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# Penrith Lakes Pipeline and Weir Construction

## Terrestrial Ecological Assessment

Prepared for Penrith Lakes Development Corporation

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Cover Photograph – Nepean River looking north from the Main Lake Southern Site (Cardno, 2010)

## Document Control

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# EXECUTIVE SUMMARY

Penrith Lakes Development Corporation (PLDC) who are currently quarrying for sand and gravel on alluvial soils at Penrith, propose to transform the quarry site into a series of unique lake systems (Penrith Lakes Scheme (PLS)). Two of the major lakes are the Main Lake (ML) and the Wildlife Lake (WL). In order to protect the lakes under high flood events PLDC proposes a pipeline and weir development to ensure that following flood events, water levels re-establish normal operating levels and riparian vegetation along the banks adjacent to Penrith Lakes and the Nepean River are not significantly submerged for extended periods of time. Two potential pipeline discharge points along the Nepean River were assessed for each major lake. For the Main Lake, the two sites are described as Main Lakes North (MLN) and Main Lakes South (MLS), and for the Wildlife Lake, the two sites are described as Wildlife Lakes North (WLN) and Wildlife Lakes South (WLS). One site was assessed as a potential Weir site. Field investigations were conducted by Cardno, in conjunction with Ecological, as part of this study. The purpose of this report is to describe the existing riparian flora and fauna of the area, identify the potential impacts that the works would have on the native biodiversity of the area, and identify mitigation procedures to minimise the potential impacts.

The long history of anthropological disturbances in the area, such as quarrying and agriculture, has resulted in the degradation of all sites, which are currently characterised as having low ecological value due to the dominance of weeds and abundance of feral fauna in the area. Vegetation across the five study sites was predominantly represented by exotic riparian vegetation, dominating all growth forms including the graminoid, herbs, shrub and tree layers. However, a few scattered endemic and non-endemic native trees and shrubs were observed within the sites. Across all the weir and pipeline sites assessed a total of 119 species belonging to 44 families and 97 genera were recorded. Only 34 of these were native, representing 27% of the total species. No threatened flora species were recorded on any of the five sites assessed. Species which represent minor components of the River-Flat Eucalypt Forest (RFEF) on Coastal Floodplains Endangered Ecological Community were observed at the study sites. The characteristic dominant eucalypt species of this community (e.g. *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple), *Eucalyptus baueriana* (blue box), *E. benthamii*) were not, however, present within the sites (although some planted juvenile individuals were present at WLN). The Seven Part Test of Significance concluded that no significant impacts on the RFEF would occur as a result of the proposed works since only a very small area (up to 500 $m^2$) would be disturbed requiring the removal of only a few native trees, and the vegetation is dominated by exotic species which will continue to inhibit the survival of the native understorey.

Across both the weir and pipeline sites a total of 15 native fauna species were recorded during the ecological survey, with eight being highly mobile bird species and the others being reptile species. None of the species identified are currently listed as endangered or vulnerable under the Threatened Species Act (TSC Act) 1995 or Environmental Protection and Biodiversity Conservation Act (EBPC Act) 1999. Due to the highly degraded nature of the sites and the lack of contiguous native vegetative cover, the majority of the sites provide a limited variety of fauna habitats that are suitable for utilisation by native species. In addition, the presence of feral fauna scats and markings, and the records of feral fauna in

previous studies of the riparian corridor, suggest feral pest species are present and may have driven out many native terrestrial mammals. It was concluded that no threatened species occur within the study sites. It is considered that the sites' most important ecological feature is the fact that it forms part of a habitat corridor which may provide important linkages with other flora and fauna habitat in the local and regional area in light of the proposed Penrith Lakes Scheme.

A range of mitigation measures have been considered to minimise the impacts of the proposed works on riparian flora and fauna occurring at the proposed work sites. In terms of ecological value, none of the work sites possessed significant environmental values that would prohibit the proposed developments.

# 1 INTRODUCTION

This terrestrial ecology survey has been prepared for Penrith Lakes Development Corporation (PLDC) who are proposing pipeline and weir construction works at two lakes within the Penrith Lakes Scheme. Following the cessation of quarrying, PLDC proposes to convert the existing quarry site into a unique lake system including a main recreational lake (in the southern portion of the site) and a conservation based wildlife lake (in the northern portion of the quarry site) (**Figure 1.1**).


**Figure 1.1:** Penrith Lakes Scheme (Source: PLDC)

The completion of the scheme will require the establishment of a weir in the northern portion of the site and a number of discharge pipelines (**Figure 1.1**). The purpose of the pipelines and weir development is to ensure that following flood events, water levels re-establish to normal operating levels so that riparian vegetation along the banks adjacent to Penrith Lakes are not significantly submerged for extended periods of time. One set of pipelines will be required for the Wildlife Lake and another for the Main Lake. At the time of survey the exact dimensions of the proposed pipelines and impact areas were unavailable. As such this survey covers a greater area than that required by the construction works. It is predicted that the proposed works would have beneficial impacts on the existing riparian vegetation and associated fauna in the long term, by maintaining threshold resilience capabilities of existing vegetation.

The objectives of this report are to provide an analysis of the nature conservation values of the proposed pipeline location and weir works areas and the potential constraints to the proposed development which may arise. In particular, the presence of threatened species and ecological communities which are historically known to occur or have been sighted in the general Penrith/ Hawkesbury area, were targeted for assessment during the survey. The survey was undertaken at four sites along the river bank identified as potential locations of the pipelines (two sites adjacent to the proposed Wildlife Lake (WL) and two adjacent to the Main Lake (ML)) as well as the weir site (**Figure 2.2**). Possible mitigation procedures to avoid adverse environmental impacts to flora and fauna within the vicinity of the work sites are also discussed, particularly in relation to protection of native tree species within the work sites.

The report is based on the results of qualitative flora and fauna habitat assessment surveys, examination of aerial photography, and a review of relevant literature resources (database searches and previous reports (i.e. Mission Australia (2002), DoP (2005), Abel Ecology (2007), Ecological (2009)) including applicable Commonwealth, State and Local government legislation.

The report is divided into nine sections which are described as follows:

- Section 1 contains a brief introduction of the study.
- Section 2 comprises information concerning the general characteristics of the quarry site, and proposed works sites and plan of works.
- Section 3 consists of information regarding the assessment methodology and field survey techniques.
- Section 4 contains a description of the vegetation community occurring at each of the proposed work sites with special reference to flora species of recognised conservation significance.
- Section 5 consists of information concerning fauna species observed at each of the proposed work sites and other species of conservation significance that may potentially utilise the proposed work sites or adjacent land.
- Section 6 provides a description of the potential impacts of the proposed plan of development.
- Section 7 provides a list of mitigation measures to minimise the potential impacts
- Section 8 includes seven part tests for threatened species and ecological communities upon which the project may have a significant impact.
- Section 9 provides a summary of the study findings and recommendations.

# 2 SITE DESCRIPTION AND PROPOSED DEVELOPMENT

## 2.1 Site Description

The Penrith Lakes Scheme is located approximately 1.5-2 km north of the Penrith CBD and is within the Middle Nepean – Hawkesbury and Blue Mountains catchments, Sydney Bio-region. The Scheme involves quarrying and rehabilitating nearly 2000 ha of land, approximately 7 km north-south and up to 4 km east-west. The site is bounded to the west by the Nepean River with the Yellowmundee Recreation Park on its western bank. The eastern bank of the Nepean River, through which the pipelines are proposed to extend, has not been cleared for quarrying and retains a narrow strip of riparian vegetation. Previous mapping and studies of this region has identified the presence of both Riparian Forest (Map Unit 5, Tozer 2003) and Alluvial Woodland (Map Unit 11, Tozer 2003) within this area, both of which are classified as comprising an Endangered Ecological Community under the Threatened Species Act 1995 (River-flat Eucalypt Forest on Coastal Floodplains (RFEF)) (Eco-Logical, 2009). Appendixes C and D to this report describe the species which form the River-flat Eucalypts Forest communities. Subsequent field studies, identified this riparian vegetation to be in generally poor condition and highly degraded due to the invasion and dominance of exotic weeds. The condition of the riverbank is observed to have been indirectly influenced by quarrying activities and existing agricultural activities in the Penrith area.

The Penrith lakes quarry site originally supported a rich array of healthy diverse ecosystems, providing essential resources to local Aboriginal people. The current state of the environment however is markedly different to the original ecosystems, as the long history of agricultural and quarrying land uses have significantly altered the landscape and created highly disturbed areas. The current open cut quarrying operations concentrate on the sand and gravel fraction of a Quaternary Alluvial that occurs across the floodplain area. Other than the riparian regions there is very little remnant vegetation left on the quarry site.

**Figure 2.1** shows the location and large scale of the Penrith Lakes Scheme. The Yellowmundee Recreation Park / Blue Mountains National Park (west of the site) and the Agnes Banks Nature Reserve (north of the site) represent the major areas of ecological value in the region. The riparian corridor (minimum width 40m) within the Penrith Lakes Scheme site on the eastern bank of the Nepean River is visible, and provides a continuous corridor to Penrith Weir and Victoria Bridge upstream. **Figure 2.1** also indicates the four specific sites along the riparian corridor and the proposed weir site assessed within this report.

A photolog created during site survey is provided in Appendix B

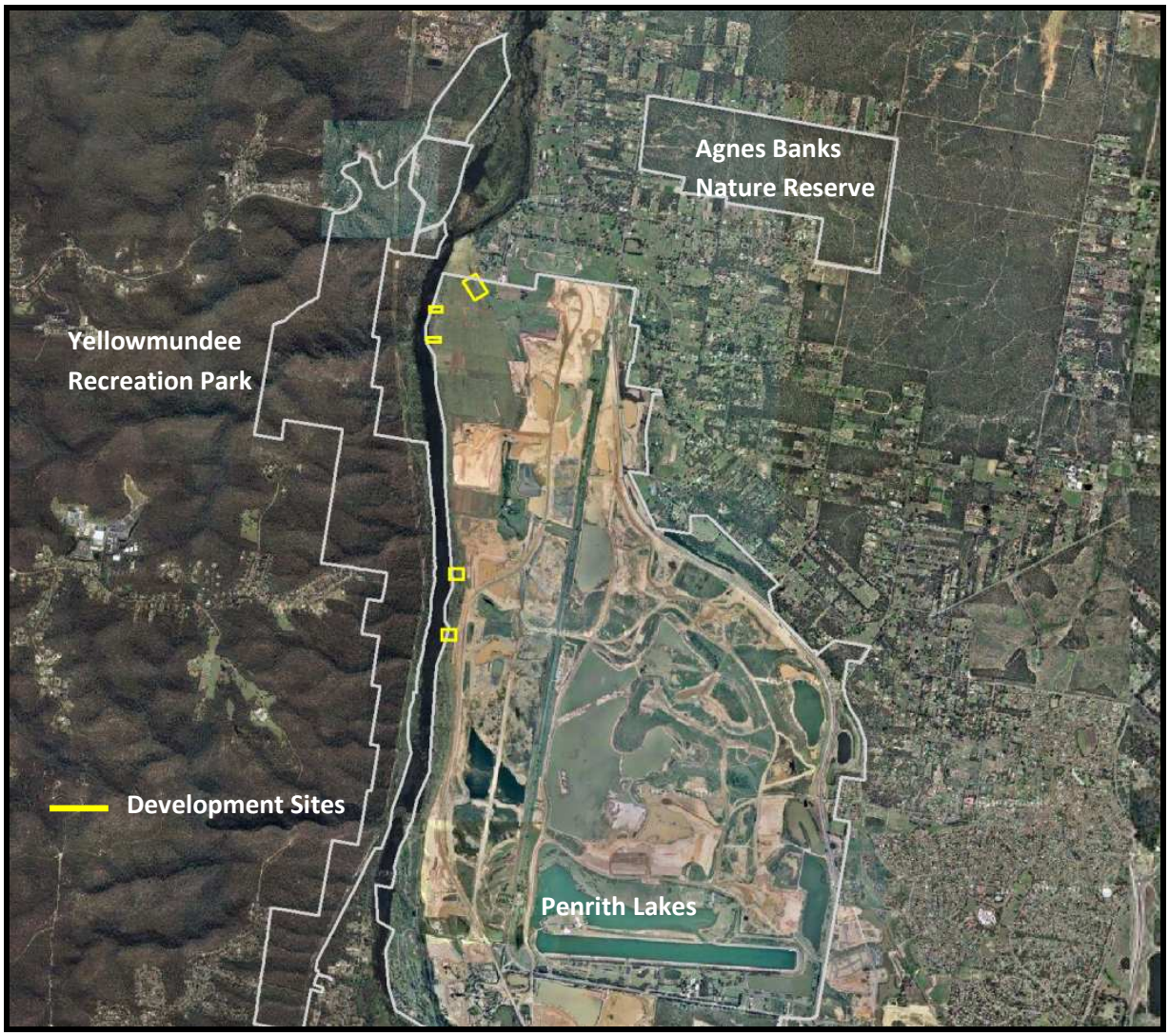


**Figure 2.1:** Location of Penrith Lakes and Survey Sites (Source: Google Earth, 2010)

## 2.2 Proposed Pipeline and Weir Plan of Development

PLDC are proposing the development of two sets of pipelines for two lakes within the Penrith Lakes Scheme. After a natural flooding event, the pipes would function to discharge flood water back into the Nepean River to allow the lakes to return to operating water levels so that:

- the surrounding riparian vegetation is not submerged for extended periods; and
- potential flooding impacts upon surrounding residential developments are minimised.

Extended periods of inundation may potentially disrupt the vegetation's threshold level of resilience affecting their survival and restricting habitat for native fauna. A weir is also planned to be constructed at the north of the Wildlife Lake to control the backing up of floodwaters from the Nepean River and to provide for the controlled release of excess inflows. The weir is to be established across Hunts Gully Creek which is currently piped to the north of scheme prior to discharging to the Nepean River.

Two potential pipeline locations are envisaged for each lake (Wildlife Lake (WL) and Main Lake (ML)) (**Figure 2.2**). The set of pipelines proposed for the ML will comprise 6 individual pipelines immediately adjacent and parallel to each other and traversing an east-west direction. The set of pipelines for WL will comprise 2 individual pipelines immediately adjacent and parallel to each other and also traversing an east-west direction. The final location of the proposed pipes had not been determined at the time of survey.

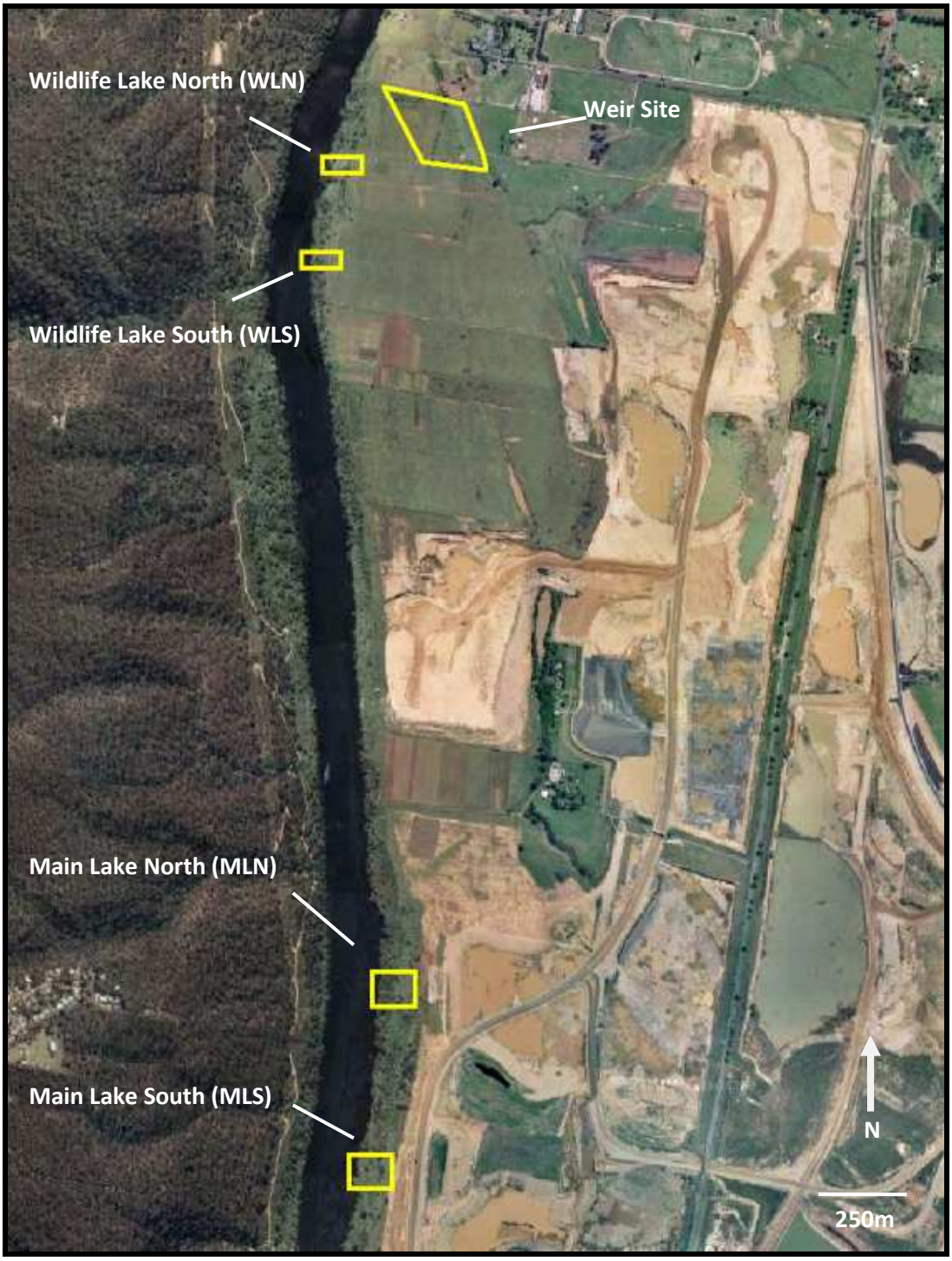


**Figure 2.2**. Location of Survey Sites (Source: Google Earth, 2010)

Each of the potential pipeline sites assessed was approximately 100m in length and extended from the immediate river foreshore to the top of river bank. This width (approximately 50 m) varied with the gradient at each site. The weir site encompassed a narrow stretch of remnant vegetation along Hunts Gully Creek which would be lost under the proposed establishment of a weir.

