

Lake Macquarie City Council

Bushland Management Plan: Hunter Sports Centre, Glendale

May 2006

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1.0 INTRODUCTION

The Hunter Sports Centre (Lot 32 DP 883898) is located on land owned by Lake Macquarie City Council (LMCC) on Stockland Drive, Glendale, approximately 4 kilometres north of Lake Macquarie, NSW (**Figure 1.1**). The Sports Centre has been in operation since February 1999 and the need for the addition of a cross-country running track through the riparian bushland on the site has been identified.

Development consent for the Hunter Sports Centre was granted on 27 March 1998. Due to the identification of a significant impact on threatened species and the subsequent preparation of a Species Impact Statement (SIS) the National Parks and Wildlife Service (now the Department of Environment and Conservation, DEC) was required to grant concurrence to the construction of the Centre. Concurrence was granted on 28 October 1997. As part of the development consent, conditions relating to the protection and enhancement of the ecological values of the riparian zone adjacent to the Sports Centre were included. Conditions 40 and 41 of the development consent (DA /98/00073) require the preparation of a Bushland Management Plan to the satisfaction of DEC. Conditions 40 and 41 state:

40. The applicant is to prepare, within one (1) year of the date of this consent; a Management Plan which outlines measures to:

- (i) rehabilitate riparian areas within the subject site; and*
- (ii) enhance the habitat values and maintain and improve the ecological integrity of areas zoned 7(a) Environmental Protection within the study area.*

41. All actions and measures outlined in the Management Plan are to be implemented to the satisfaction of Council and the National Parks and Wildlife Service.

The aims of the Bushland Management Plan, as stated in the consultants brief provided by LMCC, are:

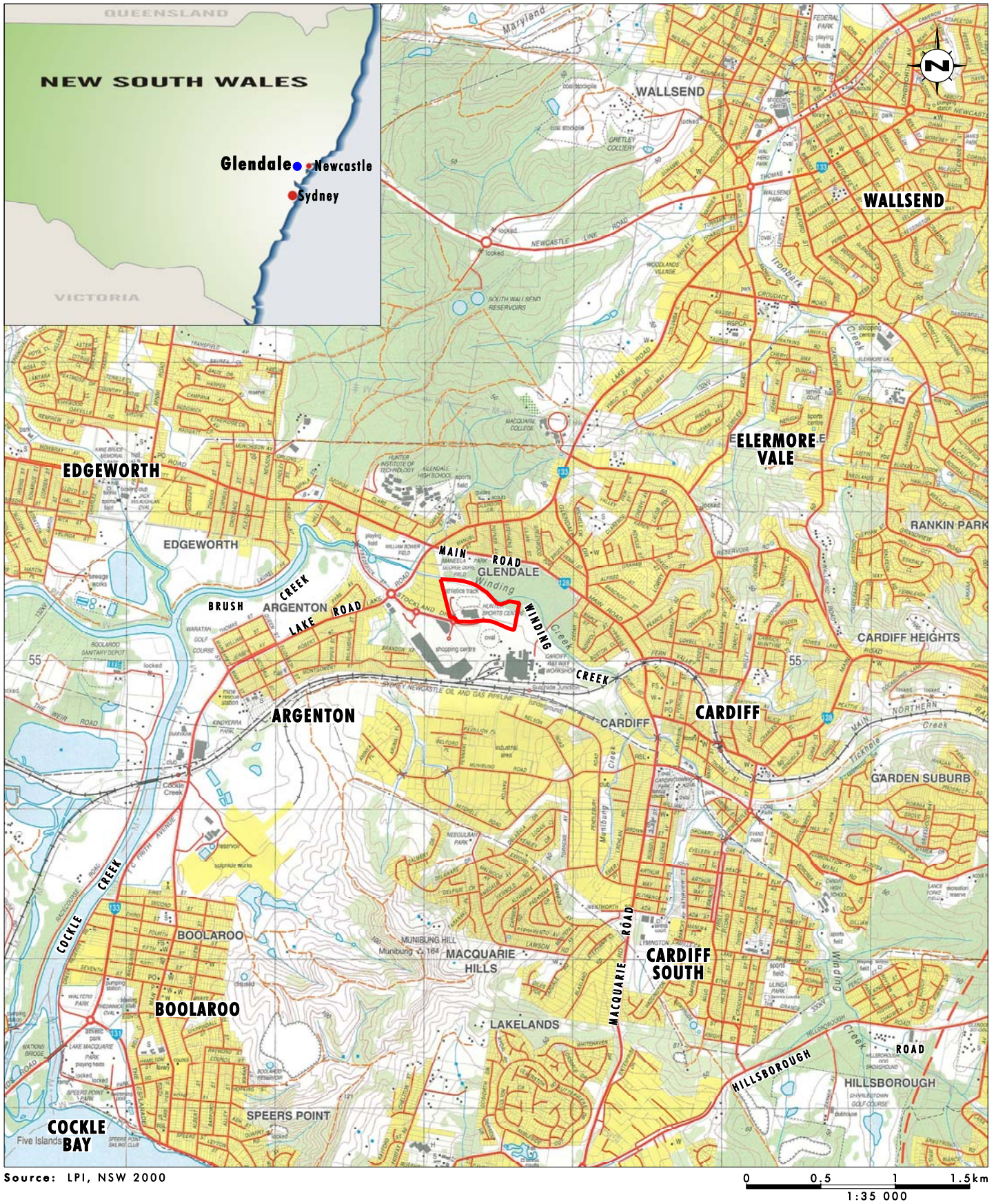
- to rehabilitate riparian areas within the subject site;
- enhance the habitat values; and
- maintain and improve the ecological integrity of the area.

The Plan will address the potential inclusion of a cross-country running track through the riparian bushland, and adjoining areas, to the Glendale Sports Centre.

