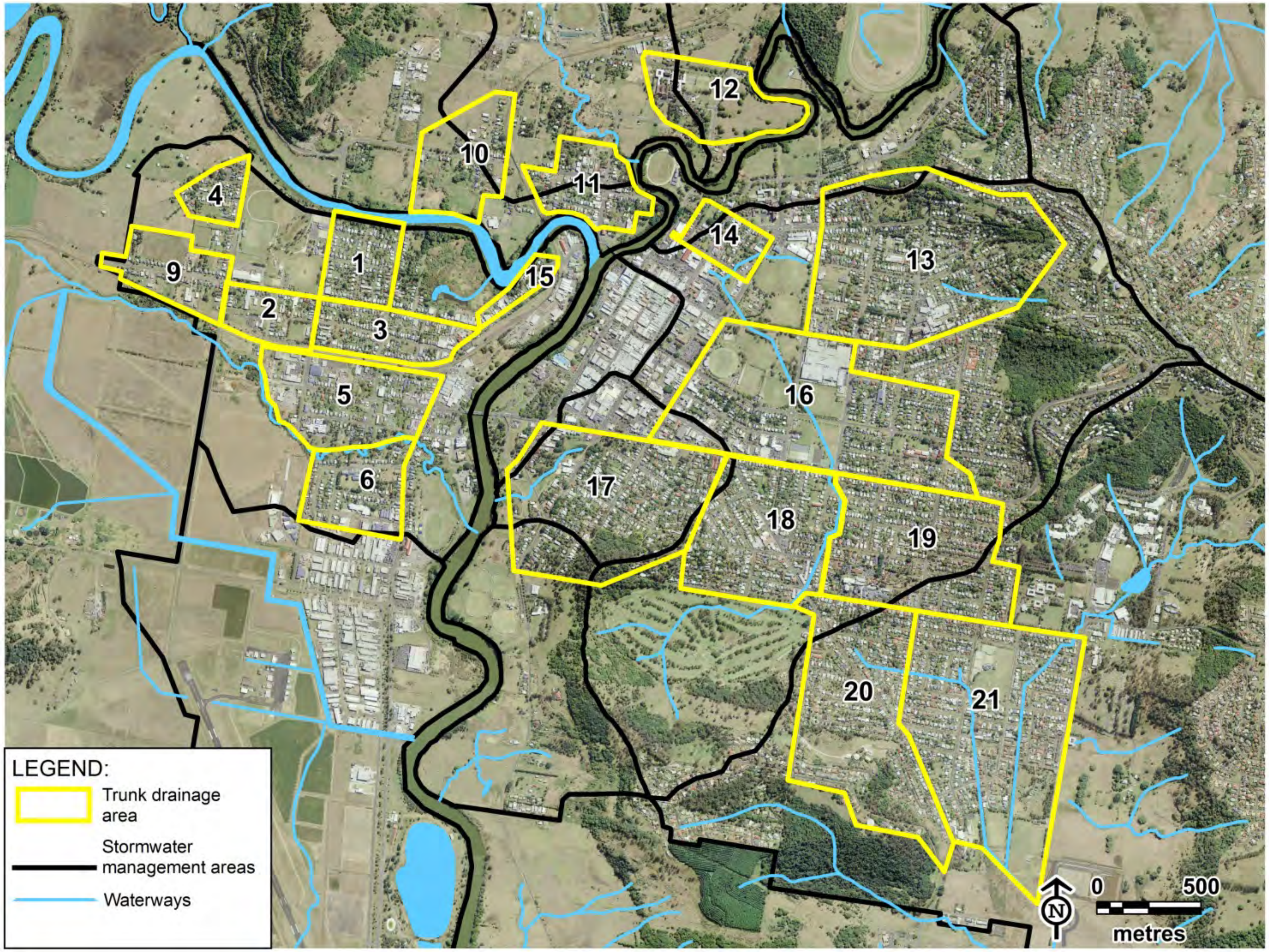


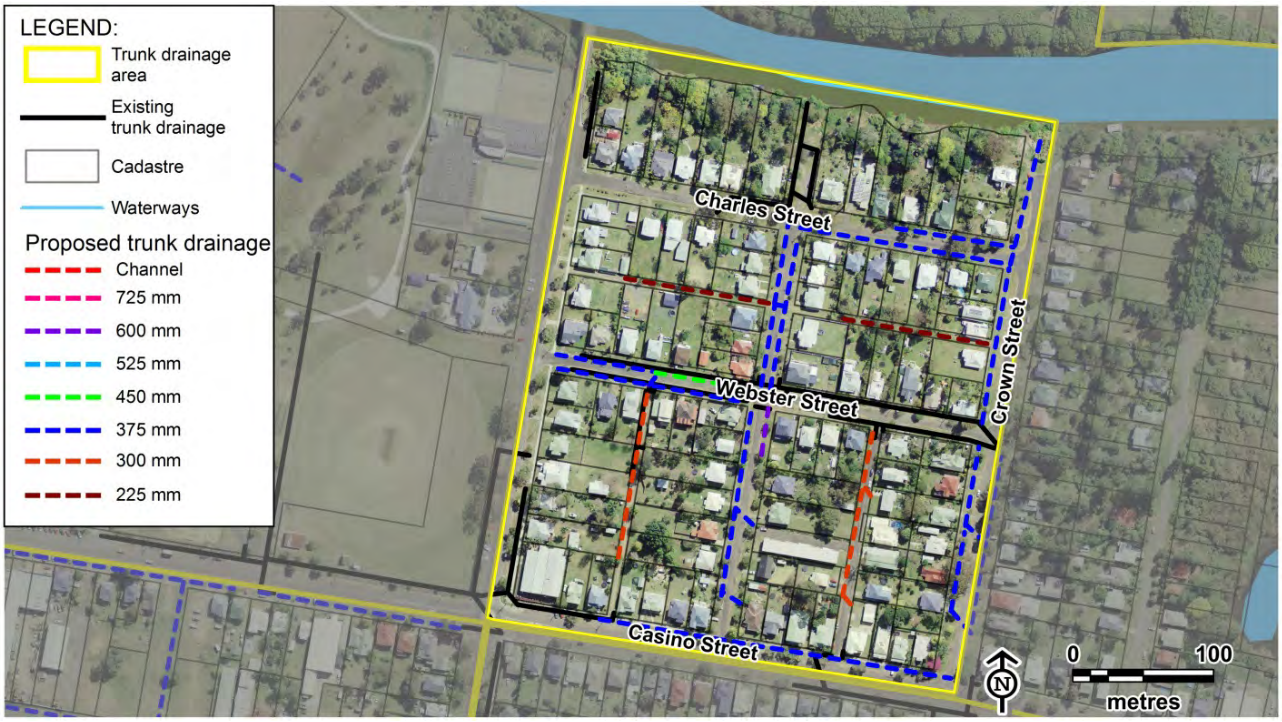
Figure 68: Locations of proposed trunk drainage works

Sub Catchment No.		Trunk Drainage Estimate	Outlet Structures	Cost	Treatment device	Cost	Total Treatment Cost	Treatment Cost incl. SID	Total Cost
1	Webster Street	1,048,840	1	5,100	small	15,000	20,100	24,120	1,072,960
2	Edward Street	733,070					0	0	733,070
3	Phyllis Street	921,700					0	0	921,700
4	Caniaba Street	834,405	1	5,100	small	15,000	20,100	24,120	858,525
5	Elliott Road	955,890			small	15,000	15,000	18,000	973,890
6	Cook Street	770,120					0	0	770,120
9	Casino Street	860,990					0	0	860,990
10	Terania Street	577,785	1	5,100	small	15,000	20,100	24,120	601,905
11	Bridge Street	649,805	2	10,200	2xsmall	30,000	40,200	48,240	698,045
12	Winterton Parade	684,385	1	5,100	small	15,000	20,100	24,120	708,505
13	Diadem Street	1,790,659					0	0	1,790,659
14	Keen Street	636,415	1	5,100	small	15,000	20,100	24,120	660,535
15	Union Street	398,190	2	10,200	2xsmall	30,000	40,200	48,240	446,430
16	Brewster Street	2,729,545			medium	25,000	25,000	30,000	2,759,545
17	Dawson Street	2,013,960	1	5,100			5,100	6,120	2,020,080
18	Clarice Street	1,684,930					0	0	1,684,930
19	Dibbs Street	1,784,185					0	0	1,784,185
20	Wyrallah Road	1,511,120			large	40,000	40,000	48,000	1,559,120
21	East Lismore Catchment	4,008,745					0	0	4,008,745
		24,594,739						**319,200**	**24,913,939**

