



APPENDIX C
Ploughmans Valley
Ecological Assessment

THE ECOLOGY OF PLOUGHMANS CREEK WETLAND AND CREEK SYSTEM TO THE MOLONG ROAD ORANGE.

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1. INTRODUCTION

This report gives the results of a flora and limited vertebrate survey on three blocks of land owned by Orange City Council at the junction of Ploughmans Lane and the Cargo Road, and on Ploughmans Creek downstream to the Molong Road.

The aims of the survey were to:

- Describe the study area;
- Identify and define the vegetation types;
- Identify the range of vertebrate fauna present and their relative abundance;
- Compile a comprehensive list of native and introduced species;
- Determine the presence of any rare or threatened species, or plant communities;
- Assess the quality of the extant flora and fauna in terms of its representativeness of the likely pre-European communities;
- Assess ecosystem function and the relative health and sustainability of the system;
- Identify current and future constraints on ecosystem processes;
- Assess the conservation significance of the study area at local, regional and national level; and
- Assess the potential for site regeneration, restoration and/or other scenarios.

2. SITE DESCRIPTION

The main focus of the study was on three contiguous parcels including Lot 1 DP997063, Lot B DP150805 and Lot 1 DP214645. The subject land is on the corner of Cargo Road and Ploughmans Lane and comprises 12.15ha. The recent proposed reclassification, would permit the use of the subject land for urban residential development, open space and constructed wetland. Specifically, Council's draft concept (OCC Drawing No:SE296, June 2004) includes:

- 3.25ha of operational land for a cluster of 30 urban residential lots; and
- 8.90 ha of community land for open space and wetland construction.

In addition, Ploughmans Creek and the immediately adjacent mown areas in the road reserve between the Cargo and Forbes Roads were also inspected. A cursory inspection was also made of Ploughmans Creek between Forbes Road and Molong Road.

2.1 Ploughmans Creek 'wetland'

General Description of the Study Area

The study area is a shallow valley consisting of the drainage lines of Ploughmans Creek and a major tributary from Wentworth Golf Course to the east. Within the main study area, the terrain is gently sloping on either side of the drainage lines, with the lower areas prone to

waterlogging and the upper slopes better drained. Concrete pipes under Cargo Road connect the wetland with lower Ploughmans Creek. The areas immediately south and west are undergoing rapid change associated with present and future housing developments. Upstream developments have changed the rate of run-off significantly and this will be exacerbated with ongoing developments. Upper catchment stormwater is now directed through a pipe and channel exiting into Ploughmans Creek wetland on the southern extremity. We estimate that about 500 tonnes of silt has recently encroached into the upper section of the wetland. However this has had little impact on the conservation value of the area other than to allow further weed invasion.

A bitumen road runs along the eastern boundary of the wetland. North of the Wentworth Golf Course housing adjoins the creek more or less continuously through to the Molong Road.

Previous Land Use

Examination of the study area indicates it has previously been used for agriculture, probably including fruit growing and grazing. Old fences still traverse the area indicating the layout of the former paddocks. There are also scattered remnant fruit trees, including Apple, *Malus domestica* and Cherry rootstocks, *Prunus cerasus*. The area has been completely cleared of its original native tree cover, all current trees are introduced species.

The area has been subject to considerable historical and recent disturbance to the soil and vegetation. Within the last one to two years the eastern, southern and western boundaries have been disturbed by:

- Construction of a new fence on the eastern boundary
- Construction of new houses at the southern end with soil disturbance impinging on the study area.
- Construction of a large drain for a new housing estate to the south, which discharges into the centre of the study area at the southern end. This drain has replaced part of the southern watercourse of Ploughmans Creek, which is now dry. The new drain has discharged a very large amount of silt onto the upper end of the study area and has greatly changed the surface hydrology with consequent effects on the vegetation.
- Construction of a sewerage pipeline along the western boundary of the study area to a new pumping station in the north-west corner of the area.
- Construction of a new road perpendicular to the western boundary near its midpoint. Much excess fill from this construction has been pushed well into the study area.

At least one artificial channel has been constructed in the lower creekline to encourage better drainage to occur.

2.2 Ploughmans Creek between Cargo Road and Molong Road

For the most part the watercourse of Ploughmans Creek downstream to the Molong Road is not deeply incised and prominent creek banks are absent. The exception is the road reserve between the Cargo and Forbes Roads, where it is apparent the creek has been excavated and straightened to improve drainage and flows. Numerous stormwater outlets feed into the creek. Some walling has been undertaken to stabilise creek banks. For example a gabian weir has been constructed upstream of Glendale Crescent, and the Max Stewart tributary has been modified to flatten the channel grade. The now deeply incised creek, sometimes up to 3-4 deep, with side slopes in the order of 1 in 1 or greater, has been effectively disconnected for most of the time from the gently undulating floodplain that now is part of a human dominated cultural landscape. Medium density housing adjoins the eastern boundary and 'homes on acres' the western side. There various *ad hoc* management strategies are being practised. Non-native trees and an understorey of numerous exotic plants, mostly weed species, dominate the landscape. Parts of the understorey are regularly mown for fire and reptile protection. Many adjoining residents use the reserve areas to dump green waste. Some attempts have been made to create European gardens at spot locations along the creek reserve. The available and now constrained floodplain on either side of the stream ranges between 50-200 m in width. Hassell (1997) identified bed erosion due to increased urban runoff as a major and continuing problem.

Below Forbes Road, the general cross-section and meander of Ploughmans Creek has probably changed less than in the upper section but the grade appears greater than in the section between Cargo and Forbes Roads.

The two principal areas of frequent overbanking occur immediately upstream of Cargo Road and downstream of Forbes Road.

2.3 Ploughmans Creek Pre-European – a probable scenario

(With input from Dr Andrew Rawson, DIPNR geomorphologist who visited the site with DG. However CB and DG take full responsibility for this section and Dr Rawson's input does not necessarily represent endorsement from DIPNR).

There is strong evidence to suggest that the current 'wetland' and the downstream creek-line, was once part of a highly productive and very diverse **swampy meadow and 'chain of ponds' system**. The evidence is:

- the general cross-section of Ploughmans Creek 'wetland', and particularly the creek line downstream of the Forbes Road, where the meander has been less impacted than the very altered Cargo Road-Forbes Road section,
- the position of Ploughmans Creek within the catchment as an early order stream,
- the grade of the flow line,
- the extant but highly degraded relic *Carex* swamp vegetation community within the current 'wetland', together with clumps of Cumbungi reed beds; and
- research findings (e.g. Brierly et al 1999, Eyles 1977a, Eyles 1977b Page and Carden 1998, Wasson et al 1998).

Very few lay people or for that matter natural resource scientists understand the important role that these pre-European wetland systems played in effectively drought-proofing the landscape and driving the plant production-biodiversity system. Nor do most understand how common swampy meadows and 'chain of ponds' once were in the landscape. There are only one or two intact quality examples extant in the Central West of the many thousands that once existed. Most, including Ploughmans 'wetland' and Creek are very degraded but may still contain some relics of a once dynamic wetland system (e.g the *Carex* Swamp). Universally they have been degraded by overgrazing, reed bed burning, the construction of artificial channels to encourage better and quicker drainage or a permanent better drained landscape, and eventually, further destabilised by periodic/episodic flooding following the coincidence of drought, overgrazing by rabbits and livestock and reed bed destruction.

