

Muswellbrook Urban Riparian Landcare Master Plan

Muswellbrook Shire Council

Master Plan Report – 22/18594
June 2018

Architecture
Interior Design
Planning
Urban Design
Landscape Architecture



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22-18594-L010	22-18594-L020	22-18594-L026	22-18594-L035
22-18594-L011	22-18594-L032	22-18594-L027	22-18594-L036
22-18594-L012	22-18594-L021	22-18594-L028	22-18594-L037
22-18594-L013	22-18594-L022	22-18594-L029	22-18594-L038
22-18594-L014	22-18594-L023	22-18594-L030	22-18594-L039
	22-18594-L024	22-18594-L031	

01

Section 01

Introduction



Connection - Enhance footpath at Muscle Creek



Connection - Narrow footpath to Bridge Street



Connection - Brook Street, shared path



Connection - Existing Karoola Park playground



Connection - Existing aquatic centre



Connection - Existing Muswellbrook post office

1.1 Context

Muswellbrook Shire in the picturesque Upper Hunter is known primarily for its premium wine, but the rich farmland, rolling pasture, rocky outcrops, sandstone cliffs and small hills rising abruptly from vineyards are very attractive. The farms produce fodder crops, stud cattle, horses, sheep and dairy products. Open-cut coal mining is a major industry within the region.

Muswellbrook town centre is ideally located north of the Hunter wine region and south of the Upper Hunter horse breeding and racing community, with the coast and Newcastle, an hour's drive to the east.

Muswellbrook town centre is located 125 km north west of Newcastle, and 157 km south of Tamworth. Denman, Scone and Singleton are its closest town centres. The approximate catchment area for commerce is 25,000 people.

The Hunter wine village of Broke is just 70 km to the south. The township of Scone is just 25 km north

Muswellbrook Shire has a population of 11,792 people. One of the largest employers for the permanent and temporary residents of Muswellbrook are the thermal coal mines that surround the town (Mt Arthur, Mangoola and Bengalla, with Mt Pleasant to commence operations in 2017). This accounts for 30% of the population's employment. In recent years Muswellbrook has become the major centre of Upper Hunter coal mining, with the largest concentration of open cut mining operations, thus maintaining the second highest rate of coal extraction in New South Wales.

The civic centre of Muswellbrook is nestled in the northern alcove where the Muscle Creek joins the Hunter River. The river acts as the boundary between urban and rural land use. To the west of the Hunter River, agricultural activities persist. Whist to the east of the Hunter River, the existing heritage residential streets merge with the urban fabric of the civic centre.

The Muswellbrook levee is open ended, so it protects sections of the town west of the railway from flooding and high flow velocities. Flood waters come in behind the levee from the downstream end at a reduced level and minor flow velocities. In recent years' new residential development has occurred in the higher ground of Muswellbrook Heights. Hunter Tafe and Muswellbrook high school are located on the southern portion of town.

The built heritage fabric of Muswellbrook civic centre has numerous significant heritage items that contribute to the charm of the town. Notably the four church spires that act as orientation markers in the townscape. The town has a rich heritage culture and continues to make a proud contribution to Australian life through primary production, literature and the Arts. The Upper Hunter also contributes to the broader Hunter's heritage feel including the liberal use of sandstone as a construction material, introduced in the early settlement period.

This master plan considers Aboriginal heritage, with past and present connections to the Hunter River by providing access for fishing and recreational opportunities. We provide equal access to the riparian edge for observation and interaction, with ramps and a observation lookout area.

We aim to continue the use of sandstone as the consistent material in the proposed six precincts identified along the Hunter River and Muscle Creek study area.

During a two-day site visit and analysis, it was observed that the immediate riparian areas of the Hunter River and Muscle Creek are neglected and underutilised. Instead of the riparian system being the central activity zone of the town, as typical European settlement would suggest, the river has been cast aside. During the course of this project, we analysed the condition of the existing river and its embankments. This has assisted us to identify appropriate locations for community enhancement and development, to create a river system that is central to the prosperity of Muswellbrook civic centre. Six core areas have been nominated to take advantage of existing topography and have the opportunity to benefit the community and amenity.

To produce this report, we have studied the following documents:

- *Muswellbrook Shire Council DCP, Public Domain Manual, 2012*
- *The Muswellbrook Town Centre Strategy (DWP Suters), 2016*
- *Muswellbrook Main Street Masterplan, town centre concepts (Anton James Design), 2009*
- *Walk and Cycle Plan for Muswellbrook and Denman (Muswellbrook Shire Council), 2009*
- *Worley Parsons 2014, Hunter River Flood Study – Muswellbrook to Denman, 2011*
- *Karoola Wetland Park, Plan of Management – 2012*
- *Muswellbrook Town Centre Vision Statement 2016 (Muswellbrook Shire Council)*
- *GIS layers applicable to this work*
- *Parking study Muswellbrook and Denman 2010.*



Figure 1: Context plan





Improve shared pathway-Brook Street



Connect Muswellbrook heights-Reising Street



Improve amenity-Precinct 2



Re-activate the river edge-Precinct 1



Connect heritage -St James Church



Connect traditional streetscape-Scott Street

1.2 Purpose

The Muswellbrook Urban Riparian Landcare Master Plan aims to re-introduce the community to the benefits of their urban waterways and give them a shared vision for the future of riverside recreation.

The purpose of this master plan is to establish an overview of potential land-use opportunities that currently exist along the Hunter River and Muscle Creek, and to ensure key urban design principles are incorporated into the future development opportunities within Muswellbrook riparian corridor and town centre.

The Muswellbrook Shire Council has expressed an interest in turning the attention of the local community toward the Hunter River and Muscle Creek riparian system. The local residents have a checkered history with the river systems and their flood events. Records state significant flood level rise occurred most recently in 2000 and 2007.

Muswellbrook Shire Council undertook a community consultation process on 12 April 2016. The lack of access to the river was communicated as a community inhibitor. This report aims to address opportunities to reactivate the river edges and provide formal and informal access to the river systems, creating a sustainable source of tourism and maintaining local community pride in their backyard.

1.3 Methodology

This Master Plan Report is a multi disciplinary collaboration between urban design, landscape architecture, ecology and geomorphology.

For the purpose of analysing the condition of the river system, we identified the study area as three main landscape character zones. Due to the lack of safe access to the riparian corridor these zones are located close to existing infrastructure and designated open space areas with existing informal pedestrian access. These three zones are used to describe the overarching vegetative condition of the riparian system. More information on the vegetation assessment and recommendations can be found in Section 4.

Within the three main landscape character zones, six precinct areas were identified for potential development and community activation as recreational resources for the Muswellbrook community. The six chosen precinct areas are in the following zones:

- Zone 1, Hunter River - Karoola Wetlands (Precinct 1)
- Zone 2, Hunter River - The Greenroom at Rutherford Park and the Village Green (Precinct 2 and 3)
- Zone 3, Muscle Creek - Nature Trail and Olympic Park (Precinct 4 and 5)

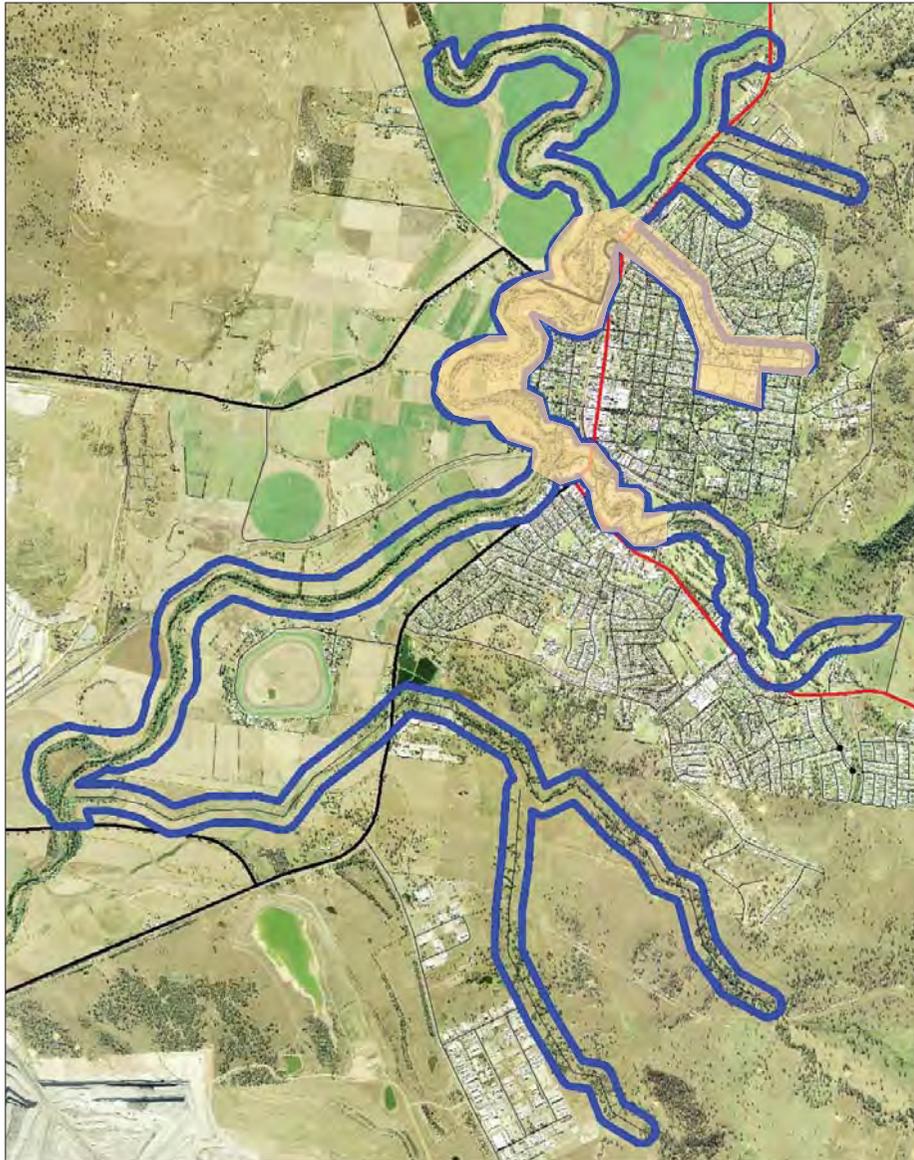


Figure 2: Study area plan

1.4 Scope of work

The 'Muswellbrook Urban Riparian Landcare Master Plan' (MURLMP). This plan includes the strategic framework and design components that will form the basis of structural riparian stabilisation works, natural area restoration activities to improve biodiversity connectivity, and a planned approach to facilitate public access and enjoyment of urban waterways around the township of Muswellbrook.

A primary requirements of the Muswellbrook Urban Riparian Landcare Master Plan (MURLMP) is to provide an assessment of the urban riparian waterways and recommend site specific structural riparian stabilisation works and/ or vegetation rehabilitation works for areas identified as being high risk, priority areas.

The original brief outlined that the study area should have a combined area of approximately 760ha (see study area plan).