Sub Catchment No.		Street Name	Length	Pipe Size	Rate	Estimate	Pits	Rate	Estimate	Total Estimate (incl 30% contingency)
1 Webster Street	(a)	Charles Street	320	375	460	147200	7	2200	15400	211380
	(b)	laneway to (Centre St)	130	225	360	46800	2	600	1200	62400
	(c)	laneway to (Crown St)	130	225	360	46800	2	600	1200	62400
	(d)	Webster Street (North)	220	375	460	101200	3	2500	7500	141310
	(e)	Webster Street (South)	60	450	490	29400	2	2500	5000	44720
	(f)	Centre Lane (to Webster St)	125	300	420	52500	2	600	1200	69810
	(g)	Crown Lane (to Webster St)	145	300	420	60900	2	600	1200	80730
	(h)	Crown Street	580	375	460	266800	9	2500	22500	376090
										1048840
2 Edward Street	(a)	Kyogle Street to Nesbitt Park	350	375	460	161000	4	2200	8800	220740
	(b)	Phyllis Street (East of Edwards St)	165	375	460	75900	2	2200	4400	104390
	(c)	Phyllis Street (West of Edwards St)	170	375	460	78200	2	2200	4400	107380
	(d)	Casino Street (Caniaba to Edwards)	215	375	460	98900	4	2500	10000	141570
	(e)	Casino Street (Edwards to Wilson)	150	375	460	69000	3	2500	7500	99450
	(f)	Caniaba Street (Casino to Phyllis)	90	375	460	41400	2	2200	4400	59540
										733070
3 Phyllis Street	(a)	Casino /Ona/ Phyllis Streets	400	375	460	184000	6	2500	15000	258700
	(b)	Phyllis (Crown to Ona St to Union St)	275	375	460	126500	4	2500	10000	177450
	(c)	Kyogle St (Crown to Union)	225	375	460	103500	4	2500	10000	147550
	(d)	Ona Street (to Kyogle)	75	375	460	34500	2	2500	5000	51350
	(e)	Casino St /Union/Kyogle	175	375	460	80500	5	2500	12500	120900
	(f)	Casino Street (Wilson to Crown)	250	375	460	115000	5	2500	12500	165750
										921700
4 Caniaba Street	(a)	Charlton Street	170	375	460	78200	4	2500	10000	114660
	(b)	Basin to Caniaba Street	285	375	460	131100	4	2200	8800	181870
	(c)	Meadow Drive	200	375	460	92000	4	2500	10000	132600
	(d)	Caniaba Street	535	600	550	294250	7	2500	17500	405275
										834405
5 Elliott Road	(a)	Elliott Road (Wilson to Crown)	275	375	460	126500	4	2500	10000	136500
	(b)	Elliott Road (Crown East 100m)	100	450	490	49000	2	2500	5000	54000
	(c)	Newbridge Street (Wilson to Crown)	320	375	460	147200	4	2500	10000	157200
	(d)	Newbridge Street (Crown to Rawson)	100	375	460	46000	2	2500	5000	51000
	(e)	Engine Street (Crown to Union)	260	375	460	119600	4	2500	10000	129600
	(f)	Rawson Street	150	725	610	91500	2	2500	5000	96500
	(g)	Crown Street (Elliott to Newbridge)	100	375	460	46000	3	2500	7500	53500
	(h)	Crown Street (Newbridge to Creek)	100	525	520	52000	2	2500	5000	57000
										735300
6 Cook Street	(a)	Cromer Street (Barnes to Union)	210	375	460	96600	3	2500	7500	104100
	(b)	Drain - Cook Street (Southside)	115	375	460	52900	2	2200	4400	57300
	(c)	Barnes Avenue	200	375	460	92000	4	2500	10000	102000
	(d)	Maloney Street	200	375	460	92000	4	2500	10000	102000
	(e)	Cook Street (Northside)	200	375	460	92000	4	2500	10000	102000
	(f)	Rhodes Street	250	375	460	115000	4	2500	10000	125000
										592400
9 Casino Street	(a)	Hanlon Street	110	450 culvert	1500	165000			0	214500
	(b)	Casino Street (South West)	250	375	460	115000	4	2200	8800	160940
	(c)	Casino Street (South East)	250	375	460	115000	4	2200	8800	160940
	(d)	Casino Street (North West 1)	100	375	460	46000	4	2200	8800	71240
	(e)	Casino Street (North West 2)	125	450	490	61250	4	2200	8800	91065
	(f)	Casino Street (North East 1)	100	375	460	46000	4	2200	8800	71240
	(g)	Casino Street (North East 2)	125	450	490	61250	4	2200	8800	91065
										860990
10 Terania Street	(a)	Terania Street	280	375	460	128800	4	2200	8800	178880
	(b)	Tweed Street (South)	275	600	550	151250	4	2200	8800	208065
	(c)	Tweed Street (North)	300	375	460	138000	4	2200	8800	190840
										577785
11 Bridge Street	(a)	Pine Street	280	375	460	128800	6	2200	13200	184600
	(b)	Simmons Street	225	375	460	103500	3	2500	7500	144300
	(c)	Terania Street (North-West)	210	375	460	96600	3	2500	7500	135330
	(d)	Terania Street (North-East)	125	450	490	61250	2	2500	5000	86125
	(e)	Terania Street (South)	150	375	460	69000	3	2500	7500	99450
										649805
12 Winterton Parade	(a)	Pitt Lane	200	375	460	92000	3	2200	6600	128180
	(b)	Lake Street	210	375	460	96600	3	2200	6600	134160
	(c)	Lake Street (to Creek)	120	600	550	66000	2	2200	4400	91520
	(d)	Alexandra Parade	200	375	460	92000	3	2200	6600	128180
	(e)	Alexandra Parade (to River)	125	600	550	68750	2	2200	4400	95095
	(f)	Winterton Parade	165	375	460	75900	3	2200	6600	107250
										684385
13 Diadem Street	(a)	Diadem Street (Leycester to High)	140	375	460	64400	2	2200	4400	89440
	(b)	Diadem Street (Leycester to Orion - West)	250	450	490	122500	4	2500	10000	172250
	(c)	Diadem Street (Leycester to Orion - East)	125	375	460	57500	2	2200	4400	80470
	(d)	Diadem Street (Orion to Laurel - West Side)	180	450	490	88200	3	2500	7500	124410
	(e)	Diadem Street (Orion to Laurel - East Side)	75	375	460	34500	2	2500	5000	51350
	(f)	Leycester Street (East of Hunter)	215	450	490	105350	3	2200	6600	145535
	(g)	Leycester Street (Diadem to Hunter)	212	450	490	103880	3	2500	7500	144794
	(h)	Leycester Street (Brewster to Diadem)	300	375	460	138000	4	2500	10000	192400
	(I)	Jubilee Street (West to Brewster)	180	375	460	82800	3	2500	7500	117390
	(j)	Jubilee Street (East to Diadem)	120	375	460	55200	2	2500	5000	78260
	(k)	Orion Street (Hunter to Jasmyne St)	280	600	550	154000	4	2200	8800	211640
	(l)	Gaggin Lane (Brewster to Diadem)	165	375	460	75900	3	2500	7500	108420
	(m)	Laurel Avenue (Brewster to Diadem)	200	450	490	98000	3	2500	7500	137150
	(n)	laurel Avenue (Diadem to Hunter)	200	450	490	98000	3	2500	7500	137150
										1790659
14 Keen Street	(a)	Orion Street (Keen to Little Keen)	125	375	460	57500	2	2500	5000	81250
	(b)	Coleman Street	150	375	460	69000	3	2500	7500	99450
	(c)	Keen Street (Zadoc to Orion - West Side)	175	450	490	85750	3	2500	7500	121225
	(d)	Keen Street (Zadoc to Orion - East Side)	100	375	460	46000	2	2500	5000	66300
	(e)	Zadoc Street (Molesworth to Keen - South)	80	375	460	36800	2	2500	5000	54340
	(f)	Zadoc Street (Molesworth to Keen - North)	100	375	460	46000	2	2500	5000	66300
	(g)	Zadoc Street (Keen to Dawson - South)	125	375	460	57500	2	2500	5000	81250
	(h)	Zadoc Street (Keen to Dawson - North)	100	375	460	46000	2	2500	5000	66300
										636415
15 Union Street	(a)	Orion Street (South End)	270	375	460	124200	2	2500	5000	167960
	(b)	Orion Street (to River)	75	525	520	39000	2	2200	4400	56420
	(c)	Orion Street (North End)	180	375	460	82800	3	2500	7500	117390
	(d)	Orion Street (to River)	75	525	520	39000	2	2200	4400	56420
										398190
16 Brewster Street	(a)	Mckenzie Street (Diadem to Hunter)	200	375	460	92000	3	2500	7500	99500
	(b)	Mckenzie Street (Diadem to Hunter)	200	375	460	92000	3	2500	7500	99500
	(c)	Diadem Street (Mckenzie to Magellan)	200	450	490	98000	3	2500	7500	105500
	(d)	North Place	100	375	460	46000	2	2200	4400	50400
	(e)	Cochran Place	125	375	460	57500	2	2200	4400	61900
	(f)	Dibbs Street (West Side)	150	375	460	69000	2	2200	4400	73400
	(g)	Diadem Street (Ballina to Magellan - North)	125	375	460	57500	2	2200	4400	61900
	(h)	Diadem Street (Ballina to Magellan - South)	125	375	460	57500	2	2200	4400	61900
	(I)	Hunter Street (Ballina to Magellan - North)	125	375	460	57500	2	2200	4400	61900
	(j)	Hunter Street (Ballina to Magellan - North)	125	375	460	57500	2	2200	4400	61900
	(k)	Pound Street (Diadem to Hunter - West)	200	450	490	98000	3	2200	6600	104600
	(l)	Pound Street (Diadem to Hunter - East)	250	375	460	115000	4	2200	8800	123800
	(m)	Magellan Street (Dawson to Catchart - South	200	375	460	92000	3	2200	6600	98600
	(n)	Magellan Street (Dawson to Catchart - North	150	450	490	73500	2	2200	4400	77900
	(o)	Magellan Street (Catchart to Brewster - Sout	80	450	490	39200	2	2200	4400	43600
	(p)	Magellan Street (Catchart to Brewster - Nort	225	600	550	123750	3	2200	6600	130350
	(q)	Magellan Street (Brewster to Drain)	150	450	490	73500	2	2200	4400	77900
	(r)	Ewing Street (Dawson to Cathcart - North)	80	375	460	36800	2	2200	4400	41200
	(s)	Ewing Street (Dawson to Cathcart - South)	150	375	460	69000	2	2200	4400	73400
	(t)	Ewing Street (Cathcart to Brewster - North)	150	375	460	69000	2	2200	4400	73400
	(u)	Ewing Street (Cathcart to Brewster - South)	100	375	460	46000	2	2500	5000	51000
	(v)	Brewster Street (Ewing to Magellan)	80	375	460	36800	2	2500	5000	41800
	(w)	Cathcart Street (Conway to Ewing - West)	70	375	490	34300	2	2500	5000	39300
	(x)	Cathcart Street (Conway to Ewing - East)	100	375	460	46000	2	2500	5000	51000
	(y)	Cathcart Street (Ewing to Magellan - West)	125	450	490	61250	2	2500	5000	66250
	(z)	Cathcart Street (Ewing to Magellan) - West)	125	450	490	61250	2	2500	5000	66250
	(a1)	Ballina Road (Dibbs East)	150	375	460	69000	3	2500	7500	76500
	(b1)	Ballina Road (Dibbs West)	250	375	460	115000	4	2500	10000	125000
										2099650