Relic but degraded swampy meadows are reasonably common in the landscape (e.g. the Ploughmans Creek 'wetland'), but 'chain of ponds' are not. The once common and complex combination of intact swampy meadows and chain of ponds is now an endangered land form-riparian system but not one yet recognised in legislation.

Some difference between the swampy meadow-chain of ponds complexes and typical extant creek lines such as Ploughmans Creek are identified in Table 1 below:

Table 1: Comparison of Ploughmans Creek with a pre-European Swamp Meadow-Chain of Ponds system

Ploughmans Creek	Swampy meadows/chain of ponds
Meander fixed in landscape or artificially straightened.	Dynamic meandering over geological time.
Creek line effectively functionally disconnected from the flood plain.	Creek line and floodplain an operational connected unit.
A relic more-or-less non-functional swamp is present.	A fully functional swampy meadow-chain of ponds complex.
Biodiversity dramatically decreased.	Relatively mega-diverse.
Significant weed incursion.	Native plants only.
Water flows through the system rapidly within a discrete channel.	Other than for fresh or flood events, water flows very slowly through the system and across most of the primary flood plain;
Spongy water-storing underlay has disappeared (plant decay remains or sphagnum moss beds).	Spongy water storing underlay present across much of the primary floodplain.
Relatively little water is stored/banked in the system	Significant water stored across the floodplain in moss beds or similar and within temporary dams created by reed walls and beds.
Bank and instream erosion can be a significant problem.	Erosion not usually a problem.
Poor water filtering capacity.	Superb water filtering capacity.
Complete loss of 'chain of ponds' dammed by dynamic reed bed formation and loss.	Sequence of 'Chain of ponds' – swampy meadows the norm.
Loss of role as a drought refuge.	Significant drought refuge role.
Primarily stormwater function.	Stormwater function unnecessary.
Very degraded wetland with traversing of significant and irreversible ecological thresholds.	Fully functional wetland with significant capacity for self restoration in the short and long term.
Significant loss of ecosystem resilience and capacity for self repair.	Significant system resilience and self repairing dynamic system.
Limited restoration possible at great cost with no possibility of recreating the original system biodiversity and function.	Important natural systems now largely lost from the post-European landscape or very degraded
Important open space with the potential to create a contrived artificial wetland system that would be accompanied by an increase in: native biodiversity, water filtering capacity, flood mitigation within a built environment, and a significant increase in visual amenity and recreational space.	Fully functional natural wetland system

3. METHODS

3.1 Survey methods:

Flora

The survey was carried out by walking to all parts of the study area and recording all vascular plant species. This was done systematically by dividing the area into blocks and walking each in turn. Different vegetation types were defined by clear discontinuities in the dominant plant species present across the site (Figure 1). Once the main vegetation types were identified, plant species lists were compiled separately for each (Appendix 1).

Each species was assigned a subjective rating for its abundance within each vegetation type (Appendix 1) as follows:

- Abundant – present in high numbers throughout
- Common – regularly encountered in moderate numbers
- Occasional – of scattered occurrence in low numbers
- Uncommon – few occurrences, but widespread

Rare – only one or very few individuals present

Any species that could not be recognised in the field were collected and identified in the FloraSearch laboratory using a binocular microscope and the identification keys in the Flora of New South Wales (Edited by G. Harden, 1990-2002). Other floras were used as necessary for confirmation. Collected specimens have been preserved by pressing them in a plant press, and allowing them to dry.

Vertebrate fauna

The following groups were targeted: fish, amphibia, reptiles, birds and selected mammals. Fish were captured using a small hand net. Amphibians were identified primarily by call following a storm event while systematically sampling within the wetland and along the lower Ploughmans Creek, and by opportunistic encounters while surveying for birds. Reptiles were observed on an opportunistic basis while surveying for birds. Birds were surveyed along two transects along a north south axis within the wetland and another continuous transect along Ploughmans Creek between Cargo and Forbes Roads. Each transect was traversed twice. The available habitat for native mammals was judged to be very low to non-existent. Bats were not targeted although there are a number that could utilise the open space corridor. Small mammal trapping was not deemed necessary since the habitat is so degraded and most likely to support populations of introduced rats and mice given the proximity to human habitation and refuse. Platypus and Water Rat, if in the unlikely case they were present, were amenable to visual observation during early morning and late afternoon bird surveys along the lower creek. The only other species that are likely to be present were; macropods (can be located by opportunistic sightings and droppings), the echidna (sightings and droppings, and ringtail and brushtail possums (spotlighting and calls). Introduced mammals such as rabbit, hare and fox are readily identified through opportunistic sightings and droppings. Approximately 2.5 days were expended on the fauna survey.

4. RESULTS

Flora

4.1 Vegetation Types

Four vegetation types were recognised on the study area as follows (Figure 1)

4.1.1 Watercourse Community

The Watercourse Community is centred on Ploughmans Creek and its main tributary arising to the east in the Wentworth Golf Course. This community is narrowly confined to the creek bed and adjacent sloping banks and is dependent on the flow of water in the creek. It is characterised by aquatic and semi-aquatic plant species, but also contains low numbers of some species more characteristic of surrounding communities. A full list of species associated with the creeks is given in Appendix 1.

The watercourse community supports several species of introduced willow trees in scattered stands, the most common being the White Willow, *Salix alba*, but is mainly open and treeless, with Cumbungi, *Typha* spp. and Tall Sedge, *Carex appressa*, as the dominant species.

Typical native species found in this community include Cumbungi, *Typha domingensis* and *T. orientalis*; a rush, *Eleocharis acuta*; Tall Sedge, *Carex appressa*; Knob Sedge, *Carex inversa*; several species of *Juncus*; a raspwort, *Haloragis heterophylla*; Hyssop Loosestrife, *Lythrum hyssopifolium*; a willowherb, *Epilobium hirtigerum*; Pale Knotweed, *Persicaria lapathifolia*; White Purslane, *Neopaxia australasica* and a grass, *Amphibromus pithogastrus*.

Common introduced species include Common Sowthistle, *Sonchus oleraceus*; Two-rowed Watercress, *Rorippa nasturtium-aquaticum*; Common Starwort, *Callitriche stagnalis*; Clustered Dock, *Rumex conglomeratus*; Curled Dock, *Rumex crispus*; Creeping Buttercup, *Ranunculus repens*; White Willow, *Salix alba*; Toad Rush, *Juncus bufonius*; Oatgrass, *Arrhenatherum elatius*; Reed Sweetgrass, *Glyceria maxima*; Yorkshire Fog, *Holcus lanatus* and Phalaris, *Phalaris aquatica*.

