Positively PENRITH

Creek Care Guide

PENRITH CITY COUNCIL

penrith.city

Contents

Acknowledgment of Country

We acknowledge and pay respect to the Darug and Gundungarra people who are the traditional owners in which Penrith Local Government Area is situated. We also pay our respect to elders past, present and emerging, and to the First Nations people living in our community today.

1. About this guide

The waterways in the Penrith local government area (LGA) are under pressure from increased urbanisation, land use changes, and development. As a result, most waterways are damaged and contain much higher levels of contaminants such as sediment, nutrients, chemicals, and pathogens compared to their natural levels, negatively impacting the health of the waterways, and poses threats to humans, biodiversity and ecological processes. Everyone living in the Penrith LGA can protect, preserve, and rehabilitate our waterways.

Water is our life source. We all rely on clean drinking water to survive, and plants and animals do, too. But water also plays an important role in improving our overall wellbeing.

We use water for recreational purposes such as swimming, kayaking, boating, fishing, or simply having a picnic on the shore on a warm summer afternoon. We all take pleasure in a tranquil waterway that is flourishing with biodiversity. It is essential that we all take responsibility caring for our waterways as everyone and everything is entitled to live in a clean and healthy environment, free from pollution.

We are lucky to have many waterways in Penrith. Penrith City Council proactively manages waterways that are under our care and control.

Many of Penrith's waterways (particularly creeks) flow through private land, meaning that Council relies on the assistance of landowners to help manage their care. This guide has been created to help landholders make decisions relating to the management of waterways flowing through their land. The aim is to create an integrated, best-practice approach to overall waterway health. This guide is also aimed at supporting and encouraging the wider community to participate in the conservation and protection of waterways in their community.

If you are looking to undertake any works on your property, you can contact one of the following Landcare groups:

- **Mulgoa Valley Landcare** (lisa@mulgoalandcare.org.au)
- **Cumberland Land Conservancy** (president@cumberlandlc.org.au)
- **Hawkesbury-Nepean Landcare Network** (landcare@hrcc.nsw.gov.au)

These groups aim to grow, develop and influence the community and landscape. They empower community action by promoting conservation on properties, reserves, and school projects.

2. Waterway ecosystems

2.1 – Flora and fauna

Penrith's waterways are full of biodiversity: a variety of native fish, such as Bass and Silver Perch, wander the waterways in search of aquatic insects and plants to feed on; wombats waddle the banks of the Nepean River, feeding on native grasses; a wide variety of native birds fill our skies with colour and our ears with wonderful sounds; and platypuses are now showing up in Penrith's waterways, rummaging around for insects, small fish, and worms to feed on. On the rocks of the riverbanks, you may see an Eastern Water Dragon or hear the popping call of the Striped Marsh Frog. The waterways and riparian vegetation along the banks are their homes, and they require healthy, unpolluted ecosystems to thrive.

Native vegetation also plays a crucial role in ecosystem health. We are lucky in Penrith to support a large portion of the remaining Cumberland Plain Woodland which is teeming with biodiversity. Our bushland contains over 500 native plant species and 13 vegetation communities, many of which are endangered and need additional protection. Vegetation also plays an important role in erosion control, improving water quality, storing carbon, and mitigating the impacts of a changing climate.

2.2 – Invasive species

Australia's native plants and animals are well adapted to the local environment, having evolved on an isolated continent for millions of years. Invasive introduced plants and animals pose significant threats as they compete for land and resources with the native flora and fauna. Furthermore, invasive pests often have fewer natural predators and higher reproductive rates, meaning their populations expand quicker than native species.

Greater Sydney Local Land Services (GSLLS) and Hawkesbury River County Council (HRCC) coordinates pest animal and weed management in accordance with the NSW Biosecurity Act 2016.

If you require advice on weed management then you can contact HRCC at **inspections@hrcc.nsw.gov.au** or for pest animals contact GSLLS **gs.service@lls.nsw.gov.au** or for more information, visit their websites .

Hawkesbury River County Council
hrcc.nsw.gov.au

Greater Sydney Land Services
lls.nsw.gov.au/regions/greater-sydney

3. Understanding Waterways and the Riparian Zone

3.1 – From Creeks to Catchments

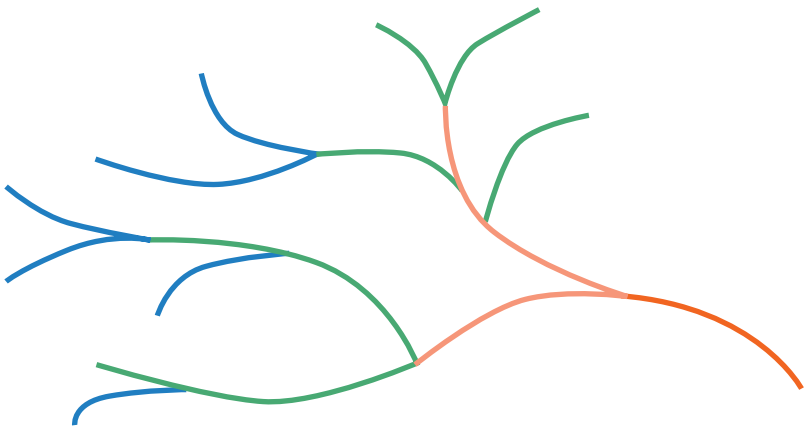
Waterways around Penrith provide essential ecosystem services and are hosts to a wide variety of animals and plants. When thinking about a waterway ecosystem, it is important to not only think about the body of water, but the entire catchment. A catchment is defined as the entire area where water is captured by the natural landscape. Regarding waterways, this would be the area of land which flows into that waterway, and therefore, each waterway has its own unique catchment.

3.2 - Classifying Waterways

Penrith contains numerous waterways, most of which have their own unique name and classification, while there are also many unnamed tributaries. It is important to understand how waterways are classified as this will help inform your management approach. The NSW Department of Primary Industries apply the Strahler stream classification system, where waterways are given an 'order' according to the number of smaller streams that flow into it . This system gives us an indication of the size and complexity of the waterway.

Lower order streams may not always have water in them and may only flow for short durations during periods of high rainfall. We call these types of waterways "ephemeral waterways". Prior to undertaking any management actions, it is important to check what order the stream is and if the waterway is a mapped waterway on a topographic map. You can do this on the Hydro Line website: water.dpie.nsw.gov.au/our-work/licensing-and-trade/controlled-activity-approvals/waterfront-land-e-t

1. 1st order - the headwater
2. 2nd order - where 2 flow paths of order 1 join
3. 3rd order - where 2 flow paths of order 2 join
4. 4th order - where 2 flow paths of order 3 join



3.3 – The Riparian Zone

The waterway or stream order will dictate how wide the minimum vegetated riparian zone (corridor) should be to support good waterway health. Essentially, the riparian zone is the area which surrounds the waterway. The table below outlines how wide the vegetated riparian zone should be depending on the stream order.