During early stages of the project inception, the project team identified the complexity of successfully completing a strategic framework for the whole of the study area. It was agreed with Council during the project inception meeting that due to the height and steepness of the banks in most of the proposed area, the extent of works Council would have the ability to manage and improve would be limited to the accessible urban reaches of the Hunter River and Muscle Creek.

Council advised that a risk analysis should be undertaken for the Urban areas in and around Muswellbrook Township with the intent to manage the impact of flooding. Council also identified that community activation of the urban riparian environs could be limited to six priority areas. These areas of community activation provide paths to access the river and riparian parklands.

 Study area



02

Section 02

**Existing
conditions**

2.1 Existing site

Precinct 1 - Karoola Wetlands



Karoola pond



Existing cut for flooding - The Avenue



Existing high ground - above 147m



Existing Hunter River beach

Karoola Wetlands is characterised by the meandering Hunter River and its gravel riparian edges. A large portion of this site is flood plain. The site rises to the east with a steep embankment to an area of flat plateau. A recent Hunter River flood study of Muswellbrook shows this higher area of the site is outside the two year ARI flood event but inside the Five year ARI flood event. According to the 'Hunter River Flood study (Muswellbrook to Denman)' completed by Worley Parsons in September 2014, the Peak Design Flood level is 147m for Karoola Wetlands.

Precinct 2 - The Greenroom



Grass lawn



Playground



Existing river access



View to lawn areas

Rutherford Park is accessed by Scott street, a short walk from the civic centre of Muswellbrook. The existing topography on this site gradually falls towards the Hunter River at a slope no greater than 1 in 6. The site currently has no formal land use. A portion of the site is maintained by council to keep the grass cover low. It is bound to the south by the Muswellbrook water treatment centre.

Precinct 3 - Village Green



Existing footpath connection



Existing levee



Walkway connection



View to river

This portion of open space is a small pocket to the edge of the Hunter River levee. Currently there is an existing stand of mature trees with an outlook towards the civic centre and the residential housing on Scott Street.

Precinct 4 - Nature Trail



Community gardens



Open space area



Wildlife



Existing walkway

To the edge of Muscle Creek, this site is currently a green open space with no formal land use. It is bound by the rail corridor to the north, and New England Highway to the west. The existing concrete walkway facilitates pedestrian movement to the civic centre and aquatic centre.

Precinct 5 - Olympic Park



Existing fence along the pathway



Lawn area



Existing riparian edge



Steep embankment between aquatic centre and Muscle creek

This area extends towards the east from Precinct 4. It has direct vehicle access over Muscle Creek to the aquatic centre. Its proximity to the railway station suggests the opportunity for over rail pedestrian connection. Its existing pedestrian use encourages this area as a more formalised connection hub.

Precinct 6 - Karoola Park



Concrete channel



Culvert to Karoola Wetlands



Existing pit to Karoola Wetlands



Playground and netball courts

Karoola Park is an existing park that provides a green link from Muswellbrook Heights to the Hunter River at precinct 1.

This park is maintained by Muswellbrook City Council, the netball courts experience flooding during periods of high rainfall.

This master plan outlines design opportunities to protect the netball courts and slow the flow of stormwater prior to entering the culvert that connects Karoola Wetlands.

2.2 Analysis

Introduction

This analysis diagram illustrates the existing opportunities and constraints of the urban study area close to the Muswellbrook civic centre. As a result of poor accessibility and private land use inhibiting access surrounding the Hunter River, this master plan focuses in detail on the portion of the urban riparian system at the Hunter River and Muscle Creek. This report reflects the background information provided by Muswellbrook Shire Council.

OPPORTUNITIES

- 1 Provide new identity/ character to Simpson Park, Precinct 4 and Dumaresq Street to enhance these areas as a 'gateways' to Muswellbrook
- 2 Improve accessibility to the foreshore, The Village Green, The Greenroom and Karoola Wetlands
- 3 Enhance the community experience by improving river system condition and amenity
- 4 Maintain/ enhance significant views of heritage structures and church spires
- 5 Integrate site heritage into design
- 6 Connect Muswellbrook Art Gallery to The Greenroom sculpture garden
- 7 Connect to existing car parking on Bridge Street and Brook Street and to the shopping centre.

CONSTRAINTS

- A Lack of pedestrian connectivity across the New England Highway
- B Lack of pedestrian safety at rail crossing points to Brook Street, Lower William Street and Wilkins Street
- C The steep topography of the riparian embankments present accessibility constraints and safety issues
- D Limited car parking facility to Scott Street at The Greenroom
- E Risk of asset damage in times of flood at Karoola Parklands, local roads and infrastructure
- F High visibility of Muswellbrook water treatment centre at The Greenroom



LEGEND

- Railway Line
- Main Road
- Crown Land
- Recreational Land
- Waterways
- Easement
- Muswellbrook Town Centres
- Existing Facility
- Accommodation
- Church
- Proposed Facility
- Shared Pathway
- Heavy vehicle bypass
- Improve accessibility - opportunity
- Gateway - opportunity
- Existing heritage - opportunity
- Existing road - constraint
- Existing rail - constraint
- Pedestrian crossing points - constraint
- High risk
- Medium risk
- Low risk

Figure 3: Opportunities and constraints diagram





Precinct 2 - Slope 1 in 6



Sinnamon Park



Precinct 1 - Slope 1 in 3 to 1 in 6



Staked rock



Muscle Creek - Slope 1 in 1



Vegetated rock stabilisation

2.3 Hydraulic and terrain analysis

To advise on channel stabilisation for the protection of infrastructure and property, that also accommodate for channel capacity and flow hydraulics.

Purpose

Advise on presentation methods to maintain and improve the waterways ecological value, including bed and bank stabilisation.

Existing environment

The following slope classes were observed on the site:

- 0 to 17% (Less than 1 in 6)
- 17 to 33% (1 in 6 to 1 in 3)
- 33 to 50% (1 in 3 to 1 in 1)
- >50% (>1 in 1)

Banks are typically steeper than 1 in 3 along most of the length of the Hunter River and Muscle Creek. Gentle sloped banks are limited being present over large areas to only the inside bends in the locations of Precinct 1 and 2.

Constraints and opportunities

- Constraint: a large portion of the river system has embankments steeper than 1 in 6
- Opportunity: banks are typically stable and well vegetated with exotics
- Opportunity: no significant bed instabilities were observed along the assessed extents of Muscle Creek and the Hunter River.

Recommendation

- Stabilisation of banks through rock protection of the lower profile may be required on the outside bends along Muscle Creek in the event weed control activities are undertaken. Refer to 2.5 Rock revetment plan.
- Elsewhere bank re-profiling may be required where space allows to address safety issues associated with steep banks
- Increased native vegetation to embankments will aid to improve water quality
- Precinct 6 illustrates measures to slow down stormwater prior to entering Karoola Wetlands.

Rock revetment strategy

From a geomorphological perspective, both Muscle Creek and the Hunter River do not exhibit any significant instability issues. Typically where localised instabilities exist, current practices would follow vegetative techniques rather than civil works. Hence, the areas requiring civil works are very limited.

Recent creek stabilisation works are driven largely to establish access routes across the channels and to address the stabilisation works to protect new infrastructure based on a potential low risk of instability rather than an existing real need.

There are some areas of Muscle Creek where drainage civil stabilisation works are warranted. These include:

- A stormwater swale next to the Wayfarer Motel is experiencing headcut erosion just upstream of the confluence with Muscle Creek. A rock drop structure at this location has been proposed and needs to be designed and approved for construction.
- Very steep and high outside bank of Muscle Creek. This appears stable but due to height/steepness poses a level of risk of erosion/slumping in the future.

Observed from imagery:

- Immediately upstream of the Karoola Gully culvert under Hunter St where an overland flow path is causing headcut erosion and requires a drop structure.
- There is some land/drainage instability in Karoola Gully in the dog off leash area at the back of 70/72 Queens St. This appears as some network gullying associated with saline scalding.
- There is some minor gullying in the drainage line that runs between Bimbadeen Drive and Day St
- Further, there is the potential to consider naturalising the roughly 350 metres of concrete channel along Karoola Gully upstream of Hunter St. This would cost in the order of \$0.5 to \$1M.

Recent visits to Muswellbrook:

- Many stormwater outlets to Muscle Creek discharge at levels above the low flow channel, we would recommend a rock lined, cascading channel.
- Possum Gully inlet to Muscle Creek - This is quite a chasm and warrants further investigation.