The impact footprint of the options will vary between the sites. The expected impact footprint for each of the options is described below:

**Main Lake Pipeline**: The width of the impact footprint will diminish as the shoreline is approached due to the steepness of banks. Impact width at the top of bank will be in the order of 90m, reducing to 40m at the water' edge (**Figure 2.3**)


**Figure 2.3**. Indicative zone of impact at Main Lake South

**Wildlife Lake Pipeline**: The width of the impact footprint will diminish as the shoreline is approached due to the steepness of banks. Impact width at the top of bank will be in the order of 40m, reducing to 20m at the water' edge (**Figure 2.4**).


**Figure 2.4: I**ndicative zone of impact at Wildlife Lake North

**Weir**: The installation of a weir will require the removal of 60m of Hunts Gully creekline vegetation and fill to ensure weir stability. Given that the construction of the weir will require a diversion of the creek approximately 50m upstream from the weir it has been assumed that the creekline vegetation downstream of the diversion will be lost. It is noted that 100m north of the Weir Site this creek is piped underground and the riparian corridor terminates (**Figure 2.5**). This 100m stretch of vegetation downstream of the weir will experience severely reduced flows. The final design of the weir had not been determined at the time of survey.

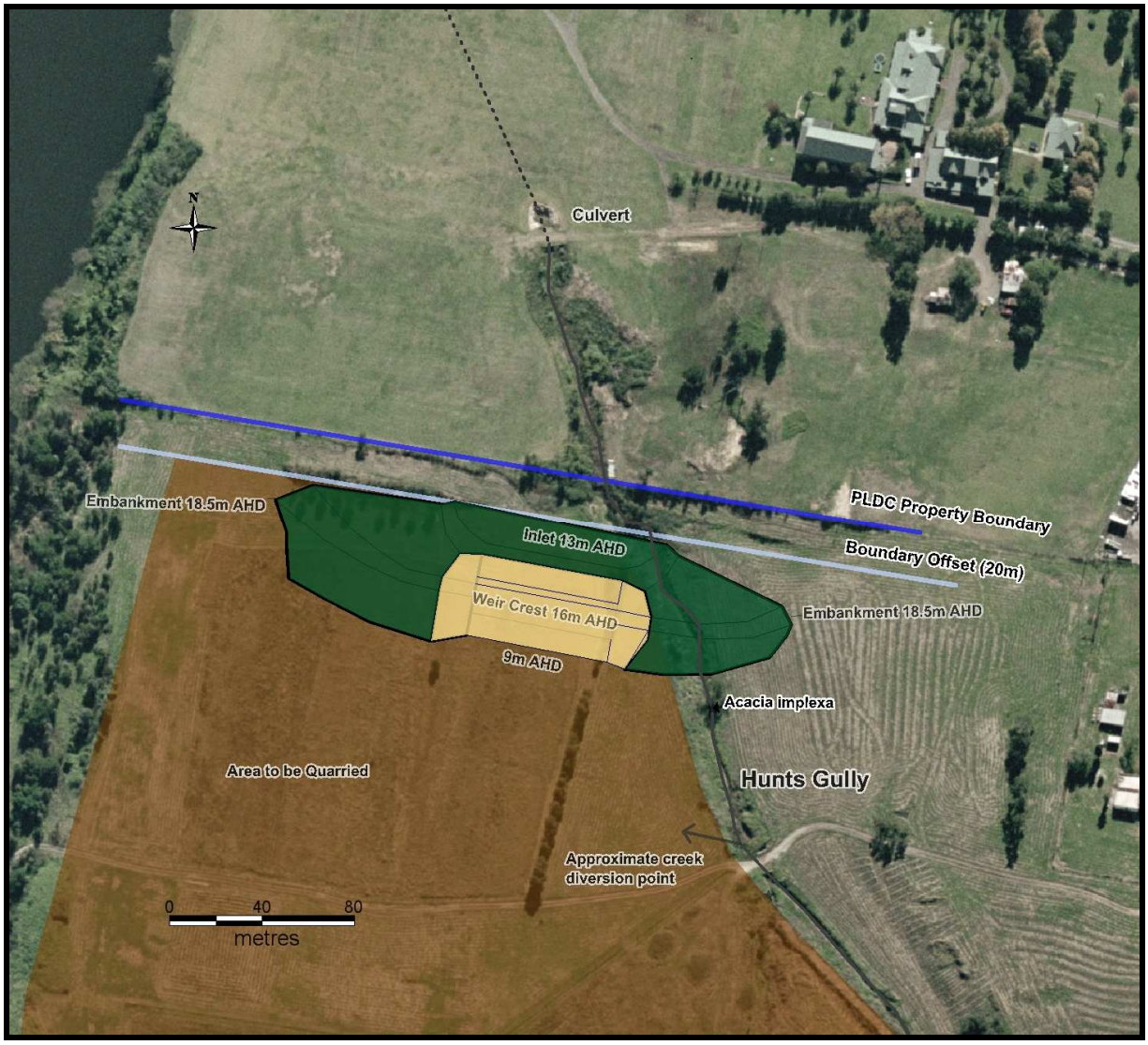


**Figure 2.5:** Location of Wildlife Lake weir.

# 3 ASSESSMENT METHODOLOGY

## 3.1 Overview

To assess the biodiversity and conservation values of the proposed works sites and the potential impacts of the proposed plan of development on these natural values, the following assessment procedure was completed:

1. An initial review of background information on the flora and fauna of the site (particularly threatened species) and adjacent properties from relevant sources, including reviews on previous reports.

2. A field survey to collate information on the:

- vegetation communities and flora species that occur within the five sites (including targeted threatened species searches);

- vertebrate fauna observed on the site, or those that are considered likely to utilise the site or adjacent properties due to the presence of suitable habitat; and

- areas or aspects of the site identified as having functional wildlife conservation values or a high conservation status.

3. Evaluation of the potential impacts of the proposed plan of development on the ecological values of the site locality with particular attention given to those aspects which are of recognised conservation significance.

4. Evaluation of the degree of compliance the proposed plan of development achieves with the requirements of the local planning scheme and relevant State and Commonwealth legislation having a biodiversity conservation focus.

## 3.2 Field Survey Techniques

Field surveys were conducted on 17 and 18 February, 2010. The survey was conducted by Cardno representatives with specialist input from Eco-Logical (Liz Norris). The surveys involved collating site-specific information on the vegetation types and flora species that occur within the five proposed work sites (MLN, MLS, WLN, WLS, Weir). The survey effort involved a qualitative analysis of the ecological values of the proposed work sites. The flora survey involved detecting and assessing the presence of suitable habitat areas for flora species of formally recognised conservation significance that have been previously recorded, or are considered likely to occur, in the locality of the site. The survey effort also focused on detecting and assessing the presence of suitable habitat areas and resources for fauna species, with particular emphasis on those species of formally recognised conservation significance that have been previously recorded, or considered likely to occur, in the locality of the site.

Flora survey utilised a meandering transect to characterise each of the sites and generate a species listing for each site. The species listing included both native and non-native vegetation. In addition to presence/absence data, further characterisation was undertaken by assessing condition, abundance and spatial diversity. All individual native mature trees (those with a stem diameter greater than 20cm dbh) within each site were geospatially tagged and mapped. All mature trees were assessed in terms of:

- species;
- height;
- canopy diameter;
- condition;
- presence of hollows; and
- trunk diameter.

In order to assist with pipeline route selection, tree mapping was undertaken. Mapping incorporated both geospatial location of the trees as well as an assessment of the importance of the individual tree in regards to its local and regional context. To do so a score was assigned to each individual tree based on its relative ranking out of all of the trees individually assessed in regards to height, canopy cover, and trunk diameter. The sum of its rankings was then scaled to incorporate a range of qualitative characters including:

- overall tree condition (low – high);
- species origin (local, non-local, native, non-native, noxious weed);
- presence of key fauna habitat or indicators of fauna utilisation (e.g. hollows, scratches, nests); and
- conservation status.

The unique final figure for each tree represented a comparable Significance Value (SV), allowing a graphical representation of the relative conservation importance of each tree within each work site. The calculation and illustration of SVs is a unique method developed specifically for this project to assist in the selection of the various pipeline routes. This measure is not to be confused with Importance Values which refers to the dominance of a species within a community based on relative density, dominance and frequency.

Fauna survey was limited to observations made during the meandering transect surveys. Observations included direct sightings and recorded vocalisations as well as indirect evidence (e.g. scats, scratches, tracks). Fauna trapping was not undertaken as part of this assessment.

Prior to the site surveys a search of the NSW National Parks and Wildlife Service online Atlas of NSW Wildlife database, Commonwealth Environment Protection and Biodiversity Conservation database, and NSW Government BioNet system was used to assess records of species occurring, or likely to occur, within a 10 km radius of the site. The habitat requirements and the functional contribution that specific areas or aspects of the site may make towards the preservation of populations of these species in the site locality were then assessed.

Given the proposed aims of the study it was considered that this methodology was adequate to characterise the sites, identify any significant problematic issues (i.e. presence of threatened species), and recommend preferred development options in regards to ecology.

## 3.3 Review of Previous Reports

### 3.3.1 Mission Australia and University of Western Sydney (2002)

The Riverbank plan of management (Beveridge 2002) (RPOM) provides further supplementary material to assist the "Penrith Lakes Scheme - Ecosystem Management Strategy" (EMS), planned for the rehabilitation of the riparian zone adjacent to the Penrith Lakes Scheme and the Nepean River. Due to the long history of in-situ and ex-situ disturbances (agriculture, quarrying etc.), the riverbank has been substantially modified leading to ecosystem instability and the loss of habitat for native fauna. The RPOM assessed the existing condition of the riparian corridor and provides methods to restore the banks to a more improved state. Management strategies identified to assist in ecosystem recovery include:

- the removal of threatening processes (e.g., weed removal, control of feral fauna, eliminating four wheel driving);
- soft engineering works to improve bank stability;
- regeneration in areas capable of regenerating into a more improved condition;
- revegetation of areas showing no signs of regeneration potential; and
- improving habitat complexity.

### 3.3.2 NSW Department of Planning – Nepean Pump and Pipeline Project (2005)

A series of Environmental Assessment requirements were issued by NSW Department of Planning in regards to the installation of a pump and 4.5 km pipeline to extract water from the Nepean River to facilitate the filling and provision of a stable water supply for the Penrith Lakes Scheme. It should be noted that the Nepean Pump and Pipeline Project is a separate project to that assessed under this study. The key ecological factors to be addressed for the Nepean Pump and Pipeline Environmental Assessment included:

- The potential impact upon the threatened species including the local population of *Eucalyptus benthamii*; and
- The potential impact of reduced waterflows on downstream endangered ecological communities.

This report documents the perceived potential impact of the proposed pump and pipeline works on all threatened species within the pump and pipeline work sites (which is approximately 4.5km upstream of our assessment sites).

### 3.3.3 Abel Ecology (2007)

In September 2006, a threatened fauna species survey and habitat assessment was conducted on the south-western banks of the Nepean River and the ponds/wetland complex at Penrith Lakes. The methods used to sample for fauna ranged from active searches to spotlighting, hair tubes, habitat board checks, and Anabat surveys. A total of 73 species were detected, including 19 (7 introduced) mammals, 40 bird *spp*., 7 frog *spp*., 7 reptile *spp*., and 3 fish *spp*. (2 introduced). Targeted surveys were conducted for two threatened species; the Green and Golden Bell Frog (*Litoria aurea*) and the Long Nosed Potoroo (*Potorous tridactylus*), however, they were not detected. Threatened fauna species recorded on site include three species of microbats, all listed as vulnerable under the NSW Threatened

Species Act 1995. The study indicated that due to the presence of introduced cats and foxes, small native marsupials may have become locally extinct in the area due to predation pressure. Dominant flora species were recorded along the riverbank and included a patchy resemblance of a highly disturbed Endangered Ecological Community, the Riverflat Eucalypt Forest. Most species which occupied the groundcover were noted to be exotic.

### 3.3.4 Eco Logical Australia (2009)

Eco-Logical Australia Pty Ltd (Sutherland) conducted a brief inspection (Dec 2009) of riparian flora and fauna at the two Main Lakes sites (MLS and MLN) described in this study. The northern Wildlife Lake and Weir sites were not inspected. They recorded dominant flora species and fauna sightings during their inspection. It was concluded that while the proposed sites were heavily infested with exotic flora species, the current vegetation community does contain a number of native flora species which resembles a component of the Endangered River-flat Eucalypt Forest Community (under the Threatened Species Conservation Act 1995). In addition, while the lower, mid and upper canopies were dominated by exotic species which are required to be removed according to the Noxious Weed Act (1993), the exotic species were observed to provide some usable habitat value for some native passerine bird species potentially including threatened species such as the Diamond Firetail (*Stagonopleura guttata*), Speckled Warbler (*Chthonicola sagittate*), and the Hooded Robin (*Melanodryas cucullata*).

# 4 FLORA HABITAT VALUES

## 4.1 Overview

Vegetation across the study sites was predominantly exotic riparian vegetation (lining the Nepean River). Some scattered local and nonlocal native trees and shrubs were observed within areas of highly disturbed vegetation dominated by non-native shrubs, herbs, and graminoid growth forms. A master list of all plant species encountered, their site locations, and a list of their biological attributes, such as growth form, families etc. is shown in tabulated form in **Appendix A**. A total of 119 species were recorded belonging to 44 families and 97 genera. However, only 34 native species belonging to 18 families were recorded (**Table 4.1**), this represents just 27% of species occurrence. **Figure 4.1** and **Figure 4.2** demonstrates the proportions of growth forms represented at each site and over all. The majority of diversity is observed within the graminoid growth forms.

**Table 4.1.** List of native plant species recorded at site MLS, MLN, WLS, WLNS, and WEIR site, in PLS.

| | | ML S | | | ML N | | | WL S | | | WL N | | | Weir | | | Vegetation Attributes | | Conservation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Family** | **P** | **C** | **C** | **P** | **D** | **C** | **P** | **D** | **C** | **P** | **D** | **C** | **P** | **D** | **C** | **Common Name** | **Growth form** | **Value** |
| *Acacia decurrens* | Fabaceae | | | | | | | | | | 1 | 2 | 2 | | | | Black Wattle | Tree | |
| *Acacia implexa* | Fabaceae | 1 | 2 | 3 | | | | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Hickory Wattle | Tree | |
| *Austrostipa verticillata* | Poaceae | 1 | 2 | 2 | | | | | | | | | | | | | Slender Bamboo Grass | Graminoid | |
| *Angophora floribunda* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Rough Barked Apple | Tree | Riverflat Eucalypt |
| *Breynia oblongifolia* | Phyllanthaceae | | | | | | | 1 | 2 | 2 | | | | | | | Coffee Bush | Shrub | Riverflat Eucalypt |
| *Bothriochloa macra* | Poaceae | | | | | | | | | | | | | 1 | 2 | 2 | Redleg grass | Graminoid | |
| *Calochlaena dubia* | Dicksoniaceae | | | | | | | | | | 1 | 2 | 2 | | | | Soft Bracken Fern | Shrub | |
| *Carex appressa* | Cyperaceae | 1 | 2 | 2 | | | | | | | | | | 1 | 2 | 2 | Tall Sedge | Graminoid | |
| *Carex inversa* | Cyperaceae | | | | | | | | | | | | | 1 | 2 | 2 | Knob Sedge | Graminoid | |
| *Carex* sp. | Cyperaceae | | | | | | | | | | | | | 1 | 1 | 2 | | Graminoid | |
| *Casuarina cunninghamiana* | Casuarinaceae | 1 | 2 | 2 | | | | 1 | 2 | 3 | 1 | 2 | 3 | | | | River Oak, River Sheoak | Tree | Riverflat Eucalypt |
| *Centella asiatica* | Apiaceae | | | | | | | | | | | | | 1 | 2 | 2 | Gotu Cola | Herb | Riverflat Eucalypt |
| *Cheilanthes sieberi* | Adiantaceae | | | | | | | 1 | 2 | 2 | | | | | | | Mulga Fern | Herb | Riverflat Eucalypt |
| *Commelina cyanea* | Commelinaceae | | | | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | | | | Scurvy weed | Graminoid | Riverflat Eucalypt |
| *Cynodon dactylon* | Poaceae | 1 | 4 | 3 | 1 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 1 | 3 | 3 | Couch, Bermudagrass | Graminoid | |
| *Eucalyptus amplifolia* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Cabbage Gum | Tree | Riverflat Eucalypt |
| *Eucalyptus baueriana* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Blue Box | Tree | Riverflat Eucalypt |
| *Eucalyptus terticornis* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Forest Red Gum | Tree | Riverflat Eucalypt |
| *Gahnia sieberiana* | Cyperaceae | | | | | | | | | | | | | 1 | 2 | 2 | Red-Fruit Saw Sedge | Graminoid | |
| *Glochidion ferdinandi* | Phyllanthaceae | | | | | | | 1 | 1 | 2 | | | | | | | Cheese Tree | Tree | |
| *Glycine tabacina* | Fabaceae | | | | | | | | | | | | | 1 | 2 | 2 | Gycine Pea | Herb | Riverflat Eucalypt |
| *Juncus usitatis* | Juncaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | Common Rush | Graminoid | |
| *Ludwigia peploides* | Onagraceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | | | | Water Primrose | Herb | |
| *Melia azedarach* | Meliaceae | 1 | 2 | 2 | | | | | | | | | | | | | White Cedar | Tree | Riverflat Eucalypt |
| *Microlaena stipoides* | Poaceae | 1 | 4 | 2 | 1 | 4 | 2 | 1 | 4 | 2 | 1 | 4 | 2 | | | | Weeping grass | Graminoid | Riverflat Eucalypt |
| *Oplismenus aemulus* | Poaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Basket Grass | Graminoid | Riverflat Eucalypt |
| *Oxalis perennans* | Oxalidaceae | | | | 1 | 2 | 2 | 1 | 2 | 2 | | | | 1 | 2 | 2 | | Herb | Riverflat Eucalypt |
| *Periscaria decipiens* | Polygonaceae | 1 | 2 | 2 | | | | | | | | | | | | | Slender knotweed | Graminoid | Riverflat Eucalypt |
| *Persicaria orientalis* | Polygonaceae | | | | | | | 1 | 1 | 1 | | | | 1 | 1 | 1 | Princess feathers | Herb | |
| *Persicaria subsessilis* | Polygonaceae | | | | | | | | | | | | | 1 | 2 | 2 | Hairy Knotweed | Herb | |
| *Phragmites australis* | Poaceae | | | | | | | | | | 1 | 2 | 2 | | | | | Herb | |
| *Sigesbeckia orientalis* | Asteraceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | | | | | Herb | Riverflat Eucalypt |
| *Typha orientalis* | Typhaceae | 1 | 2 | 2 | | | | | | | | | | | | | Broadleaf Cumbungi | Graminoid | |
| *Wahlenbergia gracillis* | Campanulaceae | | | | | | | 1 | 2 | 2 | | | | | | | Australian Bluebell | Herb | Riverflat Eucalypt |
| | **TOTALS** | **13** | | | **4** | | | **15** | | | **13** | | | **14** | | | | | |

MLS = Main Lakes South, MLN = Main Lakes North, WLS = Wildlife Lakes South, WLN = Wildlife Lakes North, P = Presence (1 = present), D = Density (Rough estimates - 1 = 1 individual, 2=2-20 individuals, 3 = 21-100 individuals, 4 = over 100 individuals), C = Crown Cover (Rough estimates - 1 = 1-5%, 2 = 5-25%, 3 = 26-75%, 4 = 76-100%).