4.1.2 *Carex* Swamp Community

The *Carex* Swamp Community is dominated by the Tall Sedge, *Carex appressa*, and occurs on low areas prone to waterlogging, which were very wet underfoot during the survey. Tall Sedge forms dense stands up to about 1.5m high that are difficult to traverse. Other plant species are largely restricted to small breaks in the sedge cover. The *Carex* Swamps generally occur adjacent to the Watercourse Community.

The main native species in this community were Tall Sedge, *Carex appressa*; White Purslane, *Neopaxia australasica*; Swamp Dock, *Rumex brownii*; a raspwort, *Haloragis heterophylla* and a rush, *Juncus gregiflorus*.

Introduced species included Spear Thistle, *Cirsium vulgare*; Flatweed, *Hypochaeris radicata*; Common Sowthistle, *Sonchus oleraceus*; Hexham Scent, *Melilotus indicus*; White Clover, *Trifolium repens*; Oatgrass, *Arrhenatherum elatius* and Yorkshire Fog, *Holcus lanatus*.

4.1.3 Grassland Community

The Grassland Community occurs upslope of the *Carex* Swamps on better drained sites. It is dominated by twelve introduced grasses, mainly Browntop Bent, *Agrostis capillaris*; Oatgrass, *Arrhenatherum elatius* and Yorkshire Fog, *Holcus lanatus*. Only three native grasses were found, a Wallaby Grass, *Austrodanthonia pilosa*, Wheat Grass, *Elymus scaber* and Blown Grass, *Lachnagrostis filiformis*, all in low numbers.

The grasslands are generally free of shrubs and trees apart from scattered small individuals of introduced species such as Hawthorn, *Crataegus monogyna*; Apple, *Malus domestica*; Sour Cherry, *Prunus cerasus*; Sweet Briar, *Rosa rubiginosa*; Blackberry, *Rubus discolor* and Common Sallow, *Salix cinerea* subsp. *oleifolia*.

Native herbaceous species were present only in very low numbers including Small St. Johns Wort, *Hypericum gramineum*; a raspwort, *Haloragis heterophylla*; Hyssop Loosestrife, *Lythrum hyssopifolia*; Slender Knotweed, *Persicaria decipiens*; Swamp Dock, *Rumex brownii* and Common Bog-rush, *Schoenus apogon*. By contrast, introduced herbs were much more abundant, the dominant species being Flatweed, *Hypochaeris radicata*; Common Sowthistle, *Sonchus oleraceus*; Hexham Scent, *Melilotus indicus*; White Clover, *Trifolium repens*; Common Vetch, *Vicia sativa*; Lamb's Tongue, *Plantago lanceolata*; Sorrel, *Acetosella vulgaris* and Curled Dock, *Rumex crispus*.

4.1.4 Disturbed Sites

The fourth vegetation type is represented by a very large array of colonising weed species on disturbed sites, mainly around the eastern, southern and western sides of the study area (Appendix 1). Many of these weeds are abundant only on the disturbed ground and are absent, or occur only in very low numbers, within the core area that has not been subject to recent soil disturbance.

The marginal areas of the site are also subject to the activities of neighbours, some of whom view the site as a convenient place on the one hand to dump garden waste, or on the other to enhance with horticultural plantings. The marginal areas had some plants that appear to have escaped from garden waste, such as Petunia, *Petunia axillaris* and Love-in-a-mist, *Nigella damascena*. One landowner adjoining the reserve between the Cargo and Forbes Roads has established a garden in the reserve including plantings of introduced creepers that have moved onto the bank of Ploughmans Creek. These include Climbing Rose, *Rosa* sp.; Blue Periwinkle, *Vinca major*; English Ivy, *Hedera helix* and Japanese Honeysuckle, *Lonicera japonica*, the last three of which are regarded as serious environmental weeds in coastal areas.

4.2 Plant species

A total of 138 vascular plant species were found during the survey, of which 35 (25.4%) were native and 103 (74.6 %) were introduced. Appendix 1 gives a breakdown of the numbers and percentages of native and introduced species found in each vegetation type. By far the largest number of species (102) was found on areas of recently disturbed soil at the edges of the study area. These were predominantly introduced weeds (83 species, 18.6%) capable of rapidly colonising disturbed sites. Some 19 (18.6%) native species with similar colonising characteristics were also found in the disturbed areas, but none were common or abundant.

Far fewer species were found in the core areas of the site which tended to be dominated by a smaller suite of species able to compete with each other. The grasslands and watercourses had very similar numbers of species, 55 and 56 respectively, with the watercourses having slightly more native species, 14 (25.5%) and 17 (30.4%) respectively. Relatively few species were found in the *Carex* swamps (12) due to the overwhelming dominance of the Tall Sedge, *Carex appressa*. Five species (41.7%) in the *Carex* swamps were native, all aquatic or semi-aquatic forms.

It is of interest that of the 35 native species occurring on the study area, just over half (18 species, 51.4%) were aquatic or semi-aquatic taxa found in the *Carex* swamps and watercourses. This suggests the area provides a small refuge for these species in a landscape from which some of them have largely disappeared.

4.3 Freshwater algae

No survey was undertaken to determine the diversity of algal species present. However a study was carried out between Cargo and Forbes Roads by the University of Sydney in 2000 and the following species were identified: *Fragilaria*, *Melosira*, *Phormidium*, *Stigeoclonium*, *Gomphonema*, *Phytoconis*, *Synedra* and *Zygnema*.

4.4 Vegetation and habitat quality

The original vegetation of the site is likely to have been a tall open woodland dominated by the following tree species:

- Ribbon or Manna Gum, *Eucalyptus viminalis*
- Apple Box, *Eucalyptus bridgesiana*
- Snow Gum, *Eucalyptus pauciflora*
- Black Sally, *Eucalyptus stellulata*

The wetter areas may also have had some Black Gum, *Eucalyptus aggregata*, but this is less certain. The main low tree or shrub would have been Silver Wattle, *Acacia dealbata*, and a few juveniles of this species were found in the disturbance along the eastern fenceline. Below the tree cover would have been a tussock grassland dominated by Tussock, *Poa labillardieri*, in the drier parts and Tall Sedge, *Carex appressa*, in the wetter sections. There would also have been a diverse array of other native grasses and herbs, most of which have been eliminated by past land uses. Of the original flora, only the *Carex* species have proved resilient enough to persist in significant numbers.

Fauna

4.5 Fauna species present

A list of the vertebrate fauna located is found in Appendix 2. Fifty nine species were recorded, including 41 (69.5%) native vertebrates and 18 (30.5%) introduced species. More native species were found along the creek line (34) than in the 'wetland' (26). No fish were found in the wetland and only two species in the downstream creek, one introduced. The number of frog species were well represented overall (7) but only three frogs were located in the wetland whereas seven were located in and along the downstream creek line. Only three reptiles were observed, one in the wetland and three along the downstream creek. Of the 26

native birds identified, equal number of species (20) were observed in each survey area. Bird species numbers in the wetland were significantly boosted by 20 temporary visitations by species alighting on trees for relatively short periods of time. Only two native mammals were located.

Both the wetland and Ploughmans Creek below Cargo Road are relatively vertebrate species poor areas, when compared with the species known to be present in the Orange 1:100,000 map sheet that potentially could be present.