2.4 Slope analysis plan

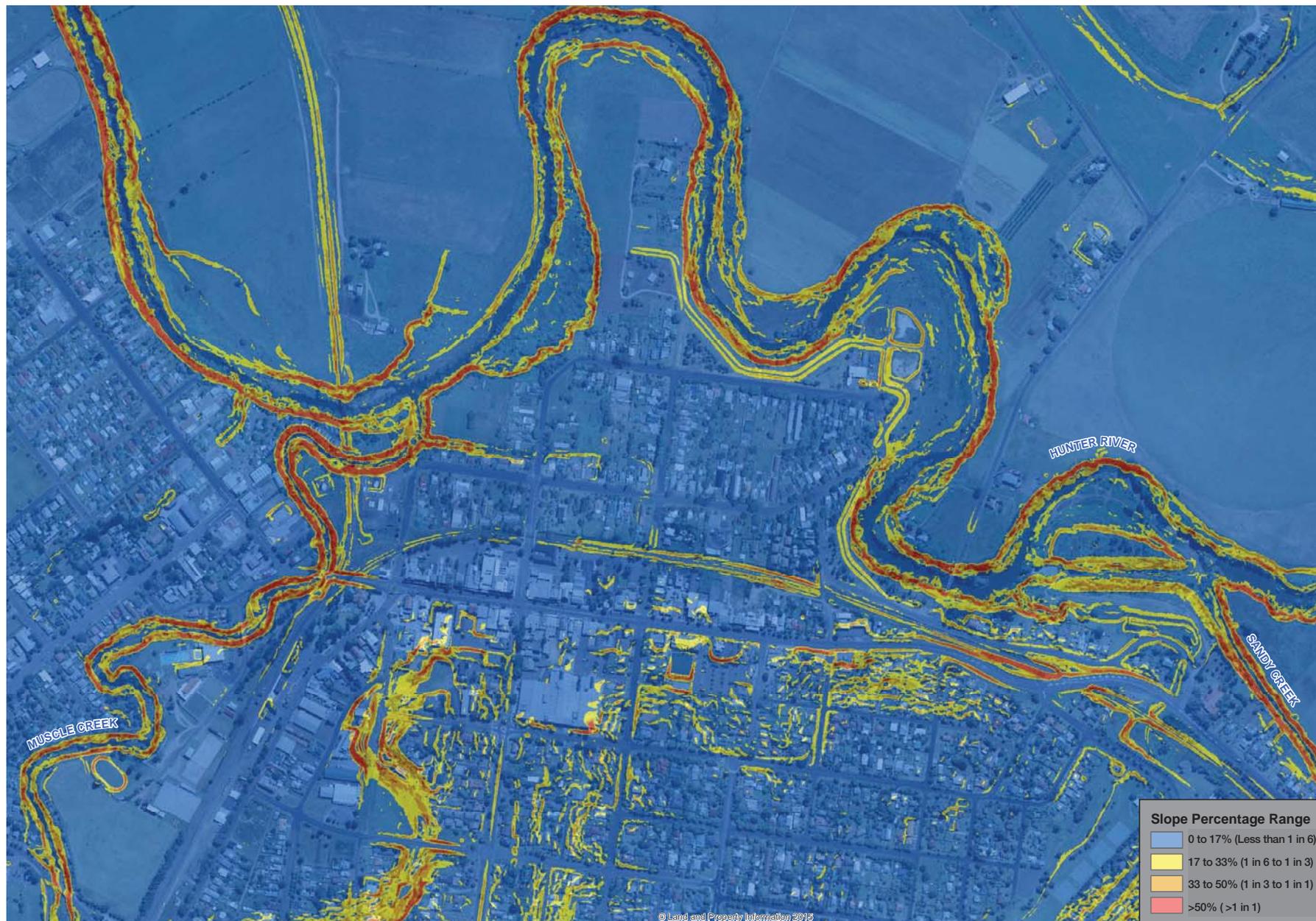
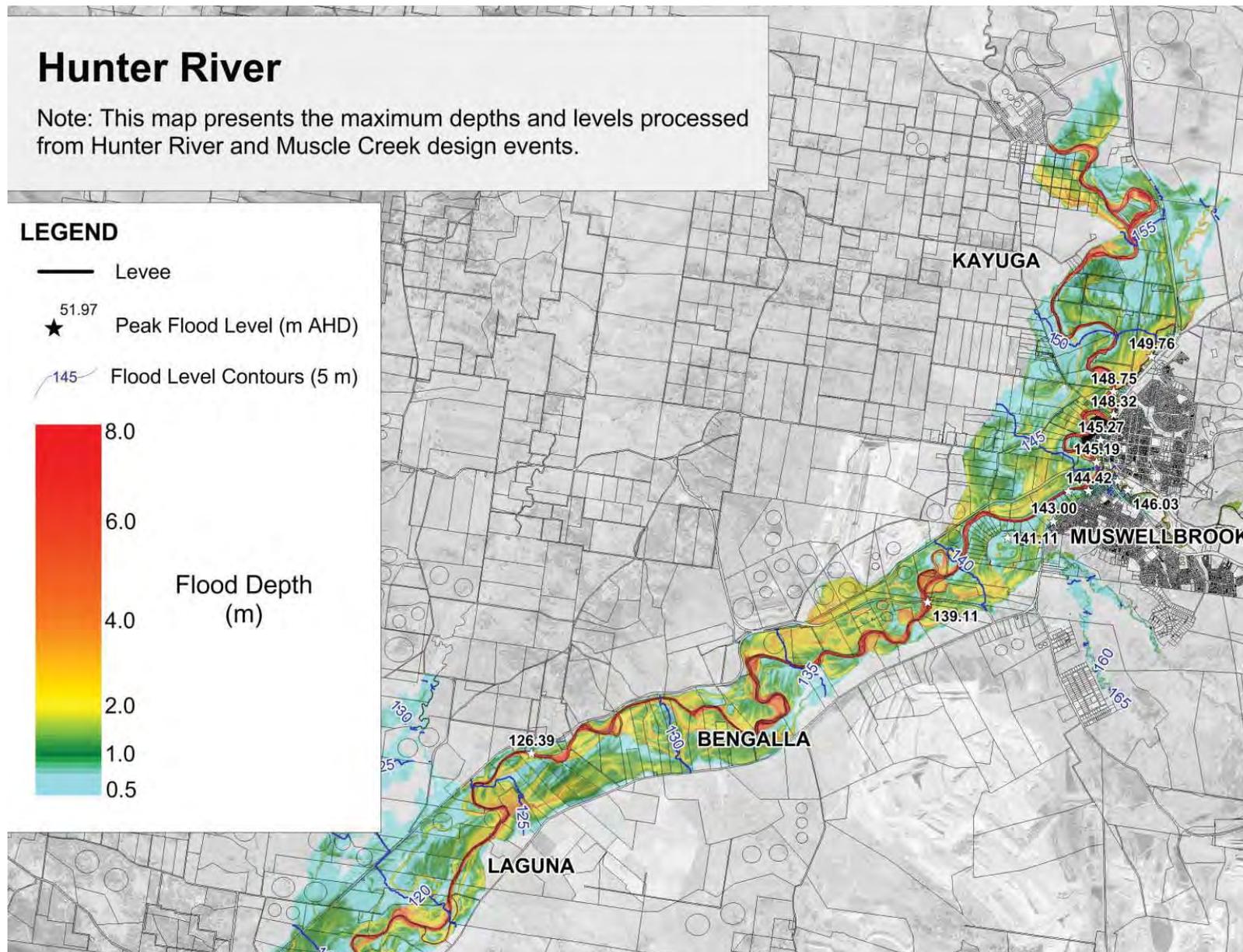


Figure 4 : Slope analysis

2.5 Peak flood depth (1% AEP event)



We reviewed the peak flood depth map provided by Royal Haskoning DHV. We recommend future designs prepared for infrastructure works to the riparian foreshore of the Hunter River and Muscle Creek refer to the anticipated flood levels to the urban riparian areas of Muswellbrook.

Figure 5 : Peak flood depth map

2.6 Rock revetment plan



Figure 6: Rock revetment plan

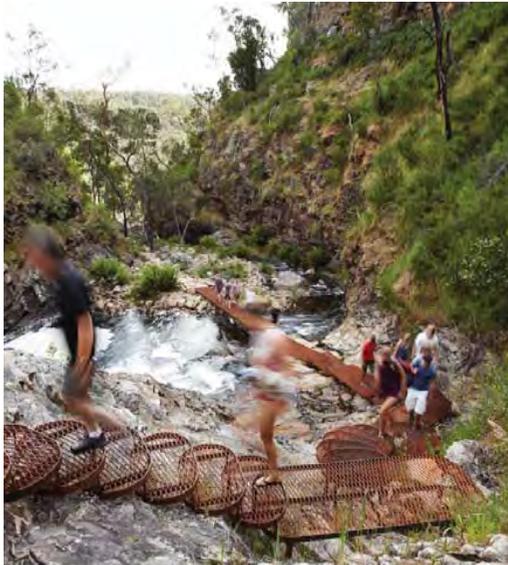
Rock revetment risk analysis

RISK CATEGORY	ID REFERENCE	DESCRIPTION	RECOMMENDED ACTION
High	No. 1	Muscle Creek - Erosion to embankment close to residential property (No 5 Saint Andrews Place) where the river naturally wants to erode at the outer meander of flow direction.	Rock revetment to stabilise the embankment. This area appears stable but due to height/steepness poses a level of risk of erosion/slumping in the future.
High	No. 2	Muscle Creek - Erosion to the outer meander south of the aquatic centre.	Rock revetment to stabilise the embankment, incorporate batter to upper embankment where possible.
High	No. 3	Hunter River - Erosion to western embankment close to the confluence of Sandy Creek and Hunter River.	Rock revetment to stabilise the embankment.
Medium	No. 4	Muscle Creek – Stormwater swale next to the Wayfarer Motel is experiencing head cut erosion just upstream of river confluence.	Rock revetment to stabilise the embankment. Drop structure designed by NSW Soil Conservation Services.
Medium	No 5	Many stormwater outlets to Muscle Creek discharge at levels above the low flow channel. Therefore, stormwater discharge down the banks is uncontrolled causing rill/ gully erosion of the banks.	We recommend that these stormwater discharge points be reviewed and prioritised for provision of stabilising the discharge flow path down the bank - we would recommend a rock lined, cascading channel.
Medium	No. 6	Hunter River/Muscle Creek - The natural meander of Muscle creek at the confluence with the Hunter River. This area is highlighted a risk area because the meander of Muscle Creek naturally wants to merge with the Hunter River.	We recommend this area is monitored and managed to limit river bank erosion.
Medium	No. 7	Karoola Park - land/drainage instability in Karoola Gully in the dog off leash area at the back of 70/72 Queens St. Some network gullying associated with saline scalding.	Warrants further investigation.
Medium	No. 8	Muscle Creek - Possum Gully inlet to Muscle Creek evidence of erosion.	Warrants further investigation.
Medium	No. 9	Immediately upstream of the Karoola Gully culvert under Hunter St, an overland flow path is causing headcut erosion.	This area requires a drop structure.
Medium	No. 10	There is some minor gullying in the drainage line that runs between Bimbadeen Drive and Day St. (off the map area)	Warrants further investigation.
Low	No. 11	There is the potential to consider naturalising the roughly 350 metres of concrete channel along Karoola Gully upstream of Hunter St.	Warrants further consultation.

03

Section 03

Master Plan



Stairs at McKenzie Falls



Bedlam Bay - Sandstone paving



Johnstons Canal - Threshold paving



Pathway Johnstons - Canal walkway



Johnstons Canal - Threshold



Memorial forest path - Boardwalk

3.1 Urban strategy and vision

'Activating the edges of the Hunter River and Muscle Creek to provide a range of river related activities that capitalise on their location, for the enjoyment and pride of the Muswellbrook community.'

Objectives

The following design objectives will provide the local community with a regionally acclaimed facility:

- A place the local community will take pride in and cherish
- A destination for school educational outdoor classrooms to communicate the value of the river, heritage, arts and culture
- An outdoor living room with picnic facilities, swimming areas, fishing and beach volleyball
- A river environment that will bring revenue to local business through accommodation, cafe, restaurants and education
- A network of DDA access paths to the Hunter River, amenities, camper parking, and sustainability/ accommodation hub
- A healthy river system that will provide shelter to threatened native wildlife and bird life.
- A nature trail that will provide access to and across the river at Muscle Creek
- An integrated art trail that promotes community expression.

Principles

The following design principles will form the foundations of this master plan:

- Establishing green links from Muswellbrook Civic Square to the Village Green
- Connecting local schools and hospitals to the river with shared pathways for cycle and pedestrian movement
- Introducing the community to the possibilities of outdoor recreation in a river environment
- Providing formal community activity areas for music entertainment, the arts, culture, exercise, cinema and artisan markets
- Maintaining wildlife corridors with canopy trees, and local species of endemic plants for native bird habitats
- Implement art 'moments' into the riparian precincts through the design of footpaths, fencing and planting strategies.

3.2 Master plan

The following elements make up the key interventions of the master plan shown in figure 4.

Public domain improvements and connections

- Maintaining existing crossings over rail at Brook Street
- Improve pedestrian crossing at Lower William Street

Provide shared pathway to connect precincts with existing Civic Centre facilities.

Activation zones

- Karoola Wetlands
- The Greenroom at Rutherford Park
- Village Green (This was identified in the *Muswellbrook Town Centre Strategy Plan 2016-Draft*)
- Nature Trail
- Olympic Park

Gateways to Muswellbrook at three locations:

- Precinct 4 - Entry into Muswellbrook from Newcastle / Denman
- Simpson Park - Entry into the Civic centre
- Dumaresq Street - Entry into Muswellbrook from Scone/ Aberdeen (In line with the Muswellbrook Town Centre Strategy Plan 2016 - Draft).