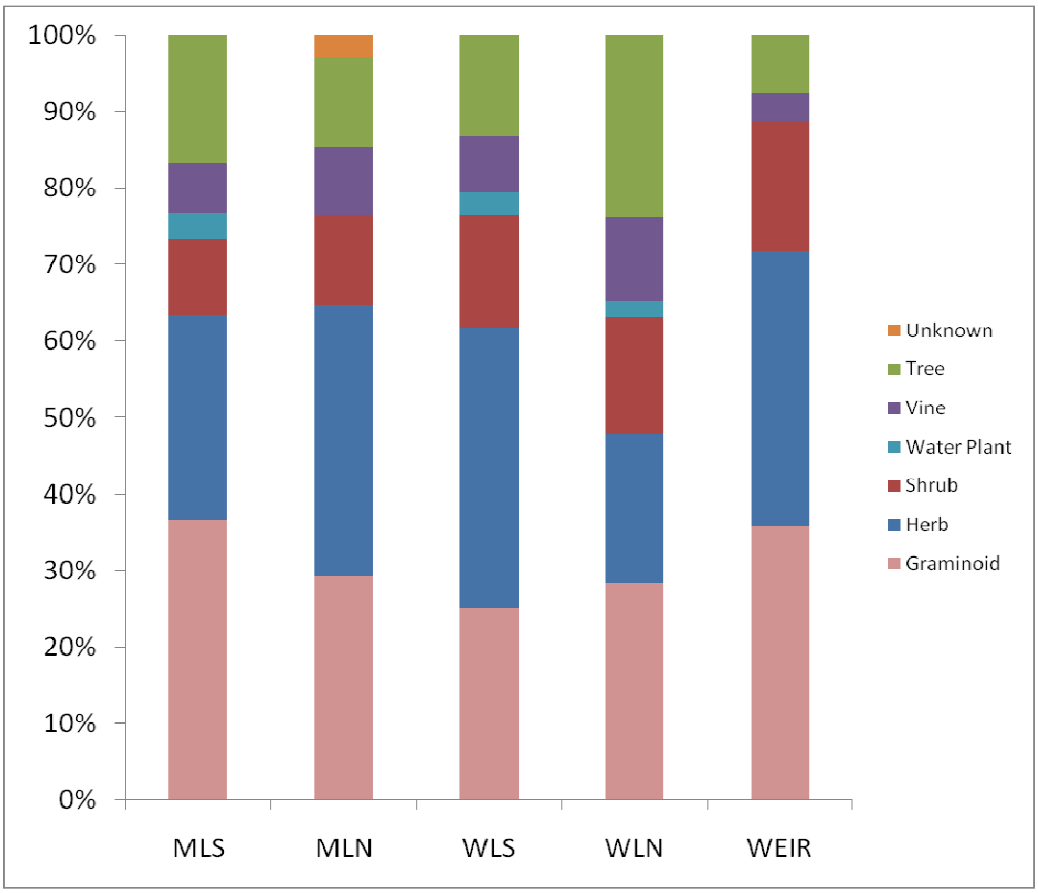


**Figure 4.1:** Proportionate species richness within vegetation categories

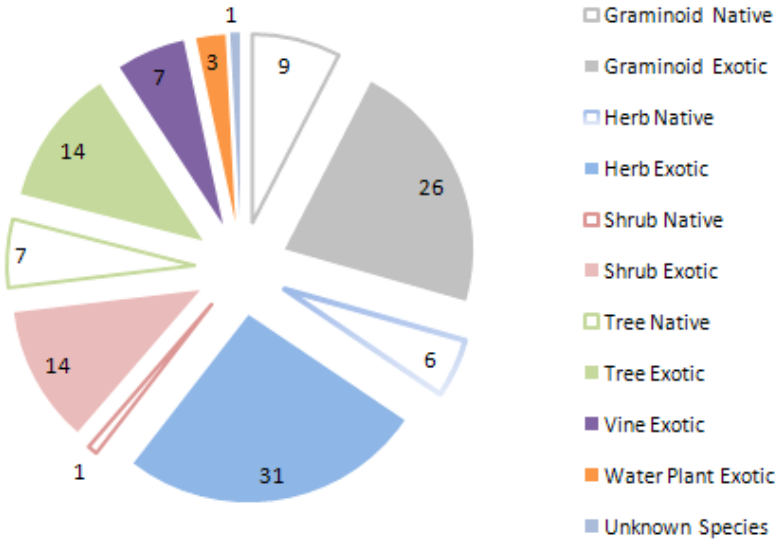


**Figure 4.2:** Pie graph displaying the average proportion of growth forms across all sites

Within each site, over 80% of the recorded species were classified as weeds (**Figure 4.3**, **Figure 4.4**). Dominant species in the groundcover include many grasses such as Kikuyu grass (*Pennisetum clandestinum*), Prairie Grass (*Bromus catharticus*), *Eharta erecta*, African Lovegrass (*Eragrostis curvula*), Summer Grass (*Digitaria ciliaris*) and *Paspalum dilatatum*. The total number of species per site ranged from 34 at MLN to 68 at WLS, however, within all sites, the proportion of native species was less than 20%.

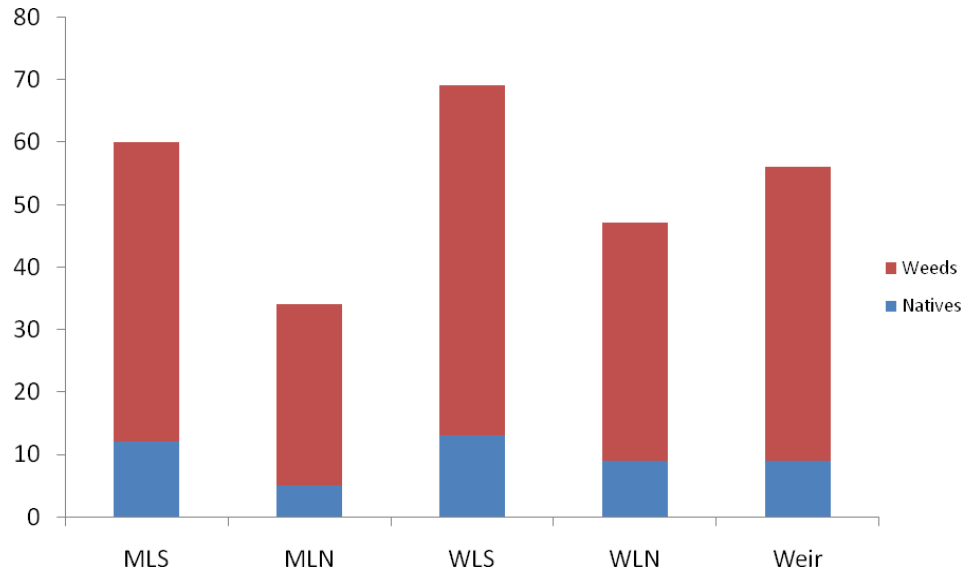


**Figure 4.3:** Total numbers of species and proportion of native and weed species, per site.

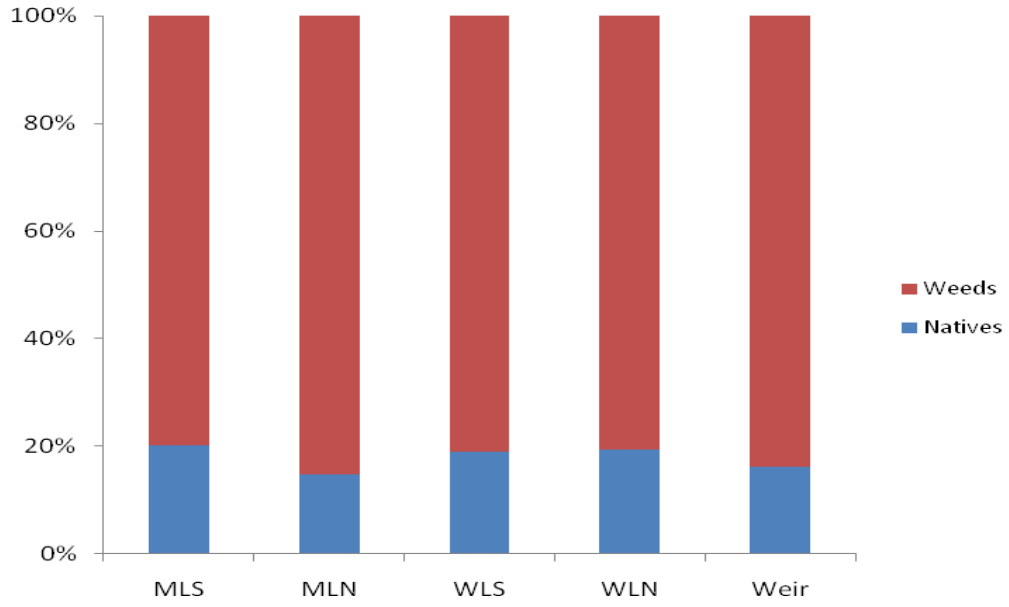


**Figure 4.4:** Fraction of native/weed species in proposed sites at Penrith Lakes.

## 4.2 Site Vegetation

### 4.2.1 Main Lake South

MLS comprised a total of 60 species belonging to 24 families (**Appendix A).** However, only 12 native species (nine families) were recorded (**Table 4.3**). These native species included trees belonging to three species (*Casuarina cunninghamiana, Acacia implexa, Eucalyptus deanii,* one unknown *Eucalyptus* sp.), four species of graminoids (*Melia azedarach*, *Microleana stipoides* and *Persicaria decipiens*) and one species of herb (*Sigesbeckia orientalis*).

The site is largely open with no significant canopy layer present (refer to photographs presented in **Appendix B**), with *C. cunninghamiana,* being the dominant overstorey species present, being scattered sparsely across the site. Of the 12 *C. cunninghamiana* individuals present 10 were considered to be in good condition. One individual was observed to be a hollow bearing tree. *C.cunninghamiania* is a key component within the Endangered Ecological Community (EEC); River-flat Eucalypt Forest (listed under Part 3 of Schedule 1 of the TSC Act 1995, **Appendix D**). None of the other tree species present are recognised components of the River-flat Eucalypt Forest EEC.

A single *Eucalytpus deanii* represented the largest and most significant (as determined by Significance Value) tree on site. A small number of non-local (*i.e. Grevillia robusta*) and non-native (i.e. *Robinia pseudoacacia*) trees occurred in the site providing habitat for arboreal and avian fauna.

The location and significance value of the mature trees recorded within MLS are displayed in **Figure 4.5**.

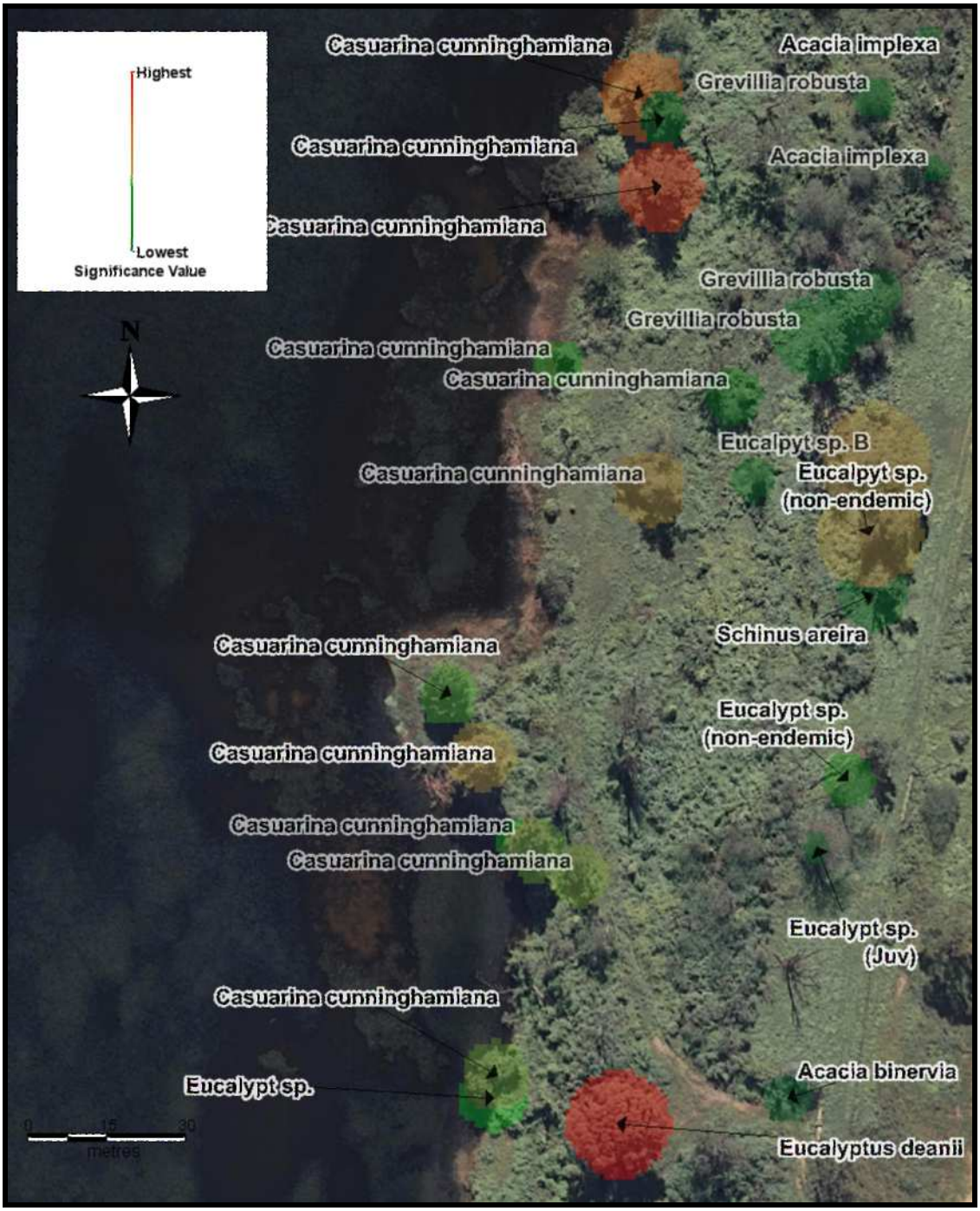


**Figure 4.5:** Location and Significance Value of mature trees with a stem diameter > 0.2 dbh recorded within MLS.

Apart from these native trees, the other native floras were comprised of mostly graminoid and herb growth forms with limited conservation value. The majority of the groundcover was dominated by weedy grass species, including *Bromus catharticus, Digitaria ciliaris*, *Eharta erecta*, *Eragrostis curvula*, *Paspalum dilatatum*, and *Pennisetum clandestinum*.

### 4.2.2 Main Lake North

The vegetation at MLN consisted of 34 species belonging to 17 families (**Appendix A**). Only five species belonging to four families were recorded to be native (Table 4.1). Of these natives, only two grass species (*Microleana stipoides* and *Commelina cyanea*) and one herb (*Oxalis perennans)* were observed to be of conservation significance or a minor component of the Riverflat Eucalypt Community.

The site was heavily dominated by weeds and vines, to the extent that the site would be characterised as having almost no extant native flora value. The majority of the groundcover was dominated by the weedy shrub species *Lantana camara* (forming a largely continuous hedge of 1.5m depth) and grass species, including *Bromus catharticus, Conyza bonariensis*, and *Pennisetum clandestinum*. The density of lantana was such that movement and the ability to survey were restricted (**Appendix B**).

The tree overstorey layers consisted of a number of sparsely located non-native *Robina pseudoacacia* and *Gleditsia triacanthos* individuals. These trees were heavily infested with parasitic vines (*Cardiospermum grandiflorum)* to the extent that a number of trees had been killed by the vines. Along the water edge a significant number of willow trees (Salix spp.) congested the banks. Only one native tree (*Casuarina cunninghamiana*) was located towards the north edge of the site on the river bank (**Figure 4.6**).