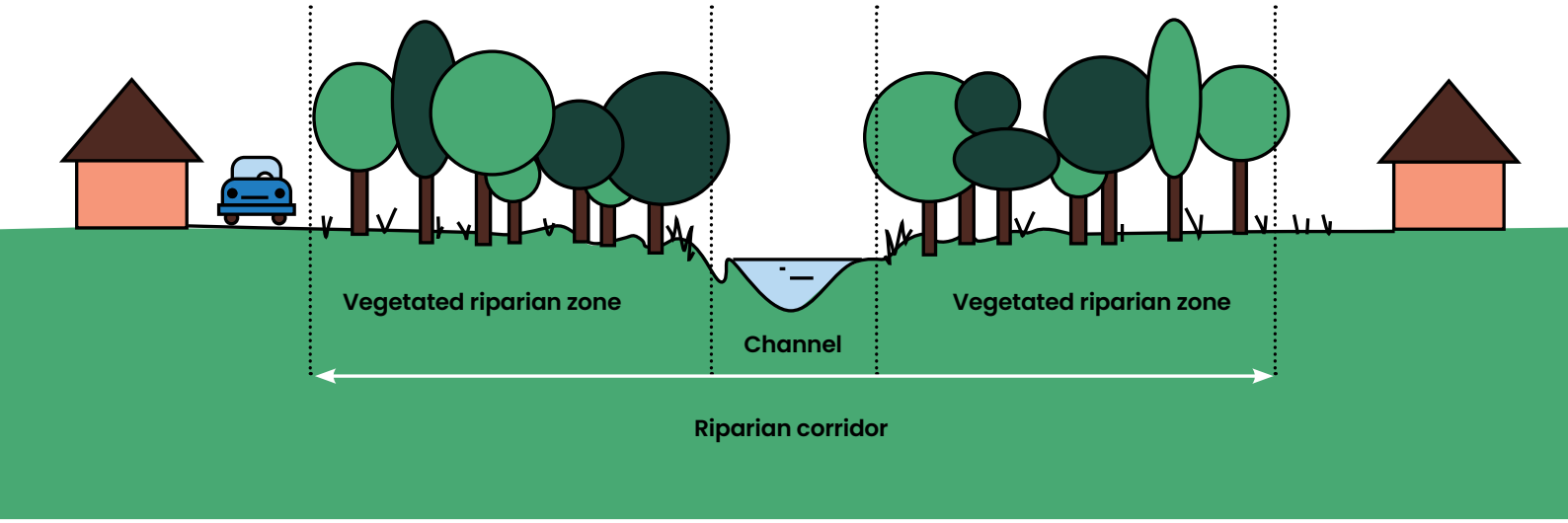
1st order	10 metres either side
2nd order	20 metres either side
3rd order	30 metres either side
4th order	40 metres either side

The riparian zone should contain native vegetation that is extensive and runs in a corridor down either side of the waterway. This corridor provides multiple benefits for the environment, such as:

- Provides food and habitat resources for native animals.
- Provides habitat connectivity for flora and fauna throughout the urban and rural landscape.
- Provides refuge for native plants and animals, especially during climatic extremes such as droughts and bushfires.
- Acts as a buffer against nutrient and contaminant pollution.
- Positively influences instream ecosystem productivity and temperature control through shading.
- Shading from the overstory limits the growth of algae.
- Reduces flood vulnerability by slowing down the flow of water before it overwhelms the waterway.
- Stabilise banks to reduce erosion and the build-up of suspended sediments and silt which impacts photosynthesis.

3.4 – Observed and expected changes to waterway ecosystems

Our waterways are at risk due to a changing climate. Western Sydney is experiencing increased temperatures and risk of bushfires, heavy rainfall, and flooding, sometimes resulting in damage to the riparian zones. These impacts are predicted to become more severe and common in the future, which is why it's important we protect and restore our natural environment to ensure it has the resilience to continue to function correctly and provide the benefits we require.



4. Waterway health

4.1 – What does a healthy waterway look like?

Sometimes evaluating the health of a waterway can be a tricky task. Some aspects of the waterway may be healthy, while other aspects may be unhealthy. Being able to identify these issues is important so you can choose which management approach is the most suitable.

The following list describes key elements of what a healthy riparian environment should look like. All these elements can be easily improved by landowners.

Figure 9 – An example of a healthy waterway environment.

ELEMENT AND BENEFIT	HOW TO IMPROVE
Organic matter and woody debris • Diverse organic debris in and around a waterway is strongly associated with a healthy waterway and diversity in macroinvertebrate and insect populations. • An abundance of macroinvertebrates (water bugs) and insects is beneficial for larger animals such as platypus and fish to persist. • Provides natural carbon from outside sources which is a key energy source for the plants and animals living along the edges of waterways. • Has potential to reduce excess nitrate loads in waterways. • Provides flow refuges and cover or camouflage for fish from predators.	• Increase the amount of rocky substrate in the waterways' bed to allow for the collection of organic matter. • Increase riparian tree density to increase the amount of organic matter that falls into the waterway and is present on the banks of the creek. • Ensure that organic matter that enters the waterway is not removed.
Consolidated native vegetation that runs down either side of the waterway • Ground cover, midstory, and overstory. • Provides shade for temperature regulation. • Stabilises banks and reduces erosion.	• Revegetation/planting projects. • Install fencing to stop cattle from grazing in the riparian zone. • Minimise stormwater runoff from your property. Implement "no mow" zones within the riparian zone.