With the exception of frogs, all vertebrate groups were under-represented. Significant suites of species are missing from the sample, including waterbirds, finches, honeyeaters, aquatic and terrestrial reptiles.

There appear to be few if any viable vertebrate populations present within the study area.

It is likely that other additional bird species could be found using the wetland and Ploughmans Creek.

4.6 Threatened species and communities

No plant species or communities listed as threatened under the NSW *Threatened Species Conservation Act 1995* or the Commonwealth *Environmental Protection and Biodiversity Conservation Act 1999*, were found on the study area.

No threatened fauna were located during the study, either under New South Wales Threatened Species legislation, or EPBC legislation. However, while Latham's Snipe also known as the Japanese Snipe, (*Gallinago hardwickii*) was not located during this study, the species has recently been observed in the wetland area by competent amateur ornithologists. This species is a listed EPBC migratory species under EPBC legislation in relation to the JAMBA agreements (Japan-Australia Migratory Bird Agreement and the CAMBA agreement, (Chinese Australian Migratory Bird Agreement). Under the EPBC Act actions that are likely to have a significant impact on a matter of national environmental significance are subject to a rigorous referral assessment and approval process. An action includes a project, development, undertaking, activity or series of activities.

4.7 Noxious weeds and fauna

Several noxious weeds occur on the study area including St. John's Wort, *Hypericum perforatum*, Blackberry, *Rubus discolor* and Sweet Briar, *Rosa rubiginosa*. None occurs in large numbers and the Blackberry, in particular, has been subject to active control since dead vines were found in several places.

Nine introduced species were located during the study, including pest species such as the common starling and blackbird, house mouse, black rat, rabbit, cat, fox, and domestic dog. The location of the study area in relation to urban development and relatively large populations of domestic cats and dogs is likely to have had a significant and deleterious impact on many native aquatic and terrestrial fauna.

5. Summary of Conservation and system values

Flora

From the above description of the likely original vegetation it is clear the study area has undergone dramatic change since white settlement. The character of the site has altered from a tall open woodland to grassland and sedgeland, and the original native plants have largely been replaced by introduced species. Therefore, the site can only be described as highly degraded in terms of its original vegetation. The surviving native species are those that can cope with disturbance and, as such, are generally widespread and common.

Fauna

Likewise, the faunal complement present, with the possible exception of amphibians represents a highly depleted faunal assemblage, not surprising given the long term changes that have occurred, the presence of degraded and simplified habitats and a significant non-native predator population, habitat destruction, fragmentation and degradation and ongoing external impacts. It is very likely that many more species utilise both wetland and creek areas from time-to-time. However 'visitation' is not to be equated with population viability. It appears that there are very few viable populations of the species located. Furthermore, the area has virtually no links with existing native vegetation and little value as a wildlife corridor.

It can be concluded therefore, that the study area has minimal conservation value for native flora and fauna, since it is too highly altered from its original condition and retains very few of the likely original complement of species.

System values

The extant wetland-Ploughmans Creek system is now very simplified and compromised. It operates almost entirely as a stormwater drainage line retaining few of the original system processes associated with the swampy meadow – chain of ponds complex.

National Conservation value

Degraded swampy meadows with a history of agricultural land use are abundant in the wheat-sheep belt and coastal areas of Australia and have limited conservation value.

The swampy meadow/wetland:

- has lost its original plant communities through land clearing and past agricultural use
- is highly disturbed around its margins
- is dominated by introduced plant species
- currently has three main plant communities, all of which are secondary communities developed from small remnants of the original natural communities and a large infusion of introduced species
- has a small suite of native aquatic and semi-aquatic plant species, some of which are scarce elsewhere in the district
- contains no threatened plant species or communities
- has a low value for conservation of native flora
- has a very depauperate faunal community with few if any viable populations contained within its borders
- limited linkages with other natural areas mainly through the highly degraded Ploughmans Creek linkage with the Bell River
- no threatened fauna species were observed but has some capacity to provide limited habitat for migratory species such as Latham's/Japanese Snipe and
- the wetland-Ploughmans Creek corridor now has a primary function as a degraded stormwater conduit.

Regional conservation value

Marginal for the above reasons. However

- has a small suite of native aquatic and semi-aquatic plant species, some of which are scarce elsewhere in the district
- no threatened fauna species were observed but has some capacity to provide limited habitat for migratory species such as Latham's/Japanese Snipe

Local conservation value

Limited value.

- Has some capacity as a refuge for limited use by small numbers of wetland species
- Has potential for development as an open space multi-functional urban corridor with increased conservation values associated with targeted native amenity plantings.
- Good representation of local frog species.

6. Potential for restoration of wetland and Creek line

Very significant and deleterious changes have occurred that have impaired and/or destroyed ecosystem function, reduced species diversity etc. Ecosystem resilience is now very low and significant ecological thresholds have been crossed. Natural regeneration cannot be used as a restoration tool. It is neither possible nor cost effective to restore Ploughmans Creek to its pre-European condition.

However it is possible to enhance local amenity and recreational opportunities through thematic native plantings using local provenance, that create contrived habitat and attract wildlife, particularly native birds, slow water flow and reconnect creek-line and floodplains, via the creation of artificial wetlands, small step dams along the length of Ploughmans Creek, remove weed species, and targeted use of native emergent water plants as agent of water flow control and purification.

7. Hydrological and built environment constraints

There are now very significant constraints as to the future landuse of Ploughmans Creek/wetland. These constraints are:

- **Urban development**

Present and planned urban development is well documented (see main report). The pre-existing primary and secondary floodplains are now truncated and in some locations choked.

- **Hydrological and water quality control**

Urban development, extant and planned has and will continue to significantly increase the rate of runoff from impervious surfaces into Ploughmans Creek, with the potential for overbanking to occur following storm events or extended rainfall events. Overbanking can and does occur at Ploughmans wetland and downstream of Forbes Road (refer Appendix B to the main report). Overbanking will be exacerbated with further planned urban development.

Water quality generally does not meet ANZECC guidelines for the protection of aquatic ecosystems (Hassals 1997).

- **Ecological**

We have argued that Ploughmans Creek/wetland is a degraded swampy meadow – chain of ponds system once common in the landscape. It now operates as primarily a stormwater channel with very little capacity to absorb and or modify high flow regimes.

8. Future options open to council

8.1 Leave wetland more-or-less unchanged

Given the above constraints and the limited conservation values of the wetland and the general degraded nature of Ploughmans Creek, there is little justification for this option. Furthermore, the potential for high level restoration is very low and very expensive. Neither

does such an option address the overbanking issues that can impact on existing and planned built environments. This option is not recommended.

8.2 Retain and restore current wetland

This option is not recommended for the same reasons identified in 8.1 above.

8.3 Create a series of multi-purpose constructed wetlands along Ploughmans Creek, including within Ploughmans Creek Wetland

Council has made it very clear since 1997 that the subject land (and other strategic locations along the creek system to Molong Road) would be dedicated for construction of stormwater facilities. Detail of what is proposed was prepared in a design report completed in July 1998 by Lyall & Macoun Consulting Engineers.