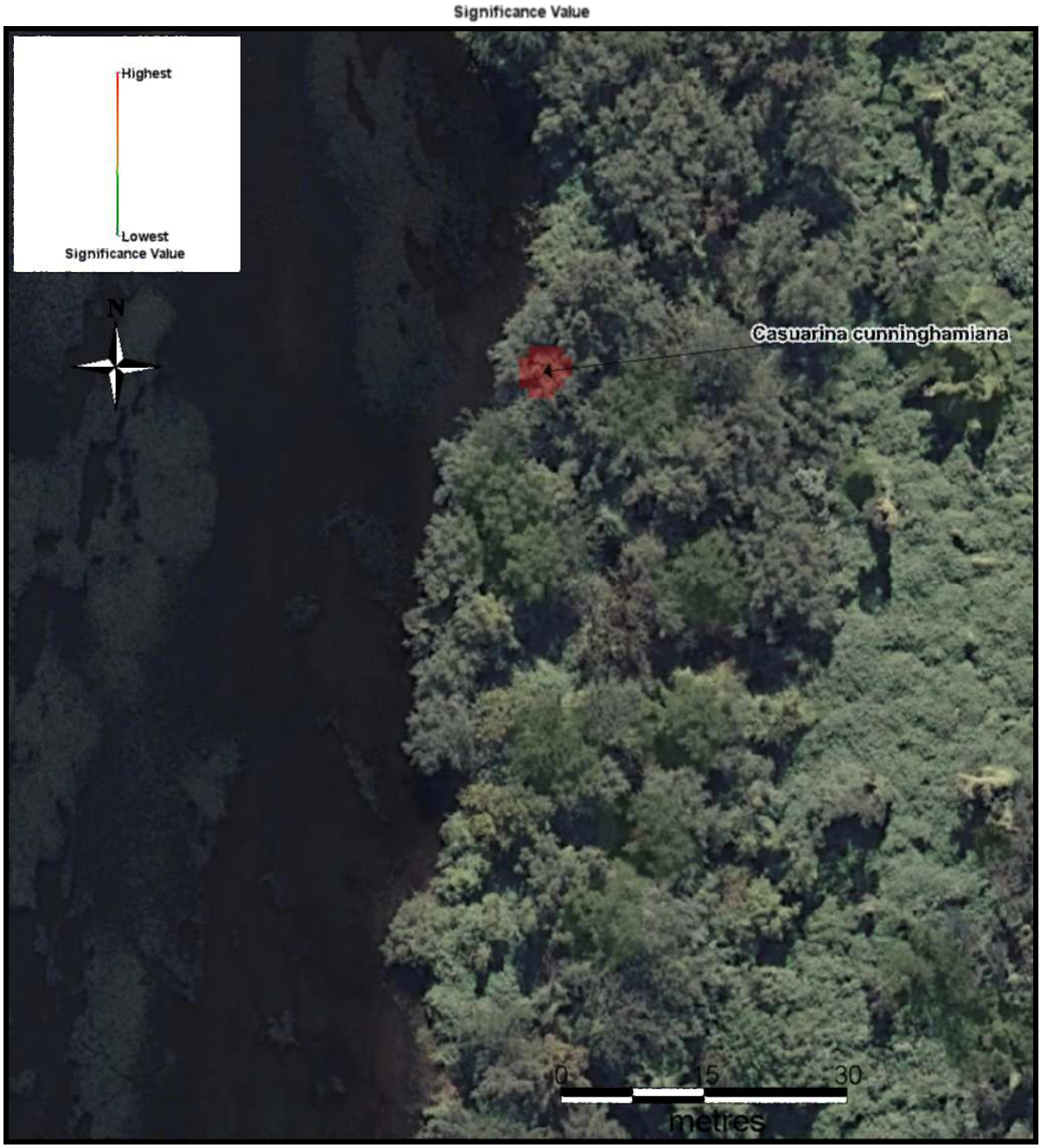


**Figure 4.6:** Location and Significance Value of mature native trees with a stem diameter > 0.2 dbh recorded within MLN.

### 4.2.3 Wildlife Lake South

WLS represented the most diverse site out of the five sites surveyed, and was observed to have the lowest degree of infestation of exotic species. A total of 68 species belonging to 31 families were observed on-site (**Appendix A**). Only 14 species belonging to ten families were recorded to be native (Table 4.1), and most were not of significant conservation concern, apart from *Casuarina cunninghamiana*, *Breynia oblongifolia*, *Microleana stipoides*, *Whalenbergia gracillis*, *Oxalis perennans* and *Chelianthes sieberi* which form a small component of the River-flat Eucalypt community listed as endangered under the TSC Act 1995 (**Appendix C**, **D**).

The understorey and ground cover was observed to be relatively dense and continuous. Evidence of recent clearing of *Lantana camara* was present on site, with patches of dense weed infestation remaining. A mid-storey of mixed non-native and native shrubs and trees (e.g. *Glochidion ferdinandi*) was present (in contrast to the majority of the other sites assessed), providing some habitat for fauna species (**Appendix B**).

The overstorey comprised of scattered clusters of 17 individual trees predominantly consisting of *Casuarina cunninghamiana*, *Acacia implexa (native species) and a number of non-native species (e.g. Gleditsia triacanthos*, *Ailanthus altissima, Ligustrum lucidium*, *Ligustrum sinense, Salix* sp. and *Viscum album).* The diversity of tree species present provides habitat value for fauna. The locations of the trees are mapped in **Figure 4.7**.

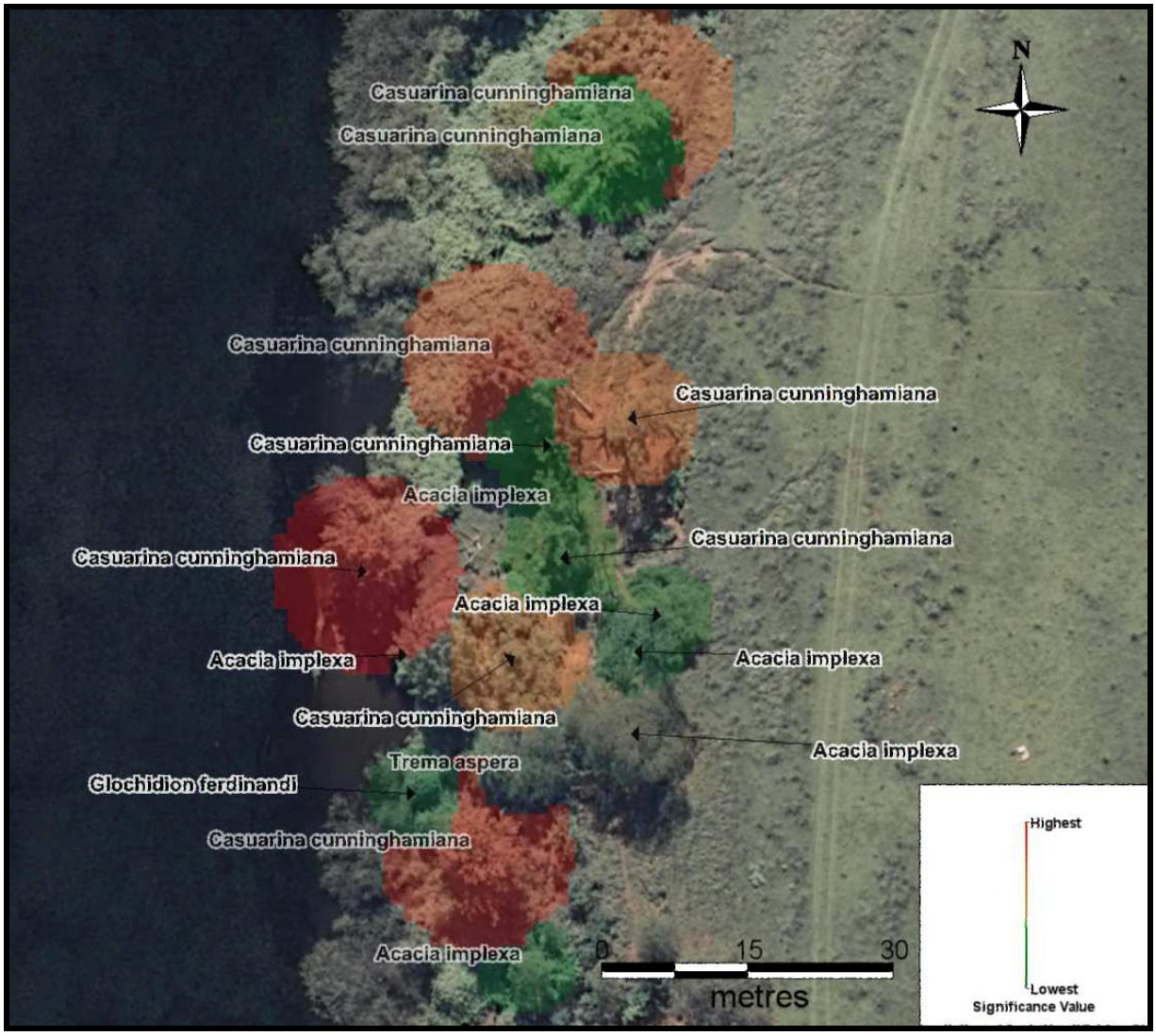


**Figure 4.7:** Location and Significance Value of mature trees with a stem diameter Significance Value recorded within WLS.

### 4.2.4 Wildlife Lake North

WLN comprises a mixture of relatively open and closed vegetation as a result of both previous clearing, land use and weed infestation (**Appendix B**). A total of 46 species belonging to 23 families were observed on the site (**Appendix A**). Only 13 native species belonging to five families were recorded to be native (Table 4.1) and most were not of significant conservation concern.

A significant stand of 20 *Casuarina cunninghamiana* was recorded along the bank in the centre of the site. This stand was seen to be of high quality, with all individuals mature and in good condition. Aside from this stand, the majority of tree species on site were scattered individuals of *Acacia implexa*. To the immediate west of the site a stand of planted, relatively juvenile trees was present. Species present within the stand included *C. cunninghamiana, Angophora floribunda, Eucalyptus ampifolia and Eucalyptus baueriana*. These planted species included members of the River-flat Eucalypt Forest. The locations of the trees within the site are mapped in **Figure 4.8**.

In addition to *C. cunninghaminana*, a number of native understorey species forming a very small component of the EEC – Riverflat Eucalypt forest were observed on site in low abundance. These included the graminoid species *Commelina cyanea*, *Microlaena stipoides* and *Oplismenus aemulus*. However, the majority of the groundcover was dominated by weedy shrub species (*Lantana camara*), Vine species (*Cardospermum grandiflorum*), and grass species *(Paspalum dilatatum*, *Eharta erecta*, *Eragrostis curvula and Pennisetum clandestinum*.

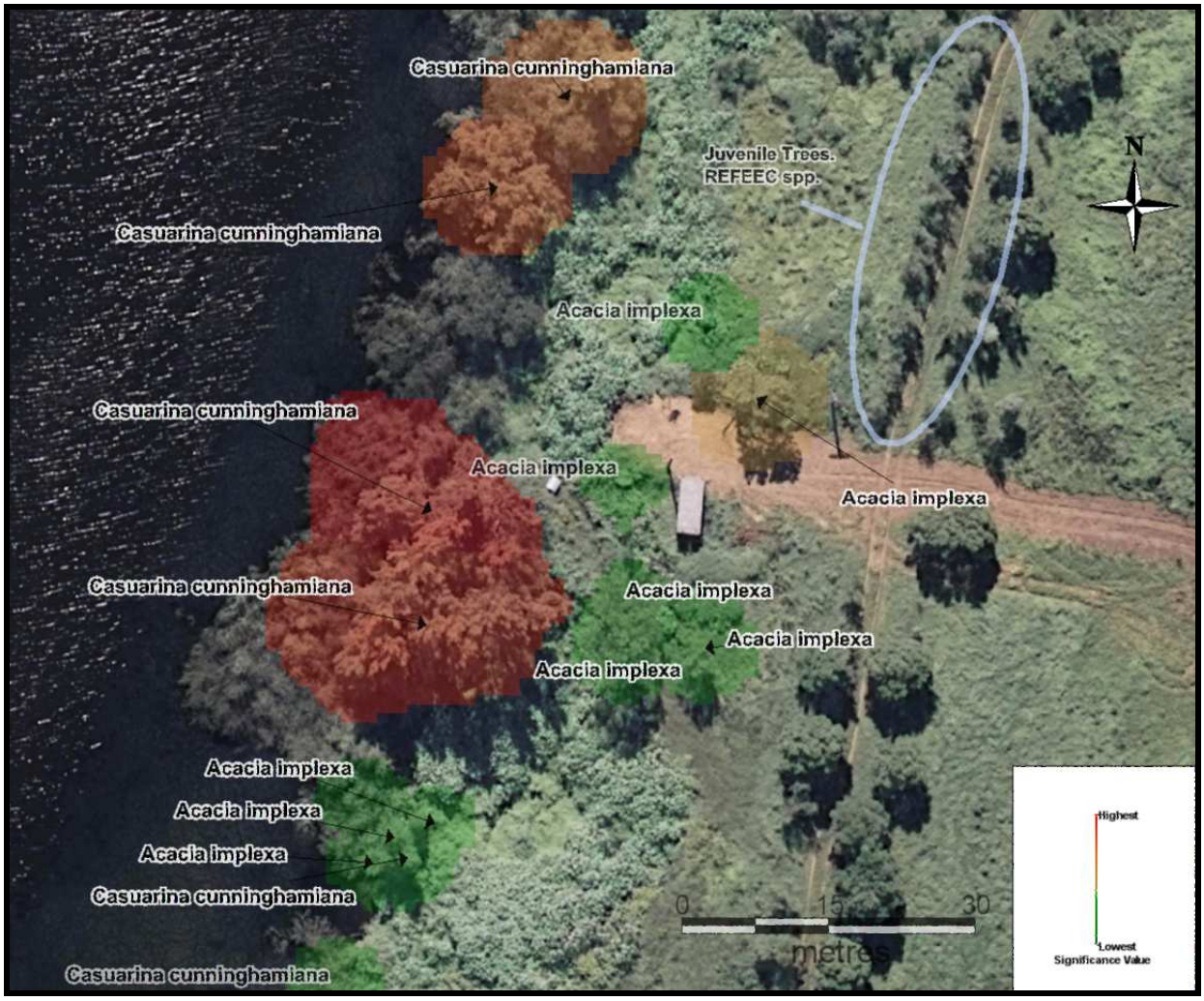


**Figure 4.8:** Location and Significance Value of mature trees within the Riparian Corridor with a stem diameter > 0.2 dbh recorded within WLN (Juvenile River Flat Eucalypt tree species circled).

### 4.2.5 Weir Site

In comparison to the other sites the Weir site is significantly more open due to the previous clearing and land-use in the area. Only a small remnant of native vegetation remains on either side of Hunts Creek (**Figure 2.5**, **Appendix B**).

The Weir site comprises a total of 54 species belonging to 21 families (**Appendix A**). Only 14 native species were recorded belonging to 7 families and most were not of significant conservation concern.

No overstorey or mid-storey is present at the site, with only one individual tree present (a mature *Acacia implexa* in good condition).

The majority of vegetation present was grass and shrub groundcover dominated by weedy grass species, including *Bromus catharticus, Eharta erecta*, *Eragrostis curvula*, *Pennisetum clandestinum* and *Setaria parviflora*. Despite the dominance of weeds, a number of native species that form a small component of the Riverflat Eucalypt community were observed in low abundance on site. Species observed included the graminoid (*Oplismenus aemulus*) and the herbs (*Centella asiatica*, *Wahlenbergia gracillis*, *Glycine tabacina*, *Oxalis perennans*).

## 4.3 Flora Species of Significance

A review of flora records from the site locality was undertaken to assess the occurrence or likely occurrence of significant flora species pursuant to the TSC Act, the EPBC Act and the Noxious Weeds Act 1993. Records utilised included records held within the Atlas of NSW Wildlife, NSW BioNet and EPBC Act Online databases.

### 4.3.1 Threatened Species

A review of flora records from the site locality indicated 11 species of conservation significance that may potentially occur on the site based upon the availability of suitable habitat. These species and their relevant status under the Atlas of NSW Wildlife, NSW Bionet database EPBC Act and TSC Act are provided in **Table 4.2**.

**Table 4.2**: Significant flora species likely to occur in the site locality

| Species Name | Common Name | Status * |
|---|---|---|
| *Allocasuarina glareicola* | | E1 |
| *Hibbertia puberula* | | E1 |
| *Dillwynia tenuifolia* | | V |
| *Pultenaea parviflora* | | E1 |
| *Acacia bynoeana* | Bynoe's Wattle | E1 |
| *Micromyrtus minutiflora* | | E1 |
| *Pterostylis saxicola* | | E1 |
| *Grevillea juniperina* subsp. *juniperina* | Juniper-leaved Grevillea | V |
| *Persoonia nutans* | Nodding Geebung | E1 |
| *Pimelea spicata* | Spiked Rice-flower | E1 |

* CE, CV = Commonwealth (Endangered, Vulnerable) – *EPBC Act*
NE, NV = New South Wales (Endangered, Vulnerable) – *TSC Act*

The flora survey (Section 3.2) undertaken was designed appropriately to conclude that these threatened species were not present at the proposed work sites. It was also apparent that heavily disturbed, weed infested characteristics of all the sites at Penrith Lakes would be unlikely to provide suitable habitat for many of the endangered or vulnerable species in **Table 4.2**, due to the high competitive ability of the weeds and their domination in the soil seedbank. However, it is acknowledged that there is the unlikely chance that some species may not have been sighted, or they may be in a dormant form as seeds in the soil seedbank which are undetectable from a single sampling event.

### 4.3.2 Weed Species

The Noxious Weed Act 1993 aims to reduce the negative impacts of weeds by preventing the establishment of significant new weeds whilst the restricting the spread and reducing the distribution of existing significant weeds. It also provides for monitoring and reporting on the outcome of weed management within the State. Pursuant to the Noxious Weed Act 1993, a weed may be classified as one of the following categories.