Master plan

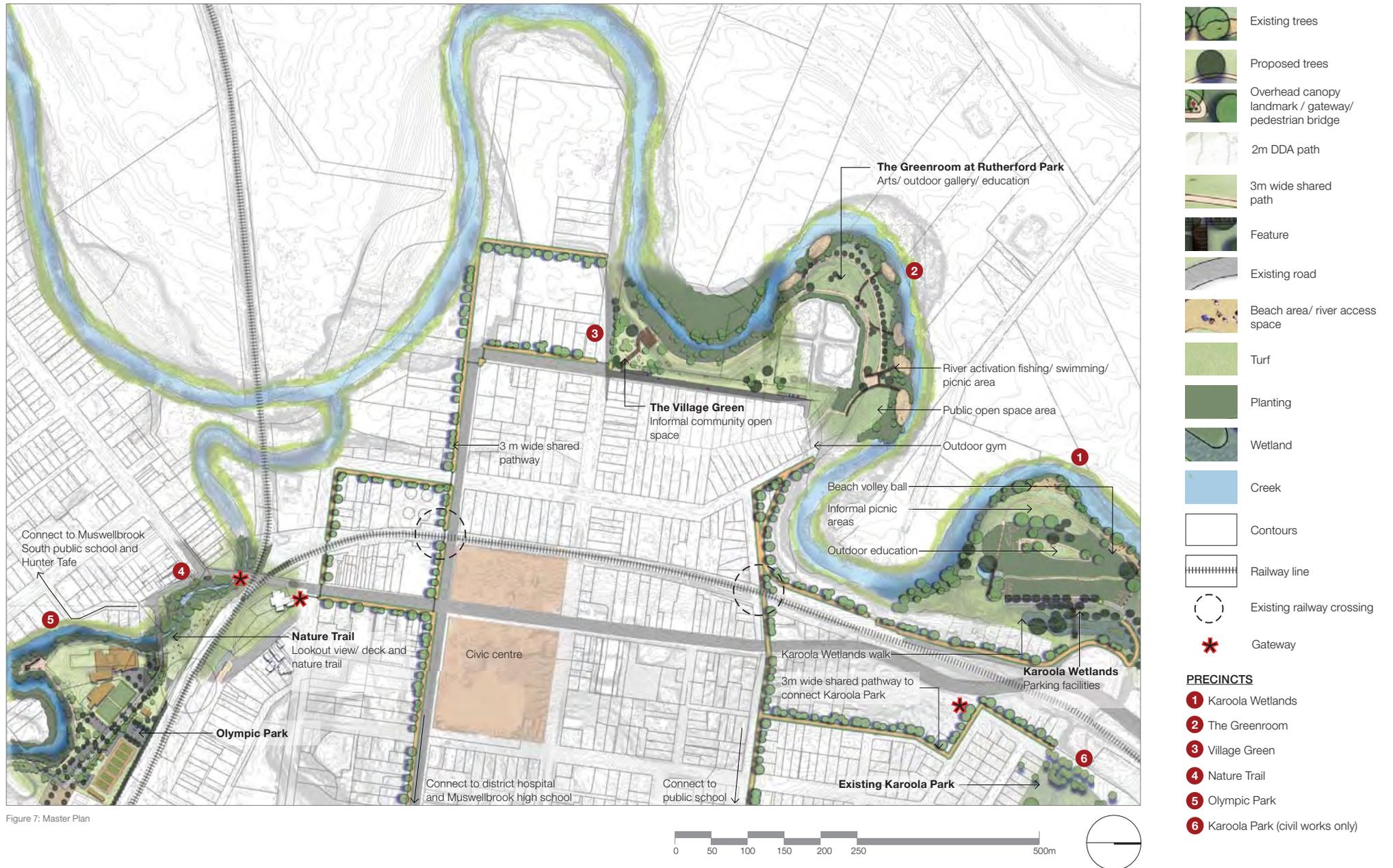


Figure 7: Master Plan



Precinct 1 - Bridge over Karoola ponds



Precinct 1 - The Avenue walk



Precinct 2 - Public Art in footpath



Precinct 1 - Urban beach and look out



Precinct 2 - Sculpture boardwalk



Precinct 3 - Village green

3.3 Precinct areas

The precincts have been identified as areas that will reactivate particular zones and encourage the community to enjoy them. The areas all have distinctive characters to provide a range and variety of activities and spaces adjacent to the waters edge. Some of the spaces will be designed for quiet passive recreation while others will be designed for more active formal recreation activities.

1 Precinct 1 - Karoola Wetlands

The design intent for this precinct is to provide activity zones connected by a shared pathway link between the upper amenities area, the upper bushland viewing area and the lower urban beach river foreshore.

2 Precinct 2 - The Greenroom at Rutherford Park

The Greenroom will be a recreation parkland for fishing and informal recreation opportunities

3 Precinct 3 - The Village Green

This area has the opportunity to connect land use with the civic square in the heart of the civic centre of Muswellbrook. The Village Green will entice users from the town centre to visit the Hunter River

4 Precinct 4 - Nature Trail

Located on the banks of the Muscle Creek between Bridge Street and Wilkinson Avenue, the existing open space has the opportunity to be a gateway park for Muswellbrook. A gateway lookout located in close proximity to Bridge Street has the potential to extend the green lung of the town centre. An informal path to the river with fishway will activate Muscle Creek.

5 Precinct 5 - Olympic Park

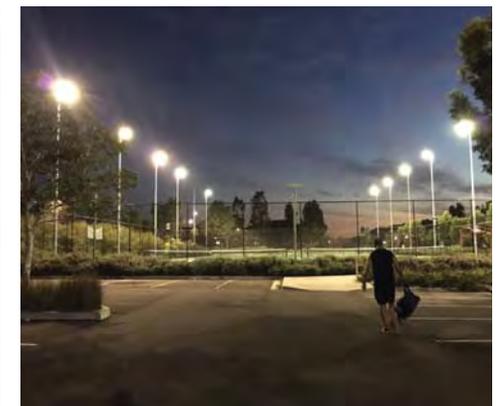
This precinct contains a number of design elements including a footpath that follows the creek edge to a seating area with information signage and other elements provided as part of the overall Olympic master plan.

6 Precinct 6 - Karoola Park

We propose to improve existing infrastructure that connects Karoola Park with Karoola Wetlands. There are opportunities for grass mounds to slow stormwater at catchment areas, protect the existing netball courts and replace the existing concrete channel with a grass swale.



Precinct 4 - Nature Trail



Precinct 5 - Olympic Park

3.3.1 Precinct 1 - Karoola Wetlands



Figure 8 : Landscape concept plan for Karoola Parklands

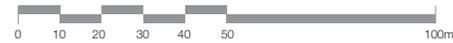
3.3.2 Precinct 2 - The Greenroom



-  Existing trees
-  Proposed trees
-  Overhead canopy landmark/ gateway
-  Riverside access paving boardwalk
-  2m DDA path
-  3m wide shared path
-  Existing road
-  River access spaces
-  Turf
-  Planting
-  River
-  Contours

- ① Public open space area
- ② Greenroom outdoor studio (Sculpture Gallery)
- ③ River access spaces (Canoe access)
- ④ Existing levee
- ⑤ Muswellbrook water treatment centre
- ⑥ Proposed car parking

Figure 9: Landscape concept plan for the Greenroom



3.3.3 Precinct 3 - Village Green



Figure 10 : Landscape concept plan for the Village Green

3.3.4 Precinct 4 - Nature Trail



Figure 11: Landscape concept plan for the Urban Garden

3.3.5 Precinct 5 - Olympic Park

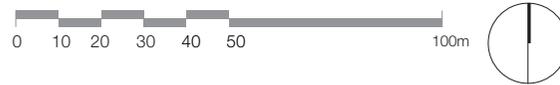


-  Existing trees
-  Proposed trees
-  Overhead canopy landmark/ gateway
-  3m wide shared path
-  Existing road
-  Turf
-  Planting
-  Creek
-  Contours
-  Proposed road and parking
-  Information signage to fishing spot

- ① Play courts
- ② Parking area
- ③ River walk
- ④ Rest area

Note: This precinct contains the endangered ecological community Hunter River Red Gum Woodland