The stormwater facility proposed is a constructed wetland. The wetland features have been designed according to principles outlined in the *Constructed Wetlands Manual* (DLWC, 1998). Specialist advice was obtained on aquatic planting details and an Operation and Maintenance Manual has been prepared. The design also included testing of topsoil for suitability as a substrate for aquatic plants.

The wetland was designed based on the following objectives.

- Mimic natural systems to the extent possible, provide a range of ecological niches currently missing from the degraded system, provide a range of wetland landforms (e.g. irregular shoreline, structural diversity, varied plant succession via management strategies etc.
- Treatment of stormwater runoff and improvement of the quality of discharges (reduced nutrients, gross litter and sediments) from the wetland.
- Enhancement of wildlife habitat (waterbird, amphibians and other) on site and downstream.
- Development of a viable wetland treatment system which has low maintenance requirements.
- Enhancement of visual amenity with a large open water area and provision of recreational opportunities by landscaping the foreshore areas.
- Providing an educational function for local schools and community groups.
- Potential for intergrading wetland with reconstructed grassy woodland and existing riparian zone.

The planned constructed wetland will have the following components.

- A forebay area (sedimentation pond).
- A shallow area planted with macrophytes with a central island area to increase the flow path and provide a mud flat for wading birds.
- A large open water area with gentle sloping foreshores and a central habitat island.
- A walkway between the wetland and open water areas connecting the eastern and western foreshores.
- An embankment and spillway at the downstream end of the open water area.

- Pipework to control water levels during the wetland planting, commissioning and operational phases, and to allow for de-watering for maintenance purposes.

Such urban wetland developments are increasingly common in Australian cities and have a track record of markedly increasing local species diversity, restoring some limited ecological function, as well as providing recreational opportunities and high amenity outcomes. However they are not self managing systems and management inputs are needed on an ongoing basis. A list of proposed species for the proposed constructed wetland and riparian terrestrial plantings are provided in Appendix 3.

While this is not quite the option that the local action group envisages, it appears to be the only viable outcome given the constraints identified above.

9. Recommendations

- 9.1** Council develop a ten year master plan for the partial restoration and enhancement of Ploughmans Creek, including constructed wetlands, riparian and adjacent potential grassy woodland-shrub zones, instream zone, recreational and amenity facilities- infrastructure, and street-parkland plantings that are more sympathetic with the creation of the desired transformation.
- 9.2** Optimise the available area for the development of the upper Ploughmans Creek constructed wetland.
- 9.3** Modify the Lyall and Macoun (1988) wetland Design as suggested in Appendix 3.
- 9.4** Utilise the plant and faunal species identified in Appendix 3
- 9.5** Develop a curfew policy on urban animals particularly cat and dog incursion into wetland-urban creek-bushland areas.
- 9.6** Develop an urban feral animal control program (exotic fish, rabbit, fox, cat and dog) with particular emphases on creek-line corridors.
- 9.7** Develop a ten year willow removal-replacement program based on Windsor, Goldney and Bloomfield (2004)
- (N.B. Willow species are declared noxious weeds, with Tortured Willow being particularly evasive and present in some adjacent gardens. Tortured Willow should be targeted immediately. However a willow removal program needs to be well thought through, gradually implemented concurrently with a native tree-shrub replacement program. Wholesale removal of willows can lead to catastrophic stream destabilisation.
- 9.8** Consider the long term replacement of present street and within park trees (e.g poplar rows) adjacent and/or fronting Ploughmans Creek, with native plantings that will better complement the amenity outcomes suggested in Recommendation 1.
- 9.8** In conjunction with DIPNR and fisheries officers (DPI), develop a plan to address stream incision along Ploughmans Creek.
- 9.9** As a long to mid term outcome consult with NPWS and DPI to consider the possibility of native fauna reintroductions along Ploughmans Creek dependant on the availability of suitable habitat.
- e.g. Native fish, frogs, small non-venomous reptiles, ringtail possums and sugar gliders. Birds and other fauna e.g. echidna, will colonise the area as suitable habitat becomes available.
- 9.10** Ensure that two council staff visit constructed wetland sites in at least three locations to gain experience in developing and maintaining constructed wetlands e.g. Albury, Port Adelaide and Eastern Adelaide.

10. References

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APPENDIX 1

Systematic list of plants recorded on the Ploughman's Creek Study Area (December 2004).

Scientific Name	Common Name	Vegetation Type			
		Disturbed	Grassland	Watercourse	Carex Swamp
CLASS MAGNOLIOPSIDA					
SUBCLASS MAGNOLIIDAE					
Aceraceae					
* <i>Acer pseudoplatanus</i>	Sycamore Maple		r		
Amygdalaceae					
* <i>Prunus cerasus</i>	Sour Cherry	u	u		
* <i>Prunus domestica</i>	Plum	r			
* <i>Prunus</i> sp.	Ornamental Prunus	u	o		
Apocynaceae					
* <i>Vinca major</i>	Blue Periwinkle			r	
Araliaceae					
* <i>Hedera helix</i>	English Ivy			r	
Asteraceae					
* <i>Arctotheca calendula</i>	Capeweed	r			
* <i>Carduus pycnocephalus</i>	Slender Thistle	r			
* <i>Carthamus lanatus</i>	Saffron Thistle	u			
* <i>Cirsium vulgare</i>	Spear Thistle	c	c	u	o
* <i>Conyza</i> sp.	A Fleabane	r			
* <i>Crepis capillaris</i>	Smooth Hawksbeard	u			
<i>Euchiton involucreatus</i>	Common Cudweed	r			
* <i>Hypochaeris radicata</i>	Flatweed	a	a	u	o
* <i>Lactuca serriola</i>	Prickly Lettuce	c	o	o	
* <i>Leontodon taraxacoides</i> subsp. <i>taraxacoides</i>	Lesser Hawkbit	o			
<i>Senecio quadridentatus</i>	Cotton Fireweed	u		u	
<i>Senecio tenuiflorus</i>			u		
* <i>Silybum marianum</i>	Variegated Thistle	o			
* <i>Sonchus oleraceus</i>	Common Sowthistle	c	c	c	o
* <i>Taraxacum officinale</i>	Dandelion	r			
* <i>Tragopogon porrifolius</i>	Salsify	o	u		
Boraginaceae					
* <i>Echium plantagineum</i>	Paterson's Curse	o	o		
Brassicaceae					
* <i>Raphanus raphanistrum</i>	Wild Radish	u			
* <i>Rorippa nasturtium-aquaticum</i>	Two-rowed Watercress			c	
Callitrichaceae					
* <i>Callitriche stagnalis</i>	Common Starwort			c	
Campanulaceae					
<i>Wahlenbergia communis</i>	Tufted Bluebell	r			
<i>Wahlenbergia stricta</i> var. <i>stricta</i>	Tall Bluebell	r			
Caprifoliaceae					
* <i>Lonicera japonica</i>	Japanese Honeysuckle	r			
Caryophyllaceae					
* <i>Cerastium glomeratum</i>	Mouse-ear Chickweed	r		o	
* <i>Stellaria flaccida</i>	A Chickweed		r		
Clusiaceae					
<i>Hypericum gramineum</i>	Small St. John's Wort		r		
* <i>Hypericum perforatum</i>	St. Johns Wort	u	o		
Convolvulaceae					
* <i>Convolvulus arvensis</i>	Bindweed	r			
Euphorbiaceae					
* <i>Euphorbia lathyris</i>	Caper Spurge	r			
Fabaceae - Mimosoideae					
<i>Acacia dealbata</i>	Silver Wattle	r			