> ***Class 1, State Prohibited Weeds:*** *Class 1 noxious weeds are plants that pose a potentially serious threat to primary production or the environment and are not present in the State or are present only to a limited extent.*
>
> ***Class 2, Regionally Prohibited Weeds:*** *Class 2 noxious weeds are plants that pose a potentially serious threat to primary production or the environment of a region to which the order applies and are not present in the region or are present only to a limited extent.*
>
> ***Class 3, Regionally Controlled Weeds:*** *Class 3 noxious weeds are plants that pose a serious threat to primary production or the environment of an area to which the order applies, are not widely distributed in the area and are likely to spread in the area or to another area.*
>
> ***Class 4, Locally Controlled Weeds:*** *Class 4 noxious weeds are plants that pose a threat to primary production, the environment or human health, are widely distributed in an area to which the order applies and are likely to spread in the area or to another area.*
>
> ***Class 5, Restricted Plants:*** *Class 5 noxious weeds are plants that are likely, by their sale or the sale of their seeds or movement within the State or an area of the State, to spread in the State or outside the State.*

A noxious weed that is classified as a Class 1, 2 or 5 noxious weed is referred to in the Noxious Weed Act as a notifiable weed. The significant weed species pursuant to the Noxious Weeds Act 1993 that were recorded on site are detailed in **Table 4.3**.

**Table 4.3:** Declared weed species and their control categories as listed under the Noxious Weeds Act (1993) at the five selected sites.

| Species | ML S | | | ML N | | | WL S | | | WL N | | | Weir | | | Weed Class |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | P | D | C | P | D | C | P | D | C | P | D | C | P | D | C | |
| *Cestrum parqui** | | | | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 3 |
| *Eichhornia crassipes** | 1 | 2 | 2 | | | | | | | | | | | | | 5 |
| *Lantana camara** | 1 | 2 | 2 | 1 | 4 | 4 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 2 | 5 |
| *Ligustrum lucidium** | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | | | | 4 |
| *Ligustrum sinense** | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 4 |
| *Ludwigia peruviana** | 1 | 2 | 2 | | | | 1 | 2 | 2 | 1 | 2 | 2 | | | | 3 |
| *Opuntia* sp. * | | | | | | | 1 | 1 | 2 | | | | | | | 4 |
| *Rubus fruiticosus** | | | | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | 4 |
| *Salix* sp. * | 1 | 2 | 3 | | | | 1 | 2 | 3 | | | | 1 | 1 | 1 | 5 |
| *Sorghum halepense** | 1 | 3 | 2 | 1 | 3 | 2 | | | | | | | | | | 4 |
| *Sporobolus fertilis** | 1 | 2 | 2 | | | | 1 | 1 | 1 | | | | 1 | 1 | 1 | 3 |

MLS = Main Lakes South, MLN = Main Lakes North, WLS = Wildlife Lakes South, WLN = Wildlife Lakes North, P = Presence (1 = present), D = Density (Rough estimates - 1 = 1 individual, 2=2-20 individuals, 3 = 21-100 individuals, 4 = over 100 individuals), C = Crown Cover (Rough estimates - 1 = 1-5%, 2 = 5-25%, 3 = 26-75%, 4 = 76-100%).

A large number (85) of the other weed species observed within the study sites are classified as notifiable species in other LGAs and regions within NSW, but are not listed within the Hawkesbury River County Council Noxious Weeds list.

## 4.4 Summary

The flora present at each of the five sites evaluated does not represent communities, species or habitat of significant conservation value. No threatened species were observed on site. No Endangered Ecological Communities (EEC) were observed to occur on site. All five sites demonstrate a significant species richness and abundance of exotic species, typically dominating the native species (particularly at MLN).

It is acknowledged that several component species of the River-Flat Eucalypt Forest on Coastal Floodplains EEC were sighted within the study area. However, the characteristic dominant eucalypt species (e.g. *Eucalyptus tereticornis* (forest red gum), *E. amplifolia* (cabbage gum), *Angophora floribunda* (rough-barked apple), *E. baueriana* (blue box), *E. benthamii*) were not present within the sites (although some planted juvenile individuals were present surrounding the sites). Given this, it can be concluded that the River-Flat Eucalypt Forest on Coastal Floodplains EEC does not occur within any of the proposed development sites. Given the known occurrence of this community further upstream and downstream, as well as the presence of some minor components on site, it is noted that there may be significant potential for any revegetation and rehabilitation works in the area to establish this community in the area.

The site with highest floral value was considered to be the WLS, due to its higher diversity levels, richness and abundance of native species in comparison to the other sites. However, even at this site the weeds were dominant and the site did not reflect native vegetation of high value. The trees present at each of the sites, predominantly *Casuarina cunninghamiana* and *Acacia implexa*, are widespread throughout the region and unlikely to be threatened as a population or species by any proposed works in the study sites. Occasional stands of *C.cunninghamiana* and a solitary *E.deanii* represented the most Significant Value trees across the study areas. A number of planted local and non-local trees (both as a result of historic agricultural practices in the area and the current quarrying operations) exist around the sites. While not representing remnant native vegetation these individuals do still provide habitat diversity and structure to the ecosystems and should be preserved where possible.

# 5 FAUNA HABITAT VALUES

## 5.1 Overview

Due to the highly degraded nature of the entire quarry site and the lack of contiguous native vegetative cover, the majority of the proposed work sites provide a limited variety of fauna habitat resources that are suitable for utilisation by native species. It is considered that the quarry site's most important ecological feature is the fact that the riparian vegetation acts as a habitat corridor providing linkages with other flora and fauna habitat in the local and regional area. A brief summary of the proposed work sites existing fauna habitat types is provided below. Due to the overall similarity in vegetation structure and species between the sites (including weir and pipeline related sites) as well as the similarity in potential fauna

species utilising each site, the sites were assessed collectively rather than individually. Where unique habitat features were identified with a site they have been specified herein.

## 5.2 Birds

The riparian vegetation extending along the eastern bank of the Nepean River provides some temporary and permanent nesting, perching and foraging habitat for a range of avian species. Typically it is considered that the avifauna diversity in positively related to diversity of vegetation, in particular floristic and structural diversity. In regards to the overstorey, three of the sites (MLS, WLS, WLN) were observed to be similar in terms of both structural and floristic diversity with the dominant species being *C.cunninghamiana* across the sites. The unique seed cones, flowers and foliage of these trees limits the utilisation of the trees by native fauna. The remaining sites (MLN and Weir) had markedly different structures in regards to overstorey. The weir site contained almost no overstorey with the exception of a single *A.implexa*, while MLN was dominated by *Salix spp*., *Robina pseudoacacia* and *Gleditsia triacanthos*. MLN and WLS were the only sites to have any form of midstorey, typically juveniles of the dominant species as a result of the patchy and disturbed nature of the areas.

In terms of groundcover, all five sites contained significant grass and shrub cover providing considerable habitat for insectivores, florivores and granivores. However, the abundance of exotic species across all five sites limits the range of native avian fauna utilising the area.

A range of bird species were observed during the field inspections. Due to the small scale of the sites as well as the relative proximity of the sites to each other many of the birds observed were sighted multiple times both within and in the vicinity of the sites. Native species identified included:

- Darter (*Anhinga melanogaster*),
- Australian magpie (*Gymnorhina tibicen*),
- Laughing kookaburra (*Dacelo novaeguineae*),
- White Bellied Sea Eagle (*Haliaeetus leucogaster*),
- Welcome swallow (*Hirundo neoxena*),
- Eurasian coot (*Fulica atra*),
- Peregrine falcon (*Falco peregrines*); and
- Australian Pelican (*Pelecanus conspicillatus*).

One tree within WLS was observed to contain an abandoned nest. It was impossible to identify the species associated with the nest, most likely a smaller passerine species. Very few tree hollows were observed across the sites and no external evidence of hollow nesting was discernable.

## 5.3 Arboreal Mammals

No arboreal mammals were visually sighted in the area. It is considered unlikely that many arboreal mammals permanently inhabit the riparian corridor due to the lack of Eucalyptus trees containing potential hollow bearing trunks or limbs. River Oaks (Casuarina cunninghamiana) and Acacia species may provide some small shelter sites in the form of branch forks or fissures within the bark, but too a lesser extent than those of mature Eucalypt

species. The exotic tree species present (i.e. *Salix spp*., *Robina pseudoacacia* and *Gleditsia triacanthos*) are not considered to be of high habitat value for native mammal species.

Meandering scat transects as well as scat searches around the base of all trees did not reveal the presence of any native arboreal mammal species. Some scratch marks were observed within both MLS and WLN, however they were considered to be more representative of reptile marks (*c.f*. Section 5.6) than mammals.

In regards to the potential utilisation of the area by Koalas (*Phascolarctos cinereus*), it is considered unlikely they occur within the area. Almost no eucalypts (only seven out of 68 mature native trees) occur within the site. None of these Eucalypt species present are typical Koala feed tree species within NSW. Three of the eucalypts are known to have been planted individuals and are not typically associated with the region.

It is recognized that Koalas are capable of moving over large expanses of open ground and non-native habitat. Given the potential connectivity value of the site (**Section 5.9**), the sites may comprise part of a link to broader areas of habitat utilised by Koalas and other mammals.

Database searches indicated no records of Koalas occurring on site. However, personal communications with PLDC employees indicated a previous sighting of a Koala several years ago at the southern end of the Penrith Lakes site. Such an unverified sighting is considered to be irregular given the history of land use development of the site.

Previous studies have identified the most common arboreal mammals on site to be the Common Ringtail (*Pseudocheirus peregrinus*)and Common Brushtail Possums (*Trichosaurus vulpecula*)(Abel Ecology, 2007). No sighting or evidence of these species was observed within the study sites. Previous studies did not identify any evidence of Koalas on the Penrith Lakes Scheme site.

Given the lack of observable habitat utilisation, the relatively small size of the corridors (with widths ranging from 40 to 150 m), the limited amount of food resources (*Eucalyptus spp*.) within the sites, and the poor condition of the riparian corridor in general, it is considered unlikely arboreal mammals will utilise the area, and are unlikely to be impacted by the proposed works.

## 5.4 Terrestrial Mammals

The long history of agricultural utilisation and quarrying has reduced the abundance and richness of native terrestrial mammal species within the work sites. There were no terrestrial mammals sighted during the field inspections. The only evidence of terrestrial mammals related to the presence of feral animals. Fox scats were observed at WLS, as well as a hole potentially utilised by foxes. Pig scats and pig runs through the dense lantana were also observed at MLN.

It is considered that the heavy infestation of exotic plant species, small width of corridor, and disturbed nature of the adjacent quarried land, is likely to favour the establishment of pest fauna species over native species. This in turn is likely to limit the establishment of native populations.

Previous studies have identified the most common native terrestrial mammals on site to be the Swamp Wallaby (*Wallabia bicolor*)(Abel Ecology, 2007). No sighting or evidence of these species was observed within the study sites.

It is possible that native species may utilise the study sites as part of a corridor to access more suitable habitat areas to both the north (Agnes Banks Nature Reserve and agricultural lands) and south (Penrith Weir, Nepean Gorge). Some native fauna may be capable of crossing the Nepean River, particularly North of the quarry site where the Nepean River narrows considerably and is quite shallow, or South of the quarry site where a number of partial land bridges exist.

In comparison, the western bank of the Nepean River contains significant habitat areas (i.e. Yellowmundee Recreation Park).

## 5.5 Flying Mammals

No flying mammals were visually sighted during the study. However, three threatened bat species were previously recorded further south of the study sites (Abel Ecology 2007). This included three species of microbats, including the Large Bentwing Bat (*Miniopterus schriebersii*), Eastern Freetail Bat (*Mormopterus norfolkensis*), and the Large-Footed Myotis (*Myotis adversus*) all listed as Schedule 2, Vulnerable under the NSW Threatened Species Act 1995. All three of these species utilise either caves or tree hollows as roosting sites. No caves were present within any of the study sites, and the number of trees with hollows observed within and adjact to the work sites was very low. No evidence of bat roosting was observed. It is also considered that the disturbance due to historical land use activities may reduce the potential for bat species to roost on the eastern bank of the Nepean River. It may be possible that bats occupy caves and the Eucalypt forest on the western side of the Nepean River in the Blue Mountains and occasionally crossover to the Penrith Lakes Scheme with the lakes acting as possible feeding grounds for these species.

## 5.6 Reptiles

A range of reptile species are considered likely to occur on site and a number of species were observed during the site inspections. Eastern water skinks (*Eulamprus quoyii*), Garden Skinks (*Lampropholis delicata*) and Grass Skinks (*Lampropholis guichenoti*) were observed at many of the sites and are considered likely to be common throughout the region.

In addition to these species a number of other species were observed at individual sites:

- MLS: Red-bellied black snake (*Pseudechis porphyriacus*);
- MLN: Eastern Water Dragon (*Physiagnathus leseurii*); and
- WLN: Lace Monitor (*Varanus varius*), Eastern Water Dragon (*Physiagnathus leseurii*).

Database searches and communication with employees of PLDC indicate that other common reptile species found in the area include the Eastern Brown Snake (*Pseudonaja textilis*) and Diamond Python (*Morelia spilota spilota*). However, no evidence of these species was observed during site inspections.

It is considered that the dense weed habitat is not favourable to reptile species, due to the cooler thermal habitat it creates. Weed removal, and generation of more open spaces would likely generate a more favourable habitat for reptile species.

## 5.7 Amphibians

No detailed amphibian sampling was conducted during the site inspection. Given the riparian nature of all sites it is highly likely a number of amphibian species occupy the area. The only frog species identified during site inspection was the Striped Marsh Frog (*Limnodynastes peroni*) at the Weir site.

Database searches and previous studies indicated a number of common frog species may occur within the sites. These include:

- Common Eastern Froglet (*Crinia signifera*);
- Green Tree Frog (*Littoria caerulea*);
- Bleating Tree Frog (*Litoria dentata*); and
- Broad-palmed Frog (*Litoria latopalmata*).

Threatened species searches indicated that there is potential for the Giant Burrowing Frog (*Heleioporus australiacus*), Green and Golden Bell Frog (*Litoria aurea*) and the Red-crowned Toadlet (*Pseudophryna australis*) to occur in the region. Abel Ecology (2007) indicates that the last known sighting of *L.aurea* at the Penrith Lakes site was in 1981.

The dominance of weed species in the riparian vegetation and absence of ponding freshwater is considered likely to limit the occurrence of frog species at each of the study sites. However, the presence of ponded water and marshy ground at both the Weir site and MLN in particular provide suitable amphibian habitat.

## 5.8 Invertebrates

The abundance of vegetation, although predominantly exotic, provides habitat for invertebrate species within the study sites. However, such areas of highly degraded forests are usually accompanied by a food web of pest invertebrate species and a limited number of native species (Herath, 2003).

The Cumberland Plain Land Snail (*Meridolum corneovirens*) is known to be associated with fringe areas of River-flat eucalypt forest. It is considered all of the proposed sites would have originally represented potential habitat for the Cumberland Land Snail. However, no previous sightings have been recorded in the area, no evidence of the presence of this species was observed during site inspection, and the substantial disturbance that has occurred to the quarry site indicates that the potential for the Cumberland Land Snail to currently occur at the proposed work sites is low.

Due to the small area required for the proposed works, and due to the fact that the system is currently highly degraded, it is unlikely that a predominantly native invertebrate community exists and the chances of recording threatened invertebrate species is considered highly unlikely. Precautionary mitigation measures (**Section 7**) should be established in the instance of any such species being discovered during construction.

## 5.9 Corridor Values

**Figure 2.1** indicates those parts of the quarry site which encompass the eastern bank of the Nepean River form part of a wildlife corridor. The value of this corridor is influenced by:

- The lack of connection between protected habitat areas. Three protected habitat areas occur in proximity to the quarry site: Agnes Banks Nature Reserve, Yellowmundee Recreation Park, and Nepean Gorge. There is limited connectivity to these areas. Yellowmundee Recreation Park is the most accessible for fauna capable of crossing the Nepean River in narrower and shallower sections, and partial land bridges occur both to the south and north of the quarry. There is reasonable connectivity to the Agnes Banks Nature Reserve across rural lands. There is limited connectivity to Nepean Gorge as the corridor is interrupted occasionally by residential housing and recreational spaces. However, it is noted that a number of smaller pockets of habitat (*i.e*. greater than 0.5 ha and less than 50 ha) exist along the course of the river (e.g. the riparian wetlands around Penrith Weir).

- The entire corridor is bounded to the east by agricultural, industrial and urban areas. The Nepean River to the west of the corridor limits movement for non aquatic / avian species. Avenues for the movement of terrestrial fauna across the Nepean River are available to the north of the quarry site where there is a narrowing of the Nepean River channel and also adjacent to the centre of the quarry site where a partial land bridge exists between the eastern and western banks of the Nepean River. Access across these sections will be highly dependent on the mobility species and depth / speed of river flow. The river also creates unique riparian ecosystems within the corridor.

- The proposed future development of the Penrith Lakes scheme will affect the connectivity value of the corridor. The development of the wildlife lake (a protected habitat area) as well as the recreational main lake will provided valuable new habitat for species, increasing the number of habitat areas accessible via the existing highly constrained corridor. The quarry rehabilitation will lead to a widening of the riparian corridor and the potential establishment of new corridors connecting habitat areas east of the quarry site to the Nepean River.

It is considered that in the connectivity value of the existing corridor is currently relatively low, particularly in comparison to the western bank of the Nepean River. It is likely that a small range of native fauna species (e.g. small terrestrial and arboreal mammals, reptiles and birds) utilise the riparian vegetation for movement along the river, however current utilisation will not extend to colonization and population establishment in large habitat areas. The ability for migration is also significantly limited by the degraded condition of the site. The future establishment of the Lakes Scheme as well as a weed management/rehabilitation program will primarily improve the habitat values of the quarry site but will also have an associated positive connectivity impact for the corridor. It is not anticipated that the proposed short term works would detrimentally impact upon the limited wildlife corridor values and functions of the Nepean River east bank.