ELEMENT AND BENEFIT	HOW TO IMPROVE
Correct management of other waterbodies (dams) on your property  *Figure 10 – An example of a healthy farm dam.*	• Limit stock access by fencing around the dam and piping water to external watering points such as troughs or tanks. This is the best long-term solution to maintaining clean and healthy water and minimising damage to your dam. • Maintain good groundcover in the catchment area around your dam as this will increase the water quality. It will also improve soil stability, and minimise fertilisers, animal droppings, and other pollutants from entering the water body. • Plant or encourage aquatic vegetation to assist in the removal of chemicals and nutrients from the water. • Attract wildlife such as birds to the dam by introducing native fish or yabbies species. This in turn will help to manage mosquito populations. • Provide a diversity of habitats, such as, fringing and emergent aquatic vegetation, hollow logs, irregular shorelines, rocks, built islands, and variable water depths.
Wide vegetated riparian zone • As outlined in section 3.3.	• As outlined in section 6.
Limited levels of suspended sediments and siltation	• As outlined in section 5.2.
Abundance and diversity of flora and fauna species • Complex habitats are generally a sign of a healthier riparian environment. • An abundance of bugs means that it is likely that larger animals such as platypus, echidna, or fish will also be present. • If you notice that waterways on your property lack biodiversity (plants and animals), this may be a sign that your waterway is unhealthy, and wildlife is choosing not to inhabit the waterway.	• Revegetation projects. • Limit stormwater runoff through water sensitive urban design (WSUD). Further details outlined in section 7.
In-stream vegetation • In-stream vegetation is important for fish as they provide shelter and feeding opportunities. • Fish may also lay eggs around aquatic vegetation.	• Revegetation projects.
Waterway is flowing freely	• Do not over extract ground water.

Figure 11 – An example of a potential source of point source

4.2 – Water pollution

Pollution and damage to waterway ecosystems is a common occurrence in rural and urban areas and is not unique to Penrith. This occurs primarily from stormwater runoff from impermeable surfaces such as driveways, footpaths, roads, roofs, artificial grass surfaces, etc. This results in stormwater and its associated contaminants running off into waterways faster and in greater volumes than it naturally would, bypassing the riparian zones natural filtering and buffering capacity. This can result in a significant increase in the flow of waterways, resulting in further issues such as erosion, sedimentation, and flooding.

There are two main forms of water pollution:

Point source pollution is from a single identifiable source; for example, a pipe or drain coming from a factory flowing directly into a waterway.

Diffuse source pollution is primarily caused by stormwater runoff, which collects contaminants as it flows over the land and carries them into the waterway. This form of water pollution is one of the most abundant sources in the state's waterways and is exacerbated when large impermeable surfaces are present. This disrupts the natural flow regime and transports water and its associated contaminants into the waterways faster than usual.

The sources of diffuse pollutants are different between urban and rural areas, which is outlined in the table below.

Pollution can also arise from other sources, such as litter or incorrectly disposing of waste. No matter the source, all forms of pollution decrease water quality, making it potentially no longer viable to drink, use for stock, or swim in, and can impact the health of plants and animals.

	Source	Pollutants
Urban	Road surfaces, industrial and commercial premises, parks, gardens, degraded riparian areas, bushfires, boats, animal faeces (particularly from dogs), and households.	Litter, microbial (bacteria, fungi, moulds, and mites), nutrients, chemicals, pesticides, metals, sediment, vegetation, and pathogens.
Rural	Broadacre cropping, irrigation farming, grazing and intensive livestock industries, animal faeces, and land clearing.	Litter, microbial (bacteria, fungi, moulds, and mites), nutrients, chemicals, pesticides, metals, sediment, vegetation, and pathogens.

4.3 – Eutrophication

Stormwater runoff can cause excess nutrients, such as phosphorus and nitrogen, to build up in the waterways. While nutrients may sound like a positive thing, this in fact lowers the available dissolved oxygen in the water, creating a hypoxic environment. This process is called eutrophication. Algae thrives in such environments, which releases toxic chemicals into the water, making it harder for other animals and plants to survive, and can be damaging to the health of humans. This can also slow down the natural flow regime of the waterway, resulting in stagnant waterways, impacting downstream environments.

The most common source of these nutrients is from fertilisers and cattle on agricultural land; however, they can also arise from sewage, animal faeces or excessive use of garden fertilisers.

4.4 – Managing pollutants on your property

It is crucial to know how to use and manage potential pollutants on your property and land. Pollution from your property will not only damage the waterway on your property but will also damage downstream environments. Below is a list of ways you can manage pollutants:

- Revegetate the riparian corridor to provide a buffer and filter for stormwater runoff.
- Avoid blowing or raking leaves or grass clippings into stormwater drains or along the roadside. Instead, gather them and place them in the green-lidded FOGO bin.
- Do not dump green waste from your household or garden into bushland as this has a multitude of negative impacts, including; introducing invasive species, creating fire hazards, preventing the natural regeneration of native plants, and affecting native animals who rely on native plants for food and shelter. Dumped green waste can also get washed into our stormwater system and end up in waterways, suffocating native ground cover, and attracting breeding grounds for rats and mice.
- Dispose of unwanted vegetation, and animal waste in the green lid organics bin.

Figure 12 – An algae bloom in a waterway as a result from eutrophication.

Take paint, turpentine, and solvents to your local recycling centre or chemical clean out. You can find out more about disposing of your waste at **penrithcity.nsw.gov.au/waste-environment/waste**

- Pick up any litter you see while out on a walk.
- Wash your car on grass or gravel.
- Ensure all pet poo is picked up and disposed of correctly.

Fishing is a common recreational activity around Penrith. Unfortunately, the issue of fishing lines being left along the banks of rivers is becoming increasingly common. Wildlife such as ducks, pelicans, and platypus can become entangled in the fishing lines, which in many cases results in a slow painful death of the animal. It is critical that all fishing materials are collected and disposed of properly to ensure our wildlife is protected. For more information on this topic, visit: **water.dpie.nsw.gov.au/our-work/licensing-and-trade/controlled-activity-approvals/waterfront-land-e-tool/hydro-line-spatial-datareducing-fishing-litter,-lost-gear-and-pollution**.

Figure 13 – Grass clippings clogging a stormwater drain on an urban street.

Figure 14 – Litter accumulating at the outlet of a stormwater pipe.

If you suspect or see pollution in our waterways, you can contact the Council via our website at my.penrith.city

4.5 - Other ways to understand the health of a waterway

A useful way scientists can understand the health of a river is to study the health of the macroinvertebrate (water bug) community. Waterways with good water quality will exhibit biodiverse aquatic macroinvertebrates and a high number of organisms, while waterways with poor water quality (typically those impacted by urban development) will have fewer types of macroinvertebrates living in them. Essentially, a healthy macroinvertebrate population correlates with a healthy river. Penrith Council already undertakes biannual waterway health monitoring, which includes measuring the health of the macroinvertebrate communities, nutrient levels in the water, and the health of the vegetation in and around the waterways. This monitoring helps us to track our waterway health and alerts us of changes which may require further investigation.

Performing your own waterway health study for the waterways on your property or local waterway is also possible. Greater Sydney Landcare sells testing kits and provides instructions on their website on how to perform testing. For more information on this, contact **streamwatch@greatersydneylandcare.org** to discuss purchasing a kit.