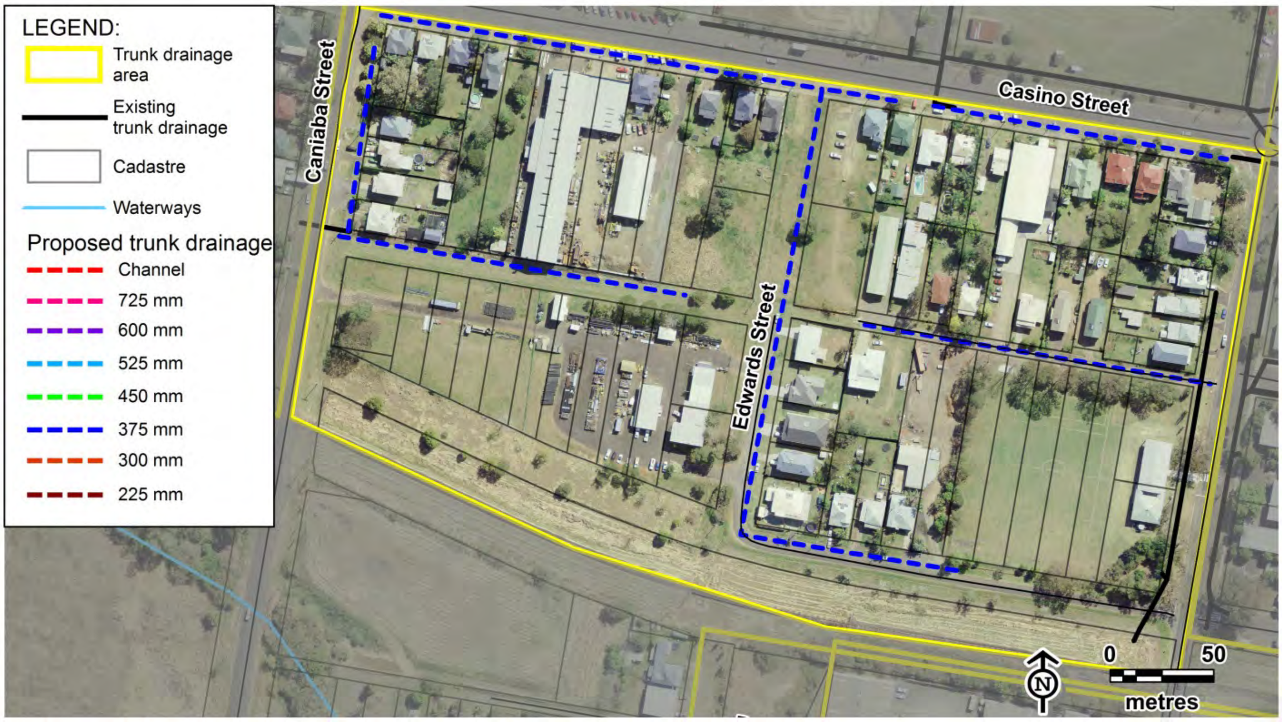
	Sub Catchment No.		Street Name	Length	Pipe Size	Rate	Estimate	Pits	Rate	Estimate	Total Estimate (incl 30% contingency)
17	Dawson Street	(a)	Junction Street (Keith to Keen Street)	150	450	490	73500	3	2200	6600	80100
		(b)	Virtue Street	50	375	460	23000	2	2200	4400	27400
		(c)	Junction Street (Keen to Ballina Road)	320	375	460	147200	5	2500	12500	159700
		(d)	Junction Street (to River)	320	450	490	156800	4	2200	8800	165600
		(e)	Keith Street	150	375	460	69000	2	2200	4400	73400
		(f)	Keith Street (to Keen St)	125	450	490	61250	3	2200	6600	67850
		(g)	Keen Street (James to Parkes - East Side)	250	450	490	122500	5	2200	11000	133500
		(h)	James Street (Keen to Dawson- West)	125	450	490	61250	2	2200	4400	65650
		(I)	James Street (Keen to Dawson- East)	125	375	460	57500	2	2200	4400	61900
		(j)	James Street (Dawson to Cathcart - West)	80	450	490	39200	2	2200	4400	43600
		(k)	James Street (Dawson to Cathcart - East	135	375	460	62100	4	2200	8800	70900
		(l)	Dawson Street (Virtue to James)	125	375	460	57500	2	2200	4400	61900
		(m)	Dawson Street (James to Parkes)	200	600	550	110000	4	2200	8800	118800
		(n)	Dawson Street (Parkes to Ballina - West)	75	375	460	34500	2	2200	4400	38900
		(o)	Dawson Street (Parkes to Ballina - East)	80	375	460	36800	2	2200	4400	41200
		(p)	Allen Street	90	375	460	41400	3	2200	6600	48000
		(q)	Cathcart Street (James to Esyth - West)	90	375	460	41400	2	2200	4400	45800
		(r)	Cathcart Street (James to Esyth - East)	90	375	460	41400	3	2200	6600	48000
		(s)	Esmonde Street (East of Cathcart)	75	375	460	34500	2	2200	4400	38900
		(t)	Esyth Street (East of Cathcart)	75	375	460	34500	2	2200	4400	38900
		(u)	Panorama Road	120	375	460	55200	2	2200	4400	59600
		(v)	Anstey Street	120	375	460	55200	2	2200	4400	59600
											1549200
18	Clarice Street	(a)	Elton Street (West of Esyth)	50	375	460	23000	1	2200	2200	25200
		(b)	Esyth Street (Daphne to Wyrallah)	200	375	460	92000	3	2200	6600	98600
		(c)	Daphne Street	100	375	460	46000	2	2200	4400	50400
		(d)	Elton Stree (Esyth to Esmonde)	180	375	460	82800	3	2200	6600	89400
		(e)	Esmonde Street (West of Garden st)	90	375	460	41400	2	2200	4400	45800
		(f)	Esmonde Street (Daphne to East of Elton)	200	375	460	92000	5	2200	11000	103000
		(g)	Showview Street (Garden to Parade)	180	375	460	82800	3	2200	6600	89400
		(h)	Parade Street (Esmonde to Showview)	125	375	460	57500	2	2200	4400	61900
		(I)	Garrad Street (Parade to Wyrallah Rd Pipe)	150	375	460	69000	2	2200	4400	73400
		(j)	Eden Street (Garden to Wyrallah Drain)	400	375	460	184000	6	2200	13200	197200
		(k)	Brewster Street (Cottee to Ballina Road)	230	375	460	105800	8	2200	17600	123400
		(l)	Cottee Street (Brewster to Clarice)	110	375	460	50600	3	2200	6600	57200
		(m)	Clarice Street (North to Ballina Rd Sth to Dra	300	375	460	138000	12	2200	26400	164400
		(n)	First Avenue (Sth to Drain/North to Drain)	230	375	460	105800	5	2200	11000	116800
											1296100
19	Dibbs Street	(a)	Spring Street (Second Ave to Drain)	175	600	550	96250	3	2200	6600	102850
		(b)	Spring Street (Second Ave to Dibbs Street)	300	450	490	147000	5	2200	11000	158000
		(c)	Spring Street (Dibbs Street to Nielson St)	300	375	460	138000	5	2200	11000	149000
		(d)	Bright Street (Short Street to Dibbs Street)	150	375	460	69000	2	2200	4400	73400
		(e)	Bright Street (Dibbs Street to Nielson Street	200	375	460	92000	3	2200	6600	98600
		(f)	Second Avenue (Avondale to Bright)	125	375	460	57500	2	2200	4400	61900
		(g)	Avondale Ave (Short St to Dibbs Street)	200	375	460	92000	3	2200	6600	98600
		(h)	Jacaranda Ave (Dibbs to Nielson)	250	375	460	115000	4	2200	8800	123800
		(I)	Sommerville Ave (Gorton Ave to Nielson)	165	375	460	75900	3	2200	6600	82500
		(j)	College Road (North)	100	450	490	49000	2	2200	4400	53400
		(k)	College Road (South)	125	525	520	65000	2	2200	4400	69400
		(l)	Ballina Road	400	375	460	184000	6	2500	15000	199000
		(m)	Dalley Street	200	375	460	92000	4	2500	10000	102000
											1372450
20	Wyrallah Road	(a)	Dalley Street	200	375	460	92000	3	2200	6600	98600
		(b)	Oakley Avenue	150	375	460	69000	4	2200	8800	77800
		(c)	Oliver Street	180	375	460	82800	4	2200	8800	91600
		(d)	Wyrallah Road (North-West Side to Rosedale	150	450	490	73500	4	2200	8800	82300
		(e)	Wyrallah Road (North-East Side to Rosedale	100	375	460	46000	3	2200	6600	52600
		(f)	Wyrallah Road (South - West Side)	200	375	460	92000	5	2200	11000	103000
		(g)	Atlas Street	200	375	460	92000	4	2200	8800	100800
		(h)	Smith Street	100	375	460	46000	3	2200	6600	52600
		(I)	Rosedale Square	80	375	460	36800	3	2200	6600	43400
		(j)	Floral Avenue	125	375	460	57500	3	2200	6600	64100
		(k)	Murray Street	200	375	460	92000	5	2200	11000	103000
		(l)	Conte Street	75	375	460	34500	3	2200	6600	41100
		(m)	Arnett Street	75	375	460	34500	3	2200	6600	41100
		(n)	Conte Street (Arnett to Pollard)	75	375	460	34500	3	2200	6600	41100
		(o)	Conte Street (Pollard to Wyrallah)	75	375	460	34500	3	2200	6600	41100
		(p)	City View Drive (to Wyrallah Rd - Pot Future	250	375	460	115000	6	2200	13200	128200
											1162400
21	East Lismore Catchme	(a)	Oakley Avenue (Dibbs St to Drain)	125	375	460	57500	3	2200	6600	64100
		(b)	Oakley Avenue (Drain to College Street)	150	450	490	73500	3	2200	6600	80100
		(c)	Oakley Avenue (Nielson Street to College St	200	600	550	110000	3	2200	6600	116600
		(d)	Oakley Avenue (College Street to Military Ro	300	375	460	138000	6	2200	13200	151200
		(e)	Granger Avenue	100	375	460	46000	3	2200	6600	52600
		(f)	Zambelli Drive	250	375	460	115000	5	2500	12500	127500
		(g)	Paunelle Avenue	250	375	460	115000	4	2500	10000	125000
		(h)	Marilyn Avenue	120	375	460	55200	2	2500	5000	60200
		(I)	College Street	250	375	460	115000	4	2200	8800	123800
		(j)	Walker Street	100	375	460	46000	2	2200	4400	50400
		(k)	Park Avenue	250	375	460	115000	6	2200	13200	128200
		(l)	Peter Street	185	375	460	85100	5	2200	11000	96100
		(m)	Hudson Avenue	150	375	460	69000	4	2200	8800	77800
		(n)	Walker Street (Dibbs to Nielson - West)	150	375	460	69000	3	2200	6600	75600
		(o)	Walker Street (Dibbs to Nielson - East)	80	450	490	39200	2	2200	4400	43600
		(p)	Walker Street (Nielson to College)	60	375	460	27600	3	2200	6600	34200
		(q)	Caldwell Avenue (Dibbs to Nielson West)	150	375	460	69000	3	2200	6600	75600
		(r)	Caldwell Avenue (Dibbs to Nielson East)	150	450	490	73500	5	2200	11000	84500
		(s)	Caldwell Avenue (West of College)	100	375	460	46000	3	2200	6600	52600
		(t)	Harmony Avenue (Dibbs to Nielson - West)	150	375	460	69000	3	2200	6600	75600
		(u)	Harmony Avenue (Dibbs to Nielson - East to	175	450	490	85750	5	2200	11000	96750
		(v)	Wade Street (Wyrallah to Nielson)	150	375	460	69000	3	2200	6600	75600
		(w)	Wade Street (Nielson to Drain)	120	450	460	55200	3	2200	6600	61800
		(x)	Nielson Street	60	375	460	27600	3	2200	6600	34200
		(y)	Concrete Channel 1	370		700	259000				259000
		(z)	Concrete Channel 1	355		700	248500				248500
		(a1)	Concrete Channel 1	875		700	612500				612500
											3083650

Project	TD1 - Trunk Drainage Upgrades – Webster Street, South Lismore
Location	South Lismore
Management Area	15 – South Lismore/Hollingsworth Creek

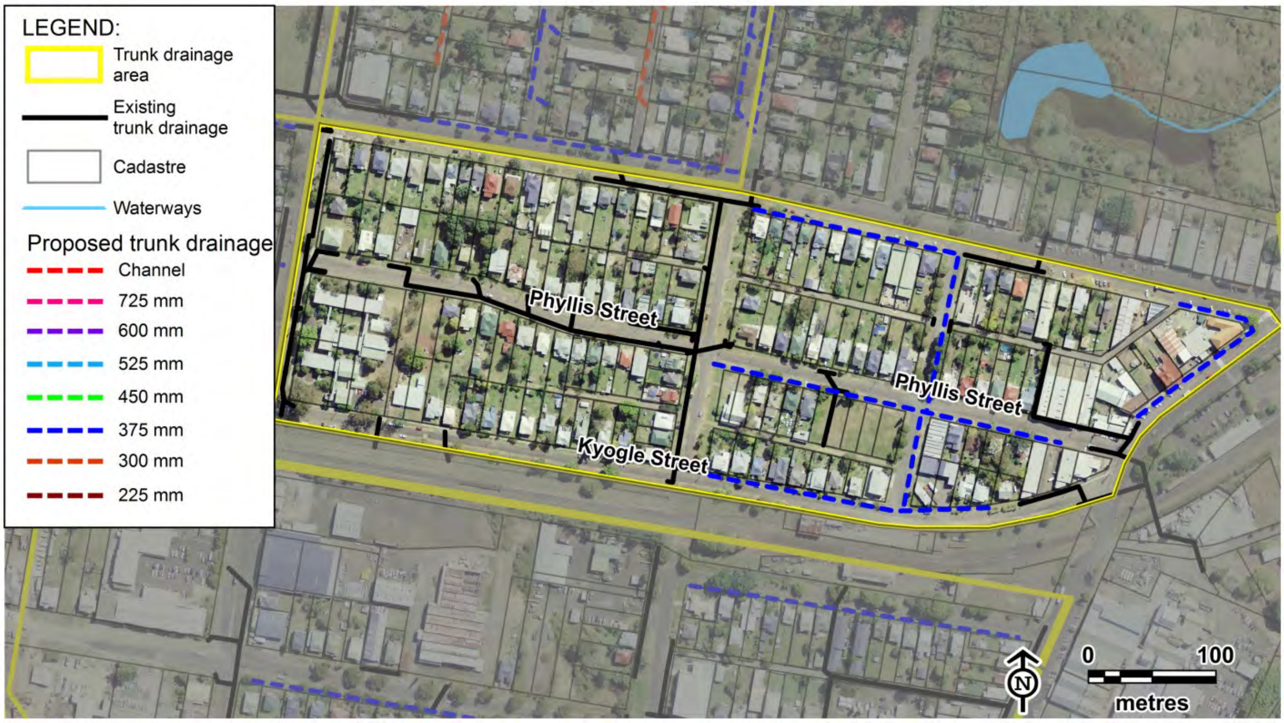


Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipe
Proposed Treatment Devices	Refer above figure. Includes one outlet structure and one in-line treatment device on Crown Street.
Capital cost estimate	$1,073,000

Project	TD2 - Trunk Drainage Upgrades – Edward Street, South Lismore
Location	South Lismore
Management Area	15 – South Lismore/Hollingsworth Creek



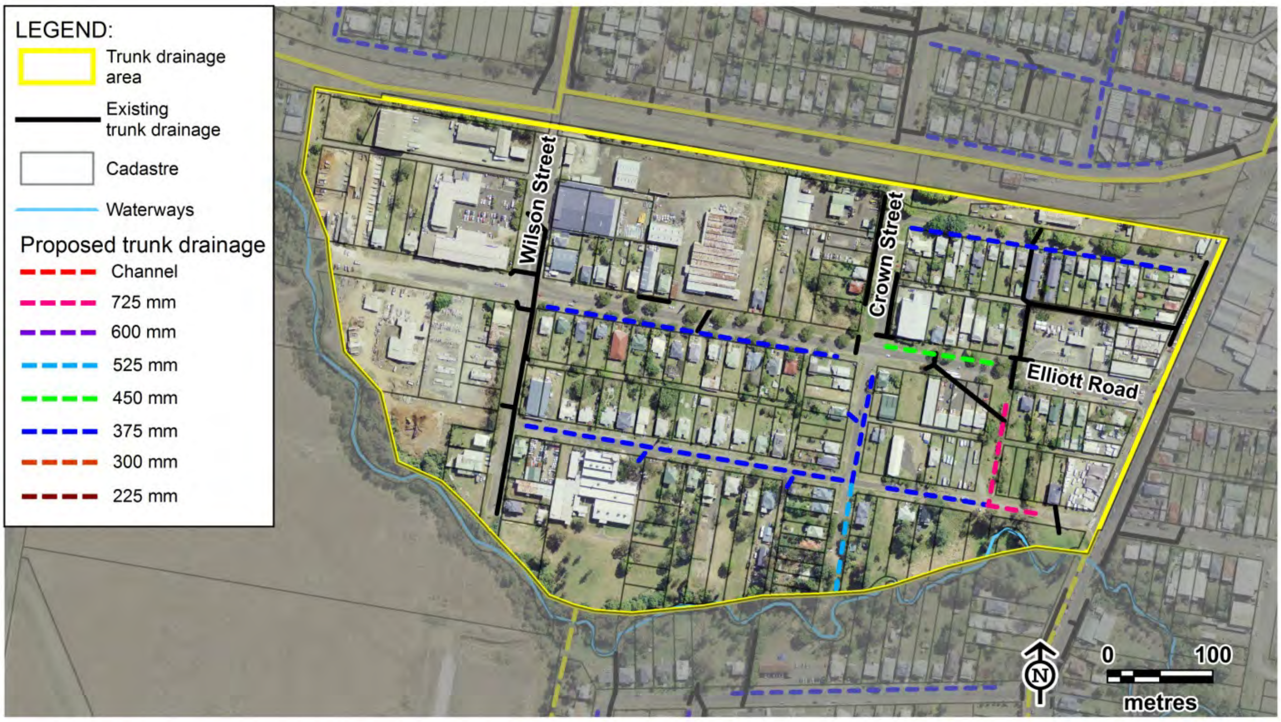
Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipe
Proposed Treatment Devices	None
Capital cost estimate	$733,000

