Weedy Wasteland to Wildlife Wetland

Final recommendations for
Dumaresq Creek rehabilitation

In collaboration with the Armidale Urban Rivercare Group

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Dumaresq Creek revegetation recommendations

1st site visit: 2nd September 2022: Angus Adair, Bryan Johnston, Gordon Bell (AURG representatives) and Sarah Mika (UNE).
2nd site visit: 12th October 2022: Angus Adair, Bryan Johnston, Gordon Bell (AURG representatives), and Ben Vincent (UNE).

Project aims

The aim of the Wildlife Wetland project is to remove woody weeds and use various suitable native plant species to revegetate and improve the ecological condition of a low-lying depositional area located on the inner bank and bench of a meander bend as well as the adjacent riparian zone (Figure 1). It is thought that this low-lying area may have once been a wetland type and so the revegetation focus will be on returning endemic wetland and riparian plant species to restore elements of natural ecological function and to retain the 'island of silt', which has predominantly been trapped and accumulated by willows over the years. An additional project aim is to engage and connect local community members where possible throughout all stages of the project, with the final goal of creating a place where people can connect and interact with the Wildlife Wetland and watch it grow.

Figure 1. Wildlife Wetland aerial view and project extent.

Identified challenges and opportunities

- Willow stumps: following the removal of woody weedy species, willow stumps will be retained to support wetland and bank substrate stability. There is further opportunity to use willow stumps as 'stump islands' to promote flow path and wetland zone complexity while simultaneously offering temporary planting substrates that will support the establishment of new plantings and slowly rot away over time (c. 4 years).

- Public area: the wetland project area is adjacent to a public recreation and reserve area and is frequented by many locals that use the area to walk, spend time outside, cycle and exercise dogs, etc. It may be beneficial in the first instance to selectively and temporarily retain several prominent willows to maintain parkland aesthetics and offer some shaded areas while providing ecological stepping-stones and temporary riparian habitats during project works and while native plants are establishing. Ideally, selected willows would be easily accessible so that future removal can remain an option as native replacements grow and mature (c. 5-10 years; Figure 2).

- Creek access points: as a public use area, locals enjoy viewing points and access to the creek. Given the proximity of the wetland project area to the walking track, it may be favourable to retain one or two creek access points on existing sections of gentle bank slopes. These areas may support seating and nonobstructive ecological signage that highlights the aims and efforts of the restoration works, aquatic processes, riparian vegetation function and/or promotion of citizen science activities, such as bird and frog call counts, and a photo point to assist in visually capturing change over time. Such areas can promote focused interaction with the creek, which over time enables connection to place. Suggested access points, picnic tables and 'lines of sight' are presented in the conceptual design (Figure 5). However, final locations of these infrastructure will be determined by Armidale Regional Council in consultation with stakeholders.

- Readily establishing native plants: in some circumstances, native plants can become weedy and this is driven by current and historic disturbances to soil and increased nutrient levels. However, in highly altered landscapes such as the Wildlife Wetland project site, it is hard to determine what might have been the natural density of a particular native species that is now deemed to be weedy: Phragmites (*Phragmites australis*) and cumbungi (*Typha orientalis*) are two cases in point. Upstream barriers and disruption to flow, increased siltation and bank slumping are additional factors that may have increased the presence of both phragmites and cumbungi at the project site. However, before it is considered a weed necessary for removal, there are likely zones within the rehabilitation project where it would be beneficial to retain. To assist with this process, it is worth considering the roles, functions and habit that these species perform in an aquatic ecosystem. Phragmites and cumbungi*:*

    - readily establish and can outcompete weedy species
    - can form relatively extensive and impenetrable reed beds that are low in species diversity
    - act as 'wet filters' by removing excess nutrients and suspended sediments from the water column
    - provide habitat and protection for both water bird and terrestrial bird species, including reed warblers
    - are considered to be a natural part of the Dumaresq Creek system

- may be deemed ‘over abundant’ or ‘weedy’, but are also performing valuable ecosystem functions and should be viewed as a symptom not the cause.