4.6 – Water extraction

Under the Water Management Act (2000), landholders can extract ground water from an aquifer for domestic consumption or stock watering. Prior to doing so, landholders must acquire a water supply works approval to construct a bore, well, or spearpoint. It is an offence to do so without approval.

- Domestic consumption refers to the use of water for typical household activities within domestic properties located on the land.
- Stock watering refers to providing water for livestock raised on the land. It does not apply to intensive commercial operations where animals are housed in feedlots or buildings.

It is unlawful to extract water for the purposes of watering cultivated areas such as plantations or orchards that are used for commercial purposes without the required license. Landholders wishing to use ground water must obtain a water supply works approval prior to extracting water . Further details on this can be found on the WaterNSW website: **waternsw.com.au**

It is important to not over extract ground water, as this can have serious long-term and sometimes permanent impacts on groundwater and waterway systems. Groundwater also takes longer to recover compared to overland flowing water.

Some key impacts of over-extraction include;

- Reduced volume and quality of water available for other landowners.
- Reduced volume and quality of water available for ecosystems that depend on this water source.
- Increased risks from drought.

  When groundwater is over extracted, the aquifer and connected waterways also have their supply diminished. During periods of low rainfall, landholders who rely on groundwater may be significantly impacted if they are unable to access adequate amounts of water.
- Land subsidence.

  This occurs when large amounts of water are removed from the underground aquifer, causing the surface of the earth to collapse into the space left behind. This can cause significant damage to buildings and infrastructure, increase the risk of flooding, and change surface water systems.

Sustainably extracting water will benefit the riparian environment. To ensure you are not over extracting from the aquifer, ensure that

- Systems are designed to cater for projected future increases in demand.
- Understand the rate of aquifer recharge and do not extract beyond this limit.
- Adopt water saving behaviours.
- Identify alternative sources of water such as rainwater reuse.

Figure 16 - Flooding of a rural area near Penrith.

5. Erosion and sedimentation

5.1 – Causes and implications of erosion and sedimentation

Erosion is a natural process that occurs over long periods of time, and in times of high rainfall. The exact causes and implications of it can be complex. Generally, water erosion is caused by stormwater runoff that flows over land and removes soil, gravel and other material, which is often transported to our waterways. Human activities have accelerated erosion due to the increased volume and velocity of water flowing from developed areas. This can result in large amounts of sediments entering waterways faster than they can be removed or passed through the system, leading to a loss in available groundcover for vegetation and sediment build-up downstream that degrades habitats, decreases water quality, and increases flood risk.

Erosion also causes higher levels of suspended sediments and siltation in waterways. This diminishes light penetration and the potential for photosynthesis, resulting in the loss of habitat and spawning grounds for insects and certain fish species. Additionally, erosion is linked to various other problems in waterways, including pollution, eutrophication, and turbidity.

Figure 15 – Erosion occurring along Peachtree Creek, Penrith.

5.2 – Managing erosion and sedimentation on your property

Some large-scale erosion rectification or mitigation works within the riparian zone will require approval. However, there are a range of ways to manage and mitigate erosion and sedimentation on your land that do not require regulatory approvals, including;

• Revegetation of the waterway bed and banks will help stabilise the bank slope and contribute to controlling sedimentation. • Ensure you use biodegradable tree guards to minimise pollution.	 *Figure 17 – Revegetation project using biodegradable tree guards at Hollier Reserve, Emu Plains at the Trees for Mum 2024 planting event.*
• Do not undertake any form of construction or earthworks within proximity to the waterway bank. It is essential to contact Council prior to undertaking any earthworks within a riparian zone as you may require approval. Conducting works that require approval without consent carry costly penalties to landholders.	 *Figure 18 – An excavator undertaking construction in a waterway.*
• Implement a sediment and erosion control plan prior to undertaking any construction works to prevent sand, soil, and other building material running down stormwater drains and into our local waterways.	
• Removing flood debris from fence lines.	
• Retain organic matter (sticks and logs) in the waterway to help slow the flow of water. This decreases sedimentation by creating a natural weir: as water approaches the debris, it slows down and allows sediment to fall to the waterway bed rather than gathering on the surface.	 *Figure 19 – A healthy waterway environment, with a healthy amount of organic matter.*
• Limit access of stock and other activities within the riparian zone.	 *Figure 20 – An example of fencing on a rural property to limit stock access to the riparian zone.*
• Monitor the condition of the waterway overtime. Taking pictures periodically over time will help you understand how the environment is changing and help to inform you on what issues need addressing.	

6. Revegetation/riparian planting project guidelines

Revegetating riparian zones takes careful consideration and planning. It is important to plan the process completely prior to undergoing a revegetation project so you understand what the project involves and to ensure that your project has the best chance of succeeding. The table below outlines a typical process for undertaking a revegetation project. This planting guide was adapted from a guide created by the NSW Local Land Services.

Step 1: Species selection

Selecting the right species is crucial for the success of a revegetation project. Begin by looking for what types of plants are growing in the neighbouring riparian zone and take note of the distance that they are growing from the waterway.

You can also contact Council's Bushcare team for assistance on selecting appropriate species at **bushcare@penrith.city**

Figure 21 – Biodegradable tree guards used in a revegetation project at Grey Gums Reserve, Cranebrook for the Creating Canopies planting event.

Step 2: Establish a planting plan

You will need to plant species in the correct locations of the bank, and at the right spacing to increase the chance of success. It's best to consider:

- **Water shallows** – Retain or add in-stream woody debris for edge protection and habitat.
- **Toe of the bank** – Dense groundcover for erosion control and fringing habitat.
    - *Adiantum aethiopicum* (groundcover)
    - *Alternanthera denticulata* (groundcover)
    - *Carex appresa* (groundcover)
    - *Commelina cyanea* (groundcover)
    - *Juncus usitatus* (groundcover)
- **Slope of the bank** – Fully plant banks with a minimum of three layers: canopy, midstorey and understorey.
    - *Acacia binervia* (small tree)
    - *Acacia implexa* (small tree)
    - *Angophora floribunda* (tall tree)
    - *Breynia oblongifolia* (shrub)
    - *Eucalyptus saligna* (tall tree)
    - *Eucalyptus amplifolia* (tall tree)
    - *Commelina cyanea* (groundcover)
    - *Hibiscus heterophyllus var. heterophyllus* (shrub)
    - *Pittosporum revolutum* (shrub)
    - *Phyllanthus gunnii* (small shrub)
    - *Ficus coronata* (small tree)
- **Top of the bank** – Maximise vegetated riparian width.
    - Appropriate species are the same as the slope of the bank.