Project	TD3 - Trunk Drainage Upgrades – Phyllis Street, South Lismore
Location	South Lismore
Management Area	15 – South Lismore/Hollingsworth Creek
	
Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	None
Capital cost estimate	$922,000

Project	TD4 - Trunk Drainage Upgrades – Caniaba Street, South Lismore
Location	South Lismore
Management Area	15 – South Lismore/Hollingsworth Creek

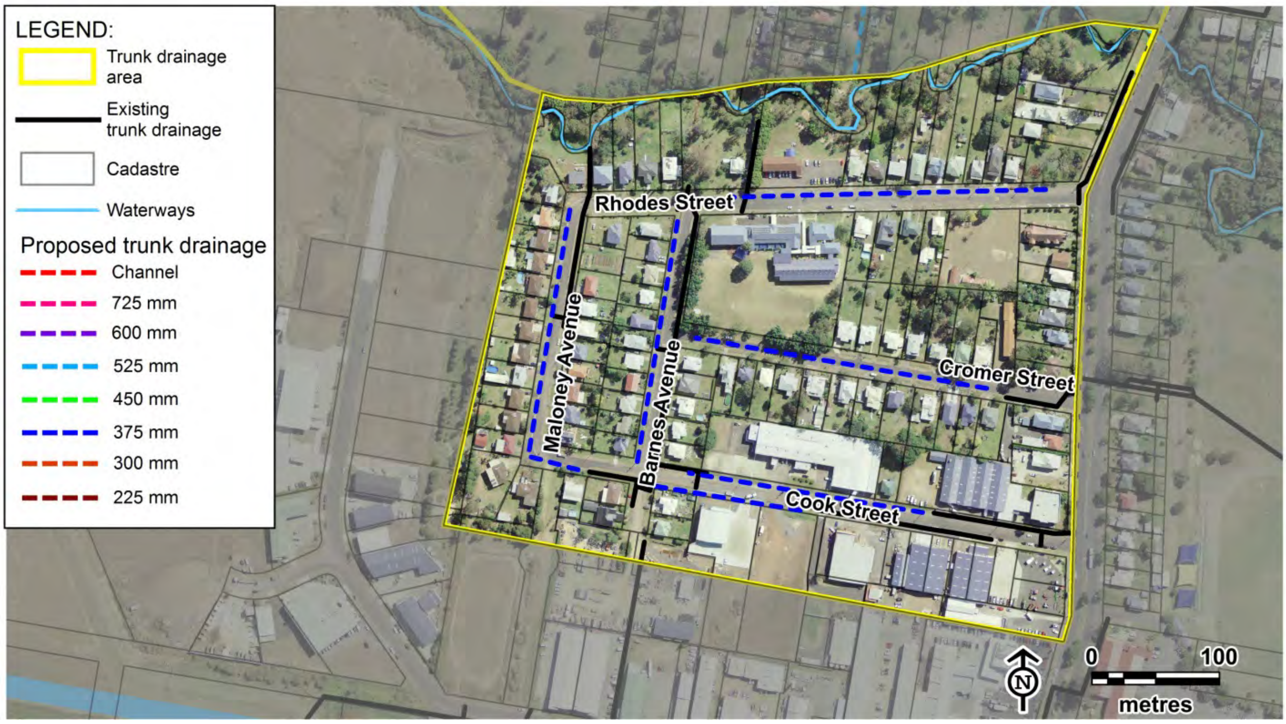
Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	Includes one outlet structure and one in-line treatment device at Caniaba Street.
Capital cost estimate	$859,000

Project	TD5 - Trunk Drainage Upgrades – Elliot Road, South Lismore
Location	South Lismore
Management Area	15 – South Lismore – Hollingsworth Creek



Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	Includes one in-line treatment device at Crown Street.
Capital cost estimate	$974,000

Project	TD6 - Trunk Drainage Upgrades – Cook Street, South Lismore
Location	South Lismore
Management Area	15 – South Lismore – Hollingsworth Creek



Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	None
Capital cost estimate	$770,000

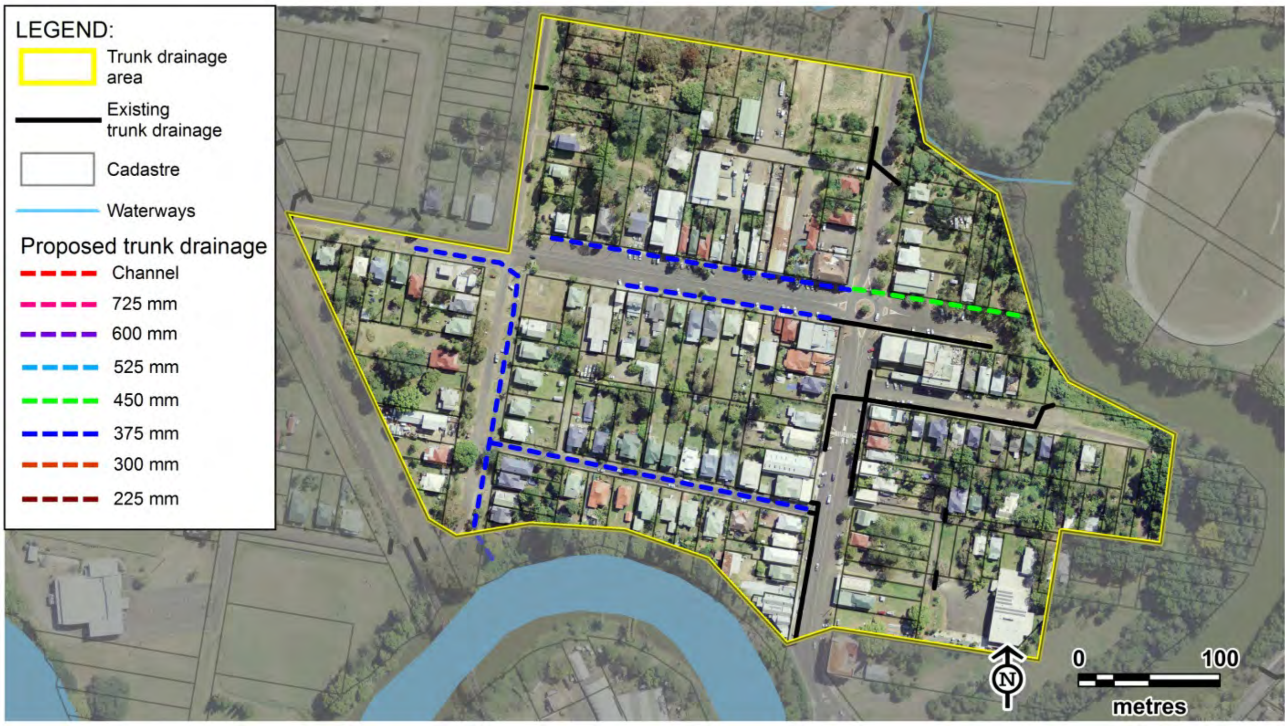
Project	TD9 - Trunk Drainage Upgrades – Casino Street, South Lismore
Location	South Lismore
Management Area	15 – South Lismore/Hollingsworth Creek

Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales
Proposed Treatment Devices	None
Capital cost estimate	$861,000

Project	TD10 - Trunk Drainage Upgrades – Terania Street, North Lismore (west of railway)
Location	North Lismore
Management Area	1 – North Lismore/Leycester Creek

Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales
Proposed Treatment Devices	Includes one outlet structure and one in-line treatment device at Tweed Street.
Capital cost estimate	$602,000

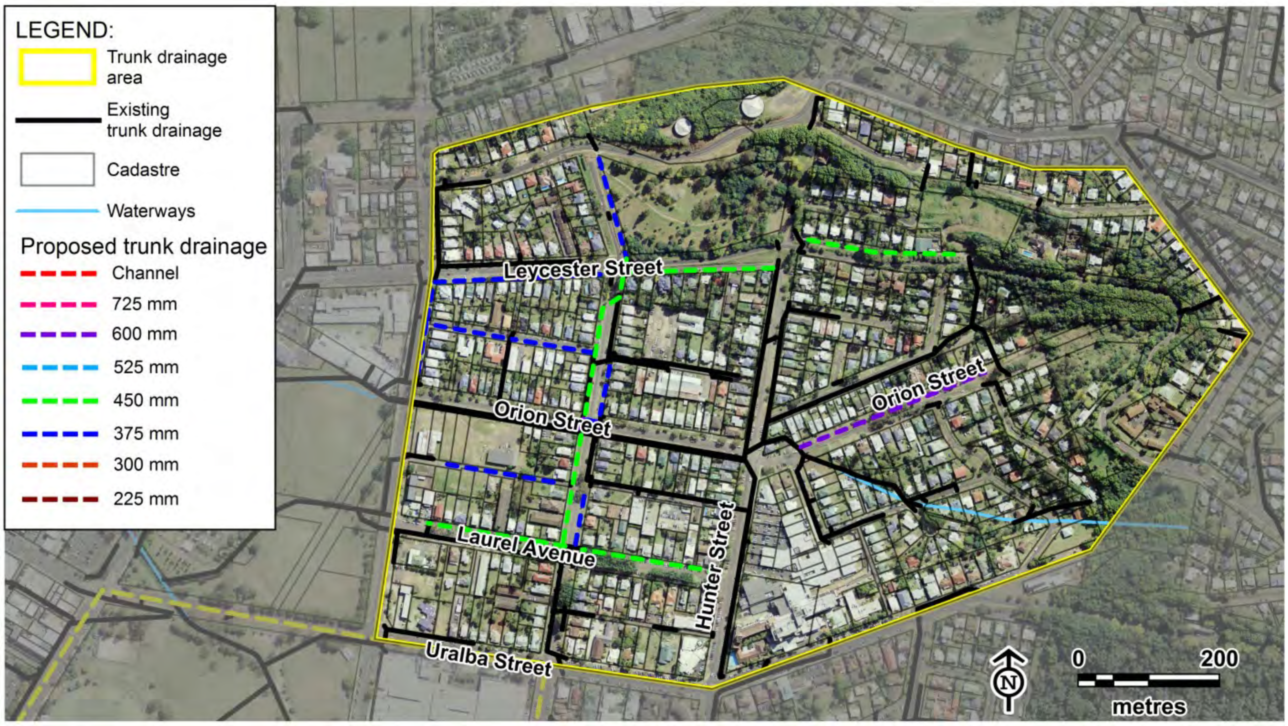
Project	TD11 - Trunk Drainage Upgrades – Bridge St Street, North Lismore
Location	North Lismore
Management Area	1 – North Lismore/Leycester Creek and 3 – Slaters Creek



Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	Includes two outlet structures and two in-line treatment devices at Pine Street and Terania Street.
Capital cost estimate	$698,000

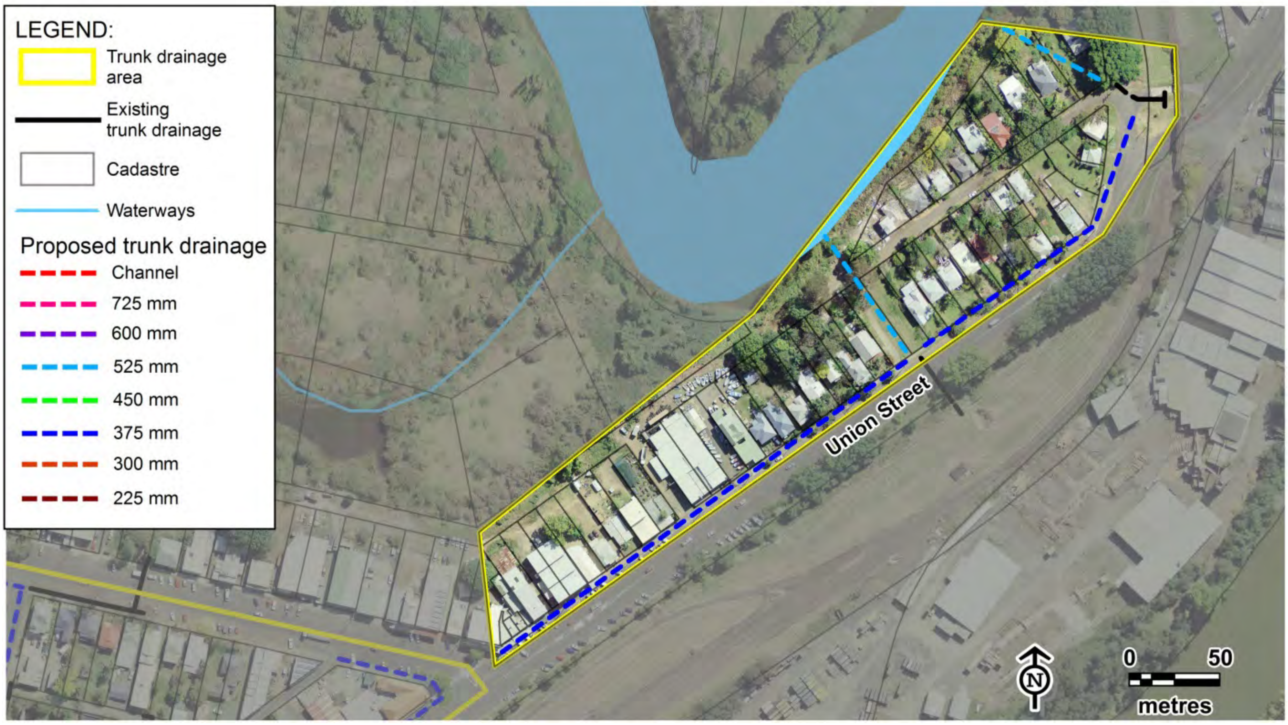
Project	TD12 - Trunk Drainage Upgrades – Winterton Pde, North Lismore
Location	North Lismore
Management Area	4 – Currie Creek

Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales
Proposed Treatment Devices	Includes one outlet structure and one in-line treatment device at Alexandra Parade.
Capital cost estimate	$79,000

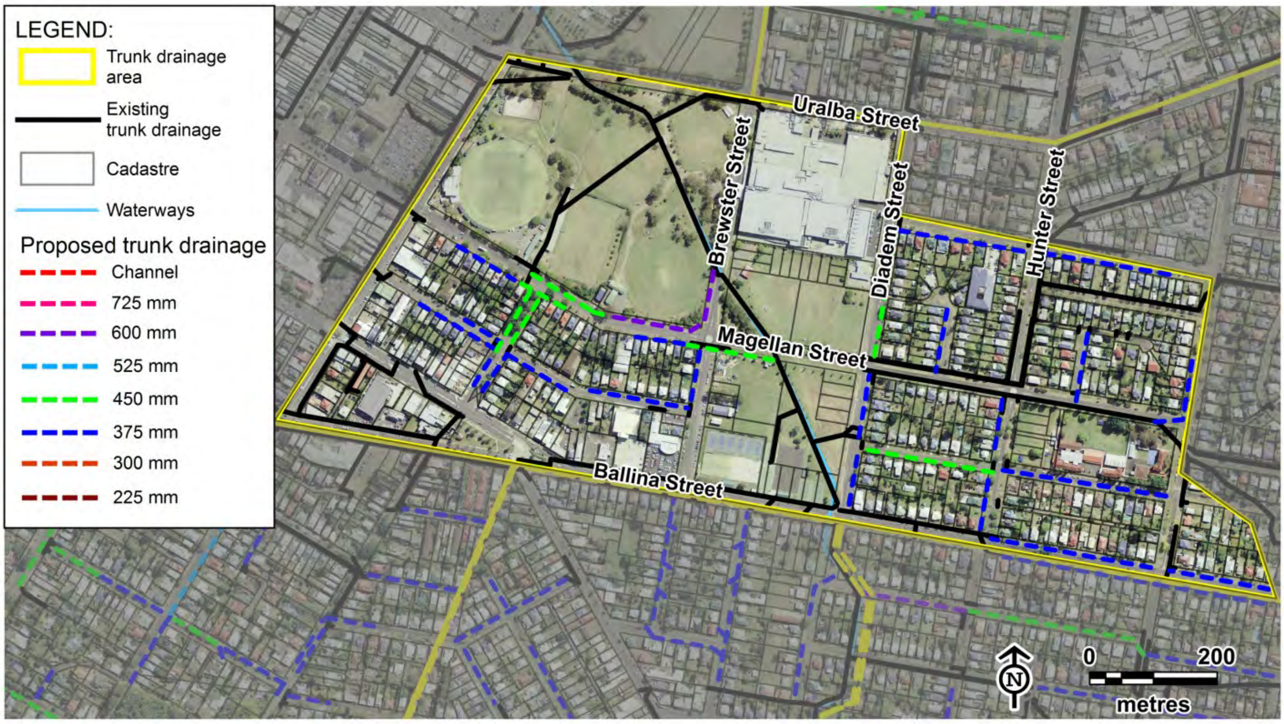
Project	TD13 - Trunk Drainage Upgrades – Diadem St Street, Lismore
Location	Lismore
Management Area	11 – Browns Creek
	
Management Issue/s	Future proposed medium density development, localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	None. Centralised treatment proposed downstream within Lismore Park.
Capital cost estimate	$1,791,000

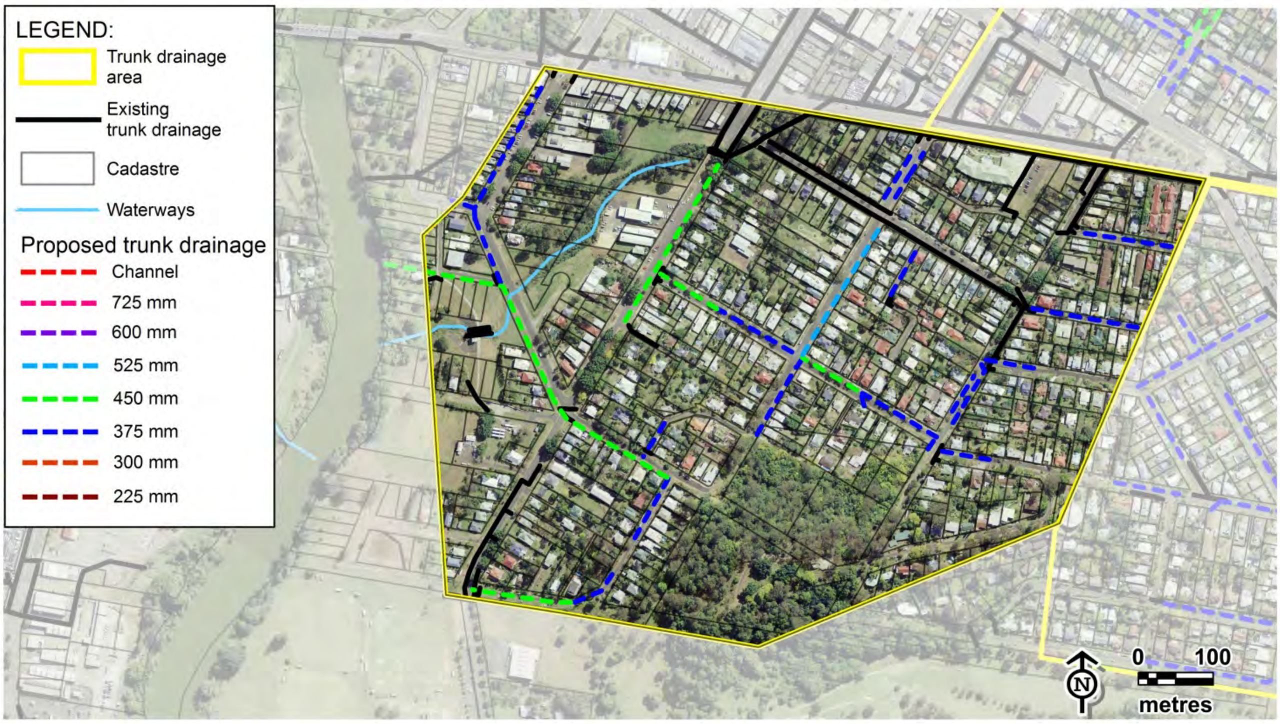
<table>
<tr><td>Project</td><td>TD14 - Trunk Drainage Upgrades – Keen St Street, Lismore</td></tr>
<tr><td>Location</td><td>Lismore</td></tr>
<tr><td>Management Area</td><td>11 – Browns Creek</td></tr>
<tr><td colspan="2">
</td></tr>
<tr><td>Management Issue/s</td><td>Localised flooding</td></tr>
<tr><td>Existing drainage infrastructure</td><td>Swales</td></tr>
<tr><td>Proposed Treatment Devices</td><td>Includes one outlet structure and one in-line treatment device at Zadoc Street.</td></tr>
<tr><td>Capital cost estimate</td><td>$661,000</td></tr>
</table>

Project	TD15 - Trunk Drainage Upgrades – Union St Street, South Lismore
Location	South Lismore
Management Area	15 – South Lismore – Hollingsworth Creek

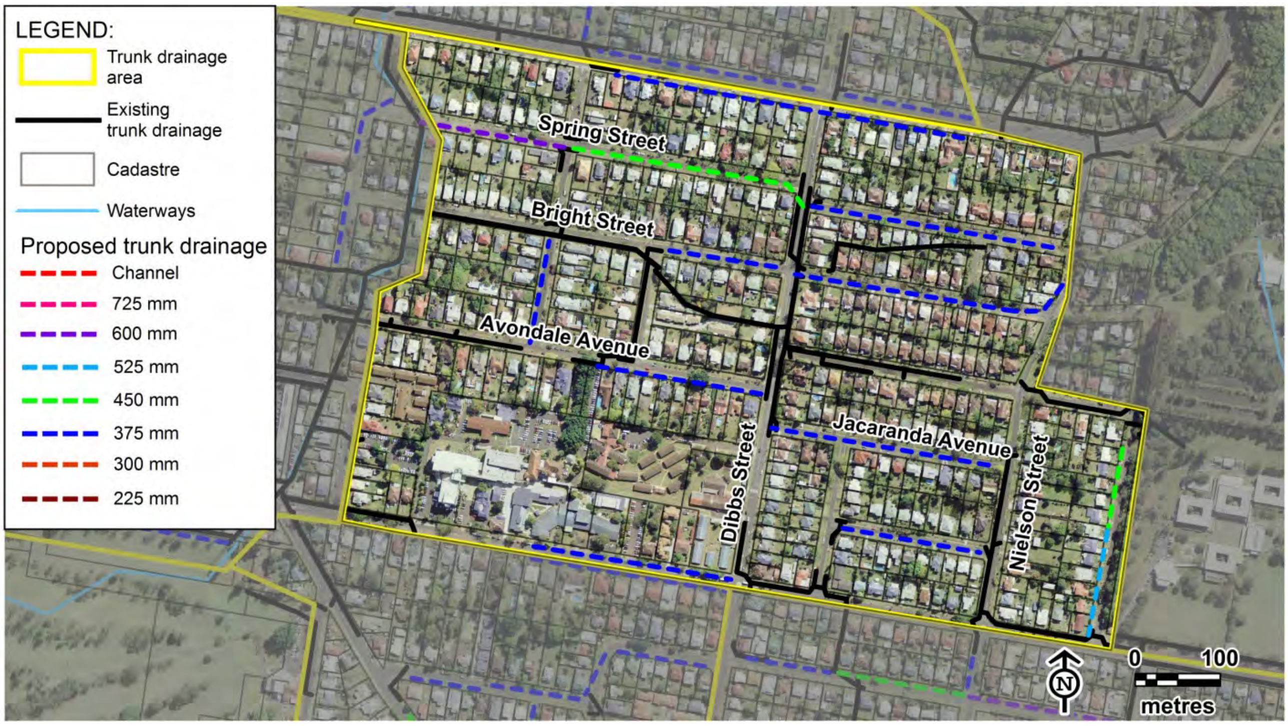


Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales
Proposed Treatment Devices	Includes two outlet structures and two in-line treatment devices (prior to discharge to Wilsons River).
Capital cost estimate	$446,000