Fabaceae - Faboideae					
* <i>Chamaecytisus palmensis</i>	Tree Lucerne	r			
* <i>Medicago polymorpha</i>	Burr Medic	c			
* <i>Medicago lupulina</i>	Black Medic	o			
* <i>Mellilotus indicus</i>	Hexham Scent	c	c	r	o
* <i>Robinia pseudoacacia</i>	Black Locust	o			
* <i>Trifolium angustifolium</i>	Narrow-leaved Clover	r			
* <i>Trifolium arvense</i>	Hare's Foot Clover	c			
* <i>Trifolium campestre</i>	Hop Clover	o			
* <i>Trifolium cernuum</i>	Drooping-flowered Clover	u			
* <i>Trifolium glomeratum</i>	Clustered Clover	a			
* <i>Trifolium repens</i>	White Clover	a	a	o	o
* <i>Trifolium subterraneum</i>	Subterranean Clover	u			
* <i>Vicia hirsuta</i>	Hairy Vetch	u			
* <i>Vicia sativa</i>	Vetch	o	c		
Gentianaceae					
* <i>Centaurium erythraea</i>	Common Centaury		o	u	
Geraniaceae					
* <i>Geranium retrorsum</i>		c			
Haloragoraceae					
<i>Haloragis heterophylla</i>		c	u	c	o
Lamiaceae					
* <i>Salvia verbenaca</i>	Wild Sage	u			
Lythraceae					
<i>Lythrum hyssopifolia</i>	Hyssop Loosestrife	o	u	c	
Malaceae					
* <i>Crataegus monogyna</i>	Hawthorn	o	o		
* <i>Malus spp.</i>	Apple / Crabapple	o	o	o	
* <i>Pyracantha fortuneana</i>	Firethorn	r			
Malvaceae					
* <i>Modiola caroliniana</i>	Red-flowered Mallow	c			
Oleaceae					
* <i>Ligustrum lucidum</i>	Large-leaved Privet	r			
Onagraceae					
<i>Epilobium billardioreanum</i> ssp. <i>cinereum</i>	A Willowherb	u			
* <i>Epilobium ciliatum</i>	A Willowherb	u		o	
<i>Epilobium hirtigerum</i>	A Willowherb	o		r	
Papaveraceae					
* <i>Papaver somniferum</i> ssp. <i>setigerum</i>	Opium Poppy	r			
Plantaginaceae					
* <i>Plantago lanceolata</i>	Lamb's Tongue	c	c		
Polygonaceae					
* <i>Acetosella vulgaris</i>	Sorrel	o	a		
<i>Persicaria decipiens</i>	Slender Knotweed		u		
<i>Persicaria lapathifolia</i>	Pale Knotweed			c	
* <i>Polygonum aviculare</i>	Wireweed	c		o	
<i>Rumex brownii</i>	Swamp Dock	o	o		o
* <i>Rumex conglomeratus</i>	Clustered Dock		o	c	
* <i>Rumex crispus</i>	Curled Dock	o	a	c	
Portulacaceae					
<i>Neopaxia australasica</i>	White Purslane			o	o
Primulaceae					
* <i>Anagallis arvensis</i>	Pimpernel	c	u		
Ranunculaceae					
* <i>Nigella damascena</i>	Love-in-a mist	r			
* <i>Ranunculus muricatus</i>	Sharp Buttercup			u	
* <i>Ranunculus repens</i>	Creeping Buttercup			a	
Rosaceae					
* <i>Aphanes arvensis</i>	Parsley-piert	r			

* <i>Rosa rubiginosa</i>	Sweet Briar	u	u		
* <i>Rosa</i> sp.	Climbing Rose			r	
* <i>Rubus discolor</i>	Blackberry	o	o	o	
<i>Rubus parvifolius</i>	Native Raspberry	u			
Rubiaceae					
* <i>Galium aparine</i>	Cleavers	r			
Salicaceae					
* <i>Populus alba</i>	White Poplar	r			
* <i>Populus nigra</i>	Lombardy Poplar	c	u		
* <i>Salix alba</i>	White Willow			c	
* <i>Salix babylonica</i>	Weeping Willow			r	
* <i>Salix cinerea</i> ssp. <i>oleifolia</i>	Common Sallow		u		
* <i>Salix matsudana</i> 'Tortuosa'	Tortured Willow			r	
Scrophulariaceae					
* <i>Veronica anagallis-arvensis</i>	Blue Water Speedwell			o	
* <i>Veronica peregrina</i>	Wandering Speedwell	r			
Solanaceae					
* <i>Datura stramonium</i>	Common Thornapple	r			
* <i>Petunia axillaris</i>	Petunia	r			
Verbenaceae					
* <i>Verbena hispida</i>	Rough Verbena	r			
SUBCLASS LILIIDAE					
Cyperaceae					
<i>Carex appressa</i>	Tall Sedge	o	c	a	a
<i>Carex inversa</i>	Knob Sedge		a	c	
* <i>Cyperus eragrostis</i>	Umbrella Sedge			o	
* <i>Cyperus tenellus</i>	A Sedge		u		
<i>Eleocharis acuta</i>	A Rush			o	
<i>Schoenus apogon</i>	Common Bog-rush		u		
Iridaceae					
* <i>Romulea rosea</i>	Onion Grass	r			
Juncaceae					
* <i>Juncus articulatus</i>	Jointed Rush		u		
* <i>Juncus bufonius</i>	Toad Rush	c		c	
<i>Juncus fockei</i>	A Rush			c	
<i>Juncus gregiflorus</i>	A Rush	u	o	o	o
<i>Juncus subsecundus</i>	A Rush			u	
<i>Juncus vaginatus</i>	A Rush			c	
Orchidaceae					
<i>Microtis unifolia</i>	Onion Orchid		o		
Poaceae					
* <i>Agrostis capillaris</i>	Browntop Bent	o	a		
<i>Amphibromus pithogastrus</i>				c	
* <i>Anthoxanthum odoratum</i>	Sweet Vernal Grass	c		o	
* <i>Arrhenatherum elatius</i>	Oatgrass	c	a	a	o
<i>Austrodanthonia caes pitosa</i>	White Top	r			
<i>Austrodanthonia pilosa</i> var. <i>pilosa</i>	A Wallaby Grass	o	u	o	
<i>Austrodanthonia racemosa</i>	A Wallaby Grass	r			
* <i>Briza minor</i>	Shivery Grass	c	o	u	
* <i>Bromus cartharticus</i>	Prairie Grass	u	u	o	
* <i>Bromus diandrus</i>	Great Brome	u			
* <i>Bromus hordeaceus</i> subsp. <i>molliformis</i>	A Soft Brome	o	c		
<i>Cynodon dactylon</i>	Couch	o			
* <i>Dactylis glomerata</i>	Cocksfoot	o	u	u	
* <i>Eleusine tristachya</i>	Goose Grass	r			
<i>Elymus scaber</i>	Wheat Grass		u		
* <i>Glyceria maxima</i>	Reed Sweetgrass			c	
* <i>Holcus lanatus</i>	Yorkshire Fog	c	a	a	o
<i>Lachnagrostis filliformis</i>	Blown Grass	u	o		
* <i>Lolium perenne</i>	Perennial Ryegrass	o	o		