Create a plan of the area to be revegetated that maps out each of the relevant zones with approximate areas. This will assist you in determining the number and type of plants that are required for each zone.

It is recommended that you plant fast-growing and hardier species first, such as trees, larger shrubs, etc., as this will help establish a canopy, attract wildlife, and encourage natural regeneration of the understory by creating a favourable microclimate.

Once the first stage of planting has been completed, the understory can begin to be planted, such as grasses, smaller shrubs, etc. These plants will have a greater chance of survival due to the protection provided by the canopy.

Step 3: Site preparation

Weed control is a difficult task particularly in riparian zones, as woody species may remain viable for long time periods, and seeds are easily dispersed along watercourses.

It can also be difficult to distinguish between native and weed species particularly when the plants are young. If unsure, seek advice from Council's Bushcare team before removing vegetation.

In addition to the above, search on the NSW WeedWise website to find out the exact species of weeds you are dealing with. WeedWise will give you detailed information regarding successful weed control relevant to each species. The website is **weeds.dpi.nsw.gov.au**

You will need to consider if it is viable to remove all weeds and assess whether they are serving a purpose in the area. Weeds may be providing bank stabilisation, erosion control, habitat, or a food source for native wildlife. It's best to seek professional advice if you believe any of these may be an issue, as removing them may have an adverse impact on the environment. In these instances, a staged approach to weed removal may be appropriate.

Step 4: Planting

It is critical to time your planting correctly. Choose a time when rainfall is expected and the weather isn't too hot, otherwise you will need to water the plants manually.

Ensure that the seedling is placed in a hole that is approximately twice as wide and 50% deeper than the pot.

Fertilisers are generally recommended to support planting due to Penrith's clay-like soils and climate. Each plant should be planted using a soil conditioner, water crystal and slow-release fertiliser suitable for native species. Make sure the fertiliser is placed at the bottom of the hole and mixed with soil to ensure it doesn't wash into the waterway during high rainfall events. Plants should be watered right away to activate the fertilisers.

Mulching around the plants is beneficial to suppress weeds and maintain moisture. Make sure the mulch is good quality and of native origin to ensure it is free from exotic plant propagules. It's important to also ensure that the mulch is not choking the plant stem.

Biodegradable tree guards may be necessary to stop disturbances from wildlife. Consider the materials that will be used, as in some cases they can be washed away during heavy rainfall, high winds or flooding events, and may cause unnecessary pollution in the environment.

Step 5: Maintenance

Keeping the site free from weeds will give plants the best opportunity to survive. This can be very labour intensive during the first 12-18 months Supplementary watering may also be necessary during hot periods and while plants are establishing.

It is likely that if the process is followed correctly, maintenance will become less intense over time. As weeds are removed post-planting, this gives the native plants more of a chance to dominate the environment. Once the plants become more established, weeds will become less abundant, and the plants will generally require less watering.

7. Water Sensitive Urban Design (WSUD)

Water Sensitive Urban Design is a broad field that has a wide range of objectives. The primary function of WSUD is to capture, treat, and recycle stormwater to prevent it from polluting and degrading our waterways. WSUD also has broader objectives, such as;

- increasing ecosystem service,
- improving opportunities for recreation,
- improving the aesthetics of the built environment, and
- improving urban cooling and reducing the urban heat island effect.

All these benefit the environment and the liveability of the places we live in. For instance, constructed wetlands treat stormwater through natural processes and reduce the risks of floods, resulting in beautiful outdoor spaces and helping people connect better with nature. Implementing a wetland is not a feasible option for the majority homeowners; however, some homeowners may have dams on their property, which can be home to a diversity of wildlife if cared for properly. Caring for these ecosystems may also prove fruitful for stormwater management.

There are a variety of WSUD measures that can be implemented on your property. The following table outlines common household WSUD devices. Some of these may be present on your property already, so we have provided suggested maintenance and inspection actions to help you maintain these devices.

WSUD DEVICE	BENEFITS PROVIDED	MAINTENANCE/INSPECTION RECOMMENDATIONS
Rainwater tanks Capture and store stormwater run-off from your roof that otherwise has the potential to cause flooding, erosion and pollution.  *Figure 22 – Rainwater tank on an urban property.*	• Simplest solution for stormwater management and water conservation. • Water can be used for washing clothes, toilet flushing, washing your car, and garden irrigation. • Reduces the demand on the centralised water system and puts water to use rather than polluting our waterways. • Conserves water for periods of low rainfall. • Reduces overall water bill. • Plays a role in local flood control.	• Basic checking and cleaning of debris from your roof, gutters, pipes, tank, and filters can and should be conducted regularly by the homeowner. Check to see if the pumps are functioning correctly. • If there are any concerns or issues with the tank integrity or functionality, a professional should be consulted.

WSUD DEVICE	BENEFITS PROVIDED	MAINTENANCE/INSPECTION RECOMMENDATIONS
Pit inserts Designed to filter out fine pollutants such as fine solids, soluble heavy metals, oils, and nutrients.	• Pit inserts are typically only present on either industrial sites or strata housing complexes. • Generally, not considered a WSUD device as they do not foster the principles of integrated water cycle management; however, they still provide benefits such as catching litter, debris, and some pollutants before it enters the main stormwater network.	• Check the drainage pits to ensure the filter is not clogged or damaged. • Remove the grate and clean the filter of debris if you have the equipment to do so. • Do not clean if it is in a confined space; this should be carried out by a licensed professional. • If you spot a fault in one, report this to your site or strata manager.

WSUD DEVICE	BENEFITS PROVIDED	MAINTENANCE/INSPECTION RECOMMENDATIONS

Bioretention basin (raingarden)
 	
A vegetated basin that treats stormwater through a soil filter media. Treatment occurs as the water soaks down vertically through the various layers, and where plants and microbes in the soil remove pollutants.
 	
Soil filter media is soil mixed with other materials such as sand, which allows plants to grow while also providing adequate filtering capacity.
 	