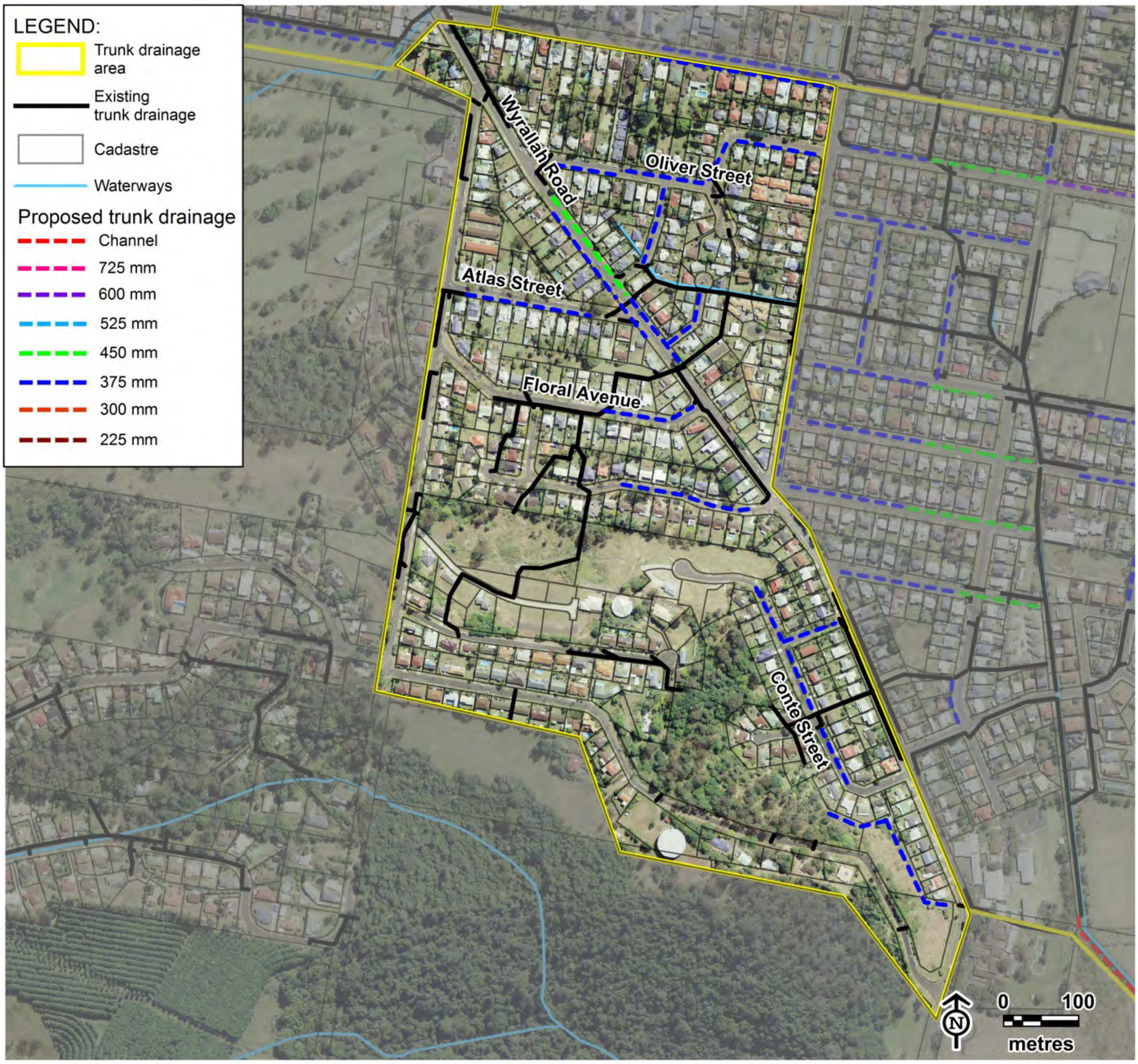
Project	TD16 - Trunk Drainage Upgrades – Brewster Street, Lismore
Location	Lismore
Management Area	11 – Browns Creek
	
Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes, channel
Proposed Treatment Devices	Refer above figure. Includes one in-line treatment device at Magellan Street (in addition to those proposed as part of the Browns Creek Master Plan).
Capital cost estimate	$2,760,000

Project	TD17 - Trunk Drainage Upgrades – Dawson Street, Lismore
Location	Lismore
Management Area	12 – Gasworks Creek, 11 – Browns Creek, 14 - CBD
	
Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	Includes one outlet structure.
Capital cost estimate	$2,020,000

Project	TD18 - Trunk Drainage Upgrades – Clarice Street, Lismore
Location	Lismore
Management Area	11 – Browns Creek
	
Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	None
Capital cost estimate	$1,685,000

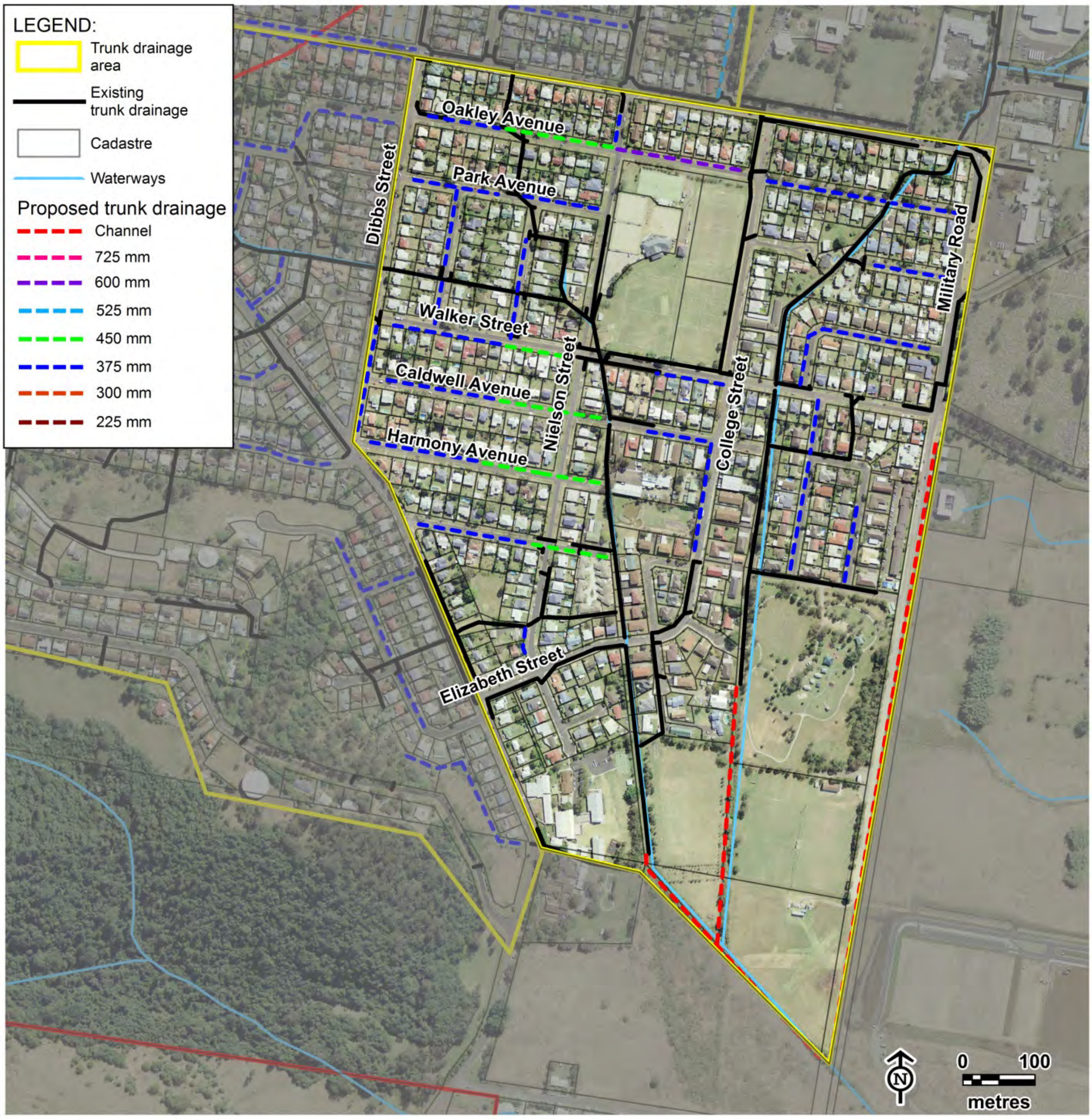
Project	TD19 - Trunk Drainage Upgrades – Dibbs Street, East Lismore
Location	East Lismore
Management Area	11 – Browns Creek, 10 – Monaltrie Creek
	
Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	None
Capital cost estimate	$1,784,000

Project	TD20 - Trunk Drainage Upgrades – Wyrallah Road, East Lismore
Location	East Lismore
Management Area	10 – Monaltrie Creek



Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes
Proposed Treatment Devices	Includes one in-line treatment device on Wyrallah Road.
Capital cost estimate	$1,559,000

Project	TD21 - Trunk Drainage Upgrades – East Lismore
Location	East Lismore
Management Area	10 – Monaltrie Creek



Management Issue/s	Localised flooding
Existing drainage infrastructure	Swales, pipes, channel
Proposed Treatment Devices	None. Wetland proposed at bottom of catchment.
Capital cost estimate	$4,008,000

Appendix 10: Sealed Roads Rehabilitation Program and Trunk Drainage Program

Table 28: Sealed roads rehabilitation program segments and trunk drainage upgrades

Program Year	Segment	Treatment	Road Name	Location	Suburb	Trunk Drainage Program Reference [1]
2015/16	54172	Rehabilitate	Brewster Street	Seg 004 From Ewing To Magellan	Lismore	16 (v)
2015/16	55128	Rehabilitate	Casino Street	Seg 009 From Caniaba To Hanlon	South Lismore	9 (c), (f), (g)
2015/16	55497	Rehabilitate	Magellan Street	Seg 007 From Cathcart To Brewster	Lismore	16 (o), (p)
2015/16	55542	Rehabilitate	Zadoc Street	Seg 002 From Keen To Change in Width	Lismore	14 (g), (h)
2015/16	55591	Rehabilitate	Cathcart Street	Seg 001 From Magellan To Ewing	Lismore	16 (y), (z)
2015/16	55592	Rehabilitate	Cathcart Street	Seg 002 From Ewing To Conway	Lismore	16 (w), (x)
2016/17	53747	Rehabilitate	Wyrallah Road	Seg 008 From Oliver To Smith	East Lismore	20 (d), (e)
2016/17	53748	Overlay & Stabilise	Wyrallah Road	Seg 009 From Smith To Floral	East Lismore	20 (f)
2016/17	55541	Rehabilitate	Zadoc Street	Seg 001 From Molesworth To Keen	Lismore	14 (e), (f)
2018/19	55614	Rehabilitate	College Street	Seg 002 From Colleen To Walker	East Lismore	21 (i)
Future	54200	Rehabilitate	Dawson Street	Seg 002 From James To Parkes	Girards Hill	17 (m)
Future	54201	Rehabilitate	Dawson Street	Seg 003 From Parkes To Ballina	Girards Hill	17 (n), (o)
Future	54296	Rehabilitate	James Street (Girards Hill)	Seg 001 From Keen To Dawson	Girards Hill	17 (h), (i)
Future	54297	Rehabilitate	James Street (Girards Hill)	Seg 002 From Dawson To Cathcart	Girards Hill	17((j), (k)
Future	54319	Rehabilitate	Leycester Street	Seg 004 From Hindmarsh To O'Flynn	Lismore	13 (h)
Future	54321	Rehabilitate	Leycester Street	Seg 006 From Diadem To New Ballina	Lismore	13 (g)
Future	54345	Rehabilitate	Orion Street	Seg 002 From Keen To Leycester	Lismore	14 (a)
Future	55115	Rehabilitate	Caniaba Street	Seg 003 From Casino To Change of Seal	South Lismore	4 (d)
Future	55564	Rehabilitate	Avondale Avenue	Seg 005 From Short To Dibbs	East Lismore	19 (g)

1. Refer Appendix 9

Appendix 11: Public Exhibition – Submissions Report

Lismore City Council

Draft Urban Stormwater Management Plan

Public Exhibition - Submissions Report

4 February 2016

Prepared on behalf of Lismore City Council by Hydrosphere Consulting.

Suite 6, 26-54 River Street
PO Box 7059, BALLINA NSW 2478
Telephone: 02 6686 0006
Facsimile: 02 6686 0078

PROJECT 15-013 – LISMORE USMP

REV	DESCRIPTION	AUTHOR	REVIEW	APPROVAL	DATE
0	Draft for LCC review	R. Campbell	M. Howland	M. Howland	4 Feb 2016

Hydrosphere Consulting

CONTENTS

TABLES

1. INTRODUCTION

Hydrosphere Consulting has prepared a Draft Urban Stormwater Management Plan (USMP) on behalf of Lismore City Council (Hydrosphere Consulting, 2015). The draft USMP was placed on public exhibition from 25 November 2015 to 22 January 2016.

Four submissions were received during the public exhibition phase. The submissions are summarised in Table 1 together with a response to the points raised in the submissions. The submissions are attached in Appendix 1.