## 5.10 Significant Fauna Species

Field surveys, the Atlas of NSW Wildlife and the DEWHA Online databases have been utilised to compile a list of significant fauna species that may occur on the site or on adjacent properties. Previous distribution records and habitat requirements for these species have

been examined to identify the likelihood of occurrence within the site. Each species has been allocated a rating of Very High, High, Moderate or Low according to the following criteria:

***Very High:*** *species observed on the site.*

***High:*** *no site observations but previously recorded in the site locality or records for the species held by both the Atlas of NSW and DEWHA databases in the site locality, with substantial areas of suitable habitat on the site.*

***Moderate:*** *no site observations, but previously recorded in the site locality by or Atlas of NSW records for the species in the site locality, with suitable habitat at the site.*

***Low:*** *no site observations, but either Atlas of NSW records or DEH records for the species in the site locality, with little or no suitable habitat at the site.*

A summary of the significant species likelihood of occurrence, based on the availability of suitable habitat, are listed in **Table 4.4**.

**Table 4.4:** Significant fauna species likely to occur on the site

| Order | Species Name | Common ame | Status | Habitat requirements | Likelihood of occurrence at site |
|---|---|---|---|---|---|
| Amphibia | *Litoria aurea* | Green and Golden Bell Frog | E1 | Marshes, dams and stream-sides | Low |
| | *Pseudophryne australis* | Red-crowned Toadlet | V | Open forests, sandstone soils | Low |
| | *Heleioporus australiacus* | Giant Burrowing Frog | V | Heath, woodland and open forest | Moderate |
| Aves | *Xanthomyza Phrygia* | Regent Honeyeater | E1 | Temperate woodlands and open forests | Low |
| | *Lathamus discolour* | Swift Parrot | V | Flowering Eucalypt trees | Low |
| | *Petroica rodinogaster* | Pink Robin | V | Rainforest and tall, open eucalypt forest | Low |
| | *Lophoictinia isura* | Square-tailed Kite | V | Dry woodlands and open forests | Moderate |
| | *Rostratula australis* | Australian Painted Snipe | V | Freshwater swamps and creeks, inundated grasslands | Moderate |
| | *Stictonetta naevosa* | Freckled Duck | V | Freshwater swamps and creeks | Low |
| | *Callocephalon fimbriatum* | Gang-gang Cockatoo | V | Tall mountain forests and woodlands | Low |
| | *Glossopsitta pusilla* | Little Lorikeet | V | Dry, open eucalypt forests and woodlands. | Low |

| Order | Species Name | Common ame | Status | Habitat requirements | Likelihood of occurrence at site |
|---|---|---|---|---|---|
| | *Neophema pulchella* | Turquoise Parrot | V | Edges of eucalypt woodland | Low |
| Mammalia | *Ninox strenua* | Powerful Owl | V | Range of vegetation types, dense vegetation during roosting | Moderate |
| | *Chalinolobus dwyeri* | Large Pied Bat | V | Roosts in caves, low to mid-elevation dry open forest and woodland | Low |
| | *Mormopterus norfolkensis* | Eastern Freetail Bat | V | Roosts in tree hollows, dry sclerophyll forest and woodland | Low |
| | *Miniopterus schreibersii* | Eastern Bentwing-bat | V | Roosts in caves | Low |
| | *Myotis macropus* | Southern Myotis | V | Roosts in caves and hollow bearing caves | Low |
| | *Dasyurus maculatus* | Tiger Quoll | V | Range of habitat types | Low |
| | *Potorous tridactylus* | Long-nosed Potoroo | V | Coastal heaths and dry and wet sclerophyll forests, dense understorey | Moderate |
| | *Petaurus norfolcensis* | Squirrel Glider | V | mature or old growth Box, Box-Ironbark woodlands and River Red Gum forest | Low |
| | *Phascolarctos cinereus* | Grey-headed Flying-fox | V | Eucalypt woodlands and forests | Low |
| | *Pteropus poliocephalus* | Grey headed Flying Fox | V | subtropical and temperate rainforests, tall sclerophyll forests and woodlands, heaths and swamps | Low |
| Reptilia | *Hoplocephalus bungaroides* | Broad-headed Snake | V | Shelters in rock crevices and under flat sandstone rocks on exposed | Low |

| Order | Species Name | Common ame | Status | Habitat requirements | Likelihood of occurrence at site |
|---|---|---|---|---|---|
| Gastropoda | *Meridolum corneovirens* | Cumberland Plain Land Snail | E1 | Cumberland Plain Woodland, grassy open woodland | Low |
| Insecta | *Petalura gigantea* | Giant Dragonfly | E1 | Permanent swamps and bogs with some free water and open vegetation | Low |

E1 = Endangered species list under Schedule 1 of the TSC Act 1995
V = Vulnerable species listed under Schedule 2 of the TSC Act 1995

As can be observed from **Table 4.4** it is unlikely any threatened species will be encountered on site during the proposed pipeline and weir works. Based on field inspections and these searches those species most likely to be encountered include *L.aurea* and *H.australiacus*. Mitigation measures to manage the potential impact on these species are provided in **Section 7**.

## 5.11 Summary

As described in Section 4, all sites assessed are characterised by a high dominance of exotic plants species and a low diversity of native understorey and overstorey species. These two factors considerably limit the fauna habitat value of the site. In particular, the presence of dominant exotic species has significantly reduced the quantity of available native grasses, fruits, and berries for native species to feed on. Similarly the absence of a significant and diverse canopy (observed to be present on the western bank of the Nepean River), in particular the absence of eucalypt species, removes significant habitat/cover for avian and arboreal mammals.

However, the dense ground cover of exotic species, does provide some habitat value for smaller native mammal species, birds, reptiles and invertebrates, particularly those able to adapt to a disturbed environments and cope with the high weed densities (*i.e.* omnivores and insectivores in particular).

The disturbed nature of the area (i.e. the quarry) is likely to favour populations of pest species (foxes, cats, pigs). Some evidence was observed during the site inspections, of the presence of these introduced species within the sites.

The individual sites were not observed to differ significantly in respect of the quality of fauna habitat with the exception of MLN (densely infested with lantana) and the Weir site (only one tree species was present within the site). It is considered unlikely that any of the sites provide essential habitat for any existing permanent populations of any threatened fauna species that may occur within the broader locality. Such species may utilise the works sites as part of migration corridors to the north, south, and west, however, no evidence of the movement of threatened fauna through the sites was observed on site during the inspections.

# 6 POTENTIAL IMPACTS

## 6.1 Flora

The impacts of the proposed works on each site are similar across the four pipeline locations. In each case, the primary impact will be the loss of vegetation due to clearing, cut and fill earthworks. These impacts will be temporary. Once the pipelines are in place vegetation will be able to regrow over the pipeline and re-establish continuity. The magnitude and importance of vegetation impact varies to a small extent between the sites as described below:

> ***WLN**: Of the two wildlife lake location this site represents a less diverse site, however it retains a valuable stand of C.cunninghamiana which should be retained if possible.*
>
> ***WLS**: This site represented the site of greatest native vegetation. A pipeline placed through this site would involve the loss of a greater number of mature native trees in comparison to WLN.*
>
> ***MLN**: The high weed infestation at this site, and lack of any significant native flora indicates the potential impact of a pipeline on native flora to be minimal.*
>
> ***MLS**: Although containing a number of mature native trees and less weeds than MLN, the open nature of the site is considered suitable to allow a pipeline to be established without the loss of any important habitat and minimise the construction impact footprint.*

None of the sites contains any flora species, communities, or populations of formally recognised conservation significance. However, it is recommended that the need to minimise environmental impact be considered in the selection of the pipeline locations and the design of the works program. WLN and MLS represent the two sites where pipeline construction would have the lowest impact on native vegetation considering both ecological value and the likely construction impact footprint on each site.

The scale of the impact footprint is such that it is considered unlikely to significantly impinge upon the reproduction, growth and development of flora species on the PLDC site during the operational phase of the pipeline.

Minor indirect impacts of the proposed works upon the existing vegetation across all sites may include:

- increased weed colonisation;
- smothering of plants by associated construction dust; and
- altered erosion and sediment regimes changing the flora habitat values (i.e. Salix spp. and Casuarina spp. are good at maintaining bank stability).

Such impacts are able to be managed and providing appropriate mitigation measures are applied (Section 7) it is considered that the proposed works will not have a significant impact upon any existing flora populations either in construction or operation.

In regards to the weir, for the purpose of this report it has been assumed the impact will involve the loss of the entire stretch of riparian vegetation north of the weir to the boundary of

the quarry site (**Figure 2.5**). No species or communities observed north of the proposed weir site are of formally recognised conservation significance.

It should also be noted that impacts on Hunts Gully must be taken in context of existing impacts and proposed impacts through the creation of the Wildlife Lake. Quarrying activity has resulted in the discontinuation of the major tributary leading into Hunts Gully (immediately south of the proposed weir). Subsequently, the local catchment flows received through Hunts Gully have been significantly altered.

The future transition of the quarry into a wildlife lake (aided by the construction of the weir) will result in the establishment of more valuable ecological systems than are currently sustained within Hunts Gully. Flows currently proceeding down Hunts Gully would be diverted into the Wildlife Lake, contributing to its ecological value. The loss of the limited native vegetation present at the Weir site, and downstream thereof, is considered minimal in comparison to the overall benefits from allowing the establishment of the weir.

Recommended mitigation measures to minimise the impacts are described in Section 7.

## 6.2 Fauna

Fauna impacts as a result of construction may occur due to:

- death or injury of individual animals during construction work which will involve the operation of machinery, clearance of vegetation, and the excavation/filling of trenches;
- loss of fauna habitat resources including roosting / nesting sites or food sources due to vegetation clearance;
- interference with movement patterns via the creation of exposed areas or installation of barriers (i.e. fences or trenches)which may interfere with the movement of fauna along the eastern bank of the Nepean River; and
- disturbance associated with construction noise and vibration.

The extent of these impacts is largely a function of the quality of the existing fauna habitat lost as a result of the construction works, as this will determine the existing fauna populations present and the extent of transitory fauna utilisation. As outlined in Section 5 there is little difference in habitat value between the work sites due to the dominance of exotics at all sites, with the exception of WLN and the Weir site, both of which are considered to have slightly lesser habitat values due to lack of natives and overstorey.

No significant fauna species are expected to occur on site and if any individuals specimens of native fauna are killed, injured or disturbed during construction, either directly or through loss of habitat, the extent of such impacts will be localised and will not be likely to have a discernible impact upon local or regional populations of any affected species.

The extent and likely duration of works is such that any disruption to the movement of native fauna through the site along the eastern bank of the Nepean River will be minimal. The temporary trenches will limit the movement of ground dwelling fauna travelling north and south of the riparian corridor. However, it is anticipated that the duration of the works would only be at most three months, after which rehabilitation of the soil profile and revegetation of native flora species is planned. More mobile and larger ground dwelling species would also

be capable of migrating short distances through reedy shallow waters if required (e.g. at MLS).

Providing appropriate mitigation measures are applied (Section 7) it is considered that the proposed works will not have a significant impact upon any existing fauna populations during construction. Similarly, during operation it is not expected any significant impacts will be suffered by native fauna.

# 7 IMPACT MITIGATION MEASURES

## 7.1 Recommended Mitigation Measures

Table 7.5 provides a list of recommended mitigation measures to be implemented to minimise ecological impact of the proposed works. Application of these mitigation measures will ensure there will be no significant impact on native flora and fauna communities within the final adopted sites. Where appropriate, these measures should be included within a Construction Environmental Management Plan.

**Table 7.5:** Mitigation measures

| Mitigation Number | Development Stage | Description of measure |
|---|---|---|
| M1 | Design | All mature (native) trees should be retained where practicable. |
| M2 | Design | In regards to the pipeline, site selection shall consider the relative ecological value of the sites as a factor in decision making. |
| M3 | Design | Mark the extent of vegetation to be cleared on all technical drawings and mark in the field. |
| M4 | Design & Construction | The presence of a temporary trench during construction would limit the movement of ground dwelling native fauna travelling north and south of the riparian strip. It is recommended that the duration of the works be as short as possible, and works start from the landward end of the pipeline and work linearly towards the Nepean River. |
| M5 | Construction | The locations of native trees at the selected development sites should be made known to construction contractors. All construction machinery should keep a sufficient distance from the trees (i.e. outside the canopy drip line) to limit root damage. Protective marking or fencing of trees to be retained should be considered. |
| M6 | Construction | During the vegetation clearing stage it is recommended a qualified animal handler be present to ensure that any native fauna that may be temporary occupying the area, is relocated in a safe manner. |
| M7 | Construction | Limit stockpiling of materials on site and actively manage stockpiles to minimise dust under high wind scenarios, and |

| | | |
|---|---|---|
| | | minimise weed establishment. |
| M8 | Construction | Construction contractors must be made aware of protected species which may be encountered during works (e.g. Green and Golden Bell Frog (*L.aurea*), Cumberland Land Snail (*M.corneovirens*)). Should any such species be encountered works shall cease until approval is provided by DECCW. |
| M9 | Construction | Establish a Fauna log recording any species observed on site during construction. Works shall cease until the animal moves from the area or a qualified animal handler can remove it from the site. |
| M10 | Construction | Prohibit works from exceeding the approved disturbance width and enforce boundaries. |
| M11 | Construction & Operation | A weed management plan must be employed to limit colonisation of the disturbed areas by weeds. Where possible this should include weed removal of the surrounding areas. This is considered to be important in the context of the broader Penrith Lakes Scheme. |
| M12 | Construction & Operation | Rehabilitation and restoration works following installation, should aim to reinstate a stable landform that supports a native plant community which resembles the original forest, the Riverflat Eucalypt community. Details of appropriate restoration measures are provided in Section 7.2. |

## 7.2 Rehabilitation and Weed Management Plan

A rehabilitation programme is recommended for the post pipeline and weir construction works period. The rehabilitation procedures should be based on research findings in other rehabilitation programs around Australia (e.g. Herath *et al.* 2008), and on those currently being undertaken within the Lakes Scheme as per its approved land rehabilitation manual. Issues and measures to be considered as part of the rehabilitation program include the following.

1) The above-ground vegetation component is generally a reliable indicator of below-ground soil seed-bank composition.

2) Overlaying a layer of fresh alluvial topsoil sourced from on-site (post return of subsoil) of intact riparian corridor vegetation that is also free of non-native seeds would be preferred. This would inhibit the re-establishment of weed seeds further down the soil profile.

3) Mulch may also be applied to assist in soil stabilisation and reduce the effects of summer drought.

4) A locally native seed mix should be determined carefully (species characteristic of the Riverflat Eucalypt Forest EEC) and broadcast over the topsoil. Native seedlings may also be infill planted into the rehabilitation sites.

It is noted that given the high occurrence of weeds within the study sites assessed and in neighbouring sections of the riparian corridor, it is likely on-going vegetation monitoring and management will be required to ensure the proposed works provide a positive impact and do not become re-infested with weeds. A detailed weed management plan would be required to be developed to ensure the vegetative condition following the proposed work is improved in comparison to the existing conditions.

# 8 ASSESSMENT OF SIGNIFICANCE

## 8.1 Overview

One Endangered Ecological Community (EEC) has been previously mapped as occurring within the riparian corridor around the Penrith Lakes Scheme area, this being River-flat Eucalypt Forest on Coastal Floodplains.

In addition, Abel Ecology (2007) referred to three threatened species, all listed as Vulnerable species under Schedule 2, Part 1, of the *TSC Act,* that have been recorded at the Penrith Lakes Scheme:

- Large Bentwing Bat (*Miniopterus schriebersii*);
- Eastern Freetail Bat (*Mormopterus norfolkensis*); and
- Large-Footed Myotis (*Myotis adversus*).

Other threatened species that have been recorded in the Penrith LGA, but not within the Penrith Lakes Scheme (based on database searches) include:

- Cumberland Land Snail (*Meridolum corneovirens*);
- Long nosed Potoroo (*Potorous tridactylus*);
- Diamond Firetail *(Stagonopleura guttata);* and
- Hooded Robin (*Melanodryas cucullata*).

The detailed site inspection conducted as part of this study did not identify any evidence of the River-flat Eucalypt Forest on Coastal Floodplains EEC on site, nor any evidence of any threatened species inhabiting the site. In general the dominance of weed species at all work sites suggests it is unlikely that any threatened species would be encountered on site. Providing the mitigation measures described in Section 7 are undertaken it is unlikely any threatened species would be significantly impacted.

While it is considered that the River-flat Eucalypt Forest on Coastal Floodplains EEC does not currently exist on any of the proposed sites there is potential for it to be re-established in the future and it may occur in areas adjacent to the five sites inspected. Subsequently it is considered possible that removal of the minor EEC components identified within the works sites may impact upon established River-flat Eucalypt Forest in the wider area or the potential to re-establish the EEC at the quarry site (i.e. through the reduction of component populations and reproductive potential).

A 7-part test addressing the River-flat Eucalypt Forest on Coastal Floodplains EEC has been prepared in accordance with Section 5A of the *Environment Planning and Assessment (EP&A) Act* (Revised 2005) and the *Threatened Species Conservation (TSC) Act* (1995) to assess the potential significance of the impact of the proposal. A Seven Part test was not conducted for any of the other threatened species that may occur in the area as the works are considered unlikely to impact upon these species.

## 8.2 River Flat Eucalypt Forest on Coastal Floodplains

***(a) In the case of a threatened species, whether the action proposed is likely to have an adverse effect on the life cycle of the species such that a viable local population of the species is likely to be placed at risk of extinction***

Not relevant.

***(b) In the case of an endangered population, whether the action proposed is likely to have an adverse effect on the life cycle of the species that constitutes the endangered population such that a viable local population of the species is likely to be placed at risk of extinction***

Not relevant.