1.1 SCOPE

LMCC has specified that the Bushland Management Plan addresses the following issues:

- builds upon existing knowledge and species lists;
- rehabilitation of bushland, including species recommendations;
- management of threatened flora species, including an explicit scope of works;
- rehabilitation of disturbed areas;
- preservation, rehabilitation and enhancement of fauna habitat;



Legend
 Hunter Sports Centre

FIGURE 1.1
Locality Plan

-
- restoration of erosion along creek banks;
 - identification of an alignment for a future walking/running path through the riparian zone;
 - provision of options for community involvement in rehabilitation and monitoring activities; and
 - preparation of a weed species list, a prioritisation of weed species on the site and a weed control strategy.

1.2 AREA COVERED BY BUSHLAND MANAGEMENT PLAN

The Bushland Management Plan covers the riparian area on the southern side of Winding Creek, located immediately to the north of the Hunter Sports Centre (**Figure 1.2**). The Hunter Sports Centre covers a total area of 9.6 hectares and the extent of the riparian area within it is approximately 2.2 hectares (the study area).

Lake Macquarie Local Environment Plan 2004 indicates that the riparian area is zoned 7(2) Conservation (Secondary) and the remnant bushland to the north of riparian area is zoned 3(2) Urban Centre (Support).

1.3 OBJECTIVES

A range of objectives have been determined following a site inspection, consultation with LMCC and DEC staff and consideration of the aims and scope provided in the consultants brief. The objectives of the Bushland Management Plan are to:

- provide a strategy to enhance and maintain the ecological values of the bushland contained within the study area;
- ensure effective management of threatened fauna species and regionally significant vegetation communities;
- devise management strategies to address the current threats to the ecological values of the study area;
- provide opportunities for community involvement and recreation; and
- comply with the relevant conditions of consent issued for the development of the Hunter Sports Centre, Glendale.

1.4 RELEVANT LEGISLATION

1.4.1 Threatened Species Conservation Act 1995

The *Threatened Species Conservation Act* 1995 (TSC Act) provides protection for threatened plants and animals native to NSW (excluding fish and marine vegetation). Species listed under Schedules 1 and 2 of the TSC Act are considered threatened in NSW. Those in Schedule 1 are considered endangered, whilst those in Schedule 2 are considered vulnerable.



Source: LMCC

0 100 200 300m
1:6 000

Legend

- Hunter Sports Centre
- Study Area

FIGURE 1.2

Study Area

Protection is provided by integrating the conservation of threatened species into development control processes under the *Environmental Planning and Assessment Act 1979* (EP&A Act). Under the EP&A Act, impacts on threatened species are assessed by an eight-part test to determine whether a development is likely to have a significant effect on threatened species. Where a significant effect is likely to occur, the preparation of an SIS is required.

An eight-part test was conducted prior to the development of the Hunter Sports Centre on threatened species that had previously been recorded in the study area (ERM Mitchell McCotter 1996). This resulted in the preparation of an SIS (Forest Fauna Surveys et al.) considering two threatened flora and 24 threatened fauna species.

This management plan includes management and monitoring requirements for the protection of threatened species identified by ERM Mitchell McCotter (1996) and Forest Fauna Surveys et al. (1996).

1.4.2 Environment Protection and Biodiversity Conservation Act 1999

Under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act), approval from the Commonwealth Minister for the Environment is required for any action that may have a significant impact on matters of national environmental significance. These matters are:

- World Heritage properties;
- Ramsar wetlands;
- Cetaceans, migratory species, threatened species, critical habitats or ecological communities listed under the EPBC Act 1999;
- Commonwealth land, marine areas or reserves; and
- Nuclear actions.

The EPBC Act had not commenced at the time of preparation of the Flora and Fauna Assessment (ERM Mitchell McCotter 1996) and was therefore not considered. Threatened and migratory species listed under the provisions of the EPBC Act are considered in this report (refer to **Section 2.3.1**) and in the development of management strategies.

1.4.3 Noxious Weeds Act 1993

The objectives of the *Noxious Weeds Act 1993* are to:

- identify noxious weeds in respect of which particular control measures need to be taken;
- specify those control measures;
- specify the duties of public and private landholders as to the control of those noxious weeds; and
- provide a framework for the State-wide control of those noxious weeds by the Minister and local control authorities.

Noxious weeds are categorised depending on the management and control requirements of the particular species. The categories include:

- W1:** The presence of the weed on land must be notified to the local control authority and the weed must be fully and continuously suppressed and destroyed.
- W2:** The weed must be fully and continuously suppressed and destroyed.
- W3:** The weed must be prevented from spreading and its numbers and distribution reduced.
- W4:** The weed must not be sold, propagated or knowingly distributed. Additional specific codes are related to particular species, with listing from W4a to W4g, which signify particular control strategies for given species.

1.4.4 Local Government Act 1993

The *Local Government Act 1993* (as amended) provides the key legislative framework for the management of public land under the ownership of a local government authority. LMCC is required to prepare a Plan of Management for community land in accordance with the Act. As part of the Plan of Management, the relevant land is classified according to its characteristics and use. It is considered that the study area would be classified as a natural area under LMCC's generic Plan of Management for Community Land.

The core objectives for the management of community land categorised as a natural area are:

- to conserve biodiversity and maintain ecosystem function in respect of the land, or the feature or habitat in respect of which the land is categorised as a natural area;
- to maintain the land, or that feature or habitat, in its natural state and setting;
- to provide for the restoration and regeneration of the land;
- to provide for community use of and access to the land in such a manner as will minimise and mitigate any disturbance caused by human intrusion; and
- to assist in and facilitate the implementation of any provisions restricting the use and management of the land that are set out in a recovery plan or threat abatement plan prepared under the *Threatened Species Conservation Act 1995* or the *Fisheries Management Act 1994*.

This Bushland Management Plan meets the core objectives for the management of community land, as prescribed by the *Local Government Act 1993*.

1.5 CONSULTATION

This plan has been prepared in consultation with the LMCC project manager, Meg Warnock, Strategic Landscape Planner. Further consultation was undertaken with Robbie Economos-Shaw, Strategic Planner at LMCC and Peta Norris of DEC.

A draft version of this plan was submitted to LMCC and DEC for review and comments were incorporated into the final report.