Figure 2. An example of a large streamside willow and willow stag that could be temporarily retained to achieve immediate aesthetics, shade and habitat options.

Original vegetation

The vegetation present at the Wildlife Wetland project site is predominantly exotic, making formal identification of the original vegetation difficult. However, clues to the original vegetation are provided by soil type, relief, available vegetation mapping and in some cases the presence of upstream and downstream remnant vegetation communities where they still persist. It is likely that the original riparian vegetation on-site was:

- Ribbon gum – mountain gum – snow gum grassy woodland

And the wetland may have been a:

- New England carex fen

However, it is also possible that the following vegetation communities may have been present alongside and transitioning into the above-mentioned community types, with changes driven by differences in relief, exposure, soil type and water availability:

- New England riparian shrubland
- New England peppermint grassy woodland
- River oak gallery forest

In addition to the above vegetation community types, a variety of water plants (macrophytes) would have also been present in the Wildlife Wetland project area. Macrophyte presence and density can fluctuate seasonally in response to upstream and local seed source and propagule availability, water depth, flow velocity, temperature, nutrient loads and level of site disturbance. Some macrophyte species may persist for long periods without water; but, by definition all require some level and frequency of inundation in order to grow, complete their life stages and persist into the future. Macrophytes perform important aquatic functions, such as:

- remove excess sediments and nutrients from the water column, acting as biofilters
- control light penetration and water temperature, thereby restricting algal growth and reducing the occurrence of problematic blooms
- reduce river bank and river bed erosion by slowing river flow and trapping suspended sediment
- provide food, habitat and breeding resources for a variety of aquatic and terrestrial organisms, including invertebrates, crustaceans, turtles, fish and birds
- produce dissolved oxygen which is an essential requirement for aquatic fauna and important to the regulation of nutrient release by sediments into the water column
- reduce turbidity by slowing river flow
- contribute to species diversity and aesthetic appeal.

Developing a site revegetation plan

The goals of rehabilitation are to improve the condition of a degraded system to resemble the original system, whereas remediation aims to improve the ecological condition of a degraded system, but due to extensive and irreversible modification, accepts that the end result will not necessarily resemble the original system (Rutherford et al., 2000). Historic disturbances (clearing, grazing, soil disturbance and eutrophication) have resulted in the removal and replacement of native vegetation throughout the majority of the project area and the presence of mature willows may have altered the site's original hydrology. To plan and gauge a successful project, it is important to recognise that the starting point for the Wildlife to Wetland project probably lies somewhere in-between the goals of rehabilitation and remediation. The project may be deemed successful once natural native physical and biological diversity are returned to the creek. Revegetation success should ultimately be determined by both uptake of the recommended plant species, each of which have overlapping environmental tolerances to frequency and length of inundation, as well as the suppression of weed species.

Recommendations:

1. Weeds: for best establishment uptake and project success, it will be necessary to undertake weed control both pre- and post-plantings and in-line with current practice outlined in the Southern New England Landcare (SNELC) Dumaresq Creek Weed Management Guidelines document.

2. Hydrology: a proper understanding of site hydrology and the 'new natural flow' post willow removal will be key in effectively planning out and identifying planting zones which will be used to inform what to plant where. Hydraulic modelling post woody weed-removal could be used to indicate site-scale geomorphic features that direct water movement and identify flood runners, disconnected ponds, pools and depressions. However, given the timeline and resourcing of this project, a basic hydrological assessment can be achieved by taking site photos during flow events (base, small, medium, large) to observe how water behaves and travels through the project site. Photo points and drone footage/imagery would be most useful in achieving this goal post willow removal and before planting takes place. Additionally, given that several flood events have occurred post substantial woody weed removal in the downstream end of the site, current site conditions may indicate the resistance of the site to flood erosion.

3. Active and passive revegetation: utilise both active (a) and passive revegetation (b):

    a. active revegetation in line with recommended species for proposed vegetation zones (see 'Vegetation zones and species list section' below).

    b. passive revegetation acknowledges that there will be natural future establishment of native plant species, e.g. Phragmites, Typha and several instream macrophyte species, due to their upstream presence in the Dumaresq Creek catchment. For some species, such as instream macrophytes (Zone 0 species), this is the easiest means and method of introduction.