Table 1: Summary of Written Submissions

No.	Author	Summarised Content	Response to Submission	Proposed Amendment to Draft USMP
1	Tim Heldt 816 Dunoon Road, Modanville wild-ash@bigpond.net.au 0439 984 399	Very systematic and comprehensive assessment. No specific comments.	Noted.	None
2	Viola and Uli Hoffmann 50 Macauley Street, Lismore	Stormwater issues at Macauley Street were not included in the USMP. The issues are predicted to increase with the North Lismore Plateau development. Properties on Macauley Street used to be drained by a grass swale with grazing cows. Area is not currently maintained and drain spills, causing flooding of their driveway and the house.	Council has investigated the stormwater management requirements at this location. As this is a private property, any water runoff issues between adjoining properties is a civil matter and Council has little legal power to intervene. In general, property owners are only responsible for controlling stormwater runoff from their properties if water is flowing from hard surfaces, such as paving or roofing. Owners are not responsible for controlling stormwater runoff from natural surfaces, such as grassed or treed areas, unless significant works like landscaping have created a catchment and caused a concentration of flow towards another property. A Stormwater Fact Sheet is available on Council's website that provides guidance for residents in this situation (attached in Appendix 2).	None

No.	Author	Summarised Content	Response to Submission	Proposed Amendment to Draft USMP
3	Kristin den Exter Secretary, Wilsons River Landcare Group Inc. c/ 2 Balmer Avenue, Lismore Heights kristin.denexter@gmail.com 0414 223 139	Prioritising funding to naturalisation of channels, river banks and catchment areas will produce the most cost effective outcomes.	Noted. Riparian rehabilitation projects and natural stormwater systems are key outcomes of the plan.	None
		All constructed wetland actions should be informed by best available practice and with reference to The Constructed Wetlands Manual Volumes I & II by the then Department of Land and Water Conservation NSW (1998).	Noted. All constructed wetlands would be constructed in accordance with current best practice.	None
		Plantings in high flow areas should be achieved through minimum soil disturbance, deep planting and mulching with shredded tea tree mulch. Reference is provided to an article on restoration at Riverside Park, Lismore (2010).	Noted. Further consultation with Landcare will be undertaken as partnership opportunities arise.	None
		The angle of stormwater outflows should be such that stormwater entering the river system does so with the least possible erosion of riverbanks	Agreed.	None

No.	Author	Summarised Content	Response to Submission	Proposed Amendment to Draft USMP
4	Wayne Franklin Technical Services Director, Rous Water	Rous Water considers it important that stormwater management throughout the study area is consistent with the water catchment values of this area. The draft plan represents a comprehensive and clear approach to the identified objectives and management issues identified but further consideration is requested with regard to specific matters (discussed below).	Noted	None
		The draft plan outlines a strategic approach to asset management from the planning and development stage through to the whole of asset life cycle, which forms a sound basis to progress. Whilst Rous Water supports this strategic direction, it is critical that this process be clearly documented and procedures established so that the intent of development consent conditions is not lost through the asset development, construction and operational stages. Formalised procedures would allow this approach to move beyond an aspirational objective into a formalised process.	The following actions are proposed in the draft USMP: *NS6 - Develop and implement procedures for identification and approval of ongoing maintenance requirements for all new stormwater assets;* *NS-7 - Develop procedures for referral of designs and development applications to relevant staff with knowledge of stormwater management requirements; and* *NS8 - Develop procedures for handover of stormwater assets to Council.* It is agreed that formalised procedures are required. The development of these procedures is a key action in the plan to convert the asset management objectives into formalised planning and development controls.	None.

No.	Author	Summarised Content	Response to Submission	Proposed Amendment to Draft USMP
4	Wayne Franklin Technical Services Director, Rous Water (cont.)	The draft plan does not provide any clarity as to whether the Neutral or Beneficial Effect (NorBE) criteria considered necessary by Rous Water for development in drinking water catchment areas will be applied. Rous Water requests that LCC formalise a requirement within the USMP to apply the NorBE criteria as being the appropriate stormwater objective to be applied within drinking water catchment areas for significant development.	Action *NS5 - Consult with Rous Water regarding development assessment guidelines for developments within the Wilsons River drinking water catchment* applies to this comment. While an agreement on the appropriate policies for development in the drinking water catchment has not yet been developed with Rous Water, LCC is committed to consultation with Rous Water and review of development controls and referral processes that address the risks to water quality while satisfying Council's development objectives.	None.
		Whilst recognising the funding constraints, Rous Water is supportive of any means of proactively scheduling inspections throughout construction, to ensure enforcement of development control conditions regarding erosion and sediment controls.	Noted. Action *NS9 – Review level of resources for enforcement of stormwater management requirements in development approval conditions* aims to address this comment.	None

No.	Author	Summarised Content	Response to Submission	Proposed Amendment to Draft USMP
4	Wayne Franklin Technical Services Director, Rous Water (cont.)	Very small dollar amounts have been allocated for non-structural activities particularly community education, staff training and enforcement activities. Rous Water questions whether there is scope for providing some additional allocations in these non-structural areas.	The following actions are proposed (with resourcing) in the draft USMP: *NS9 – Review level of resources for enforcement of stormwater management requirements in development approval conditions;* *NS13 - Continue to identify opportunities for community education through cost-effective programs such as community events and partnerships with other agencies such as Rous Water;* *NS14 - Continue to provide community information through Council's website and printed information where required to support these programs;* *NS15 - Develop education programs as part of the implementation of "showcase" projects such as Browns Creek water quality improvements;* *NS16 - Develop education programs targeting developers planning major developments; and* *NS19 - Ongoing review and identification of staffing requirements for delivery of the USMP implementation plan.* LCC acknowledges there is limited funding available but also recognises the potential success of education and enforcement programs. LCC will continue to identify partnership opportunities to assist with funding of these programs.	None

No.	Author	Summarised Content	Response to Submission	Proposed Amendment to Draft USMP
4	Wayne Franklin Technical Services Director, Rous Water (cont.)	An additional project that may warrant inclusion in the plan is the Wilsons River Catchment Schools Education and Restoration Project.	Agreed.	The following text will be added at the end of Section 2.9, volume 2: There are a number of other areas where riparian restoration and management is undertaken within the study area by community groups including: • ... • Rous Water, in partnership with six local schools, LCC, Landcare, WIRES, Friends of the Koala, and Southern Cross University has established a series of riparian zone improvement sites along the Wilsons River and Tucki Tucki Creek (the Wilsons River Catchment Schools Education and Restoration Project). Sites that are located within the study area include riparian zones on the Wilsons River established adjacent to Albert Park Public School, Richmond River High School, Trinity Catholic College, St Carthages Primary School and a site on Tucki Tucki Creek adjacent to Kadina High School. In undertaking these improvements in riparian condition, the project has also recognised the critical need to involve schools and young people in restoring waterways, and the collaborative partnership approach required to achieve it. The following text will be added at the end of Section 6.6.1, volume 2: • .... • The Wilsons River Catchment Schools Education and Restoration Project (refer Section 2.9) has involved schools and young people in restoring waterways.

No.	Author	Summarised Content	Response to Submission	Proposed Amendment to Draft USMP
4	Wayne Franklin Technical Services Director, Rous Water (cont.)	Given the frequency of sewer overflows and the volumes of sewage discharged, for completeness, the plan should provide a strategic outline of the measures in place to reduce contaminant loadings from sewer overflows and the associated impact on stormwater systems.	Sewer overflows are acknowledged as a key water quality issue for stormwater management in the USMP. The prevention of sewer overflows and reduction of inflow and infiltration to the sewer system are addressed through Council's sewerage strategic planning rather than the urban stormwater management program.	None.

No.	Author	Summarised Content	Response to Submission	Proposed Amendment to Draft USMP
4	Wayne Franklin Technical Services Director, Rous Water (cont.)	The analysis of stormwater management areas could be extended by considering the future development sites within each management area and the potential stormwater management options that would be most appropriate within each catchment to allow suitable locations/land to be identified for future stormwater treatment infrastructure and investment.	Stormwater servicing for future growth areas is addressed in Section 10.5 and Appendix 8 of Vol. 2. Strategic catchment based assessment of stormwater treatment strategies has been undertaken with opportunities highlighted in the Plan e.g. centralised treatment for stormwater from the hospital precinct and retention and restoration of existing gullies and creeks within and downstream of the Northern Front sites to provide environmental benefits. The rezoning of identified urban greenfield release areas will occur by way of landowner initiated planning proposals prepared in accordance with Council and Department of Planning and Environment's requirements and will address any site specific issues identified in the LCC Growth Management Strategy. Planning Proposals will be required to include Structure Plans that address infrastructure servicing including stormwater management. The Structure Plans will either be incorporated into a site specific DCP or the Urban Residential Subdivision DCP prior to or in conjunction with the amendment to the LEP being made. Action NS5 - Consult with Rous Water regarding development assessment guidelines for developments within the Wilsons River drinking water catchment is also relevant to this comment (refer response above).	None.

REFERENCES

Hydrosphere Consulting (2015) *Lismore Urban Stormwater Management Plan Volume 1: USMP Implementation Program and Volume 2: Background Information*

APPENDIX 1 – WRITTEN SUBMISSIONS

From:	Tim Heldt
To:	Records
Subject:	Submission Received: Wed, 20 January 2016 4:46:44 PM - Lismore Urban Stormwater Management Plan
Date:	Wednesday, 20 January 2016 4:46:44 PM

Submission Regarding: Lismore Urban Stormwater Management Plan

Name: Tim Heldt
Email: wild-ash@bigpond.net.au
Phone: 04399 84399
Street Address: 816 Dunoon Rd Modanville

Comments: Looks like a very systematic and comprehensive assessment. No specific comments.

Best Regards

Tim

Follow Up: nofollowup

Viola and Uli Hoffmann

50 Macaulay Street

Lismore 2480

RECEIVED
2 1 JAN 2016

Lismore City Council

General Manager

PO BOX 23a

Lismore2480

21.01.2016

Re: Lismore Urban Stormwater Management Plan

(Volume 1: USMP Implementation Program)

Since it is a goal of the USMP to manage water quantity such that damage to private property caused by localised flooding is minimised through improved asset management , maintenance and asset upgrades as well as new assets where these are warranted and

The USMP brings together the available information to identify urban stormwater management issues and formulate management actions,

We and a number of residents of Macaulay Street would urgently ask for inclusion (given greater prioritisation) into the current management action plan.

The stormwater management issues here will further be aggravated once the North Lismore Plateau development commences, so that we see the need to take action very soon.

It is certain that any development that releases more stormwater towards Macaulay Street

will adversely affect residential housing on the hill side of Macaulay Street.

Please find attached the plans 1, 2 and 15 from the Lismore USMP Background Information for clarification and please also note the (yellowed) arrows.

The properties of Macaulay Street have been protected by an open drain (grass swale) in the past, but this is not maintained by grazing cows anymore for a couple of years now.

This land/drain is not maintained at the moment and we would like to notify you of the consequences this has on our properties.

The drain has often spilled over in the past few years and has washed away our drive way a couple of times.

We also have had difficulties stopping flash flooding entering our house on a couple of occasions.

Also the drain at Macaulay Street is insufficient,
it is also causing regularly minor flooding in our neighbour's front yard.

The yellowed arrow on Plan 15 –South Lismore/Hollingworth Creek Management Area shows a stormwater flow that would be very much appreciated (away from residential houses in Macaulay Street), but it might need additional professional attention to verify the topographical situation.

We would greatly appreciate if this matter is given greater priority/inclusion into the USMP (10years) action plan.

Kind regards,

Viola and Uli Hoffmann


SLATERS CREEK
ANAGEMENT AREA
16
10
Currie
Creek
Slaters Creek
Winterton Pde
15 - SOUTH LISMORE/HOLLINGWORTH CREEK
MANAGEMENT AREA
Terania St
Casino Street
Union Street
1
2
4
5
6
7
8
9
10
11
12
13
14
15
16

Figure 29: Stormwater Management Area 15 - South Lismore - Hollingworth Creek

WILSONS RIVER LANDCARE

Urban Stormwater Management Plan Submission

January 22 2016

Dear Sir/Madam,

Congratulations on an overall good Urban Stormwater Management Plan.
The Wilsons River Landcare Group's submission consists of the following.

- Throughout, emphasis is best placed on naturalising drainage channels, river banks and to reforest available catchment areas as these actions deliver positive outcomes across all eight priority site-based issues. Urban stormwater quality, gross pollutants, sedimentation, localised flooding, weeds restricting flow, inadequate drainage, waterlogging and poor riparian condition are all ameliorated through the control of stormwater quality, sedimentation, flow speed, flow direction and drainage provided by local native natural hydrological systems, catchment and wetland ecosystems. Accordingly, prioritising funding to naturalisation of channels, river banks and available catchment areas will produce the most cost effective outcomes.
- All constructed wetland actions should be informed by best available practice and with reference to *The Constructed Wetlands Manual Volumes I & II* by the then Department of Land and Water Conservation NSW 1998.
- Also, plantings in high flow areas should be achieved through minimum soil disturbance, deep planting and mulching with shredded tea tree mulch, the long variety, because this mulch matts together, does not wash away in floods,

protects plantings from high water flow erosion and also protects plantings from waterlogging by assisting aeration around plants after flood events by providing a draining medium and promoting the cracking of flood silt deposits. See, Project Summary 28.15: Richards, Michelle (Woo Wei). "Stabilising new restoration plantings of gallery rainforest at Riverside Park, Lismore, NSW." Ecological Management & Restoration 11.2 (Aug 2010): 159-160

- The angle of stormwater outflows should be such that stormwater entering the river system does so with the least possible erosion of riverbanks. Stormwater issuing at a right angle to the river from the Molesworth St pump station has been observed to erode the riverbank opposite. Stormwater outlets need to direct stormwater flow with the direction of river water, not across it.