2.0 EXISTING ENVIRONMENT & VALUES

2.1 LOCAL CONTEXT

The study area is situated in a significant bushland remnant in Glendale, which currently occupies approximately 40 hectares. Winding Creek is an important feature of the remnant. The ecological values of Winding Creek and the Glendale bushland remnant are important in considering the ecological values of the study area, which at 2.2 hectares, forms only a small portion of the wider context area. **Sections 2.1, 2.2 and 2.4** provide contextual information that helps to identify the flora and fauna values of the study area and situate the study area in a wider total catchment perspective.

A flora and fauna assessment of a 68 hectare site, which included the Hunter Sports Centre site, was undertaken by ERM Mitchell McCotter in 1996. The report recommended the preparation of an SIS, following the identification of a powerful owl (*Ninox strenua*) and the eastern bent-wing bat (*Miniopterus schreibersii oceanensis*) and the tentative identification of a rose-crowned fruit dove (*Ptilinopus regina*). In 1996 an SIS was prepared by Forest Fauna Surveys, EcoPro Pty Ltd and Fly by Night Bat Surveys Pty Ltd for the threatened species located, or considered likely to occur, on the site. The ecological values of the riparian zone identified in these reports are discussed in detail below.

2.2 ECOLOGICAL VALUE OF WINDING CREEK UPSTREAM OF THE STUDY AREA

2.2.1 Vegetation and Ecological Function

Winding Creek flows north-west from Charlestown, through Hillsborough, Cardiff and Glendale, where it joins Brush Creek at Argenton before entering Lake Macquarie at Cockle Bay. For a large portion of its length, Winding Creek has been artificially channelised, effectively functioning as a stormwater drain. There are some remaining pockets of riparian bushland along Winding Creek at Charlestown and Glendale, however these remnant riparian areas contain a high level of weed infestation and are generally isolated from extensive areas of remnant bushland.

Winding Creek serves an important ecological function as a riparian corridor. The riparian zone within the study area has been mapped as a riparian corridor of native vegetation on the Lake Macquarie Native Vegetation and Corridors Map (LMCC 2003). The riparian areas immediately to the east and west of the study area have also been mapped as a functioning riparian corridor, and consequently the study area serves as the only corridor linking these two areas of remnant bushland. The entire length of Winding Creek however is not a continuous riparian corridor, with the areas that have been channelised in the Cardiff region mapped as requiring rehabilitation in order to assist corridor function.

The Winding Creek riparian area provides habitat for a variety of common fauna species, such as birds, reptiles, amphibians and mammals. Habitat for bird species that commonly occur in urban environments is present in the riparian zone and common mammal species such as the common brushtail possum (*Trichosurus vulpecula*) are expected to utilise the area. The riparian area also functions as a corridor for fauna species, allowing movement to nearby bushland remnants. However, the high level of disturbance, creek bank erosion and weed infestation is expected to limit the availability of habitat for many fauna species.

The vegetation communities associated with Winding Creek have been described and mapped by the Lower Hunter and Central Coast Regional Environmental Management Strategy (LHCCREMS) (NPWS 2000). The headwaters of Winding Creek are located on the western side of the Pacific Highway at Charlestown. Coastal Plains Smooth-barked Apple Woodland dominates the upper

reaches of the Winding Creek catchment. Lower order sections of the creek are characterised by Alluvial Tall Moist Forest, which occurs at Charlestown and Hillsborough, with small pockets of approximately one hectare at Cardiff South and at Glendale. At Argenton, the creek becomes more expansive and is dominated by Swamp Oak Rushland Forest at the confluence with Brush Creek (NPWS 2000).

The following descriptions have been taken from the LHCCREMS technical report (NPWS 2000) which described the floristic characteristics of the vegetation communities mapped in the lower Hunter and Central Coast region. Alluvial Tall Moist Forest is the only vegetation community that has been recorded in the study area (NPWS 2000).

2.2.1.1 Coastal Plains Smooth-barked Apple Woodland

Coastal Plains Smoothbarked Apple Woodland is a dry shrubby forest occurring along the coastal plain south from the Wyong Region to Medowie near Port Stephens in the north. Angophora costata and Corymbia gummifera consistently occur as dominant canopy species usually to height of between 20-25 metres. In some areas Eucalyptus umbra and E. capitellata will be dominant or co-dominant. Other noticeable variations in canopy species include the presence of E. piperata and E. globoidea in Medowie State Forest and the occasional occurrence of C. maculata near Wallsend to the north west of Lake Macquarie. The dry shrubby mid-story is characterised by the occurrence of Allocasuarina littoralis, Banksia spinulosa, and Acacia myrtifolia. These features often become well developed where the forest canopy is more open. Less commonly found in the mid-story are Leptospermum polygalifolium, Dodonaea triquetra, Lambertia formosa, and Dillwynia retorta. The ground layer is dominated by grasses such as Entolasia stricta and Themeda australis. Other common species found among the lower stratum are Lomandra obliqua, Pteridium esculentum, Phyllanthus hirtellus, Imperata cylindrica var. major, and Lepidosperma laterale.

2.2.1.2 Alluvial Tall Moist Forest

Alluvial Tall Moist Forest occurs in areas of higher rainfall on deep alluvial soils. The tallest stratum in this community ranges between a sparse eucalypt emergent and a tall open forest. Below this is a moderately dense small tree canopy consisting of rainforest species and Melaleuca spp. Understorey vegetation consists largely of mesic small trees, herbs and ferns. The tree stratum is highly varied with combinations of Eucalyptus saligna, Syncarpia glomulifera, Angophora floribunda, and Eucalyptus robusta most common. The small tree stratum is typified by Glochidion ferdinandi, Acmena smithii, Melaleuca styphelioides, Ficus coronata, Melaleuca linariifolia, Callistemon salignus and Backhousia myrtifolia. The shrub layer is floristically variable but commonly includes species Breynia oblongifolia, Gahnia clarkei and Acacia irrorata subsp. irrorata. The understorey in this community also supports a moderately high diversity of climbers and twiners (11 species), the most common being Geitonoplesium cymosum and Dioscorea transversa. The moderately dense ground layer is comprised of grasses, ferns and herbs such as Adiantum aethiopicum, Pseuderanthemum variabile, Entolasia marginata, Lomandra longifolia, Oplismenus imbecillis and Pratia purpurascens.