4. Priority plantings: species listed in bold are priority plantings for Zones 1-3 (see Table 1 and 'Vegetation zones and species list section' below).

5. Outcompeting weedy regrowth: the success of plantings, particularly in both Zone 1 and Zone 2, will likely be improved with greater planting density and seasonal replanting of failed plantings.

6. Planting on 'Stump Islands': when establishing plantings on top of the 'stump islands' created by willow root balls in Zone 3, greater success may be achieved with the use of a motorised auger in order to sink deeper planting holes in and between the root balls.

7. Downstream risk: all species selected for the project area should consider connectivity and risk to the Oxley Wild Rivers World Heritage Area located directly downstream. This has been taken into account in the following section (see 'vegetation zones and species list section below').

8. Guerrilla plantings: provided the above point 7 has been satisfied, established plants which have been previously planted as 'guerrilla plantings' offer further stability options to the project area and should be retained where practicable.

9. Seed source and collection: all recommended species can be found growing locally (see 'vegetation zones and species list section below'). However, not all will be readily available

through local nurseries. Where this is the case it may be possible to source and collect seed from known populations in line with appropriate collecting permits and protocols for nursery propagation.

10. Establish clear 'lines of sight': clear lines of sight are a council requirement that need to be factored into the revegetation plan for public safety considerations. Clear lines of sight could be strategically achieved throughout the project area by placing small cleared zones that provide vantage points over creek sections while simultaneously allowing visual connectivity to one another. These cleared sections could also support picnic benches or creek access points so that their end purpose is two-fold (Figure 5). Final locations should be determined by Armidale Regional Council in consultation with stakeholders.
11. Establish sites for community access to the creek.

Vegetation zones and species list

Vegetation Zones: The project area broadly consists of the following vegetation zones (Figure 3 - Figure 5):

- ***Zone 0*** = instream, permanently inundated, slow-to-high flow, supports submerged and floating macrophytes (receives passive revegetation)
- ***Zone 1*** = instream, frequently inundated, slow-to-no flow, supports submerged and emergent macrophytes (receives active revegetation revegetation)
- ***Zone 2*** = stream edge, temporarily inundated, standing water, supports emergent species (receives active revegetation revegetation)
- ***Zone 3*** = stream bank, infrequently inundated, supports terrestrial riparian shrubland species (receives active revegetation revegetation)
- ***Zone 4*** = top of bank (adjacent floodplain), rarely inundated, supports terrestrial riparian woodland species (receives active revegetation).

Species List: The following Wildlife Wetland project species list is not an exhaustive list, but offers endemic options for each of the identified zones. The availability of all species will likely be determined by existing nursery stock, seed availability and capacity to propagate. At a minimum, species listed below in bold are recommended as priority plantings in Zones 1 – 3 (Table 1). Selection of these priority planting species was guided by native species considered to be optimal for the relevant zone based on those species that are quick to establish, fast growing and will be dense enough to assist with weed suppression.

Table 1. Suitable species, their requirements and notes for each of the five Dumaresq Creek vegetation zones: Zone 0 = instream and permanently inundated, Zone 1= instream and frequently inundated, Zone 2 = stream edge and temporarily inundated, Zone 3 = stream bank and infrequently inundated, Zone 4 = top of bank and rarely inundated.