***c) In the case of an endangered ecological community or critically endangered ecological community, whether the action proposed:***

*(i) Is likely to have an adverse effect on the extent of the ecological community such that its local occurrence is likely to be placed at risk of extinction, or*

Only a small area of the riparian corridor (i.e. the pipeline sites) is planned to be cleared for the purposes of the proposed works, and is expected to be approximately 500 m² (50 × 100 m) at most, per site. The desired development route would also be aligned to reduce the number of native trees lost, especially if the species form a component of the River-flat Eucalypt Forest on Coastal Floodplains Endangered Ecological Community (RFEF), listed under Part 3 of Schedule 1 of the TSC Act 1995. Due to the low density of trees at all of the potential sites, it is expected that only two or three significant native trees would be removed at each of the two selected pipeline sites. The exact locations of significant trees are mapped (**Figure 4.5**-**Figure 4.8**) and the proposed design route will attempt to conserve these trees wherever possible. As a result, the extent and area of damage to the River-flat Eucalypt Forest on Coastal Floodplains EEC is expected to be very low, or possibly have no effect on species characteristic of the RFEF if the proposed route takes into consideration the conservation of native trees. It is observed that WLS contains the most native species diversity and most species (9 spp.) characteristic of the RFEF. This site represents the least favourable site for development in regard to terrestrial ecology. It is also important to note that all sites are heavily disturbed, and are in very poor condition, such that much of the original native species composition has disappeared over time. Therefore, future plans of rehabilitation (post construction) with species characteristic of the River-flat Eucalypt Forest on Coastal Floodplains EEC are likely to have more beneficial impacts on the health and condition of the vegetation compared with no intervention. As a result, it is considered that the proposal is highly unlikely to have an adverse effect on the extent of this EEC such that its local occurrence is likely to be placed at risk of extinction.

*(ii) Is likely to substantially and adversely modify the composition of the ecological community such that its local occurrence is likely to be placed at risk of extinction,*

It is considered that the proposed works will not significantly modify the composition of the EEC such that its local occurrence would be placed at risk of extinction. The vegetation compositions at the five sites of Penrith Lakes Scheme only contain a very minor species

composition component characteristic of the EEC, the Riverflat Eucalypt Forest. Most of the widespread and dominant trees characteristic of the Riverflat community including *Eucalyptus tereticornis* (Forest Red Gum), *E.amplifolia* (Cabbage Gum), *Angophora floribunda* (Rough-barked Apple), *A.subvelutina* (Broad leaved Apple) and *Eucalyptus bueariana* (Blue box), were not present (with the exception of juvenile planted individuals at WLN). Any proposed pipeline route would attempt to conserve these trees wherever possible and replant juveniles following the trench being filled. As a result, the extent and area of damage to the RFEF community is expected to be very low, or possibly have no effect on species characteristic of the RFEF if the proposed route takes into consideration the conservation of mature native trees.

In terms of understorey composition, there were some understorey species characteristic of the Riverflat Eucalypt community (*Breynia oblongifolia*, *Centella asiatica*, *Cheilanthes sieberi*, *Commelina cyanea*, *Glycine tabacina*, *Microlaena stipoides*, *Sigesbeckia orientalis*, *Wahlenbergia gracillis*, *Periscaria decipiens*). However, at each site, there are generally less than five understorey species characteristic of the RFEF, hence a low species composition component of the RFEF per site.

The other factor to note is that only a very small area is going to be affected per site, and is expected to be approximately 500 m² (50 × 100 m) at most per pipe site.

***(d) In relation to the habitat of a threatened species, population or ecological community:***

*(i) The extent to which habitat is likely to be removed or modified as a result of the action proposed, and*

Only a small area of the riparian corridor is planned to be cleared for the purposes of the proposed works, and is expected to be approximately 500 m² (50 × 100 m) at maximum, per site. The desired development route would also be aligned to reduce the number of native trees lost. Due to the low density of trees at the sites, it is expected that only two or three significant native trees would be removed at the desired sites. The exact locations of significant trees are mapped in Figures 4.5 – 4.8 and the proposed design route will attempt conservation of these trees wherever possible. As a result, the extent and area of damage to the RFEF community is expected to be very low, or possibly have no effect on species characteristic of the RFEF, if the proposed route takes into consideration the conservation of native trees.

Due to the highly degraded nature of the site and the lack of contiguous native vegetative cover, the majority of the site provides a limited variety of fauna habitat resources that are suitable for utilisation by native species. It is recognised that the site's most important ecological feature is the sites potential to function as a habitat corridor providing important linkages with other flora and fauna corridors in the local and regional area. The construction phase would temporarily reduce linkage for some terrestrial mammals utilizing the corridor as a method of accessing larger areas of habitat further north and south. This estimated to be only for a period of three months.

*(ii) Whether an area of habitat is likely to become fragmented or isolated from other areas of habitat as a result of the proposed action, and*

The Riparian corridor site is surrounded by the Nepean River to the west, quarrying to the east, and pockets of expanded areas of vegetation to the north and south. Due to the highly degraded nature of the site and the lack of contiguous native vegetative cover, the majority of the site provides a limited variety of fauna habitat resources that are suitable for utilisation by native species. It is recognised that the site's most important ecological feature is the fact that the sites exist as a habitat corridor which provides important linkages with other flora and fauna corridors in the local and regional area. The construction phase would temporarily reduce linkages for some terrestrial mammals utilizing the corridor as a method of accessing larger areas of habitat further north and south. However, more mobile species will still be able to crossover and the construction phase would be scheduled to and structured in such a manner as to minimise the discontinuity period.

*(iii) the importance of the habitat to be removed, modified, fragmented or isolated to the long-term survival of the species, population or ecological community in the locality,*

As discussed above, the conservation significance of the forest communities found within the proposed sites at Penrith Lakes Scheme is low, being predominantly of a highly degraded nature and the general area is characterised as being in very poor to poor condition (Abel Ecology 2007). The limited suite of RFEF components observed within the sites to be affected are considered to be of low importance for the long-term survival of the ecological community within the region. In addition, the process of rehabilitation post construction of the proposed works is likely to enhance the conservation significance of that vegetation.

***(e) whether the action proposed is likely to have an adverse effect on critical habitat (either directly or indirectly),***

At the time of preparation of this report, no critical habitat for RFEF had been declared. This matter does not require any further consideration.

***(f) Whether the action proposed is consistent with the objectives or actions of a recovery plan or threat abatement plan,***

The recovery of River Flat Eucalypt Forest on Coastal Floodplains communities is currently addressed as part of the Cumberland Plain Endangered Ecological Communities. The Cumberland Plain Endangered Ecological Communities Recovery Plan established by DECCW (June, 2005) provides a best practice guideline for the management and restoration of bushland. This guideline details the appropriate approach to be adopted through both natural regeneration management and active revegetation activities.

The proposed works are generally consistent with the identified Cumberland Plain Endangered Ecological Communities Recovery Plan due to the rehabilitation of CPW in the proposed development sites. Specific actions to be undertaken in accordance with the guideline include:

- Habitat Management – Site Protection (e.g. fencing/signage); and
- Habitat Management – Weed Control.

***(g) Whether the action proposed constitutes or is part of a key threatening process or is likely to result in the operation of, or increase the impact of, a key threatening process.***

While the proposed activity, pipeline and weir construction works, is not in itself listed as a Key Threatening Process under Schedule 3 of the *TSC Act* 1995, a component of the

proposal, clearing of native vegetation, has been listed under Schedule 3 by the NSW Scientific Committee. RFEF is included as an EEC that is affected by this Key Threatening Process (Appendix 1 of the Scientific Committee's Final Determination). The proposal will include the removal of some minor components of RFEF. However, the proposal is not considered likely to threaten the survival of the RFEF community in the area for the following reasons:

- Only a small amount of heavily degraded RFEF components (up to 500 m² per pipe site) is to be removed from the Penrith lakes Scheme corridor adjacent the Nepean River.
- It is considered that RFEF communities do not currently exist on the potential development sites.
- The clearing of heavily infested vegetation and rehabilitation with locally native species characteristic of an RFEF is to be conducted after the proposed works.
- If human intervention does not control the spread of weeds, native vegetation species characteristic of the RFEF will continue to be suppressed and the minor component of the RFEF would eventually disappear.

***Conclusion***

On the basis of the above assessment, it is concluded that the removal of the vegetation as part of the proposed pipeline and weir construction works, does not constitute a "significant effect" on the River-flat Eucalypt Forest on Coastal Floodplains EEC, pursuant to Section 5A of the *EP&A Act*.

# 9 CONCLUSIONS

## 9.1 Overview of Ecological Values

From a terrestrial ecological perspective, all sites are currently in a heavily degraded condition due to the long history of land uses such as agriculture and quarrying activities, associated clearance of native forest cover, establishment of a groundcover dominated by invasive weed species, and establishment of populations of feral animals. If no human intervention takes place to control the spread of weeds and feral animals, it is likely the native system will continue to degenerate. It is likely that without intervention the minor components of the River-flat Eucalypt Forest on Coastal Floodplains EEC that are still observable will eventually disappear at the sites, particularly the understorey component, as the native herbs, sedges, grasses and shrubs, are unlikely to be capable of regeneration, or able to compete with the high dispersal capabilities of weed species.

The riparian corridor is concluded to provide little permanent habitat value for populations of native fauna, since it is very narrow (40 to 50 m) and it would more likely function as a transient linkage corridor for access into larger and more pristine habitats to the west and north. As discussed above, all of the sites assessed contain very little ecological value and rehabilitation following pipeline and weir works will facilitate native vegetation recovery.

## 9.2 Preferred Development Pipeline Site Selection

In terms of ecological value, none of the sites are observed to contain environmental value prohibiting the proposed development.

When designing the proposed pipelines, it is recommended that the clearance of native mature trees is avoided wherever possible. A loss of a small number of native trees is unlikely to have significant impacts in the wider context, especially considering that the proposed works would benefit the riparian vegetation by reducing long periods of flood inundation.

Out of the two Wildlife Lake sites studied, WLN is considered to be the preferred development site from an ecological perspective due to its lower densities of native vegetation growth.

No significant difference in ecological value was observed between the two Main Lake sites and consequently there is no significant ecological preference for which of these sites should be developed. Both sites are considered likely to allow development with negligible ecological impact.

## 9.3 Weir Site Selection

The proposed weir site is considered to be of low ecological value due to previous disturbance. The majority of the proposed weir construction site to also to be quarried prior to weir development. As a consequence, it is considered that development of the Wildlife Lake weir at this site will have a negligible ecological impact.

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# APPENDIX A

# Master list of recorded plant species and their associated biological attributes

**Master list of recorded plant species and their associated biological attributes**

MLS = Main Lakes South, MLN = Main Lakes North, WLS = Wildlife Lakes South, WLN = Wildlife Lakes North, P = Presence (1 = present), D = Density (Rough estimates - 1 = 1 individual, 2=2-20 individuals, 3 = 21-100 individuals, 4 = over 100 individuals), C = Crown Cover (Rough estimates - 1 = 1-5%, 2 = 5-25%, 3 = 26-75%, 4 = 76-100%**,** * = weed species

| | | ML S | | | ML N | | | WL S | | | WL N | | | Weir | | | Vegetation Attributes | | Weed Control | Conservation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Family** | **P** | **D** | **C** | **P** | **D** | **C** | **P** | **D** | **C** | **P** | **D** | **C** | **P** | **D** | **C** | **Common Name** | **Growth form** | **Category** | **Value** |
| *Acacia decurrens* | Fabaceae | | | | | | | | | | 1 | 2 | 2 | | | | Black Wattle | Tree | | |
| *Acacia implexa* | Fabaceae | 1 | 2 | 3 | | | | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Hickory Wattle | Tree | | |
| *Acer negundo** | Aceraceae | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | Box Elder | Tree | | |
| *Acetosa sagittata** | Polygonaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | Turkey Rhubarb | Vine | | |
| *Ailanthus altissima** | Simaroubaceae | | | | | | | 1 | 2 | 2 | | | | | | | Tree of Haven | Tree | | |
| *Austrostipa verticillata* | Poaceae | 1 | 2 | 2 | | | | | | | | | | | | | Slender Bamboo Grass | Graminoid | | |
| *Alisma plantago-aquatica** | Alismataceae | | | | | | | 1 | 2 | 2 | | | | | | | Water Plantain | Water Plant | | |
| *Alternanthra dentata** | Amaranthaceae | 1 | 2 | 2 | | | | | | | 1 | 2 | 2 | | | | Purple Knight, Joy Weed | Shrub | | |
| *Althaea officinalis** | Malvaceae | 1 | 2 | 2 | | | | | | | | | | | | | Marshmallow plant | Herb | | |
| *Amaranthus retroflexus** | Amaranthaceae | 1 | 2 | 2 | 1 | 2 | 2 | | | | | | | | | | Redroot Pigweed | Herb | | |
| *Angophora floribunda* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Rough Barked Apple | Tree | | Riverflat Eucalypt |
| *Anredera cordiflora ** | Basellaceae | | | | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | | | | Madeira Vine | Vine | | |
| *Arajia sericifera** | Asclepiadaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 2 | 2 | Moth Vine | Vine | | |
| *Aster subulatus** | Asteraceae | | | | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | Wild Aster | Herb | | |
| *Bidens pilosa** | Asteraceae | 1 | 3 | 2 | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | Teasers | Herb | | |
| *Bidens subalternans** | Asteraceae | | | | | | | 1 | 3 | 3 | | | | 1 | 2 | 2 | Greater Beggar's Ticks | Herb | | |
| *Breynia oblongifolia* | Phyllanthaceae | | | | | | | 1 | 2 | 2 | | | | | | | Coffee Bush | Shrub | | Riverflat Eucalypt |
| *Bromus catharticus** | Poaceae | 1 | 4 | 2 | 1 | 4 | 2 | | | | 1 | 3 | 3 | 1 | 3 | 1 | Priarie Grass | Graminoid | | |
| *Bothriochloa macra* | Poaceae | | | | | | | | | | | | | 1 | 2 | 2 | Redleg grass | Graminoid | | |
| *Calochlaena dubia* | Dicksoniaceae | | | | | | | | | | 1 | 2 | 2 | | | | Soft Bracken Fern | Shrub | | |
| *Capensis* sp. * | | 1 | 2 | 2 | | | | | | | | | | | | | | Graminoid | | |
| *Capsella bursa-pastoris** | Brassicaceae | | | | | | | 1 | 2 | 2 | | | | | | | Shepherds purse | Herb | | |
| *Cardiospermum grandiflorum** | Sapindaceae | 1 | 2 | 3 | 1 | 3 | 4 | 1 | 2 | 3 | 1 | 3 | 3 | | | | Balloon Vine | Vine | | |
| *Carex appressa* | Cyperaceae | 1 | 2 | 2 | | | | | | | | | | 1 | 2 | 2 | Tall Sedge | Graminoid | | |
| *Carex inversa* | Cyperaceae | | | | | | | | | | | | | 1 | 2 | 2 | Knob Sedge | Graminoid | | |
| *Carex* sp. | Cyperaceae | | | | | | | | | | | | | 1 | 1 | 2 | | Graminoid | | |
| *Casuarina cunninghamiana* | Casuarinaceae | 1 | 2 | 2 | | | | 1 | 2 | 3 | 1 | 2 | 3 | | | | River Oak, River Sheoak | Tree | | Riverflat Eucalypt |
| *Centella asiatica* | Apiaceae | | | | | | | | | | | | | 1 | 2 | 2 | Gotu Cola | Herb | | Riverflat Eucalypt |
| *Cerinthe* major *purpurascens** | Boraginaceae | | | | | | | | | | | | | 1 | 1 | 2 | Honeywort | Shrub | | |
| *Cestrum parqui** | Solanaceae | | | | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Green Poison Berry | Shrub | 3 | |
| *Cheilanthes sieberi* | Adiantaceae | | | | | | | 1 | 2 | 2 | | | | | | | Mulga Fern | Herb | | Riverflat |