Alluvial Tall Moist Forest represents the gradient between well -developed rainforest on alluvium and Swamp Mahogany - Paperbark Swamp Forest.

2.2.1.3 Swamp Oak Rushland Forest

Swamp Oak - Rushland Forest occurs in low-lying areas and along coastal lagoon fringes where brackish-saline groundwater or periodic inundation by saline tidal waters exerts a strong influence on the range of species present. The low forest canopy ranges from moderate to open depending on the relative abundances of Casuarina glauca and Melaleuca quinquenervia. This community is often characterised by monospecific stands of Swamp Oak. In other areas where the saline influence is less pronounced, canopy species might include Melaleuca ericifolia, Melaleuca quinquenervia, Eucalyptus robusta and Eucalyptus tereticornis. Mid-storey vegetation is sparse

and often absent, although when present it is usually characterised by tall reeds and rushes (2 to 3 metres) such as *Phragmites australis* and *Cladium procerum*. The dense ground layer is characterised by salt tolerant rushes, grasses and herbs including *Baumea juncea*, *Juncus kraussii* subsp *australiensis*, *Sporobolus virginicus* and *Apium prostratum*.

Swamp Oak – Rushland Forest is widespread along lake foreshores and tributaries of the coastal plain.

2.2.2 Conservation Significance of Winding Creek Riparian Vegetation

2.2.2.1 Swamp Oak Rushland Endangered Ecological Community

Swamp Oak Rushland Forest forms part of an endangered ecological community (EEC) under the TSC Act as the community forms part of a complex the Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions (NPWS 2004). The following information has been summarised from the final determination for Swamp Oak Floodplain Forest EEC provided by the NSW Scientific Committee (NPWS 2004).

Swamp Oak Floodplain Forest of the NSW North Coast, Sydney Basin and South East Corner bioregions is the name given to the ecological community associated with grey-black clay-loams and sandy loams, where the groundwater is saline or sub-saline, on waterlogged or periodically inundated flats, drainage lines, lake margins and estuarine fringes associated with coastal floodplains. The structure of the community may vary from open forests to low woodlands, scrubs or reedlands with scattered trees. Typically these forests, woodlands, scrubs and reedlands form mosaics with other floodplain forest communities and treeless wetlands, and often they fringe treeless floodplain lagoons or wetlands with semi-permanent standing water (NPWS 2004)

2.2.2.2 Regionally Significant Vegetation

The Lower Hunter and Central Coast Regional Biodiversity Conservation Strategy (LHCCRBCS) identified communities of regional significance based on the Department of Environment and Heritage (DEH) criteria for listing communities as an EEC (LHCCRBCS 2003). Alluvial Tall Moist Forest and Swamp Oak Rushland Forest meet the criteria for listing as an EEC under the EPBC Act (LHCCRBCS 2003). Alluvial Tall Moist Forest meets criterion 1 (V), indicating that the community has suffered a substantial decline in geographic distribution which is equivalent to 70% or more of the extant distribution of the community. Swamp Oak Rushland Forest is a restricted community that meets criterion 2 (R) which indicates that the community has a small geographic distribution and a threatening process exists for which there is an understood or predicted timeframe. Both of these communities are therefore considered to be regionally significant.

2.2.2.3 Other Vegetation

Coastal Sand Apple Blackbutt Forest was not considered to be regionally significant because it did not meet the criteria for listing under the EPBC Act (LHCCRBCS 2003).

2.3 VEGETATION OF THE STUDY AREA AND SURROUNDS

2.3.1 Vegetation of the Glendale Bushland Remnant

A vegetation assessment was undertaken by ERM Mitchell McCotter (1996) with a supplementary threatened flora survey conducted by EcoPro (1996) as part of the SIS. The following vegetation communities were identified by EcoPro (1996) in the approximately 40 hectare Glendale bushland remnant of which the Winding Creek riparian area is part:

-
- cleared areas;
 - open grassland;
 - blue gum (*Eucalyptus saligna*) closed forest;
 - closed melaleuca (*Melaleuca linariifolia*) swamp forest;
 - spotted gum (*Corymbia maculata*) / white mahogany (*Eucalyptus acmenoides*) open forest;
 - ironbark (*Eucalyptus paniculata*) / white mahogany (*Eucalyptus acmenoides*) / Sydney peppermint (*Eucalyptus piperita*) open forest;
 - ironbark (*Eucalyptus paniculata*) / forest red gum (*Eucalyptus tereticornis*) closed forest;
 - riparian zone;
 - swamp mahogany (*Eucalyptus robusta*) woodland;
 - white mahogany (*Eucalyptus acmenoides*) / stringybark (*Eucalyptus agglomerata*) open forest;
 - moist soak; and
 - scribbly gum (*Eucalyptus haemastoma*) woodland.

Two vegetation communities described above are found within the 2.2 hectare study area based on the site inspection and interpretation of the vegetation mapping undertaken by EcoPro (1996). These communities comprise Riparian Vegetation and White Mahogany (*Eucalyptus acmenoides*) / Stringybark (*Eucalyptus agglomerata*) Open Forest.

2.3.2 Vegetation of the Study Area

The site inspection conducted in September 2005 and the vegetation descriptions provided in the Supplementary Flora Report (EcoPro 1996) confirms the LHCCREMS description and mapping of Alluvial Tall Moist Forest within the study area. Both the riparian zone community and white mahogany (*Eucalyptus acmenoides*) / stringybark (*Eucalyptus agglomerata*) open forest are considered to conform to the description of Alluvial Tall Moist Forest. The extent of vegetation communities in the study area is shown on **Figure 2.1**.