Zone	Common Name	Scientific name	Water depth tolerance (cm)	Inundation frequency	Notes
0	Ribbonweed	*Vallisneria nana*	Submerged	Permanently inundated	Habitat, food source, stabiliser, biofilter
0	Eel weed	*Vallisneria australis*	Submerged	Permanently inundated	Habitat, food source, stabiliser, biofilter
0	Small-fruit Pondweed	*Potamogeton cheesemanii*	Submerged/floating	Permanently inundated	Habitat, food source, stabiliser, biofilter
0	Blunt pondweed	*Potamogeton ochreatus*	Submerged/floating	Permanently inundated	Habitat, food source, stabiliser, biofilter
0	Curly pondweed	*Potamogeton crispus*	Submerged/floating	Permanently inundated	Habitat, food source, stabiliser, biofilter
0	Clasped pondweed	*Potamogeton perfoliatus*	Submerged/floating	Permanently inundated	Habitat, food source, stabiliser, biofilter
0	Swamp lily	*Ottelia ovalifolia* subsp. *ovalifolia*	Submerged/floating	Permanently inundated	Habitat, food source, stabiliser, biofilter
0	Variable watermilfoil	*Myriophyllum varriifolium*	Emergent	Permanently inundated	Habitat, food source, stabiliser, biofilter
0	Red watermilfoil	*Myriophyllum verrucossum*	Emergent	Permanently inundated	Habitat, food source, stabiliser, biofilter
1	**Tall spikerush**	***Eleocharis sphacelata***	**0-200**	**Frequently inundated**	**Habitat, food source, stabiliser, biofilter, traditional uses**
1	Cumbungi	*Typha orientalis*	0-200	Frequently inundated	Habitat, food source, stabiliser, biofilter, traditional uses
1	Common reed	*Phragmites australis*	0-200	Frequently inundated	Habitat, food source, stabiliser, biofilter, traditional uses
1	River club-rush	*Schoenoplectus validus*	0-100	Frequently inundated	Habitat, nesting material, stabiliser, traditional uses
2	Water ribbons	*Cycnogeton multifructum*	0-50	Temporarily inundated	Habitat, food source
2	Water couch	*Paspalum distichum*	0-50	Temporarily inundated	Stability, food source, biofilter
2	**Common spikerush**	***Eleocharis acuta***	**0-45**	**Temporarily inundated**	**Habitat, stability**
2	**Tall sedge**	***Carex appresa***	**0-30**	**Temporarily inundated**	**Habitat, biofilter, stabiliser, competitive, traditional uses**
2	Water primrose	*Ludwigia peploides* subsp. *montevidensis*	0-30	Temporarily inundated	Habitat, biofilter, stabiliser, competitive
2	Purple loosestrife	*Lythrum salicaria*	0-30	Temporarily inundated	Food source, attractive
2	**Rush species**	***Juncus usitatus***	**0-25**	**Temporarily inundated**	**Habitat, biofilter, stabiliser, competitive**

Zone	Common Name	Scientific name	Water depth tolerance (cm)	Inundation frequency	Notes