Kristin den Exter

Secretary, Wilsons River Landcare Group Inc.

c/ 2 Balmer Avenue, Lismore Heights NSW 2480

(M) 0414223139 (E) kristin.denexter@gmail.com

Our Ref: AA/NS:1322.10 (46460)

29 January 2016

General Manager
Lismore City Council
PO Box 23A
LISMORE NSW 2480

Attention: Mr Anton Nguyen, Environmental Strategies (Stormwater and Sustainability)

Dear Sir

Draft Lismore Urban Stormwater Management Plan

Thank you for providing Rous Water with the opportunity to comment on the *Draft Lismore Urban Stormwater Management Plan* ('the draft plan'). Rous Water is committed to providing quality drinking water to the region and therefore welcomes the opportunity to be involved in review of this draft plan so as to minimise the risk posed to the public water supply arising from urban stormwater discharges.

1. CONTEXT

As documented in the draft plan, Rous Water extracts water from the Wilsons River at Howards Grass near Lismore for the purposes of providing the bulk urban water supply for this region. As a result, the quantity and quality of urban stormwater discharged from the study area has the potential to impact upon the quality of this raw water, and Rous Water considers it important that stormwater management throughout the study area is consistent with the water catchment values of this area.

2. ROUS WATER COMMENTS

Rous Water has reviewed the draft plan (including both Volumes 1 and 2), and considers that the draft plan represents a comprehensive and clear approach to the identified objectives and management issues identified. However Rous Water considers that there are some issues which may warrant further consideration and explanation in the final document in relation to the following matters:

Volume 1

i. Whole of asset life cycle management process
ii. Planning and development within Wilsons River drinking water catchment
iii. Construction sites
iv. Review of prioritised management actions

Volume 2

v. Riparian restoration sites
vi.. Sewer overflows
vii. Urban stormwater management areas

Details are provided below.

2.1 Whole of asset life cycle management process

It is recognized that the draft plan (Section 6) outlines a whole of life cycle asset management process for stormwater assets. The draft plan outlines a strategic approach to asset management from the planning and development stage through to the whole of asset life cycle, which forms a sound basis to progress.

The draft plan identifies policies and procedures from other jurisdictions that “could be adopted” to ensure that this a whole of life cycle asset management process is actually embedded into internal Lismore City Council (LCC) management processes. Whilst Rous Water supports this strategic direction, it is critical that this process be clearly documented and procedures established so that the intent of development consent conditions is not lost through the asset development, construction and operational stages. Formalised procedures would allow this approach to move beyond an aspirational objective into a formalized process.

2.2 Planning and development within Wilsons River drinking water catchment

It is noted that the draft plan describes Rous Water’s requirements for development within drinking water catchment areas (refer Section 6.3.1, Volume 1; Section 7.2.3 and Section 8.3, Volume 2).

Further, the draft plan states that “*Rous Water considers that development consent should not be granted unless the proposed development would have a Neutral or Beneficial Effect (NorBE) on water quality*” and that “*Consultation with Rous Water is required to develop appropriate planning controls and referral processes that address the risks to water quality while satisfying Council’s development objectives*.”

However the draft plan does not provide any clarity as to whether the NorBE criteria considered necessary by Rous Water will be applied.

Whilst Rous Water is in agreement with the draft plan with respect to being willing to undertake referral processes and to provide specialist input where requested, the draft plan makes no statement as to what stormwater standards will be applied to larger scale development within the drinking water catchment area.

For some years, Rous Water has clearly communicated to LCC the NorBE criteria as being the appropriate stormwater objective for application within drinking water catchment areas. However Rous Water is frequently provided with rezoning proposals from LCC for review that have not provided any consideration of the drinking water catchment status, and certainly not addressed the NorBE criteria.

Rous Water requests that LCC formalize a requirement within the *Lismore Urban Stormwater Management Plan* to apply the NorBE criteria as being the appropriate stormwater objective to be applied within drinking water catchment areas for significant development.

2.3 Construction phase erosion and sedimentation controls

Rous Water notes the discussion in the draft plan (Section 6.3.5) with respect to construction phase erosion and sedimentation controls. Whilst recognizing the funding constraints, Rous Water is supportive of any means of proactively scheduling inspections throughout construction processes, to ensure enforcement of development control conditions.

2.4 Review of prioritised management actions

Rous Water recognizes the challenges involved in developing a sustainable approach to stormwater management across all of the objectives, constraints and with limited resources as described in the draft plan.

Review of the implementation program indicates that very small amounts have been allocated for non-structural activities, and in particular, community education, staff training and enforcement activities. Rous Water understands that stormwater education programs have been shown to compare positively with 'engineering' solutions, including favourable cost-benefit comparisons. Notwithstanding the challenges of delivering across all the nominated objectives, given the small quantum of the allocation to such non-structural strategies and the effective leveraging that such activities provide, Rous Water questions whether there is scope for providing some additional allocations in this non-structural area.

2.5 Riparian restoration sites

Section 2.9 of Volume 2 identifies a number of riparian restoration sites that have involved community groups undertaking on-ground action. An additional project that may warrant inclusion is the *Wilsons River Catchment Schools Education and Restoration Project*, where Rous Water, in partnership with six local schools, Lismore City Council, Landcare, WIRES, Friends of the Koala, and Southern Cross University has established a series of riparian zone improvement sites along the Wilsons River and Tucki Tucki Creek. Sites that are located within the study area include riparian zones on the Wilsons River established adjacent to Albert Park Public School, Richmond River High School, Trinity Catholic College, St Carthages Primary School and a site on Tucki Tucki Creek adjacent to Kadina High School. In undertaking these improvements in riparian condition, the project has also recognised the critical need to involve schools and young people in restoring waterways, and the collaborative partnership approach required to achieve it.

2.6 Sewer overflows

Following development of the Wilsons River Source, LCC commenced a notification protocol whereby the occurrence of sewer overflows within the drinking water catchment area were reported to Rous Water. Based on these notifications, it is apparent that sewer overflows represent a significant risk to stormwater quality and raw water quality within the Wilsons River.

Whilst the draft plan (Section 4.1.1) recognizes the biological and chemical oxygen demands of sewage overflowing into stormwater systems, the draft plan provides no quantification or estimation as to the likely proportion of contaminant loading associated with sewer overflows, compared to contaminant loads from stormwater discharges.

It is recognized that it is not the purpose of the draft plan to address pollution loading from sewer overflows. However given the frequency of sewer overflows and the volumes of sewage discharged, for completeness, the plan should provide a strategic outline of the measures in place to reduce contaminant loadings from sewer overflow and the associated impact on stormwater systems.

2.7 Urban stormwater management areas

Section 5 of the draft plan (Volume 2) provides an excellent summary of the characteristics of each stormwater management area, inclusive of potential stormwater pollution sources/issues and any recorded stormwater treatment devices. This analysis could be extended by considering the future development sites within each management area and the potential stormwater management options that would be most appropriate within each catchment – this would allow suitable locations/land to be identified for future stormwater treatment infrastructure and investment.

3. CONCLUSION: REQUEST FOR CONSIDERATION

The *Public Health Act 2010* requires Rous Water to maintain a quality assurance program that is consistent with the Framework for the Management of Drinking Water Quality (as set out in the *Australian Drinking Water Guidelines*). As part of Rous Water's approach to these requirements, Rous Water needs to be satisfied that urban development undertaken within water catchment areas is consistent with water catchment values and does not pose a risk to drinking water quality or catchment health/biodiversity values.

Thank you for the opportunity to detail these important issue of concern to Rous Water. In order to demonstrate compliance with contemporary standards for urban development in drinking water catchment areas as well as the water catchments clause in the *Lismore Local Environmental Plan 2012*, it is requested that LCC consider the issues raised in this letter, and respond to these comments in finalizing the draft plan. Should you require any further information regarding this letter or should you wish to discuss the issues raised further, please contact Anthony Acret on (02) 6621 8055.

Yours faithfully

W Franklin

Wayne Franklin
Technical Services Director

APPENDIX 2 – LCC STORMWATER FACTSHEET

Stormwater on your property

Water that is unable to enter the underground drainage system will find its natural way to the nearest watercourse via overflow paths. These overflow paths are typically roadways, public reserves, pathways and often through private property.

Owner's responsibilities

You must maintain the stormwater pipes, gutters, downpipes, gully pits and any other components of your approved stormwater system on your property in good condition and in compliance with any Council requirements.

You are responsible for maintaining your stormwater system to the kerb and gutter and if maintenance is needed you will be need to lodge an application to carry out work within the road reserve. Applications are available at Council offices or on the website.

Accepting natural overland flow from adjoining properties or public land is necessary and you must not divert or redirect the flow from its natural path on to neighbouring properties
.
It is important to note that a downstream property owner cannot erect any type of barrier that interferes with the path of stormwater. To put it more simply, if you are downstream, you must accept the 'natural' run-off on to your property.
When constructing hardstand areas you must control stormwater in order to prevent it from flowing on to a neighbouring property. It is preferable to minimise the area of water-resistant surfaces such as concrete or paved areas and driveways. If there is an easement on your property it must be maintained and kept clear of debris to allow the natural flow of stormwater to the field gulley.

Council's responsibilities

If the property has a stormwater installation, defined under the Local Government Act 1993 such as roof gutters, downpipes, subsoil drains and stormwater drainage for the premises, Council may direct the property owner to connect to Council's stormwater drainage system, if available and practical to do so. The Local Government Act 1993 makes provisions for the control of stormwater, and Council is empowered to issue property owners with written orders if they are in breach of this Act.

Diversion banks can be effective in diverting water from infrastructure.

Roof gutters not connected to approved stormwater outlets can cause damage to your property and neighbouring properties

Problems with overland stormwater flow between neighbouring properties are generally a civil matter to be resolved between the respective owners. Council has limited powers to intervene.`

Approved outlet to Council's stormwater drainage system.

Stormwater gully pit landscaped to collect surface water.

Legal points of discharge

There are two ways of connecting stormwater to a legal point of discharge:

1. Roof and surface water is conveyed to the kerb and channel;
2. An inter-allotment drainage system in accordance with Australian Standard AS/NZS 3500.3.2: 1998 (Clause 1.8).

Overland flow

Overland flow between private properties usually occurs when:

- The natural contours are sloping;
- A site has been excavated to build a concrete slab, eg. cut and fill style construction;
- Retaining walls, drains or other structures have been built that result in stormwater being concentrated, diverted or redirected on to other property.

Landscaping can change the topography of a property and the way it sheds water. Ideally, run-off should be promoted towards the street, or to a drainage system if provided. Cut-off drains and perimeter banks are also helpful in directing run-off towards the drainage system.

An upstream property owner cannot be held liable merely because surface water flows naturally from his land on to the lower land of a neighbour. However the upstream property owner may be liable if the water is made to flow in a more concentrated form than it would naturally flow.

Disputes between neighbours

Problems with overland stormwater flow between neighbouring properties are generally a civil matter to be resolved between the respective owners. Council has limited powers to intervene. Landowners are encouraged to talk to their neighbours about the problem and to seek a mutually suitable solution. If this is not possible, the Community Justice Centre provides a non-legal mediation service. They may be to assist without the need for expensive legal proceedings. They can be contacted on 1800 671 964.

Finally, you can seek legal advice about the feasibility of taking civil action against the party creating the problem if you feel your property has suffered or been exposed to potential damage.

Structures including fences should be clear of field gully inlets. Suitable landscaping along with grid tops to inlets and regular maintenance assists with filtration into council's stormwater system.

Definitions

Cut-off drain: an open drain designed to catch overland flow and redirect it into an acceptable stormwater system.
Gully inlet/pit: A pit covered by a grate, situated at the lowest point in the property, which connects either to the household stormwater system or the inter-allotment drainage system.
Grass swale: an indentation in the ground to direct water flow to a gully or collection point.
Inter-allotment drainage system: the stormwater system provided by the developer and positioned at the rear of the property, with a slotted grate and a grass swale to guide some of the excess overland flow into the system.
Kerb and channel: the concrete structure between the road and Council's verge (nature strip).
Natural watercourse: a watercourse that has been created naturally and has not been significantly modified.
Perimeter bank: a protection mound (grassed to prevent erosion) that surrounds assets of the property such as the house, garage, pool, entertainment areas, etc.
Stormwater: rain that accumulates in natural or constructed storage and stormwater systems during and immediately following a storm event.
Stormwater concentration: where surface flow, as distinct from that in a natural watercourse, is diverted or collected and as a result the flow is concentrated.
Surface run-off: the rainfall that moves over the ground towards a lower point and does not soak into the soil.
Surface water: water that remains on the surface of the ground.
Watercourse: every open stream, creek, culvert, channel through which stormwater flows, whether continuously or not.

Contact details

Complaints regarding stormwater within or outside the property boundaries contact Council's Customer Contact Centre:

Telephone: 1300 87 83 87
Fax: 02 66250 400

Lismore City Council
PO Box 23A, LISMORE NSW 2480
Email: council@lismore.nsw.gov.au
Web: lismore.nsw.gov.au