Figure 12 : Landscape concept plan for the Olympic Park



3.4 Staging plan

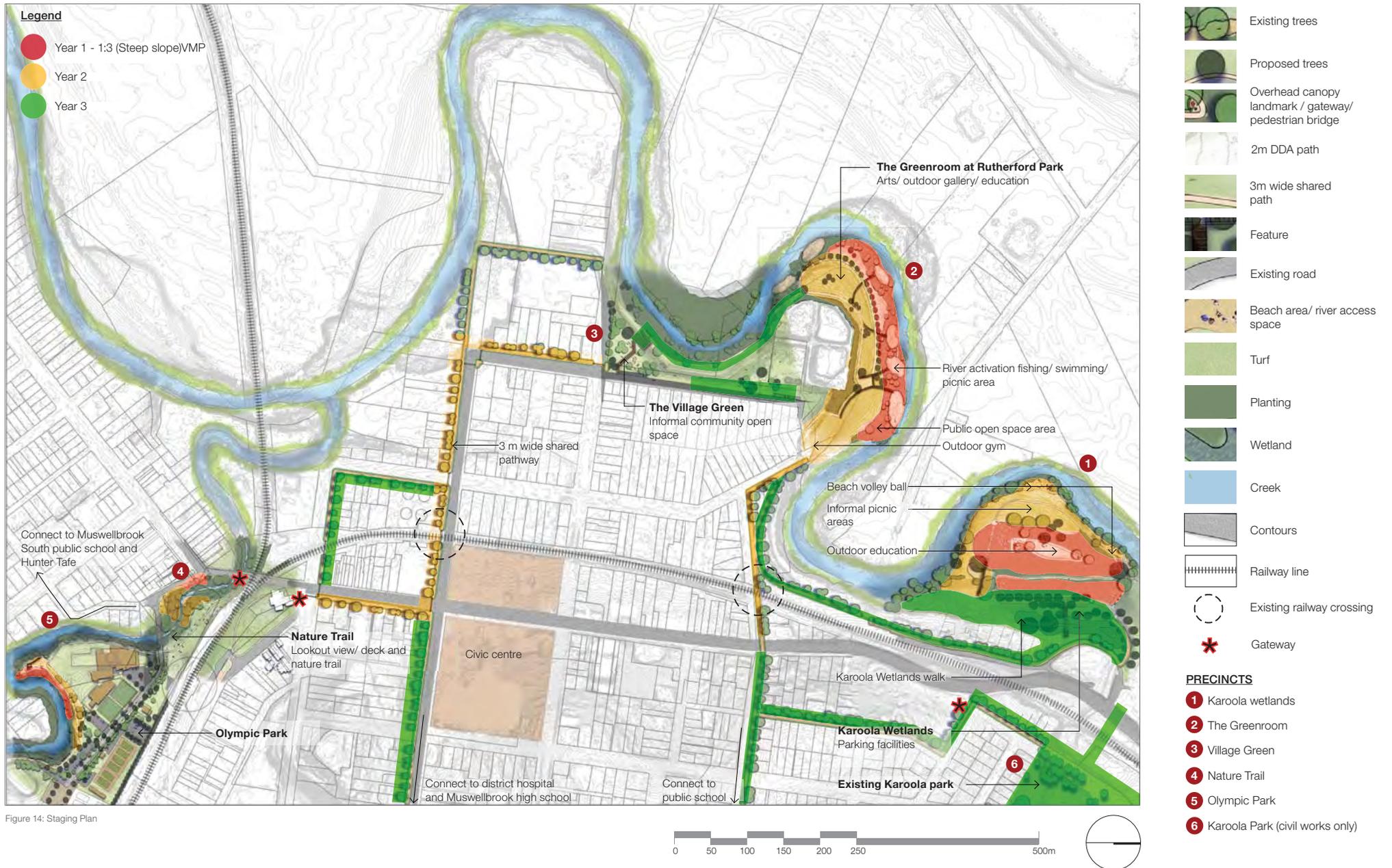


Figure 14: Staging Plan

Staging priority items

Priority	YEAR	DESCRIPTION	Location
High	1	Vegetation management to slopes greater than 1:3 and identified as high risk areas. Rock revetment to slopes identified as high risk areas.	Hunter River and Muscle Creek, refer to map for areas coloured in red.
High	1	Provide activation to areas where the riparian edge and townscape/ roads merge. Provide equal access footpath to the Hunter River.	Lookout to Muscle Creek at Precinct 4 and Precinct 1
Medium	2	Slash long grass to a height of 75mm to enable safe pedestrian access and bush fire management if required. Provide vegetation management to gentle slopes.	Hunter River and Muscle Creek
Medium	2	Provide shared pathways lined with tree planting to road verge areas that connect the CBD with the Hunter River and Muscle Creek. Provide footpaths and boardwalks to open space areas at the Hunter River and Muscle Creek.	Hunter River and Muscle Creek. Brook Street, Bridge Street and Scott Street.
Low	3	Footpath/ boardwalk connection from precinct 2 to precinct 3. Boardwalk over levee to provide equal access to the riparian walk. Shared pathway and tree planting to existing road verge to connect precinct 1 and 2. Shared footpath and tree planting to Lower William Street and Hunter Terrace. Improve rail crossing at Lower William Street. Provide shared pathway at Wilkins Street to/ from rail crossing. Provide shared footpath with tree planting to connect schools, hospitals and Karoola Park	William Street and Hunter Terrace
Low	3	Civil engineering – provide car park to Scott Street and Karoola Wetlands. Improve ecological habitat and amenity at Karoola Wetlands.	Karoola Wetlands Option 1. Excavation/ earthworks to Karoola wetlands to create native wetland river system. Option 2. Replace culvert under existing roads and rail corridor to improve stormwater management from Karoola Park.
Low	3	Improve stormwater management at Karoola Park. Provide grassed mounds to protect the existing netball courts from flooding and provide spectator seating for netball competitions. Remove exiting concrete channel. Install grass batters to temporarily slow and capture stormwater as it flows to the existing culvert connecting Karoola Wetlands.	Karoola Park



04

Section 04

**Native
vegetation
management**



Hunter River - Flood plain



Muscle Creek - Existing vegetation



Muscle Creek - Existing condition



Hunter River - Riparian edge



Hunter River - View to existing pond



Muscle Creek - Weed management

4.1 Existing environment

Introduction

The Muswellbrook Urban Riparian Landcare Master Plan study area is focussed upon three primary activation areas at the following landscape character zones:

Zone 1, Hunter River - Karoola Wetlands (Precinct 1)

Zone 2, Hunter River - The Greenroom at Rutherford Park and the Village Green (Precinct 2 and 3)

Zone 3, Muscle Creek - Nature Trail and Olympic Park (Precinct 4 and 5)

Karoola Wetlands and Rutherford Park are both located on inner depositional bends of the Hunter River, while Muscle Creek forms a major tributary, draining to the Hunter River through the centre of the Muswellbrook township.

Analysis

The hydrology, geomorphology and ecology of the Hunter River and its tributaries within the study area have been heavily modified following two centuries of vegetation clearing and landscape modification throughout the catchment. Waterways are presently characterised by narrow channels, deeply incised banks and narrow, degraded and heavily weed infested riparian vegetation corridors.

Prior to its modification and degradation, the native vegetation throughout the riparian corridors of the Hunter River and its major tributaries would have predominately been composed of River Red Gum/ River Oak and riparian woodland wetland in the Hunter Valley (NSW vegetation type HU599). Grey Box – Narrow-leaved Ironbark and shrubby woodland (NSW vegetation type HU551) would have occurred within areas upland of River Red Gum-River Oak woodland.

Little natural resilience of native vegetation communities remains within the study area. Vegetation throughout the study area is presently dominated by a range of noxious and major environmental weed species. Understorey cover is almost entirely dominated by exotic species cover, while mid-storey and canopy strata contain a mix of native and exotic species. Native mid-storey and canopy cover is composed of a mix of remnant individuals and revegetation that is not necessarily indicative of local communities or of provenance stock.

Given the poor condition of native vegetation throughout the study area, revegetation of native species from the local provenance will play an important role in re-establishing a dominant native vegetation cover. The recommended revegetation plant species lists have been derived from the native vegetation types previously present in the study area to reconstruct native vegetation that is indicative of local vegetation communities.

4.2 Constraints and opportunities



Ideal riparian outcome



Norman Creek, Greenslopes



Norman Creek 2010



Norman Creek, Greenslopes - Ideal outcome for wildlife



Norman Creek, Greenslopes - Ideal outcome for wildlife



Precinct 3 - Urban oasis opportunity

There are a number of major constraints to the rehabilitation and reconstruction of native vegetation within the study area. These primarily relate to the severe degree of modification and degradation of the hydrology, geomorphology and ecology of the Hunter River catchment, and place inherent limits on the degree to which site scale ecological restoration is possible. Aims and objectives of native vegetation reconstruction and rehabilitation works have been established in the context of these constraints.

The current condition of the study area presents numerous opportunities for its improvement, within the bounds of the constraints described. These opportunities extend beyond ecological gains, with key opportunities for social and cultural enrichment also possible.

Major constraints and opportunities relating to ecological rehabilitation within the study area are listed below:

Constraints

- Very poor condition of existing native vegetation throughout the study area provides little in-situ natural resilience from which native species may naturally regenerate
- Poor and predominately cleared condition of the Hunter River catchment has little in-situ natural resilience from which native species may disperse and regenerate
- Likelihood of potentially severe flood events due to highly altered functional ecology in the study area and repeated influx of exotic species propagules
- Prevalence of near-vertical and deeply incised riparian embankments have the potential to destabilise riparian embankments upon removal of exotic vegetation, and act as physical impediments to revegetation and weed control works
- Prevalence of private land, and lack of public lands, abutting riparian corridors results in limited opportunity to batter and reconstruct near-vertical and incised riparian embankments
- Restricted access to portions of the riparian corridor create physical impediments to accessing portions of the study area.

Opportunities

- Improved aesthetic condition and value of vegetation throughout the study area
- Improved recreational value of open space and natural areas
- Promote and develop community ownership of open space and natural areas
- Increase area and diversity of native fauna species habitat within the local area
- Increase native flora species diversity within the local area
- Reduction in local noxious and major environmental weed species infestations.

4.3 Recommendations

Given the altered, degraded and dynamic nature of waterways and their hydrology throughout the Hunter River catchment, restoration of native vegetation communities within the study area to their 'original' state is not possible and should not be considered as a project aim. The following native vegetation rehabilitation and reconstruction aims and objectives are considered as realistic in the context of existing prevailing conditions at the study area.

Aims

- Control of noxious and major environmental weed species to low levels
- Establishment and maintenance of dominant and diverse local native shrub/mid-storey and canopy cover
- Establishment and maintenance of native fauna habitat
- Stabilisation of areas subject to potential soil erosion
- Achieve increase in native understorey species diversity and promote expansion of native understorey species cover
- Management and enhancement of existing native/exotic vegetation to establish functional and aesthetically pleasing public spaces and habitat reconstruction
- Raise public awareness and appreciation of natural environmental assets such as the Hunter River and Muscle Creek

Objectives

- Prepare an adaptable, practical, site specific 10-year Vegetation Management Plan to achieve project aims
- Establish a vegetation management and restoration contract, or Council team to lead and undertake medium/ long term regular management and maintenance works
- Establish a provenance native plant supply contract or Council nursery to deliver provenance native tubestock in accordance with project programming and budget availability
- Undertake staged approach to control Willow trees and weed infestations on steep slopes
- Undertake soft stabilisation works within areas of reformed and cleared (i.e. weed removed) slopes and embankments.

Implementation

In order to establish the proposed native vegetation reconstruction and restoration works throughout the six Precincts, it is envisioned that a total dedicated budget in the order of \$250,000 p.a. would be required over at least the first ten years of the project. Following establishment of a dominant native vegetation cover throughout the Precincts, subsequent maintenance costs would be expected to decrease to \$150,000-\$200,000 p.a. in order to maintain native vegetation in good condition. Any native vegetation rehabilitation works outside the core Precincts would require additional allocations of funding. Where any proposed additional works would not require substantial ongoing maintenance (e.g. establishment of native species mid-storey and canopy along the banks of the Hunter River), one-off State and Commonwealth government grants might be considered as a potential funding source.

Key considerations

The following key considerations will be important to the successful execution and sustainability of native vegetation rehabilitation works at the study area:

- In order to achieve meaningful ecological and environmental gains, a coordinated, sustained and appropriately resourced rehabilitation effort is required. Secure ongoing funding will ensure effective resource and project planning as well as maintaining environmental gains made by previous works. The Native vegetation management recommends that these works will be sufficiently resourced on an ongoing basis in order to achieve the majority of project aims over a 10-15 year time frame
- Inappropriate planning, resourcing and implementation will run the risk of not achieving expected or meaningful environmental outcomes and wasted resource expenditure (e.g. degradation of previously rehabilitated sites or failure of rehabilitation works due to poor strategic planning)
- Successful delivery of native vegetation management and restoration works will require the preparation of detailed site/project Vegetation Management Plans. Vegetation Management Plans for individual precincts will provide adaptable practical documents to guide Council managers and bush regenerators/contractors over the short-medium-term, including clear identification of (but not limited to):
 - project aims
 - works staging and prioritisation
 - works program
 - resourcing and user expectations
 - performance targets and project milestones.
- It is envisaged that the following site-specific Vegetation Management Plans (VMP) would be prepared:
 - Karoola Wetlands construction and management plan VMP
 - Karoola Hunter River VMP
 - Muscle Creek VMP
 - Rutherford Park VMP.
- Successful rehabilitation works at all sites will require the services of an appropriately qualified and experienced bush regeneration team who can provide dedicated site and project management in order to manage the site in conjunction with Council on an ongoing basis
- Schemes such as the Commonwealth Government Green Army would be a useful additional source of untrained labour, however, should only be considered as supplementary to the services of an appropriately qualified and experienced bush regeneration team, and should not be considered as suitable for overall project delivery
- Location, composition and density of native species revegetation must take into account potential negative impacts upon flood levels and trajectories (e.g. avoid dense woody species plantings on deposition banks opposite highly incised banks in order to avoid exacerbating bank undercutting)
- All revegetation works are to utilise local native species that are indicative of local native vegetation communities (includes FloraBank seed collection guidelines)
- Throughout the study area vegetation management works are to prioritise the control of noxious and major environmental weed species and increase cover and diversity of native plant species that are indicative of local native vegetation communities.