2	Swamp foxtail	*Cenchrus purpurascens*	0-10	Temporarily inundated	Stability, food source, biofilter, attractive
2	Creeping knotweed	*Persicaria prostrata*	Damp edges	Temporarily inundated	Habitat, food source
2	Slender knotweed	*Persicaria prostrata*	Damp edges	Temporarily inundated	Habitat, food source
2	Australian sweetgrass	*Glyceria australis*	Damp edges	Temporarily inundated	Ground cover, food source
2	Mat grass	*Hemarthria uncinata* var. *uncinata*	Damp edges	Temporarily inundated	Ground cover, food source
2	Blown grass	*Lachnagrostis filiformis*	Damp edges	Temporarily inundated	Ground cover, food source
2	Tussock grass	*Poa labillardieri*	Damp edges	Temporarily inundated	Ground cover, food source
3	Native grasses	Transition of Zone 2 and Zone 4 grass species	Terrestrial	Infrequently inundated	Food source, stabiliser, competitive, attractive, traditional uses
3	**Lomandra**	***Lomandra longifolia***	**Terrestrial**	**Infrequently inundated**	**Habitat, stabiliser, competitive, traditional uses**
3	Blue-flax lily	*Dianella caerulea*	Terrestrial	Infrequently inundated	Stabiliser, attractive
3	Native raspberry	*Rubus parvifolius*	Terrestrial	Infrequently inundated	Habitat, stabiliser, food source, traditional uses
3	**Tantoon**	***Leptospermum polygalifoium* subsp. *transmontanum***	**Terrestrial**	**Infrequently inundated**	**Habitat, stabiliser, food source, attractive, traditional uses**
3	River bottlebrush	*Callistemon sieberi*	Terrestrial	Infrequently inundated	Habitat, stabiliser, food source, attractive
4	Rice grass	*Microlaena stipoides* var. *stipoides*	Terrestrial	Rarely inundated	Food source, stabiliser
4	Snow grass	*Poa sieberiana*	Terrestrial	Rarely inundated	Food source, stabiliser
4	Kangaroo grass	*Themeda triandra*	Terrestrial	Rarely inundated	Food source, stabiliser, attractive, traditional uses
4	Wild sorghum	*Sorghum leiocladum*	Terrestrial	Rarely inundated	Food source, stabiliser, attractive, traditional uses
4	Lomandra	*Lomandra longifolia*	Terrestrial	Rarely inundated	Habitat, stabiliser, competitive, traditional uses
4	Blue-flax lily	*Dianella caerulea*	Terrestrial	Rarely inundated	Stabiliser, attractive, traditional uses
4	Blackthorn	*Bursaria spinosa*	Terrestrial	Rarely inundated	Habitat, food source, traditional uses
4	Small-fruit Hakea	*Hakea microcarpa*	Terrestrial	Rarely inundated	Habitat, food source
4	Fern-leaved wattle	*Acacia filicifolia*	Terrestrial	Rarely inundated	Habitat, stabiliser, food source, attractive, traditional uses