 
Figure 23 – Drawing showing the general outline of a raingarden system.
	• Extremely effective at treating pollutants in stormwater runoff.
	• Reduces peak flows during high rainfall events and contributes to flood management.
	• Raingardens/bioretention basins provide aesthetically pleasing places on your property while also providing effective stormwater and pollution management.
	• Provide habitat for local biodiversity, such as insects, reptiles, and frogs.
		• Weed management.
		• Litter removal.
		• Supplementary planting of appropriate vegetation:
		  • ***Eight plants per square metre.***
		  • ***A mix of grasses, sedges, shrubs, or trees.***
		  • ***Some appropriate species to plant at the filter include;***
		  • *Imperata cylindrica* (Blady Grass)
		  • *Ficinia nodosa* (Knobby Club Rush)
		  • *Juncus usitatus* (common Rush)
		  • *Carex appressa* (Tussock Sedge).
		  • ***Some for the batters include;***
		  • *Lomandra longifolia* (Matrush)
		  • *Dianella caerulea* (Blue flax-lily)
		  • *Gahnia sieberiana*
		  • *Eucalyptus amplifolia*
		  • *Kunzea ambigua.*
		• A comprehensive list can be found here: penrithcity.nsw.gov.au/images/documents/building-development/development/Addendum2-PCC_WSUD_Bioretention_Standard_Drawings.pdf
		• Coarse sediment removal.
		• Flushing of underdrainage (may require a professional).
		• If plants are unable to survive or clogging is occurring, it may be necessary to contact a specialist for further assessment.

WSUD DEVICE	BENEFITS PROVIDED	MAINTENANCE/INSPECTION RECOMMENDATIONS
Vegetable Raingarden A special garden bed designed to receive and filter stormwater runoff from roofs while being used to grow vegetables. Type in "how to build a vegetable raingarden Penrith" into Google to learn more about the process of designing and building your own vegetable raingarden.	• Filters stormwater while simultaneously growing vegetables. • Can be designed and built yourself without the help from a specialist. • Note: You must contact a certified plumber for any connections or modifications to the stormwater network.	• Weed management. • Flushing of underdrainage. • Cleaning any pipes of debris and leaf litter.
Bioretention swale Swales are channels with gently sloping sides that treats stormwater through a soil filter media. Treatment occurs as the water soaks down vertically through the various layers, and where plants and microbes in the soil remove pollutants. Swales function best when they are lined with a variety of dense vegetation. Swales transport stormwater while screening and removing pollutants.	• Effective at managing pollutant loads to meet water quality targets. • Removed fine and coarse sediments. • Provides a low level of extended detention to help mitigate flooding.	• Generally, require very little maintenance; however, if the soil filter media becomes too compacted or blocked, replacement of both vegetation and filter material will be required. • Removal of litter and organic matter.

WSUD DEVICE	BENEFITS PROVIDED	MAINTENANCE/INSPECTION RECOMMENDATIONS
Permeable pavements Porous surfaces with an aggregate layer underneath consisting of crushed stone or gravel. Stormwater passes through the permeable pavement to the aggregate layer before it is discharge to a piper drainage system.	• Effective at reducing peak flow by delaying time for water to the drainage system. • Allows water to infiltrate into the ground where it can then be taken up by plants to grow. • Improves the quality of stormwater runoff by removing site pollutants.  *Figure 24 – A permeable paver.*	• May require a top-up of materials in joints and voids to decrease erosion. • Cleaning with a vacuum sweeper may be required to stop clogging. • Replace broken pavers if required. • Removal of weeds from joints and voids. • Unblock outlet pipes and pits to ensure the permeable pavement underdrainage drains freely.

For more information on WSUD devices and how to correctly maintain them, visit the *"WSUD Policy and Developer's Toolkit"* page on the Penrith City Council website: **penrith.city/waterways**

8. Legal and regulatory information

8.1 - Permits and approvals

If you are wanting to perform construction or earthworks on your property, it is important to check if you need to apply for a development application. Some minor building renovations and earthworks are exempt from needing an application, including certain sized decks, garden sheds, carports, fences and retaining walls. For more information about whether you require a development application, refer to the Exempt Development information on the NSW Government Planning Portal website or contact the Council directly: **planning.nsw.gov.au/assess-and-regulate/development-assessment/planning-approval-pathways/exempt-development**

Confirming whether you need a development application will ensure the best approach is taken regarding environmental protection, and you are adhering to your legal and regulatory requirements.

If the works you are wanting to undertake are in the waterway or the riparian corridor, you will likely be required to obtain a controlled activity approval from Water NSW. For more information visit the NSW Government webpage "Guidelines for controlled activity approvals" at **dpie.nsw.gov.au/water/our-work/licensing-and-trade/controlled-activity-approvals/guidelines**

8.2 - Local regulations, policies, and strategies

Penrith Council has developed various policies and strategies pertaining to the protection of the natural environment. The list below outlines the relevant documents, all of which can be found on the Council's website at https://www.penrithcity.nsw.gov.au/resources-documents/documents

- **Sustainability Policy** – This policy aims to commit Council to both short and long-term sustainability impacts in the decision making and operational process.
- **Water Sensitive Urban Design (WSUD) Policy** – Defines the stormwater management requirements, regarding water conservation, quality, and quantity, for new developments within the Penrith LGA.
- **Our River Masterplan** – Focuses on the Nepean River and aims to reinforce the connection between the river and the community.
- **Community Engagement Policy** – Outlines Council's commitment to better decision making through meaningful engagement.
- **Penrith Biodiversity Strategy** – The strategy aims to protect the native biological diversity of the Penrith Local Government Area and maintain ecological processes and systems.
- **Biodiversity Action Plan** – Provides specific actions to implement the objectives of the biodiversity strategy.
- **Green Grid Strategy** — The Strategy puts forward a plan to support the creation of cool and green neighbourhoods and active transport by connecting schools, public transport and town centres to green infrastructure, such as green spaces, parks, waterways, and bushland.
- **Cooling the City Strategy** – The Strategy identifies ways to cool our City and region in a way that improves liveability and prioritises protection from heat for people and communities.

8.3 - State and federal regulations, policies, and strategies

There are various state and federal policies, strategies and legislation which Council adheres to. The list below outlines some of the essential documents that Council relies on.

- NSW Diffuse Source Water Pollution Strategy – Outlines key problems regarding waterway pollution from diffuse sources and provides management actions aimed at addressing them.
- State Environmental Planning Policy (Biodiversity and Conservation) 2021 – Chapter 6 pertains to water catchments and is particularly relevant to this guide.
- Biodiversity Conservation Act 2016 – Provides guidelines on maintaining a healthy, productive and resilient environment for the greatest well-being of the community, now and into the future.
- Commonwealth Environment Protection and Biodiversity Conservation Act 1999 (EPBC Act) – Provides guidance on how to protect and manage nationally and internationally important plants, animals, habitats, and places.
- Water Management Act 2000 – The sustainable and integrated management of the State's water for the benefit of both present and future generations.
- Protection of the Environment Operations Act 1997 – Outlines general and specific circumstances that constitute pollution.