4.4 Vegetation management plan



Figure 15 Vegetation management plan

Vegetation management risk analysis and priority staging

Our suggested strategy would be to undertake targeted control of woody and vine weeds throughout Precincts 1, 2, 4 and 5. Depending upon the available budget, some localised soft bank stabilisation could also be installed if required. This strategy would exclude control of large mature Willows along the Hunter River, as these works would require medium-term strategy and funding.

Undertaking targeted woody and vine weed removal throughout the identified Precincts would be expected to require in the order of 480 on-ground hours to complete, at a cost of approximately \$25,000.00 ex GST.

GHD recommend that a number of key considerations be observed with respect to the implementation of native vegetation management and restoration works at the study area, as follows:

- In order to achieve meaningful ecological and environmental gains, a coordinated, sustained and appropriately resourced rehabilitation effort is required. Secure ongoing funding will ensure effective resource and project planning as well

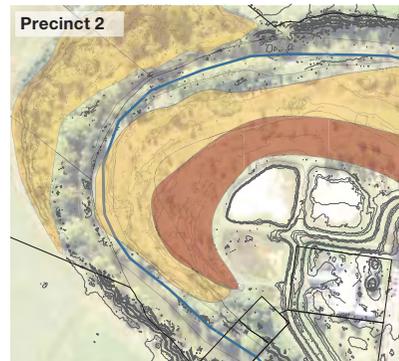
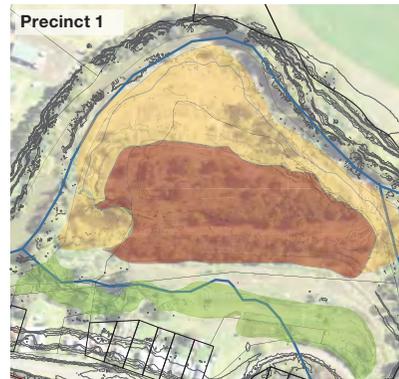
as maintaining environmental gains made by previous works. Native vegetation management master-planning assumes that works under the Master Plan will be sufficiently resourced on an ongoing basis in order to achieve the majority of project aims over a 10-15 year timeframe.

- Inappropriate planning, resourcing and implementation will run the risks of not achieving expected or meaningful environmental outcomes and wasted resource expenditure (e.g. degradation of previously rehabilitated sites or failure of rehabilitation works due to poor strategic planning).
- Successful rehabilitation works at all sites will require the services of an appropriately qualified and experienced bush regeneration team who can provide dedicated site and project management in order to manage the site in conjunction with Council on an ongoing basis (GHD can provide requirements for bush regeneration contractors)

RISK CATEGORY	ID REFERENCE	DESCRIPTION	RECOMMENDED ACTION
High	No. 1	Muscle Creek - Priority area, provide weed management to outer embankment	Remove woody and vine weeds throughout. Improve the soil with compost.
Medium	No. 2	Muscle Creek - Weed management and vegetation enhancement of gentle sloping embankment adjacent Muswellbrook aquatic centre	Remove woody and vine weeds throughout. Improve the soil with compost. Co-ordinate with bank stabilisation in this area as required.
High	No. 3	Hunter River - Vegetation management to steep slopes greater than 1:3.	Remove woody and vine weeds throughout. Improve the soil with compost where possible.
Medium	No. 4	Hunter River - Vegetation management to provide public access to the river	Remove woody and vine weeds throughout. Improve the soil with compost. Slash long grass to a height of 75mm to enable safe pedestrian access and bush fire management if required.
Medium	No. 5	Hunter River - Vegetation management to steep embankments to provide safe public access to the river	Remove woody and vine weeds throughout. Improve the soil with compost. Slash long grass to a height of 75mm to enable safe pedestrian access and bush fire management if required.

Priority staging

- Year 1
- Year 2
- Year 3



Precinct 1

Weed targeting first

- Anredera cordifolia
- Araujia sericifera
- Cardiospermum grandiflorum
- Ipomea indica
- Lonicera japonica

Weed targeting second

- Acacia podalyriifolia
- Arundo donax
- Cestrum parqui
- Cinnamomum camphora
- Ligustrum lucidum
- Morus alba
- Salix babylonica

Recommended species list >3:1 embankments

Canopy:

- Eucalyptus camaldulensis

Mid Storey:

- Casurina cunninghamiana
- Angophora floribunda
- Eucalyptus melliodora

Shrubs:

- Bursaria spinose
- Callistemon salignus
- Exocarpos strictus
- Notelaea macrocarpa

Grasses:

- Austrostipa verticillata

Sedges:

- Lomandra longifolia

Precinct 2 and 3

Weed targeting first

- Anredera cordifolia
- Araujia sericifera
- Cardiospermum grandiflorum
- Lonicera japonica

Weed targeting second

- Arundo donax
- Cestrum parqui
- Cinnamomum camphora
- Ligustrum lucidum
- Morus alba
- Salix babylonica

Recommended species list >3:1 embankments

Canopy:

- Eucalyptus camaldulensis
- Casurina cunninghamiana

Mid Storey:

- Angophora floribunda
- Eucalyptus melliodora
- Allocauarina leuhmannii
- Brachychiton populneus
- Melia azedarach

Shrubs:

- Bursaria spinose
- Callistemon salignus
- Exocarpos strictus
- Notelaea macrocarpa

Grasses:

- Austrostipa verticillata

Sedges:

- Juncus usitatus
- Lomandra longifolia

Precinct 4 and 5

Weed targeting first

- Anredera cordifolia
- Araujia sericifera
- Cardiospermum grandiflorum
- Ipomea indica
- Lonicera japonica

Weed targeting second

- Acacia podalyriifolia
- Arundo donax
- Cestrum parqui
- Cinnamomum camphora
- Ligustrum lucidum
- Morus alba
- Salix babylonica

Recommended species list >3:1 embankments

Canopy:

- Eucalyptus camaldulensis
- Casurina cunninghamiana
- Angophora floribunda
- Eucalyptus melliodora

Mid Storey:

- Allocauarina leuhmannii
- Brachychiton populneus
- Melia azedarach

Shrubs:

- Bursaria spinose
- Callistemon salignus
- Exocarpos strictus
- Notelaea macrocarpa

Grasses:

- Austrostipa verticillata
- Imperata cylindrica

Sedges:

- Juncus usitatus
- Lomandra longifolia
- Pteridan esclentum

Precinct 1 - Karoola Wetlands

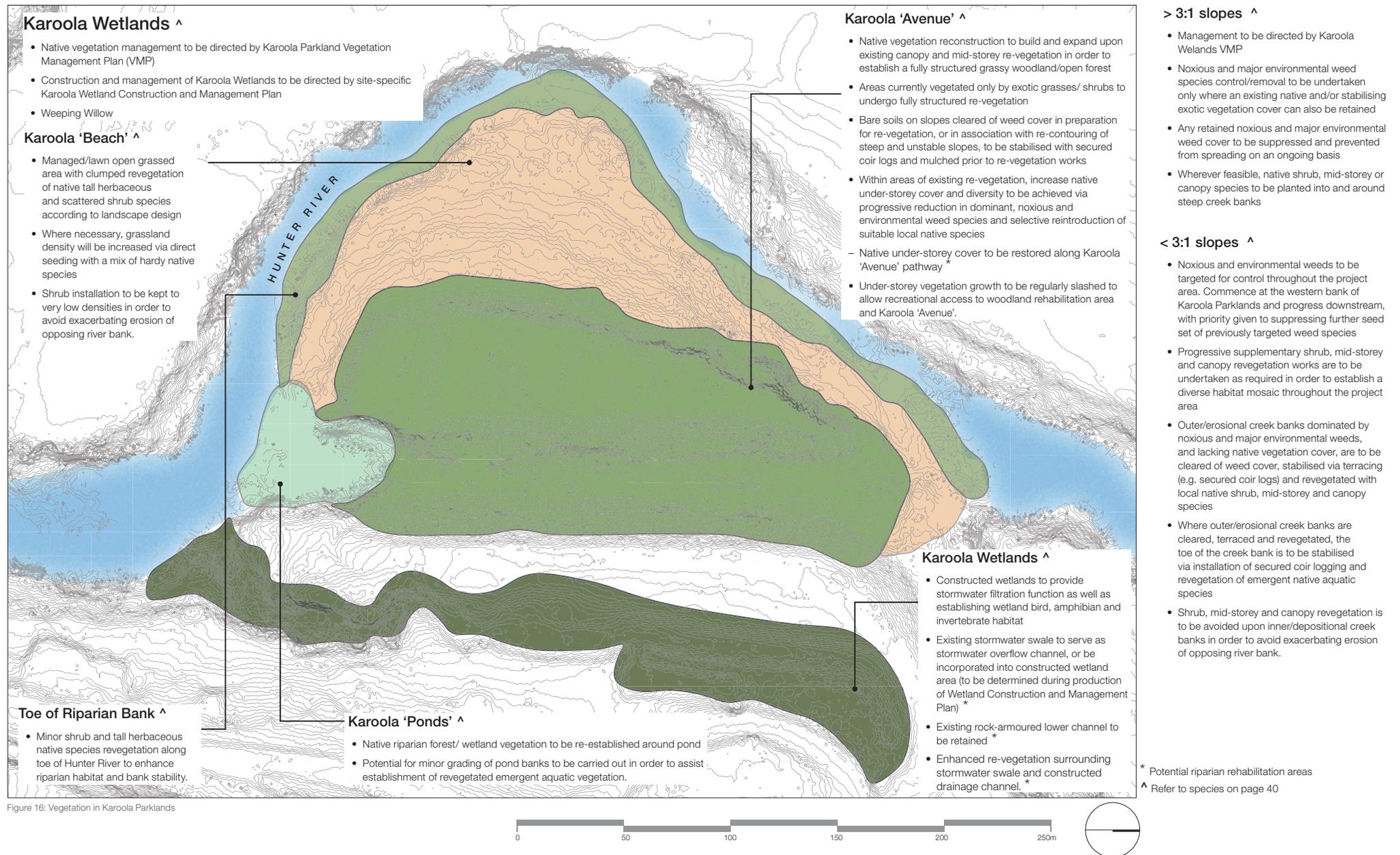
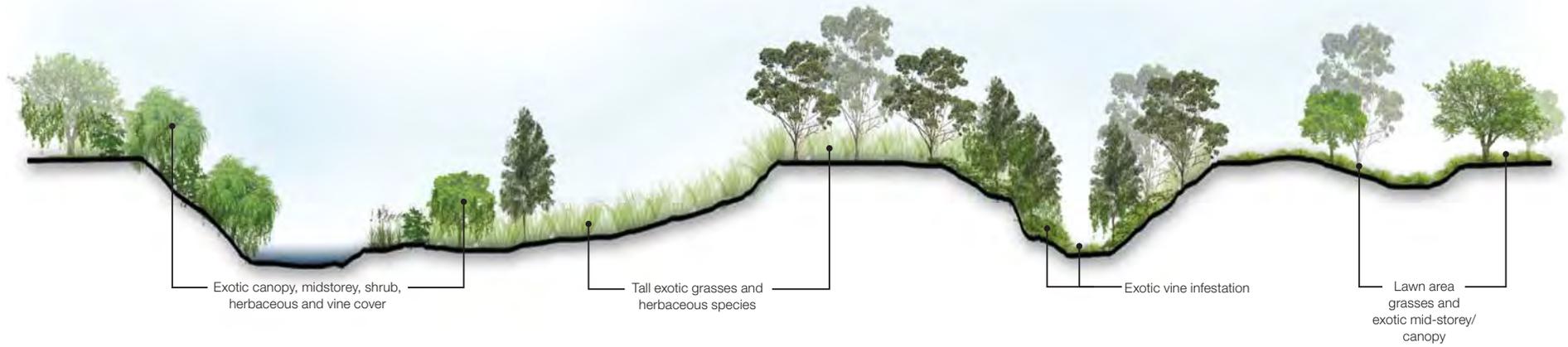