* <i>Paspalum dilatatum</i>	Paspalum	c	c	c	
* <i>Phalaris aquatica</i>	Phalaris	o	o	c	
* <i>Phalaris minor</i>	Lesser Canary Grass	c	u		
* <i>Poa annua</i>	Winter Grass	u		o	
* <i>Poa labillardieri</i>	Tussock	u		o	
* <i>Poa pratensis</i>	Kentucky Blue Grass	o	c		
<i>Themeda australis</i>	Kangaroo Grass	r			
* <i>Vulpia bromoides</i>	A Rat's Tail Fescue	o			
* <i>Vulpia muralis</i>	A Rat's Tail Fescue	o			
Typhaceae					
<i>Typha domingensis</i>	Narrow-leaved Cumbungi			o	
<i>Typha orientalis</i>	Broad-leaved Cumbungi			a	
No. native species		19	14	17	5
% native species		18.6	25.5	30.4	41.7
No. introduced species		83	41	39	7
% introduced species		81.4	74.5	69.6	58.3
Total plant species		102	55	56	12
* denotes Introduced Species					
a - abundant; found in high numbers throughout					
c - common; in moderate numbers, regularly encountered					
o - occasional; of scattered occurrence in low numbers					
u - uncommon; few occurrences, but widespread					
r - rare; only one or a very few individuals seen					

**APPENDIX 2: LIST OF VERTEBRATE FAUNA ASSOCIATED WITH PLOUGHMANS
WETLAND AND CREEK**

Scientific name	Common name	Status	Wetland	Creek	Dams
Fish					
	Mosquito Fish	I	C	MC	???
<i>Gambusia</i> sp	Native Trout		?	MC	???
Amphibia					
<i>Crinia parinsignifera</i>	Eastern Sign-bearing Froglet		U	U	U
<i>Crinia signifera</i>	Common Eastern Froglet		MC	MC	MC
<i>Limnodynastes dumerilii</i>	Eastern Banjo Frog		-	1	-
<i>Limnodynastes tasmaniensis</i>	Spotted Grass Frog		MC	C	MC
<i>Uperoleia laevigata</i>	Smooth Toadlet		-	U	-
<i>Litoria peronii</i>	Peron's Tree Frog		-	1	-
<i>Litoria verreauxii</i>	Verreaux's Tree Frog		-	U	-
Reptiles					
<i>Chelodina longicollis</i>	Eastern Snake-necked Turtle		-	1	???
<i>Ctenotus taeniolatus</i>	Copper-tailed Skink		-	U	-
<i>Pseudonaja textiles</i>	Common Brown Snake		1	1	???
Birds					
<i>Coturnix ypsilophora</i>	Brown Quail		Breeding pair	-	-
<i>Chenonetta jubata</i>	Australian Wood Duck		-	U	MC
<i>Anas superciliosa</i>	Pacific Black Duck		-	MC	U
<i>Tachybaptus novaehollandiae</i>	Australasian Grebe		-	-	
<i>Ardea intermdia</i>	Intermediate Egret		O	-	1
<i>Threskiornis molucca</i>	Australian White Ibis		1	-	-
<i>Threskiornis spinicollis</i>	Straw-necked Ibis		U	-	-
<i>Vanellus miles</i>	Masked Lapwing		O	-	1
<i>Ocyphaps lophotes</i>	Crested Pigeon		O	U	-
<i>Cacatua roseicapillus</i>	Galah		O	U	-
<i>Platycercus eximius</i>	Eastern Rosella		O	U	-
<i>Platycercus elegans</i>	Crimson Rosella		-	U	-
<i>Pachycephala rufiventris</i>	Rufous Whistler		-	U	-
<i>Acrocephalus stentoreus</i>	Reed Warbler		-	U	-
<i>Anthochaera carunculata</i>	Red Wattle Bird		1	U	-
<i>Acanthiza reguloides</i>	Buff-rumped Thornbill		U	-	-
<i>Acanthiza nana</i>	Yellow Thornbill		U	-	-
<i>Acanthiza lineata</i>	Striated Thornbill		U	-	-
<i>Gallina cyanoleuca</i>	Magpie-lark		O	U	-
<i>Rhipidura leucophrys</i>	Willie Wagtail		O	U	-
<i>Coracina novaehollandiae</i>	Black-faced Cuckoo-shrike		O	-	-
<i>Gymnorhina tibicen</i>	Australian Magpie		O	U	-
<i>Strepera graculina</i>	Pied Currawong		O	1	-
<i>Corvus coronoides</i>	Australian Raven		O	U	-
<i>Hirundo neoxena</i>	Welcome Swallow		O	U	-
<i>Zosterops lateralis</i>	Silvereye		-	U	-
<i>Turdus merula</i>	Common Starling	I	O	MC	-
<i>Sturnus vulgaris</i>	Common Blackbird	I	-	MC	-
<i>Carduelis carduelis</i>	European Goldfinch	I	-	U	-
<i>Passer domesticus</i>	House Sparrow	I	-	C	-
Mammals					
<i>Tachyglossus aculeatus</i>	Short-beaked Echidna		?	-	-

<i>Pseudocheirus peregrinus</i>	Common Ringtail Possum		-	1	-
<i>Trichosurus vulpecula</i>	Common Brushtail Possum		-	U	-
<i>Macropus giganteus</i>	Eastern Grey Kangaroo		?	-	U
<i>Mus musculus</i> ¹	House Mouse		?	?	???
<i>Rattus rattus</i> ¹	Black Rat		?	?	???
<i>Vulpes vulpes</i>)	Fox		U	U	???
<i>Felis catus</i>	Cat		?	MC	-
<i>Oryctolagus cuniculus</i>	Rabbit		U	U	???
<i>Lepus capensis</i>	Brown Hare		1	-	-
<i>Canis familiaris</i>)	Dog		?	MC	???

- Legend:**
- ¹ Assumed present
 - O Occasional visitor, flying overhead, landed on a tree
 - 1 Observed once
 - U Uncommon
 - MC Moderately common
 - A Abundant
 - ? Unable to assess abundance
 - ??? Not known if present

Appendix 3:
Suggested plant species for constructed wetland, Ploughmans Creek riparian zone, instream zone, adjacent proposed grassy-shrubby woodland plantings, together with other suggestions for the wetland-creekline design.