Zone	Common Name	Scientific name	Water depth tolerance (cm)	Inundation frequency	Notes
4	Snow gum	*Eucalyptus pauciflora*	Terrestrial	Rarely inundated	Habitat, stabiliser, food source, attractive
4	Black sallee	*Eucalyptus stellulata*	Terrestrial	Rarely inundated	Habitat, stabiliser, food source, attractive
4	Ribbon/Manna gum	*Eucalyptus viminalis*	Terrestrial	Rarely inundated	Habitat, stabiliser, food source, attractive, traditional uses
4	Mountain gum	*Eucalyptus dalrympleana* subsp. *heptantha*	Terrestrial	Rarely inundated	Habitat, stabiliser, food source, attractive
4	New England peppermint	*Eucalyptus nova-anglica*	Terrestrial	Rarely inundated	Habitat, stabiliser, food source, attractive
4	River oak	*Casuarina cunninghamiana* subsp. *cunninghamiana*	Terrestrial	Rarely inundated	Habitat, stabiliser, food source, competitive, attractive

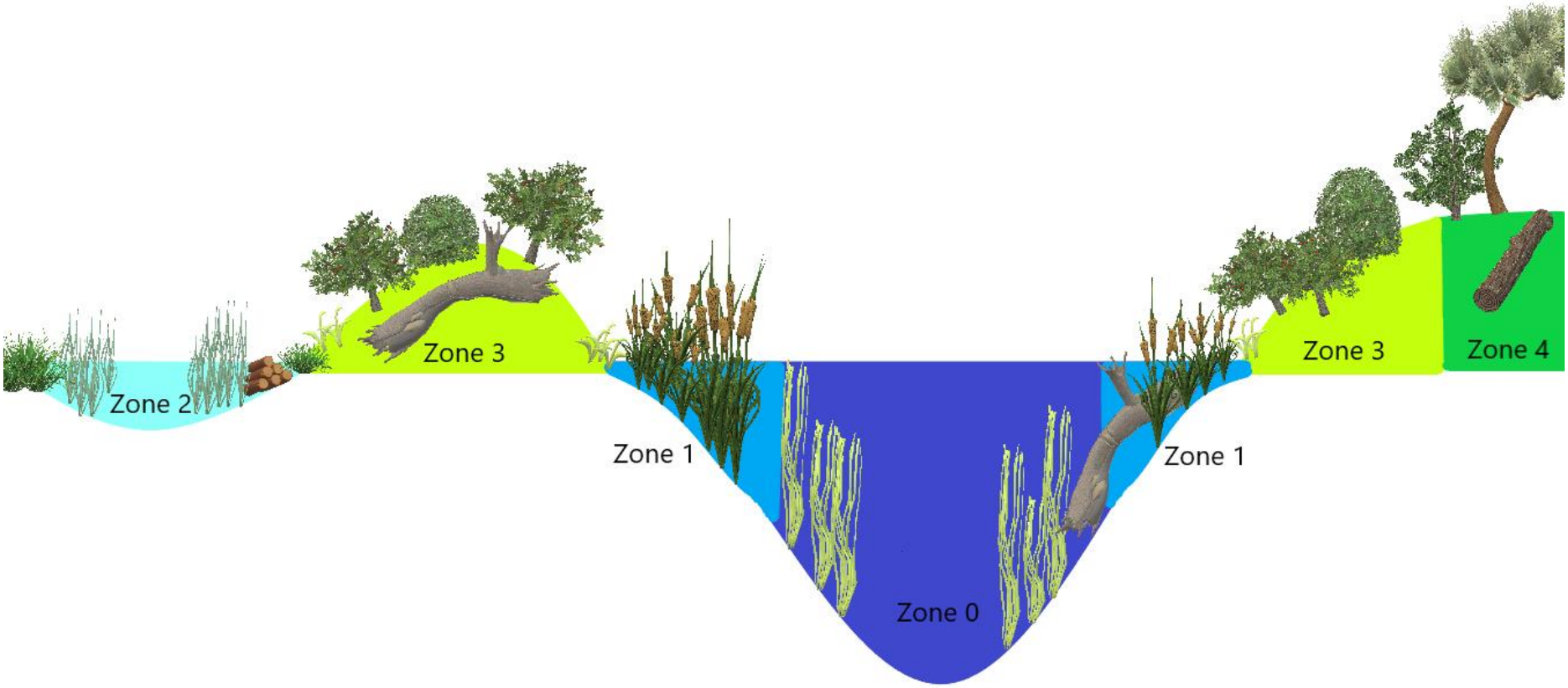

Figure 3. An illustrated cross section of the five Dumaresq Creek vegetation zones. Note the woody debris located throughout different zones and the example of 'small step jams' in Zone 2 which can be back-filled with gravel to offer stabilisation and a planting substrate in more erosive areas (see Figure 6 for more details).

Figure 4. Artist's impression showing the combination of species and vegetation zones in a treated section of the project area to visualise before (top) and after planting (bottom). Note the use of large woody debris for the provision of habitat.