2.3.2.1 Riparian Vegetation

The riparian zone community occurs along Winding Creek, including the eroded stream channel, creek banks and the disturbed edges of the forest communities. This community is dominated by introduced shrubs and small trees in the canopy layer. Mature eucalypt trees to 20 metres high occur in the riparian zone, including Sydney blue gum (*Eucalyptus saligna*), Sydney peppermint (*E. piperita*) and rough-barked apple (*Angophora floribunda*). The understorey is very dense and is dominated by the invasive weed lantana (*Lantana camara*) (EcoPro 1996).

The small tree and shrub layer of the riparian zone is dominated by lantana (*Lantana camara*), green wattle (*Acacia irrorata*), willow bottlebrush (*Callistemon salignus*), snow-in-summer (*Melaleuca linariifolia*), brush kurrajong (*Commersonia fraseri*), and the weeds cassia (*Senna pendula*) and small-leaved privet (*Ligustrum sinense*). The ground layer is also dense in areas that are not dominated by lantana and includes infestations of crofton weed (*Ageratina adenophora*), flaxleaf fleabane (*Conyza bonariensis*), wandering Jew (*Tradescantia fluminensis*) and blackberry



Source: LMCC & Ecopro (1996)

0 50 100 200m
1:4000

Legend

- Hunter Sports Centre Study Area
- White Mahogany / Stringybark Open Forest
- Riparian Vegetation

FIGURE 2.1

**Vegetation Communities
Recorded in Study Area**

(*Rubus* sp.). A range of native species were also common in the ground layer including knotweed (*Persicaria strigosa*), common devil's twine (*Cassytha pubescens*) and blady grass (*Imperata cylindrica*) (EcoPro 1996).

2.3.2.2 White Mahogany (*Eucalyptus acmenoides*) / Stringybark (*Eucalyptus agglomerata*) Open Forest

This community occurs adjacent to the riparian zone vegetation community and occurs as an open forest with canopy tress to approximately 20 metres. Dominant species include blue-leaved stringybark (*Eucalyptus agglomerata*) and white mahogany (*E. acmenoides*). Other less frequently occurring species includes rough-barked apple (*Angophora floribunda*), smooth-barked apple (*A. costata*), red bloodwood (*Corymbia gummifera*) and Sydney peppermint (*E. piperita*). The small tree layer is dominated by regenerating eucalypts, black sheoak (*Allocasuarina littoralis*) and a hybrid sheoak (*A. littoralis* x *A. distyla*) (EcoPro 1996).

The shrub layer is dominated by red-stemmed wattle (*Acacia myrtifolia*) with other species recorded including rough Guinea flower (*Hibbertia aspera*), coffee bush (*Breynia oblongifolia*) *Phyllanthus gunnii*, gorse bitter pea (*Davesia ulicifolia*) and native blackthorn (*Bursaria spinosa*). The ground layer is dominated by a number of grasses (EcoPro 1996).

2.4 BANK EROSION

Winding Creek is subject to severe bank erosion in the study area, possibly due to the effect of channelisation of the creek upstream of the study area, and the resulting significant alteration of natural flow regimes.

The erosion and sedimentation issues within the study area are likely to significantly compromise the ecological values of the riparian vegetation, and will directly impact regionally significant vegetation and known threatened fauna habitat in the study area.

2.5 FAUNA

ERM Mitchell McCotter (1996) conducted a flora and fauna assessment on the State Rail Authority Land for the development of the Hunter Sports Centre and the rezoning of much of the remaining study area for business use. A total of 50 bird species, seven mammals, five reptiles and four frog species were recorded on the site. Three fauna habitats were identified on the site: woodland, open forest and the riparian zone, however the site was considered to contain low quality habitat due to its isolation from other areas of urban bushland (ERM Mitchell McCotter 1996). The ERM Mitchell McCotter (1996) surveys identified the presence of the threatened powerful owl (*Ninox strenua*) and the eastern bent-wing bat (*Miniopterus shreibersii oceanensis*) and the potential presence of the rose-crowned fruit-dove (*Ptilinopus regina*).

The subsequent SIS identified eight fauna habitat types in the study site, these being woodland, open forest, open forest (closed understorey), swamp/swamp forest, riparian zone, open grassland, cleared areas and moist sheoak. A total of 59 bird species were recorded, with an additional 24 species that were not recorded in previous surveys (Forest Fauna Surveys et al. 1996). The study area was considered to provide a mosaic of habitat types for bird species however the absence of mature hollow-bearing trees was considered to prevent hollow-dependent bird species roosting or nesting on the site (Forest Fauna Surveys et al. 1996).

Introduced mammal species such as the black rat (*Rattus rattus*), fox (*Vulpes vulpes*) and rabbit (*Oryctolagus cuniculus*) were common within the study area (Forest Fauna Surveys et al. 1996). Arboreal trapping also resulted in the capture of seven threatened squirrel gliders (*Petaurus norfolcensis*) associated with the open forest (closed understorey) and woodland habitats. Six bat

species were recorded on the site, two of which are listed as vulnerable under the TSC Act: the little bentwing-bat (*Miniopterus australis*) and the eastern bentwing-bat (*Miniopterus schreibersii oceanensis*) (Forest Fauna Surveys et al. 1996).

Eight species of reptiles were recorded in the study area, with the bearded dragon (*Pogona barbata*), striped skink (*Eulamprus robustus*), tree skink (*E. striolata*), eastern water skink (*E. quoyii*), garden skink (*Manpropholis delicata*), eastern blue-tongue lizard (*Tiliqua scincoides*), black-bellied snake (*Hemiaspis signata*) and red-bellied black snake (*Pseudechis porphyriacus*) commonly recorded (Forest Fauna Surveys et al. 1996). Three amphibian species, the common eastern froglet (*Crinia signifera*), striped marsh frog (*Limnodynastes peroni*) and eastern dwarf tree frog (*Litoria fallax*) were identified. No threatened reptile or amphibian species were recorded in the study area.