Figure 16: Vegetation in Karoola Parklands

EXISTING



PROPOSED

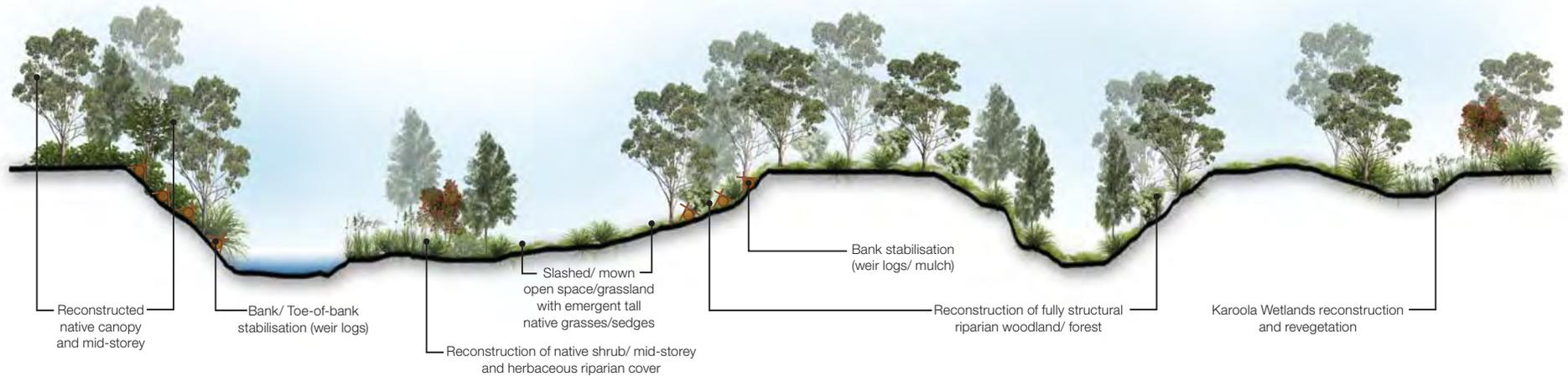


Figure 17: Section of vegetation in Karoola Parklands

Species in Karoola Wetlands - Precinct 1

MAJOR TARGET WEED SPECIES	TYPICAL DIVERSITY PLANTING
• <i>Acacia podalyriifolia</i>	• <i>Aristida ramosa</i>
• <i>Anredera cordifolia</i>	• <i>Echinopogon caespitosus</i>
• <i>Araujia sericifera</i>	• <i>Elymus scaber</i>
• <i>Arundo donax</i>	• <i>Eragrostis leptostachya</i>
• <i>Brassica</i> sp.	• <i>Microlaena stipoides</i>
• <i>Bromus catharticus</i>	• <i>Paspalidium aversum</i>
• <i>Bromus</i> sp.	• <i>Rytidosperma fulvum</i>
• <i>Cardiospermum grandiflorum</i>	• <i>Sporobolus creber</i>
• <i>Cestrum parqui</i>	• <i>Alternanthera denticulata</i>
• <i>Cinnamomum camphora</i>	• <i>Calotis lappulacea</i>
• <i>Eriobotrya japonica</i>	• <i>Commelina cyanea</i>
• <i>Foeniculum vulgare</i>	• <i>Cynoglossum australe</i>
• <i>Galium aparine</i>	• <i>Desmodium varians</i>
• <i>Ipomoea indica</i>	• <i>Dichondra repens</i>
• <i>Ligustrum lucidum</i>	• <i>Einadia hastata</i>
• <i>Lonicera japonica</i>	• <i>Einadia trigonos</i>
• <i>Morus alba</i>	• <i>Geranium solanderi</i>
• <i>Ricinus communis</i>	• <i>Lepidium pseudohyssopifolium</i>
• <i>Salix babylonica</i>	• <i>Rumex brownii</i>
• <i>Schinus areira</i>	• <i>Sida corrugata</i>
• <i>Silybum marianum</i>	• <i>Solanum americanum</i>
• <i>Tradescantia fluminensis</i>	• <i>Solanum cinereum</i>
	• <i>Urtica incisa</i>
	• <i>Glycine clandestina</i>
	• <i>Glycine tabacina</i>
	• <i>Cyperus fulvus</i>

ITEM	KAROOLA WETLANDS	KAROOLA PONDS	KAROOLA AVENUE	KAROOLA BEACH	TOE OF RIPARIAN BANK	
Canopy	<ul style="list-style-type: none"> • <i>Angophora floribunda</i> • <i>Eucalyptus crebra</i> • <i>Eucalyptus melliodora</i> • <i>Eucalyptus moluccana</i> 	<ul style="list-style-type: none"> • <i>Eucalyptus camaldulensis</i> • <i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i> • <i>Angophora floribunda</i> 	<ul style="list-style-type: none"> • <i>Eucalyptus camaldulensis</i> • <i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i> • <i>Angophora floribunda</i> • <i>Eucalyptus melliodora</i> 	<ul style="list-style-type: none"> • <i>Eucalyptus camaldulensis</i> • <i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i> 	<ul style="list-style-type: none"> • <i>Casuarina cunninghamiana</i> subsp. <i>cunninghamiana</i> 	
Mid storey	<ul style="list-style-type: none"> • <i>Allocasuarina luehmannii</i> • <i>Brachychiton populneus</i> subsp. <i>populneus</i> • <i>Melia azedarach</i> 		<ul style="list-style-type: none"> • <i>Allocasuarina luehmannii</i> • <i>Brachychiton populneus</i> subsp. <i>populneus</i> • <i>Melia azedarach</i> 			
Shrubs	<ul style="list-style-type: none"> • <i>Bursaria spinosa</i> • <i>Callistemon salignus</i> • <i>Exocarpos strictus</i> • <i>Notelaea microcarpa</i> • <i>Notelaea neglecta</i> 	<ul style="list-style-type: none"> • <i>Bursaria spinosa</i> • <i>Callistemon salignus</i> • <i>Exocarpos strictus</i> • <i>Notelaea microcarpa</i> • <i>Notelaea neglecta</i> 	<ul style="list-style-type: none"> • <i>Bursaria spinosa</i> • <i>Callistemon salignus</i> • <i>Exocarpos strictus</i> • <i>Notelaea microcarpa</i> 	<ul style="list-style-type: none"> • <i>Callistemon salignus</i> 	<ul style="list-style-type: none"> • <i>Callistemon salignus</i> 	
Grasses	<ul style="list-style-type: none"> • <i>Austrostipa verticillata</i> • <i>Oplismenus aemulus</i> 	<ul style="list-style-type: none"> • <i>Austrostipa verticillata</i> • <i>Oplismenus aemulus</i> 	<ul style="list-style-type: none"> • <i>Austrostipa verticillata</i> 	<ul style="list-style-type: none"> • <i>Austrostipa verticillata</i> <p>Direct Seeding</p> <ul style="list-style-type: none"> • <i>Bothriochloa decipiens</i> var. <i>decipiens</i> • <i>Elymus scaber</i> • <i>Eragrostis leptostachya</i> • <i>Microlaena stipoides</i> • <i>Rytidosperma fulvum</i> • <i>Sporobolus creber</i> 		
Herbs	<ul style="list-style-type: none"> • <i>Alternanthera denticulata</i> • <i>Atriplex australasica</i> • <i>Brunoniella australis</i> • <i>Centella asiatica</i> • <i>Commelina cyanea</i> • <i>Goodenia gracilis</i> • <i>Plectranthus parviflorus</i> 	<ul style="list-style-type: none"> • <i>Alternanthera denticulata</i> • <i>Atriplex australasica</i> • <i>Brunoniella australis</i> • <i>Centella asiatica</i> • <i>Commelina cyanea</i> • <i>Goodenia gracilis</i> • <i>Plectranthus parviflorus</i> 				
Sedges	<ul style="list-style-type: none"> • <i>Carex facicularis</i> • <i>Juncus usitatus</i> • <i>Lomandra longifolia</i> 	<ul style="list-style-type: none"> • <i>Juncus usitatus</i> • <i>Lomandra longifolia</i> 	<ul style="list-style-type: none"> • <i>Lomandra longifolia</i> 	<ul style="list-style-type: none"> • <i>Juncus usitatus</i> • <i>Lomandra longifolia</i> 	<ul style="list-style-type: none"> • <i>Juncus usitatus</i> • <i>Lomandra longifolia</i> 	
Aquatics	<ul style="list-style-type: none"> • <i>Alisma plantago-aquatica</i> • <i>Damasonium minus</i> • <i>Eleocharis sphacelata</i> • <i>Epaltes australis</i> • <i>Ludwigia peploides</i> subsp. <i>montevidensis</i> • <i>Paspalum distichum</i> • <i>Persicaria decipiens</i> • <i>Persicaria hydropiper</i> • <i>Triglochin procera</i> 	<ul style="list-style-type: none"> • <i>Alisma plantago-aquatica</i> • <i>Damasonium minus</i> • <i>Eleocharis sphacelata</i> • <i>Epaltes australis</i> • <i>Ludwigia peploides</i> subsp. <i>montevidensis</i> • <i>Paspalum distichum</i> • <i>Persicaria decipiens</i> • <i>Persicaria hydropiper</i> • <i>Triglochin procera</i> 				