8.4 - About the law

It is important to understand that damaging the environment can carry legal implications. According to the Biodiversity Conservation (BC) Act 2016, it is an offence to pick a plant that is:

- A threatened species, or
- A part of a threatened ecological community, or
- A protected plant.

If you are uncertain if a species is threatened or a protected plant, contact Council for further advice.

Section 120 of The Protection of the Environment Operations Act 1997 specifies that it is an offence to pollute waters. This section emphasises the importance of conducting research or consulting an expert prior to performing any environmental works. Penrith Council's website contains information on biodiversity management and provides contacts if you require further information. Visit **penrith.city/biodiversity**

Enforcement measures for unauthorised works may involve issuing Penalty Notices, formal Notices, or Orders to restore the area affected, and may also include the initiation of legal proceedings.

9. Community involvement and education

9.1 - Engaging the community

Penrith Council coordinates several Bushcare Groups, with most running monthly sessions. You can find out more information about volunteering with Bushcare at **penrith.city/bushcare**

If you wish to learn more about these sessions, contact **bushcare@penrith.city**

BUSHCARE GROUP	LOCATION	DATE AND TIME
Bass Sydney Fishing Club Bushcare	Russell Street, Emu Plains	*First Saturday of the month* @ 8:30am-12pm
Crossman Reserve Bushcare	Northern end of Kadiera Close, Wallacia	*Third Friday of the month* @ 9am-12pm
Mountain View Reserve Bushcare	Nepean Street, Cranebrook	*Last Saturday of the month* @ 8am-12pm
Friends of Ropes Creek	Cnr Sycamore St and Boronia Rd, North St Marys	*Third Saturday of the month* @ 8am-12pm
Gow Park Bushcare	Gow Park, Littlefields Road, Mulgoa	*First Wednesday of the Month* @ 9am-12pm
River Road Bushcare	Various locations along River Road, Leonay and Emu Plains	*Fourth Thursday of the month* @ 9am-12pm
Schoolhouse Creek Bushcare	Northern end of Martin Street, Regentville	*Second Sunday of the month* @ 8am-12pm
Bellbird Reserve Bushcare	Cnr Barina Crescent and Kaloona Drive, Emu Plains	*Third Saturday of the month* @ 8am-12pm
Clissold Reserve Bushcare	Litton Street, opposite Dempsey Street, Emu Heights	*Second Saturday of the month* @ 8am-12pm
Kanangra Reserve Bushcare	Glebe Place, Kingswood	*First Sunday of the month* @ 8am-12pm
Peppermint Reserve Bushcare	Southern end of Peppermint Crescent, Kingswood	*Third Sunday of the month* @ 8am-12pm
Wianamatta Bushcare	Far eastern end of Samuel Marsden Road, Orchard Hills	*First Saturday of the month* @ 9am-12pm
Hollier Reserve Bushcare	End of tattersall Place, Emu Plains	*Third Tuesday of the month* @ 9am-12pm
Seed Collection Group	Various locations	*Second Thursday of the month* @ 9am-12pm

There are various external community Landcare groups that are active around the Penrith LGA. They are always welcoming new faces to join their family-friendly activities and workshops. The following is a list of Landcare groups that are active within the Penrith LGA:

Figure 25 – The River Road Bushcare Group working hard on their revegetation project along the Nepean River.

- **Mulgoa Valley Landcare (MVLC)** operates only in Mulgoa and Wallacia **lisa@mulgoalandcare.org.au**
- **Cumberland Land Conservancy** **president@cumberlandlc.org.au**
- **Hawkesbury-Nepean Landcare Network** **landcare@hrcc.nsw.gov.au**
- **Greater Sydney Landcare** **greatersydneylandcare.org**

9.2 - Educational resources

The following websites contain a wealth of useful resources on biodiversity and waterway health and management.

ENTITY	SERVICES PROVIDED	LINK TO WEBSITE
Western Sydney University	Connects scientific water quality data, Information and stories on rivers and water with the community.	**Hawkesbury-Nepean River Watch Education and Sustainability Tools | Western Sydney University**
NSW Department of Planning, Housing and Infrastructure	Assess large-scale developments to ensure environmental protection.	**Department of Planning, Housing and Infrastructure | NSW Government**
NSW Department of Climate Change, Energy, the Environment, and Water	Aims to protect, restore, and enhance the natural environment and sustain and improve water resources.	**Department of Climate Change, Energy, the Environment and Water | NSW Government**
Natural Resources Commission	Provides evidence-based advice to the NSW Government on natural resource management.	**Natural Resources, Australia's Natural Resources**
Australian River Restoration Centre	A charity aimed at restoring rivers and empowering others to do the same.	**Australian River Restoration Centre – A charity restoring rivers and enabling others to do the same.**
Sydney Water	Supplies water, wastewater, recycled water and some stormwater services to over 5 million people in Greater Sydney, Blue Mountains and the Illawarra.	**Sydney Water**
Water NSW	Operates the states dams in Greater Sydney and Regional NSW, capturing and storing water, preparing it for distribution.	**Our role - WaterNSW**
Waterwatch NSW	A national citizen science program, involving landholders, community groups and schools, and aims to engage communities in monitoring and protecting the health of local waterways	**NSW Waterwatch**
Greater Sydney Landcare Network	A membership-based community organisation that aims to support individuals, groups and organisations who are working to protect, restore and improve the natural environment of Greater Sydney.	**Greater Sydney Landcare | People for Sydney's Environment**
Greater Sydney Local Land Service	A regional-focused NSW Government agency delivering quality customer services to farmers, landholders and the wider community.	**Greater Sydney - Local Land Services**

The sources listed in the guide's bibliography are also useful for further explanations.

10. Program and funding opportunities

Many waterway rehabilitation works, such as erosion control or revegetation, can be costly endeavours. Fortunately, there are many opportunities for landholders to apply for grants or funding. See below for a list of opportunities available and how to apply.

10.1 - Biodiversity Conservation Trust Conservation Partners Program

The Conservation Partners Program offers two options for landholders to protect biodiversity:

1. In-Perpetuity Conservation Agreements for permanent protection, suitable for properties over 20 hectares with high conservation value, and
2. Wildlife Refuge Agreements, a non-permanent option for properties of at least 10 hectares.

Both provide support, funding opportunities, and potential tax concessions for in-perpetuity agreements. Landholders are encouraged to seek financial advice and may also explore other conservation programs like Wildlife Land Trust or Land for Wildlife.