The felling of 33 habitat trees located on the area to be cleared for the Hunter Sports Centre was undertaken in January 1998 by Forest Fauna Surveys (1998). Five of the 33 habitat trees were found to support fauna. Four adult and one juvenile squirrel glider and one common ringtail possum were found in hollows in Sydney peppermint (*Eucalyptus piperita*). Approximately 10 microchiropteran bats and a Peron's tree frog (*Litoria peronii*) were found in hollows in broad-leaved scribbly gum (*Eucalyptus haemastoma*). Two microchiropteran bats were found in hollows in smooth-barked apple (*Angophora costata*). Hollow limbs from felled trees (seven large hollows and 13 small hollows) were recovered, modified and returned to the site to be installed on remaining trees at an approximate height of 10 metres.

2.6 THREATENED SPECIES

A sub-population of 70 individuals of black-eyed Susan (*Tetradlea juncea*) was reported to be located in the development footprint of the Hunter Sports Centre (EcoPro 1996) and was removed as part of the development. The incorporation of *T. juncea* into the landscaping design or the transplanting of the species to more appropriate areas was recommended. A Translocation Research Proposal was approved by the NSW National Parks and Wildlife Service and all *T. juncea* were translocated from the Glendale Sports Centre to Green Point Headland in April 1998. The translocation of *T. juncea* was found to be unsuccessful with no living plants found seven months after translocation (Payne 1998). *Tetradlea juncea* was not recorded within the riparian vegetation of the study area during the site inspection and all of the known sub-populations in the Hunter Sports Centre area were removed as part of the development (Robbie Economos pers comm.).

The powerful owl (*Ninox strenua*) listed as vulnerable under the TSC Act was recorded in the Glendale bushland remnant by ERM Mitchell McCotter (1996). The remnant does not contain nesting or roosting habitat for the powerful owl due to the lack of mature trees with hollows of sufficient size, however the site was considered to contain potential foraging habitat (Forest Fauna Surveys et al. 1996). It is expected that this species will forage within the riparian habitats of the study area.

The squirrel glider (*Petaurus norfolcensis*) was recorded by Forest Fauna Surveys et al. (1996) and the use of trapping and spotlighting indicated the Glendale bushland remnant supported a minimum of nine individuals. Two den trees were also located within the open forest (closed understorey) vegetation community to the north of Winding Creek (Forest Fauna Surveys et al. 1996). Four adult and one juvenile squirrel gliders were recorded by Forest Fauna Surveys (1998) during the felling of habitat trees on the site. These squirrel gliders were utilising a tree hollow in a Sydney peppermint (*Eucalyptus piperita*) which was modified after felling and positioned in a tree outside of the disturbance area. The squirrel glider is expected to occur in the riparian habitats pertaining to this plan.

Two threatened microchiropteran bat species, the little bentwing-bat (*Miniopterus australis*) and the eastern bentwing-bat (*Miniopterus schreibersii oceanensis*), were recorded on the site by Forest Fauna Surveys et al. (1996). Potential habitat for several other threatened microchiropteran bat species as well as the grey-headed flying fox (*Pteropus poliocephalus*) was considered to be present in the Glendale bushland remnant (Forest Fauna Surveys et al. 1996).

Since ecological surveys were completed at the Hunter Sports Centre in 1996, numerous other flora and fauna species, populations and EECs have been listed under the Schedules of the TSC Act. Four bird species, now listed as vulnerable under the TSC Act, were considered by ERM Mitchell McCotter (1996) and/or Forest Fauna Surveys et al. (1996) as likely to occur in the study area, due to the presence of suitable habitat. These species include the barking owl (*Ninox connivens*), gang-gang cockatoo (*Callocephalon fimbriatum*), grey-crowned babbler (*Pomatostomus temporalis temporalis*) and diamond firetail (*Stagonopleura guttata*). Additional threatened populations or EECs listed under the TSC Act or EPBC Act since the granting of development consent for the Hunter Sports Centre are not considered likely to occur in the study area.

2.7 ARCHAEOLOGY

An archaeological study by Dean-Jones (1989) was undertaken across an approximately 690 hectare area, which included the portion of the riparian zone of Winding Creek that occurs within the study area. Nine sites were recorded, with five sites containing scatters of less than 10 pieces of flaked stone and one site contained a concentration of more than 50 artefacts. One scarred tree was also identified within the archaeological survey area. The majority of the identified sites were located within 50 metres of Winding Creek, on the floodplain or the adjacent low terrace. The Winding Creek catchment within the study area was considered to contain a significant archaeological resource in the context of the Lake Macquarie hinterland and the high density of open sites along the creek was considered a constraint on the future development of the study area. Given the close proximity of the sites to the creek, the sites were considered to require management to overcome the significant erosion of the site.

While none of the sites were identified in the current study area the riparian zone is considered to contain potential archaeological deposit on the floodplain or adjacent low terrace.

2.8 SITE CONTAMINATION

A site contamination assessment of the Glendale Sports Centre site was conducted in November 1996 by Kinhill Engineers Pty Ltd (1996) and involved the sampling of groundwater from one original and three new bores to identify concentrations of a range of metals as well as oil and grease. The groundwater samples were compared to the ANZECC 1992 guidelines for the protection of aquatic ecosystems.

No oil or grease was detected in the groundwater which contrasted to elevated levels 6 months prior. The pH of all four samples were acidic, ranging from 4 to 6.6, and three samples were found to exceed the lower limit of the guidelines for fresh waters (pH 6.5). Elevated levels of cadmium, copper, lead and zinc were detected in the groundwater samples. Zinc was found to be the most significant contaminant in regard to prevalence and concentration, as it was detected in all four samples and exceeded the ANZECC 1992 criteria by up to five times the upper limit value. Cadmium was only detected in one sample after not being detected previously and was therefore not considered significant.

The elevated levels of copper, lead and zinc found in the groundwater samples were considered to be characteristic of the groundwater entering Winding Creek. The source of the metals in the groundwater was considered likely to be a result of past industrial activities, however further

investigation was required to more accurately assess the nature, degree and extent of groundwater contamination.