Precinct 2 - The Greenroom at Rutherford Park

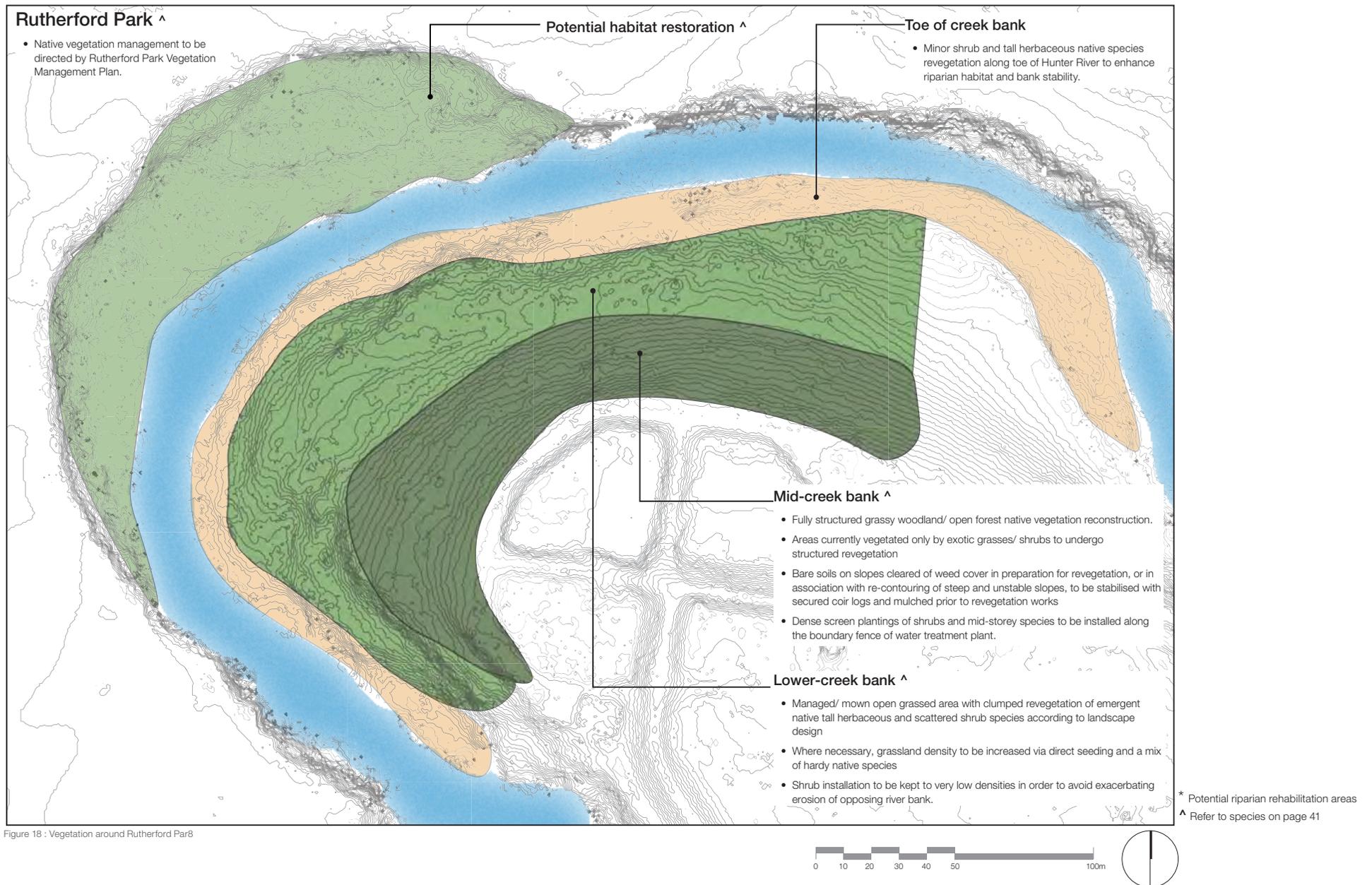
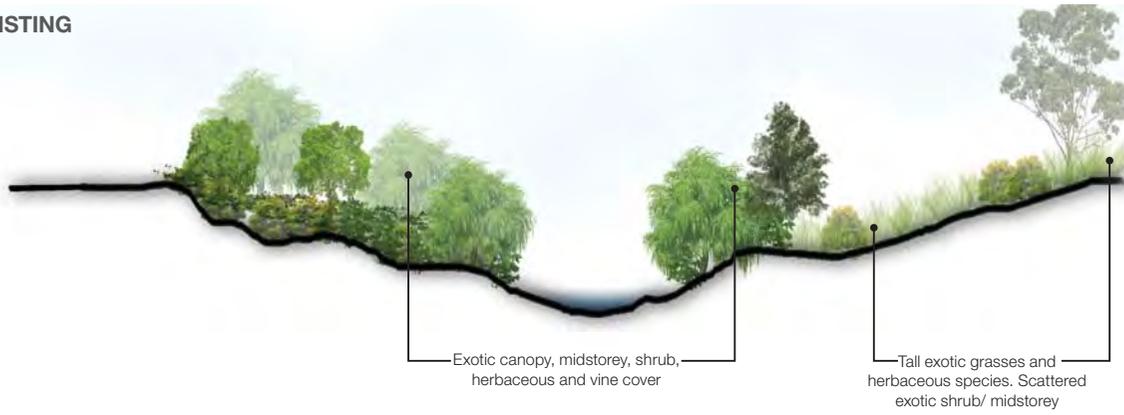


Figure 18 : Vegetation around Rutherford Park

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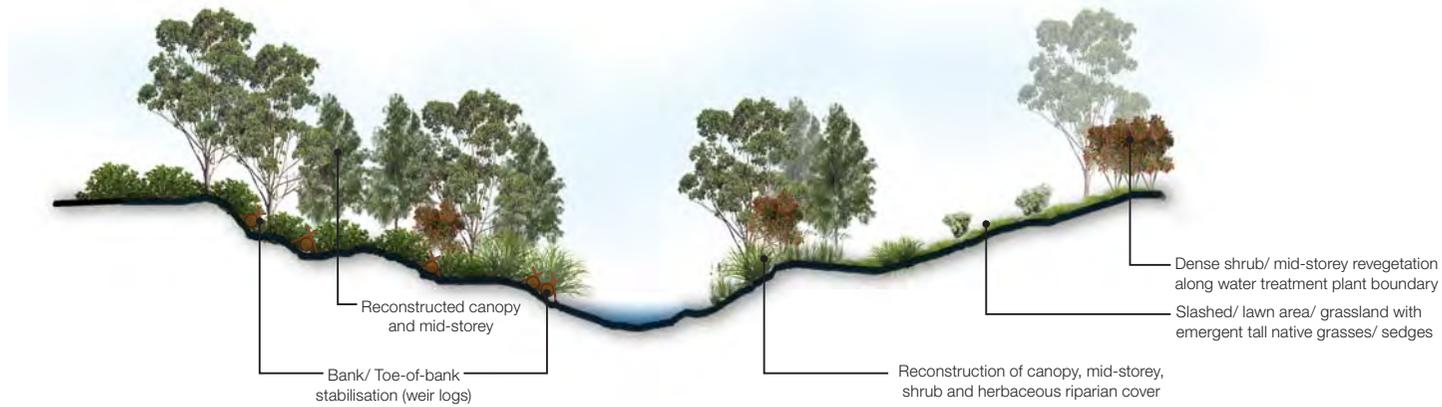


Figure 19: Section of vegetation in Rutherford Park

Species in Rutherford Park - Precinct 2 and 3

MAJOR TARGET WEED SPECIES	ITEM	MID-CREEK BANK	LOWER-CREEK BANK	TOE OF CREEK BANK
<ul style="list-style-type: none"> • <i>Anredera cordifolia</i> • <i>Araujia sericifera</i> • <i>Arundo donax</i> • <i>Brassica sp.</i> • <i>Bromus catharticus</i> • <i>Bromus sp.</i> • <i>Cardiospermum grandiflorum</i> • <i>Cestrum parqui</i> • <i>Foeniculum vulgare</i> • <i>Galium aparine</i> • <i>Ligustrum lucidum</i> • <i>Lonicera japonica</i> • <i>Lycium ferocissimum</i> • <i>Ricinus communis</i> • <i>Salix babylonica</i> • <i>Silybum marianum</i> • <i>Tradescantia fluminensis</i> • <i>Ricinus communis</i> • <i>Salix babylonica</i> • <i>Schinus areira</i> • <i>Silybum marianum</i> • <i>Tradescantia fluminensis</i> 	Canopy <ul style="list-style-type: none"> • <i>Eucalyptus camaldulensis</i> • <i>Angophora floribunda</i> • <i>Eucalyptus melliodora</i> 	<ul style="list-style-type: none"> • <i>Allocasurina luehmannii</i> • <i>Brachychiton populneus subsp. populneus</i> • <i>Melia azedarach</i> 	<ul style="list-style-type: none"> • <i>Casuarina cunninghamiana subsp. cunninghamiana</i> 	<ul style="list-style-type: none"> • <i>Casuarina cunninghamiana subsp. cunninghamiana</i>
	Mid storey			
	Shrubs	<ul style="list-style-type: none"> • <i>Bursaria spinosa</i> • <i>Callistemon salignus</i> • <i>Exocarpos strictus</i> • <i>Notelaea microcarpa</i> 	<ul style="list-style-type: none"> • <i>Bursaria spinosa</i> • <i>Callistemon salignus</i> 	<ul style="list-style-type: none"> • <i>Callistemon salignus</i>
	Grasses	<ul style="list-style-type: none"> • <i>Aristida ramosa</i> • <i>Austrostipa verticillata</i> • <i>Echinopogon caespitosus</i> • <i>Elymus scaber</i> • <i>Eragrostis leptostachya</i> • <i>Microlaena stipoides</i> • <i>Paspalidium aversum</i> • <i>Rytidosperma fulvum</i> • <i>Sporobolus creber</i> 	<ul style="list-style-type: none"> • <i>Austrostipa verticillata</i> Direct Seeding <ul style="list-style-type: none"> • <i>Bothriochloa decipiens var. decipiens</i> • <i>Elymus scaber</i> • <i>Eragrostis leptostachya</i> • <i>Microlaena stipoides</i> • <i>Rytidosperma fulvum</i> • <i>Sporobolus creber</i> 	
	Herbs	<ul style="list-style-type: none"> • <i>Alternanthera denticulata</i> • <i>Calotis lappulacea</i> • <i>Commelina cyanea</i> • <i>Cynoglossum australe</i> • <i>Desmodium varians</i> • <i>Dichondra repens</i> • <i>Einadia hastata</i> • <i>Einadia trigonos</i> • <i>Geranium solanderi</i> • <i>Lepidium pseudohyssopifolium</i> • <i>Rumex brownii</i> • <i>Sida corrugata</i> • <i>Solanum americanum</i> • <i>Solanum cinereum</i> • <i>Urtica incisa</i> 		
	Sedges	<ul style="list-style-type: none"> • <i>Cyperus fulvus</i> 	<ul style="list-style-type: none"> • <i>Juncus usitatus</i> • <i>Lomandra longifolia</i> 	<ul style="list-style-type: none"> • <i>Juncus usitatus</i> • <i>Lomandra longifolia</i>
	Twiners	<ul style="list-style-type: none"> • <i>Glycine clandestina</i> • <i>Glycine tabacina</i> • <i>Sedges</i> • <i>Cyperus fulvus</i> 		