Further information is available here: **bct.nsw.gov.au/cards/apply-voluntary-agreement**

10.2 – NSW Environment and Heritage Biodiversity Offsets Scheme

The Biodiversity Offsets Scheme in NSW helps offset the biodiversity impact of development. Developers must first try to avoid or reduce harm to biodiversity. If there are remaining impacts, they must buy credits from landholders who actively manage their land to improve biodiversity. These landholders enter into permanent agreements (Biodiversity Stewardship Agreements) and use the funds from credit sales for ongoing land management, like controlling weeds, pests, and restoring habitats. The scheme uses clear scientific methods to assess both the impacts of development and the effectiveness of land management. Further information is available here: **https://www2.environment.nsw.gov.au/topics/animals-and-plants/biodiversity-offsets-scheme**

10.3 - Land for Wildlife

Land for Wildlife (LFW) encourages landholders to integrate nature conservation with their land management goals. It's free to join, non-legally binding, and doesn't change a property's legal status. The Community Environment Network (CEN) coordinates LFW in NSW, partnering with local organisations to maintain program standards. CEN provides support including signs, newsletters, and conservation advice, while regional delivery is carried out by non-government organisations, community groups, and local councils. These regional groups offer site assessments, management advice, and encouragement for conservation actions. CEN supports them with training, resources, and funding assistance. All landholder information remains confidential. Further information is available here: **cen.org.au/projects/land-for-wildlife**

10.4 – Local Land Services

Greater Sydney Local Land Services (GSLLS) offers grants to landowners and managers for improving natural resource management and sustainable agriculture, funded by the NSW and Australian Governments. The Grant Opportunity Guidelines provide information on eligibility, activities, and how to submit proposals. Eligible applicants include private landowners with properties larger than 2 hectares, local councils, state government agencies, and NGOs. To apply, contact your LLS Officer or email **gs.service@lls.nsw.gov.au**. For more information, call **(02) 4724 2100**.

Keep an eye on the website for grant rounds: **lls.nsw.gov.au/regions/greater-sydney/financial-assistance**

11. Success stories/case studies

11.1 – Local Landowners Erosion Control Project

A local landowner's property, which includes a section of Schoolhouse Creek, had been experiencing significant erosion along its banks, threatening the health of the creek and surrounding ecosystem. The erosion was not only causing soil loss but also impacting water quality and degrading the riparian habitat. In addition, grazing by local deer had further stressed the area, preventing native vegetation from regenerating and contributing to ongoing erosion. In response, the landowner sought a comprehensive solution to restore the creek's banks, enhance water quality, and rehabilitate the riparian habitat.

The project was conducted with support from Mulgoa Landcare, funded under their Western Sydney Infrastructure Grant project. The team implemented a range of erosion control measures, including planting native vegetation along the creek banks to stabilise the soil and bioengineering techniques such as the construction of retaining walls to reinforce the banks and reduce the impact of water flow. Geotextile matting was also added to provide temporary protection in areas with the most severe erosion. Simultaneously, to protect the newly planted vegetation from deer grazing, a deer exclusion fence was constructed around the riparian zone. This fence was designed to prevent deer from accessing sensitive areas while still allowing other wildlife to pass through.

The project is now in the maintenance stage. The landowner manages the 1,900 plants that were put into the ground to ensure their successful growth.

The project proved successful in stabilising the creek banks and promoting the regeneration of native plants. The goal is that over time, the erosion along the creek will be significantly reduced, and the riparian zone will begin to regenerate, creating a more resilient ecosystem. Long-term monitoring of the site will hopefully show improvements in biodiversity and water quality, with the creek's habitat becoming healthier and more sustainable.

Overall, the project demonstrated the importance of addressing both ecological and biological factors in environmental rehabilitation. By combining erosion control with deer exclusion, they not only restored the functionality of Schoolhouse Creek but also set an example for sustainable land management practices. The success of the project underscores the value of proactive, integrated solutions to land and waterway conservation.

Figure 26 – Landowner's property before and after the erosion control works.

11.2 – River Road, Leonay – River Road Bushcare Group's weed control and revegetation

The riparian restoration project along River Road by the Nepean River was initiated to address the extensive infestation of exotic weeds that had overtaken the mature trees along the riverbank. These invasive species not only hindered the growth of native vegetation but also contributed to soil erosion, compromising the stability of the riverbank.

The restoration efforts began with the removal of the weeds through a combination of manual clearing and targeted herbicide application. After the weeds were eliminated, the area was mulched to suppress regrowth and retain soil moisture, while 150 planting holes were dug for native species.

A diverse range of plants, including Pale Fan-Flower, Wombat Berry, and Blue Flax Lily, were selected for their ability to stabilise the soil, restore biodiversity, and create a healthier habitat for local wildlife.

The project aimed not only to enhance the ecological integrity of the area but also to improve public amenity by providing a visually appealing and accessible space for the community. Native plants were carefully chosen to ensure resilience to local conditions and to support the restoration of a thriving riparian ecosystem.

The newly planted species helps stabilise the riverbank, reduce erosion, and restore habitat to attract a variety of local wildlife. Additionally, the area has become more aesthetically pleasing, enhancing the quality of life for residents and visitors alike. The project serves as a valuable example of how targeted ecological restoration can both protect and enhance the natural environment, while benefiting local communities.

Top to Bottom

Figure 27 – The River Road Bushcare revegetation works before planting was undertaken.

Figure 28 – The River Road Bushcare vegetation project with mulch and planting plots in place.

Figure 29 – The River Road Bushcare revegetation project after planting was finished.

11.3 – Crossman Reserve – Bushcare weed control and revegetation

A dedicated group of Bushcare volunteers worked along Jerrys Creek in Crossman Reserve to improve the health of the riparian ecosystem through weed control and revegetation efforts. The group focused on removing aquatic and bank weeds that had been negatively impacting the area, preventing native vegetation from establishing and contributing to soil erosion. The weed removal was a crucial first step in restoring the creek's ecological balance and promoting the growth of native species.

Following the successful removal of invasive plants, the volunteers revegetated the cleared areas with native rushes and sedges, which are well-suited to stabilising the creek banks. These plants were carefully selected for their ability to withstand waterlogged conditions while providing essential habitat for local wildlife. The revegetation work not only helped prevent further erosion but also contributed to the restoration of biodiversity in the area. This collaborative effort has resulted in a healthier, more stable riparian zone, benefiting both the environment and the local community.

Top to Bottom

Figure 30 – Volunteers working on the Crossman Reserve weed control and revegetation project.

Figure 31 – A volunteer undertaking aquatic weed removal at Crossman Reserve.

Figure 32 – Crossman Reserve after weeding and revegetation was completed.

12. Citations:

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