2.9 SOCIAL INTERACTIONS

The study area is located adjacent to Glendale shopping centre and in close proximity to the residential areas of Glendale and Cardiff, with Main Road currently separating the bushland remnant from residences. While it is heavily disturbed due to weed infestations, the study area shows little evidence of community utilisation, however rubbish dumping was identified. The study area does not currently have evidence of bike or walking tracks which are common in urban bushland.

3.0 ECOLOGICAL MANAGEMENT STRATEGIES

A range of ecological management strategies have been developed in order to manage ecological values of the site identified in **Section 2**. The most significant issue threatening the values of the site is the presence of weed species, including noxious weeds, and a weed management strategy is included below, along with a range of other strategies designed to improve and enhance the vegetation community and fauna habitats of the study area.

3.1 REHABILITATION OF RIPARIAN HABITATS

Rehabilitation of riparian habitats should aim to re-create the native vegetation community of Winding Creek. As discussed in **Sections 2.1** and **2.2.1** the riparian vegetation is consistent with the description of Alluvial Tall Moist Forest (NPWS 2000) which has been recognised as a regionally significant community (LHCCRBCS 2003).

The primary focus of ecological management strategies should be the removal of weed species from within the riparian zone. This will encourage the growth and dominance of native flora species which will in turn encourage the use of site by native fauna species.

It is considered that the medium and long term rehabilitation of the site will be affected by its proximity to an extensive area of heavily weed infested bushland. As only one side of the creek is owned by LMCC and is therefore subject to this Bushland Management Plan, and the neighbouring creek bank and upstream areas are not planned to undergo rehabilitation, the management of weed infestations will be very difficult and ongoing. It is considered that the most effective rehabilitation outcome is likely to be achieved as part of a joint rehabilitation initiative with the adjacent land holder.

It is recommended that LMCC should investigate the possibility of undertaking a joint rehabilitation initiative with adjacent land holders.

3.1.1 Weed Control Strategy

3.1.1.1 Weed Species Recorded in the Project Area

A review of previous surveys by ERM Mitchell McCotter (1996) and Forest Fauna Surveys et al. (1996), and a site inspection on 16 September 2005, identified the following weed species in the riparian area: crofton weed (*Ageratina adenophora*), flaxleaf fleabane (*Conyza bonariensis*), cassia (*Senna pendula*), small-leaved privet (*Ligustrum sinense*), lantana (*Lantana camara*), weeping willow (*Salix babylonica*), Pampas grass (*Cortaderia selloana*), curled dock (*Rumex crispus*), blackberry (*Rubus* sp.), camphor laurel (*Cinnamomum camphora*), wild tobacco tree (*Solanum*

mauritanum), alligator weed (*Alternanthera philoxeroides*), purpletop (*Verbena* sp.), American pennywort (*Hydrocotyle bonariensis*), castor oil plant (*Ricinus communis*), scarlet pimpernel (*Anagallis arvensis*), fennel (*Foeniculum vulgare*), mistflower (*Ageratina riparia*), cobbler's peg (*Bidens pilosa*), spear thistle (*Cirsium vulgare*), flatweed (*Hypochaeris radicata*), morning glory (*Ipomoea* sp.), Paddy's lucerne (*Sida rhombifolia*), wandering Jew (*Tradescantia fluminensis*), wild watsonia (*Watsonia meriana*), whiskey grass (*Andropogon virginicus*), quaking grass (*Briza* sp.), Rhodes grass (*Chloris gayana*), Guinea grass (*Panicum maximum*) and kikuyu (*Pennisetum clandestinum*).

A total of six of the weed species occurring in the riparian area are declared noxious weeds in Lake Macquarie local government area. These species are crofton weed (*Ageratina adenophora*) (W2), weeping willow (*Salix babylonica*) (W4g), Pampas grass (*Cortaderia selloana*) (W2), blackberry (*Rubus* sp.) (W3), alligator weed (*Alternanthera philoxeroides*) (W1) and mistflower (*Ageratina riparia*) (W3). The weed codes for each of the noxious weeds identified in the study area are described in full in **Section 1.4.3**.

Under the *Noxious Weeds Act* 1993 public authorities are required to control noxious weeds at least to the level necessary to stop their spread, and public occupiers of land must control noxious weeds on their land according to the requirements of the category in which the species is listed. NSW Agriculture has published a Noxious and Environmental Weed Control Handbook 2004-2005 which deals with the control of weeds in non-crop, aquatic and bushland situations. For the noxious weeds found within the study area, the handbook states the best methods for removal as hand removal or chemical (crofton weed, mistflower, blackberry), biological control or chemical (alligator weed) and mechanical removal or chemical (pampas grass and willows). Alligator weed is also listed as a W1 notifiable weed that must be reported to Local Control Authorities and NSW Agriculture. All of these weed control methods could have serious implications given the close proximity to the creek and the erosion problems that already exist.

LMCC is a stakeholder in regional management plans for alligator weed, blackberry, pampas grass, through the Hunter and Central Coast Weed Management Committee. As a stakeholder, LMCC has agreed to cooperate in controlling these weed species at a regional level.

3.1.1.2 Prioritisation of Species for Removal

The removal of noxious weeds from the project area should be considered to be a high priority due to Council's obligations under the *Noxious Weeds Act* 1993. As the area subject to weed control is only 2.2 hectares it is not considered necessary to prioritise specific areas for management, rather the site should be treated as a whole. However, a mosaic approach to weed removal and bush regeneration would allow for the maintenance of fauna habitats during the transition between the site's current state and complex post-regeneration habitats.

3.1.1.3 Recommended Methods of Weed Control

The control of weeds, and noxious weeds in particular, requires the coordinated use of a range of suitable chemical and non-chemical control methods (NSW Agriculture 2004). The aim of weed control in the study area should be to incorporate a variety of control methods that are cost-effective and practical, and that reduce reliance on herbicides. Successful and ongoing management of the site through an integrated weed management program will ensure that once weed infestations have been reduced, ongoing control will be less reliant on herbicides (NSW Agriculture 2004).