1. Plantings in the constructed wetland modified from Lyall & Macoun (1998)

1.Species for constructed wetland	Common name	Planting Density (M ²)	Location	
<i>Carex appressa</i> <i>Carex inversa</i> <i>Carex fascicularis</i> <i>Carex gaudichaudiana</i> <i>Juncus australis</i> <i>Juncus vaginatus</i> <i>Cyperus lucidus</i>	Tall sedge Knob sedge Tassel sedge A sedge A Rush A Rush Common sedge Couch	2- 4	Water's edge in wetland and froebay areas in 1-2 m wide bands above standing water levels around the perimeter. Plant on islands in wetland and open water areas.	
<i>Cyonodon dactylon</i> <i>Echinocloa telmatophila</i>	Swamp barnyard grass Cane grass Austral sweet grass	Ad lib Ad lib		
<i>Eragrostis infecunda</i> <i>Glyceria australis</i>	Swamp millet	Ad lib Ad lib		
<i>Isache globosa</i>		Ad lib		
<i>Phragmites australis</i> <i>Typha domingensis</i> <i>Typha orientalis</i>	Common Reed Narrow -leaved Cumbungi Broad-leaved Cumbungi	3-4		
<i>Bolboschoenus fluviatilis</i> <i>Schoenoplectus validus</i>	Marsh Clubrush River Clubrush	2-3 4		
2. Wetland Raised Banks and bare areas for rehabilitation with grasses,				
<i>Poa labillardieri</i> <i>Austrothandonia</i> spp <i>Themeda australis</i>	Snow Grass Wallaby grasses Kangaroo grass	Hand seed inot prepared ground ad lib		
3. Instream and wateredge plants	See 1. above, wateredge plants. See 2. above River Bottle-brush			
<i>Callistemon sieberii</i>		Cuttngs or tube stock at 5m intervals along water edge	Waters edge along Ploughmans Creek	
4. Riparian zone	Choose plants ffrom 1,2,3 & 5	As above and below	5-10 m from creek bank	
5. adjacent contrived grassy-shub layer woodland				
<i>Eucalyptus viminalis</i> <i>E bridgesiana</i> <i>E pauciflora.</i> <i>E stelluata</i> <i>E aggregata</i> <i>Acacia</i> spp <i>Mix of various native shrub species between 50 cm -3 m tall</i>	Ribbon Gum Apple Box Snow Gum Black Sally Black Gum Choose a range for attractiveness and suitability for local conditions As above	Tubestock in woodland formation at 50 trees/ha Within woodland in clumps of 15-20 spaced 3 m apart to provide denser habitat for bush birds. As above	10 -100 m from creek bank	

1. Note that Lyall and Macoun (1998) recommend against using native bullrushes (*Typha* spp). Since their study, attitudes have changed to the point that these species are now usually incorporated into wetland designs.
2. At least one board walk should be incorporated into each constructed wetland design together with an interpretation trail.
3. A winding walking trail should be constructed along the length of Ploughmans Creek to link through to an appropriate location along the Bell River.
4. One covered bird hide with glass viewing front panels should be constructed at one constructed wetland location after determining the most productive site.
5. A range of nest boxes should be constructed to encourage water and bush bird breeding, and to encourage small native mammals to colonise (possums and bats in particular).

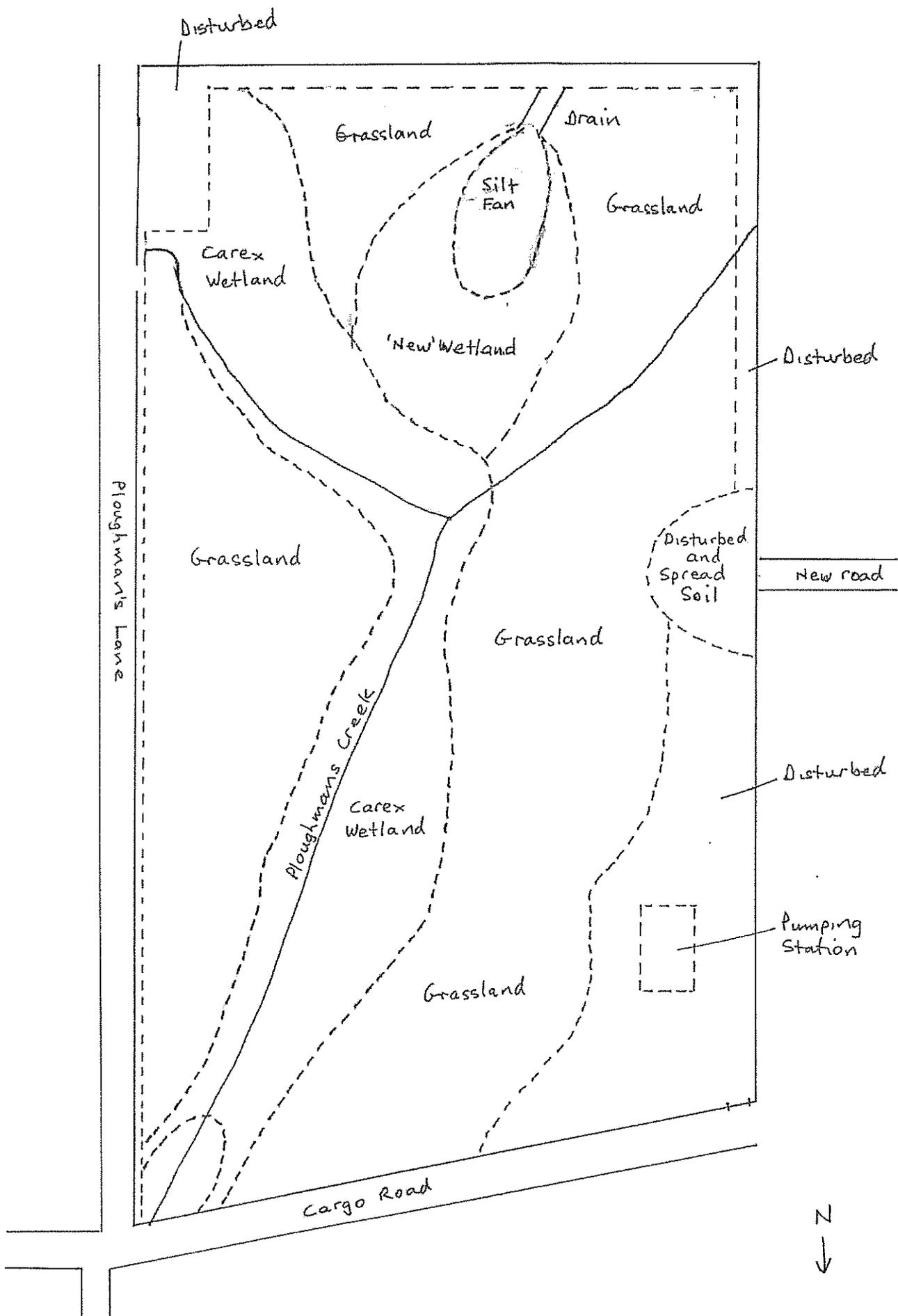


Figure 1. Ploughmans Creek Vegetation Types.