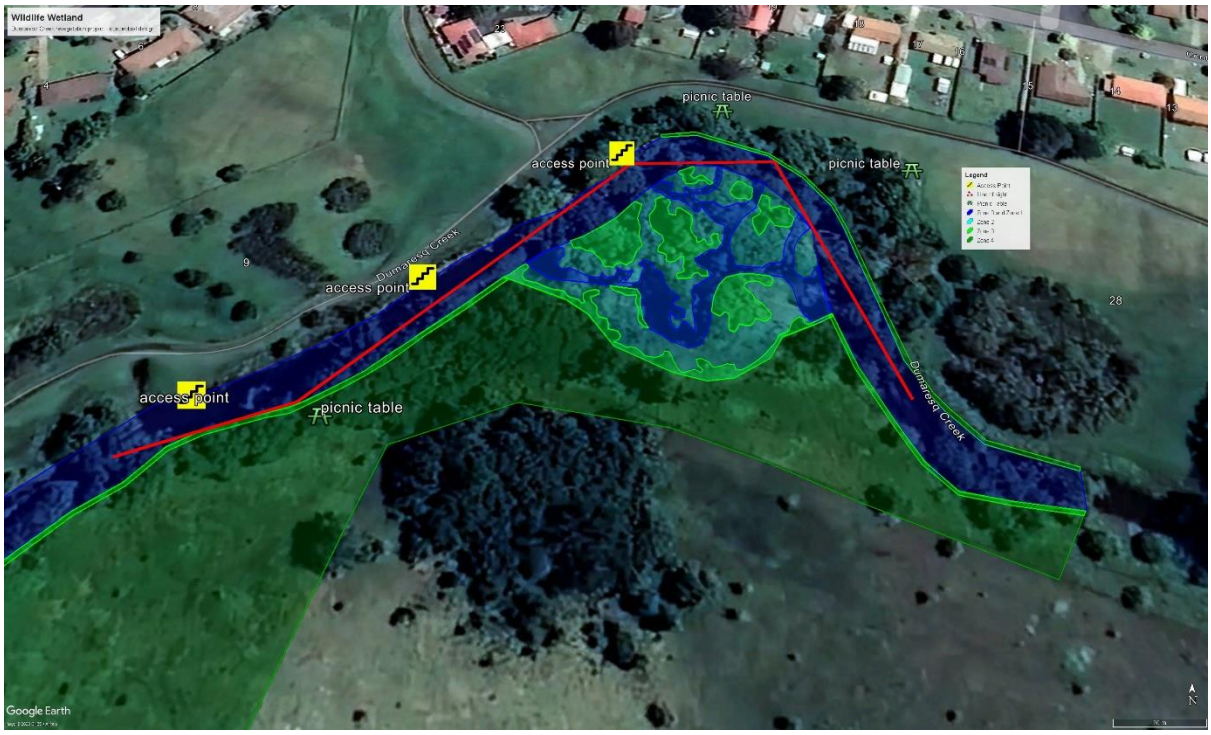

Figure 5. Wildlife Wetland aerial view and conceptual design of vegetation zones close-up. Proposed access points and picnic table locations along with 'clear lines of sight' along the creek are provided; however, final determination of these locations will be provided by Council.

Log step jams

Soft engineering, such as the installation of small log sills (Figure 6) can be used to create topographic complexity of the streambed. This increases the diversity of hydraulic habitats for aquatic plants and animals, increases oxygenation in the creek by creating small areas of turbulent flow (Figure 7), and can assist in maintaining areas of silt deposition immediately upstream of the structure that can be colonised by submergent macrophytes.

Small log sills were used in the Hunter River and Williams River in 2006-2007 and withstood several small floods (Figures 6 and 7). Similar log sills could be used to increase habitat heterogeneity within Dumaresq Creek. The installation of the log sills in the Hunter River used fence-post sized logs that could be safely handled by two people. A shallow trench was dug into the streambed using a rake hoe and the logs rolled into the trench. Partially embedding the logs ensured that water flowed over them but not under them, thereby avoiding streambed erosion under the log. Each log was anchored by a star picket at each end, and one on the lee side to support the middle. Notches were made in each end so that the star picket sat flush with the top of the log (or slightly depressed) to reduce trip hazards for river users. Fencing wire anchored the logs to the star pickets (Figure 8). Notches were also cut into the middle ends so that when placed together, a single log sill was formed (Figure 6). This was supported by a star picket on the lee side of the log and tied off using steel cable to anchor the logs to the star picket (Figure 6). Given the width of Dumaresq Creek, shorter log sills constructed around willow stumps would be more appropriate to the size of the channel. Where willow stumps can be drilled, the log sills could be cabled to these for anchorage, minimising the need for star pickets. Cables can then be covered by gravel to reduce tripping hazards

to river users. The *Design Guideline for the Reintroduction of Wood into Australian Streams* is a useful resource but focuses on much bigger and more permanent wood structures.

Figure 6. A close up of a log step comprising two 'fence-post' sized logs in the Hunter River downstream of Muswellbrook. Notches were cut into both ends for attachment to star pickets to anchor the step-jam in location. Accumulated fine sediments can be seen on the upstream side of the log. This photo was taken during very low flow conditions.

Figure 7. A similarly constructed log step-jam under high flows. The hydraulic jump and turbulent water are clearly visible. A small scour pool formed immediately downstream of the log from the turbulent flow, creating a small sediment dune immediately downstream of the pool. Sediment accumulated immediately upstream of the log, embedding it further into the stream bed. This created an area of complex topography and range of microhabitats in a previously homogeneous streambed.

Figure 8. The logs were partially buried in the sediment and fencing wire was used to anchor the logs to the star pickets.

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