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| | | ML S | | | ML N | | | WL S | | | WL N | | | Weir | | | Vegetation Attributes | | Weed Control | Conservation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Family | P | D | C | P | D | C | P | D | C | P | D | C | P | D | C | Common Name | Growth form | Category | Value |
| *Chenopodium album** | Chenopodiaceae | | | | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Fat Hen | Herb | | Eucalypt |
| *Chloris guyana** | Poaceae | 1 | 3 | 2 | | | | | | | | | | | | | Rhodes Grass | Graminoid | | |
| *Cirsium vulgare** | Asteraceae | | | | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | Spear Thistle | Herb | | |
| *Commelina cyanea* | Commelinaceae | | | | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | | | | Scurvy weed | Graminoid | | Riverflat Eucalypt |
| *Conyza bonariensis** | Asteraceae | 1 | 3 | 2 | 1 | 4 | 2 | 1 | 3 | 2 | | | | 1 | 3 | 2 | Flaxleaf, Fleabane | Herb | | |
| *Cynodon dactylon* | Poaceae | 1 | 4 | 3 | 1 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | 1 | 3 | 3 | Couch, Bermudagrass | Graminoid | | |
| *Cyperus brevifolius** | Cyperaceae | 1 | 3 | 2 | | | | 1 | 3 | 2 | | | | 1 | 2 | 2 | Mullumbimby Couch | Graminoid | | |
| *Cyperus eragrostis** | Cyperaceae | | | | | | | | | | 1 | 2 | 2 | 1 | 3 | 2 | | Graminoid | | |
| *Cyperus rotundus** | Cyperaceae | 1 | 2 | 2 | | | | | | | | | | | | | Purple Nut Sedge | Graminoid | | |
| Dandelion sp.* | Asteraceae | | | | | | | 1 | 2 | 2 | | | | | | | Dandelion | Herb | | |
| *Digitaria sanguinalis** | Poaceae | 1 | 4 | 3 | 1 | 3 | 2 | 1 | 4 | 3 | 1 | 4 | 2 | | | | Summer grass | Graminoid | | |
| *Eharta erecta** | Poaceae | 1 | 4 | 3 | 1 | 3 | 3 | 1 | 4 | 2 | 1 | 3 | 3 | 1 | 4 | 2 | | Graminoid | | |
| *Eichhornia crassipes** | Pontederiaceae | 1 | 2 | 2 | | | | | | | | | | | | | Water Hyacinth | Water Plant | 3 | |
| *Eleusine indica** | Poaceae | | | | | | | | | | 1 | 2 | 1 | | | | Crowsfoot Grass | Graminod | | |
| *Eleusine tristachya** | Poaceae | | | | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | Goose Grass | Graminoid | | |
| *Eragrostis curvula** | Poaceae | 1 | 4 | 3 | | | | 1 | 4 | 3 | 1 | 4 | 3 | 1 | 3 | 2 | African lovegrass | Graminoid | | |
| *Eucalyptus amplifolia* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Cabbage Gum | Tree | | Riverflat Eucalypt |
| *Eucalyptus baueriana* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Blue Box | Tree | | Riverflat Eucalypt |
| *Eucalyptus terticornis* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Forest Red Gum | Tree | | Riverflat Eucalypt |
| *Euphorbia peplus** | Euphorbiaceae | | | | | | | | | | | | | 1 | 2 | 2 | Petty Spurge | Herb | | |
| *Ficus coronata** | Moraceae | | | | | | | | | | 1 | 2 | 2 | | | | Sandpaper Fig | Tree | | |
| *Foeniculum vulgare** | Apiaceae | 1 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Fennel | Herb | | |
| *Gahnia sieberiana* | Cyperaceae | | | | | | | | | | | | | 1 | 2 | 2 | Red-Fruit Saw Sedge | Graminoid | | |
| *Gleditsia triacanthos** | Fabaceae | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Honey Locust tree | Tree | | |
| *Glochidion ferdinandi* | Phyllanthaceae | | | | | | | 1 | 1 | 2 | | | | | | | Cheese Tree | Tree | | |
| *Glycine tabacina* | Fabaceae | | | | | | | | | | | | | 1 | 2 | 2 | Gycine Pea | Herb | | Riverflat Eucalypt |
| *Grevillea robusta** | | 1 | 1 | 3 | | | | | | | | | | | | | Silky Oak | Tree | | |
| *Helianthus annuus** | Asteraceae | | | | | | | 1 | 2 | 2 | 1 | 2 | 2 | | | | Common Sunflower | Herb | | |
| *Heliotropium amplexicaule ** | Boraginaceae | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | | | | | | | Blue Heliotrope | Herb | | |
| *Ipomoea indica** | Convolvulaceae | 1 | 2 | 2 | | | | | | | | | | | | | Blue Morning glory | Vine | | |
| *Juncus usitatis* | Juncaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | Common Rush | Graminoid | | |

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| | | ML S | | | ML N | | | WL S | | | WL N | | | Weir | | | Vegetation Attributes | | Weed Control | Conservation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Species** | **Family** | **P** | **D** | **C** | **P** | **D** | **C** | **P** | **D** | **C** | **P** | **D** | **C** | **P** | **D** | **C** | **Common Name** | **Growth form** | **Category** | **Value** |
| *Lactuca serriola** | Asteraceae | | | | | | | | | | 1 | 2 | 2 | 1 | 2 | 2 | Prickly Lettuce | Herb | | |
| *Lantana camara** | Verbenaceae | 1 | 2 | 2 | 1 | 4 | 4 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 2 | Lantana | Shrub | 5 | |
| *Lepidium* pseudohyssopifolium* | Brassicaceae | | | | | | | 1 | 2 | 2 | | | | | | | Pepperweed | Herb | | |
| *Ligustrum lucidium** | Oleaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | | | | Large Leaved Privet | Tree | 4 | |
| *Ligustrum sinense** | Oleaceae | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 2 | Small Leafed Privet | Tree | 4 | |
| *Lonicera japonica** | Caprifoliaceae | | | | | | | | | | 1 | 2 | 2 | | | | Japanese Honeysuckle | Vine | | |
| *Ludwigia peploides* | Onagraceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | | | | Water Primrose | Herb | | |
| *Ludwigia peruviana** | Onagraceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | 1 | 2 | 2 | | | | Primrose Willow | Water Plant | 3 | |
| *Maple* sp.* | | | | | 1 | 1 | 2 | | | | | | | | | | | Graminoid | | |
| *Melia azedarach* | Meliaceae | 1 | 2 | 2 | | | | | | | | | | | | | White Cedar | Tree | | Riverflat Eucalypt |
| *Microlaena stipoides* | Poaceae | 1 | 4 | 2 | 1 | 4 | 2 | 1 | 4 | 2 | 1 | 4 | 2 | | | | Weeping grass | Graminoid | | Riverflat Eucalypt |
| *Modiola* sp.* | | | | | 1 | 2 | 2 | | | | | | | 1 | 2 | 2 | | | | |
| *Oenothera indecora subsp. bonariensis** | Onagraceae | | | | | | | 1 | 2 | 2 | | | | | | | Evening Primrose | Herb | | |
| *Oenothera rosea** | Onagraceae | | | | | | | | | | | | | 1 | 2 | 2 | Pink Primrose | Herb | | |
| *Onopordum acanthium** | Asteraceae | 1 | 2 | 2 | | | | | | | | | | 1 | 3 | 2 | Scotch Thistle | Herb | | |
| *Oplismenus aemulus* | Poaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Basket Grass | Graminoid | | Riverflat Eucalypt |
| *Opuntia* sp. * | Cactaceae | | | | | | | 1 | 1 | 2 | | | | | | | Pricly Pear | Shrub | 4 | |
| *Oxalis perennans* | Oxalidaceae | | | | 1 | 2 | 2 | 1 | 2 | 2 | | | | 1 | 2 | 2 | | Herb | | Riverflat Eucalypt |
| *Paspalum dilatatum** | Poaceae | 1 | 4 | 3 | | | | 1 | 4 | 3 | 1 | 4 | 3 | 1 | 2 | 2 | Paspalum | Graminoid | | |
| *Paspalum distichum** | Poaceae | 1 | 3 | 2 | | | | | | | | | | 1 | 2 | 2 | Water Couch | Graminoid | | |
| *Paspalum urvillei** | Poaceae | | | | | | | | | | 1 | 2 | 2 | | | | Vasey Grass | Graminoid | | |
| *Pavonia hastata** | Malvaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | | | | Pink Pavonia | Subshrub | | |
| *Pennisetum clandestinum** | Poaceae | 1 | 4 | 3 | 1 | 3 | 3 | 1 | 4 | 3 | 1 | 4 | 3 | 1 | 4 | 3 | Kikuyu grass | Graminoid | | |
| *Periscaria decipiens* | Polygonaceae | 1 | 2 | 2 | | | | | | | | | | | | | Slender knotweed | Graminoid | | Riverflat Eucalypt |
| *Persicaria orientalis* | Polygonaceae | | | | | | | 1 | 1 | 1 | | | | 1 | 1 | 1 | Princess feathers | Herb | | |
| *Persicaria subsessilis* | Polygonaceae | | | | | | | | | | | | | 1 | 2 | 2 | Hairy Knotweed | Herb | | |
| *Phragmites australis* | Poaceae | | | | | | | | | | 1 | 2 | 2 | | | | | Herb | | |
| *Phytollaca octandra** | Phytolaccaceae | | | | | | | | | | | | | 1 | 2 | 2 | Pokeweed | Shrub | | |
| *Plantago lanceolata** | Plantaginaceae | | | | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | Lambs Tongue | Herb | | |
| *Portoluca* sp. * | Portulacaceae | 1 | 2 | 2 | 1 | 2 | 2 | | | | | | | | | | | Herb | | |
| *Prunus* sp. * | Rosaceae | | | | | | | 1 | 2 | 2 | | | | | | | Wild Cherries | Shrub | | |

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| | | ML S | | | ML N | | | WL S | | | WL N | | | Weir | | | Vegetation Attributes | | Weed Control | Conservation |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Species | Family | P | D | C | P | D | C | P | D | C | P | D | C | P | D | C | Common Name | Growth form | Category | Value |
| *Ricinus comunis** | Euphorbiaceae | 1 | 2 | 2 | 1 | 2 | 3 | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 1 | 2 | Castor Oil Plant | Shrub | | |
| *Robinia pseudoacacia* * | Fabaceae | | | | 1 | 2 | 3 | | | | | | | | | | Black Locust | Tree | | |
| *Rubus fruiticosus** | Rosaceae | | | | | | | 1 | 2 | 2 | | | | 1 | 2 | 2 | Blackberry | Shrub | 4 | |
| *Rumex crispus** | Polygonaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | 1 | 3 | 2 | Curled Dock | Herb | | |
| *Salix* sp. * | Salicaceae | 1 | 2 | 3 | | | | 1 | 2 | 3 | | | | 1 | 1 | 1 | Willow Herb | Tree | 5 | |
| *Schinus molle** | | 1 | 2 | 2 | | | | | | | | | | | | | Peppercorn Tree | Tree | | |
| *Senecio madagascariensis** | Asteraceae | | | | 1 | 3 | 3 | 1 | 2 | 2 | | | | | | | Fireweed | Herb | | |
| *Setaria parviflora** | Poaceae | 1 | 4 | 2 | | | | 1 | 4 | 2 | | | | 1 | 4 | 2 | Pigeon Grass | Graminoid | | |
| *Setaria pumila** | Poaceae | | | | | | | 1 | 2 | 2 | 1 | 2 | 2 | | | | Pale Pigeongrass | Graminoid | | |
| *Sida rhombifolia** | Malvaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | Paddy's Lucerne | Shrub | | |
| *Sigesbeckia orientalis* | Asteraceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | | | | | Herb | | Riverflat Eucalypt |
| *Solanum linnaeanum** | Solanaceae | | | | | | | | | | | | | 1 | 2 | 2 | Apple of Sodom | Shrub | | |
| *Solanum mauritianum** | Solonaceae | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 1 | 2 | Wild Tobacco Tree | Shrub | | |
| *Solanum nigrum** | Solanaceae | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Blackberry Nightshade | Herb | | |
| *Sonchus oleraceous* * | Asteraceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | | | | Hares Lettuce | Herb | | |
| *Sorghum halepense** | Poaceae | 1 | 3 | 2 | 1 | 3 | 2 | | | | | | | | | | Sorghum | Graminoid | 4 | |
| *Sporobolus fertilis** | Poaceae | 1 | 2 | 2 | | | | 1 | 1 | 1 | | | | 1 | 1 | 1 | | Graminoid | 3 | |
| *Tagetes minuta** | Asteraceae | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 2 | 1 | 3 | 3 | 1 | 3 | 2 | Stinking Rodger, Purpletop | Herb | | |
| *Tredescantia albiflora** | Commelinaceae | | | | 1 | 2 | 3 | 1 | 2 | 2 | 1 | 2 | 3 | | | | Wandering Jew | Vine | | |
| Tulip sp. * | | 1 | 1 | 1 | | | | | | | | | | | | | | Herb | | |
| *Typha orientalis* | Typhaceae | 1 | 2 | 2 | | | | | | | | | | | | | Broadleaf Cumbungi | Graminoid | | |
| *Trifolium repens** | Fabaceae | | | | | | | 1 | 2 | 2 | | | | | | | White clover | Herb | | |
| *Ulmus parviflora** | Ulmaceae | 1 | 2 | 2 | | | | | | | | | | | | | Chinese Elm | Tree | | |
| Unknown weed sp. 1* | | | | | | | | 1 | 2 | 1 | | | | | | | | Graminoid | | |
| Unknown weed sp. 2* | | | | | | | | 1 | 1 | 1 | | | | | | | | Graminoid | | |
| Unknown weed sp. 3* | | | | | 1 | 2 | 1 | | | | | | | | | | | Graminoid | | |
| *Viscum album** | Loranthaceae | | | | | | | 1 | 2 | 2 | | | | | | | Mistletoe plant | Tree | | |
| *Vivia* sp.* | Fabaceae | | | | | | | | | | | | | 1 | 2 | 2 | Hairy Vetch | Herb | | |
| *Verbena bonariensis** | Verbenaceae | 1 | 3 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Purpletop | Herb | | |
| *Wahlenbergia gracillis* | Campanulaceae | | | | | | | 1 | 2 | 2 | | | | | | | Australian Bluebell | Herb | | Riverflat Eucalypt |
| | **TOTALS** | **60** | | | **34** | | | **69** | | | **47** | | | **56** | | | | | | |

# APPENDIX B

# Site Photolog

| Main Lake South | |
|---|---|
|  |  |
| 1) A high Significance Value *E.deanii* present on site. | 2) Open grassland within the site. Three planted eucalypts on top of bank. |
|  |  |
| 3) Open grassland with high weed density. | 4) A high Significance Value *C.cunninghamiana* present on site. |

| | |
|---|---|
|  |  |
| 5) Looking west across the Nepean River. | 6) Riparian vegetation adjacent to the shoreline. |
|  |  |
| 7) Previously cleared land with planted tree on top of bank. | 8) Castor Oil (*Ricinus comunis*) plants, a weed, present on site. |

| Main Lake North | |
|---|---|
|  |  |
| 1) Top of bank looking west across the Nepean River | 2) Top of Bank showing evidence of previous clearing. |
|  |  |
| 3) *Lantana camara* dominates the site. A potential pig/wombat run is present under the lantana. | 4) *Cestrum parqui* (a weed) present on site). Trees covered with Lantana *(Lantana camara),* Balloon Vine *(Cardiospermum grandiflorum)* and Madeira vine *(Anredera cordiflora)* are visible in the background. |

| | |
|---|---|
|  |  |
| 5) Lantana density covers a height of at least 1m. | 6) Looking down the bank. High presence of weeds and vines. |
|  |  |
| 7) Willow species (Salix spp.) are numerous along the shoreline. | 8) Marsh swamp present in the lower reaches of the site. |

| Wildlife Lake South | |
|---|---|
|  |  |
| 1) Site vegetation structure demonstrating, understorey, midstorey and overstorey. | 2) Presence of *A.implexa* and exotic shrubs. |
|  |  |
| 3) Exotic grass species along the top of bank. | 4) Top of bank looking east across the Nepean River. |

| | |
|---|---|
|  |  |
| 5) *C.cunninghamiana* with Balloon Vine (*Cardiospermum grandiflorum*). | 6) Areas within the site recently cleared of Lantana. |

| Wildlife Lake North | |
|---|---|
|  |  |
| 1) Exotic shrub and weed species dominant the groundcover. | 2) A remnant stand of casuarinas is present on site adjacent to previously cleared land. |
|  |  |
| 3) *A.implexa* present on site. | 4) Balloon Vine (*Cardiospermum grandiflorum*) |

| | |
|---|---|
|  |  |
| 5) Looking up towards the top of bank. | 6) The site appears to have been previously cleared. |
|  |  |
| 7) Significant *C.cunninghamiana* stand. | 8) Lace Monitor (*Varanus varius*) observed on *C.cunninghamiana* on site. |

# APPENDIX C
# River-flat Eucalypt Forest species (based on EEC listing of species in the TSC Act 1995) recorded within the proposed sites, at Penrith Lakes Scheme

| Species | Family | ML S | | | ML N | | | WL S | | | WL N | | | Weir | | | Vegetation Attributes | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | P | D | C | P | D | C | P | D | C | P | D | C | P | D | C | Common Name | Growth form |
| *Angophora floribunda* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Rough Barked Apple | Tree |
| *Breynia oblongifolia* | Phyllanthaceae | | | | | | | 1 | 2 | 2 | | | | | | | Coffee Bush | Shrub |
| *Casuarina cunninghamiana* | Casuarinaceae | 1 | 2 | 2 | | | | 1 | 2 | 3 | 1 | 2 | 3 | | | | River Oak, River Sheoak | Tree |
| *Centella asiatica* | Apiaceae | | | | | | | | | | | | | 1 | 2 | 2 | Gotu Cola | Herb |
| *Cheilanthes sieberi* | Adiantaceae | | | | | | | 1 | 2 | 2 | | | | | | | Mulga Fern | Herb |
| *Commelina cyanea* | Commelinaceae | | | | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | | | | Scurvy weed | Graminoid |
| *Eucalyptus amplifolia* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Cabbage Gum | Tree |
| *Eucalyptus baueriana* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Blue Box | Tree |
| *Eucalyptus terticornis* | Myrtaceae | | | | | | | | | | 1 | 1 | 2 | | | | Forest Red Gum | Tree |
| *Glycine tabacina* | Fabaceae | | | | | | | | | | | | | 1 | 2 | 2 | Gycine Pea | Herb |
| *Melia azedarach* | Meliaceae | 1 | 2 | 2 | | | | | | | | | | | | | White Cedar | Tree |
| *Microlaena stipoides* | Poaceae | 1 | 4 | 2 | 1 | 4 | 2 | 1 | 4 | 2 | 1 | 4 | 2 | | | | Weeping grass | Graminoid |
| *Oplismenus aemulus* | Poaceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | 1 | 2 | 2 | 1 | 2 | 2 | Basket Grass | Graminoid |
| *Oxalis perennans* | Oxalidaceae | | | | 1 | 2 | 2 | 1 | 2 | 2 | | | | 1 | 2 | 2 | | Herb |
| *Periscaria decipiens* | Polygonaceae | 1 | 2 | 2 | | | | | | | | | | | | | Slender knotweed | Graminoid |
| *Sigesbeckia orientalis* | Asteraceae | 1 | 2 | 2 | | | | 1 | 2 | 2 | | | | | | | | Herb |
| *Wahlenbergia gracillis* | Campanulaceae | | | | | | | 1 | 2 | 2 | | | | | | | Australian Bluebell | Herb |
| | Total Riverflat spp | 6 | | | 3 | | | 9 | | | 8 | | | 4 | | | | |
| | Total Native spp. | 13 | | | 4 | | | 15 | | | 13 | | | 14 | | | | |
| | Total Weed spp. | 47 | | | 30 | | | 53 | | | 33 | | | 42 | | | | |
| | Total spp | 60 | | | 34 | | | 68 | | | 46 | | | 56 | | | | |

# APPENDIX D
# River-flat Eucalypt Forest EEC Determination