Weed control methods should be matched with good land management practices to obtain the best results. Kirkpatrick and Gilfedder (1999) suggest that the following issues be considered when selecting a control method:

- degree of infestation;

- native plants present and how they should be protected;
- presence of soil erosion;
- likelihood of prolific regeneration of the weeds from seed;
- ability of the weeds to resprout from their roots; and
- likelihood of losing habitat for native wildlife.

Taking these issues into account, the proposed strategies for managing noxious weeds are outlined below in **Table 3.1**, based on the recommendations of the Noxious and Environmental Weed Control Handbook 2004-2005 (NSW Agriculture 2004). It is recommended that weed control works, especially the noxious weed control strategy, are undertaken in conjunction with the relevant LMCC weeds officer.

Table 3.1 - Recommended Methods of Removal for Noxious Weeds Identified in the riparian Vegetation of Winding Creek

Weed Species	Classification	Recommended control method (Noxious and Environmental Weed Control Handbook 2004-2005)	Comment
crofton weed <i>Ageratina adenophora</i>	W2	Non-chemical control: Small areas of scattered plants to be dug out with a mattock. Chemical control for large areas includes glyphosate and Metsulfuron methyl, or Triclopyr + picloram Fluroxypyr	Chemical treatment appears to work most effectively during late summer and autumn.
mistflower <i>Ageratina riparia</i>	W3	Chemical control using glyphosate and Metsulfuron methyl, or Triclopyr + picloram Fluroxypyr, or Picloram + 2,4-D	Apply chemicals to actively growing bushes
blackberry <i>Rubus</i> sp.	W3	Non-chemical control: Slashing of juvenile bushes. Biological control agents are also available. Chemical control using glyphosate and Metsulfuron methyl	Generally undertaken in late spring to early autumn when plants are actively growing
alligator weed <i>Alternanthera philoxeroides</i>	W1	Non-chemical options: biological control agents are effective in some coastal wetland situations for the aquatic plant form. Chemical control using glyphosate or Metsulfuron methyl	A W1 notifiable noxious weed that must be reported to Local Control Authorities and NSW Agriculture. Metsulfuron methyl should be applied in terrestrial situations only
pampas grass <i>Cortaderia selloana</i>	W2	Non-chemical options: mechanical removal, wherever possible, is best. Chemical control includes glyphosate.	
willow <i>Salix babylonica</i>	W4g	Non-chemical options: mechanical removal is best, ensuring that all of the root system is removed.	This method of control is not suitable due to the severe bank erosion in the study area. As there is not a severe infestation of this species, it is recommended that the trees not be removed in this case.

While the removal of noxious weeds is a priority in the study area, a number of other weeds are reducing the biodiversity values of the study area and control of these species needs to be

prioritised. These species include cassia (*Senna pendula*), small-leaved privet (*Ligustrum sinense*), lantana (*Lantana camara*), wild tobacco tree (*Solanum mauritianum*), castor oil plant (*Ricinus communis*), wandering Jew (*Tradescantia fluminensis*) and morning glory (*Ipomoea* sp.). Management of these species should be undertaken using a combination of chemical and mechanical control, with early herbicide application followed by mechanical removal of the weeds. As only one side of riparian zone is being treated and rehabilitated, it is considered that sufficient habitat will remain on the northern side of the creek for species utilising the habitats of the study area, while rehabilitation is progressing. LMCC should be responsible for the initial removal of noxious weeds and the chemical and mechanical control of the other identified weeds. Once the initial herbicide applications and mechanical removal are undertaken it is recommended to engage and support a Landcare group to facilitate the ongoing maintenance of the study area.

Once the majority of the weed infestation has been removed through herbicide application and mass removal of weed species, the ongoing maintenance of the site should be through mechanical removal of young plants. Hand-pulling is a labour-intensive but very effective method for reducing the size of weed populations. As the study area is small it is considered that hand weeding is likely to be the most effective ongoing form of weed control. A number of weeds can be easily hand-weeded from the bush, particularly young plants that have not developed an extensive root system. (Kirkpatrick and Gilfedder 1999).

The methods of bushland regeneration to be implemented at the site should be determined following consultation with Landcare facilitators and Landcare groups currently working in the Cockle Bay catchment, and especially the Winding Creek sub-catchment. Working in partnership with other Landcare groups will ensure the long-term success of the regeneration by improving the health of native vegetation and limiting recruitment paths for weed species. This will significantly reduce the management requirements in the future. LMCC should provide technical and financial support to the Landcare group involved in the regeneration of the site.

3.1.1.4 Additional Native Species Plantings

Six months after the initial herbicide application and mass removal of weed species LMCC officers and Landcare representatives should inspect the site and determine the success or otherwise of the initial weed control strategy. This inspection should also determine the need for additional native species plantings.

It may be necessary to supplement the rehabilitation of the study area through a planting regime, especially in an effort to control the threat of erosion. A list of suitable species is provided in **Appendix 1**. These species have been selected from the suite of native species recorded during flora surveys conducted as part of the development assessment process for the Hunter Sports Centre and also from the list of diagnostic species for Alluvial Tall Moist Forest provided by the LHCCREMS (NPWS 2000).

3.2 ENHANCEMENT AND MANAGEMENT OF FAUNA HABITAT

Fauna habitat and biodiversity in the study area generally is currently threatened by a range of issues including the prevalence of weed species; poorly managed fire regimes; erosion and sedimentation; feral and domestic animals; site contamination and numerous anthropogenic impacts.

A wide range of fauna species have been recorded in the riparian community and wider bushland remnant. The ecological management strategies identified in **Section 4** of this plan, which are designed to remove weeds and enhance the native vegetation values of the study area, should result in the general enhancement of fauna habitat if undertaken in a timely fashion and supported appropriately.

As discussed in **Section 4.2**, opportunities exist for community groups such as Landcare to become involved in the monitoring of fauna species and populations occurring within the riparian zone. With increased knowledge regarding the presence and abundance of fauna species, adaptive bushland regeneration techniques can be implemented at the site which will further benefit the range of species occurring, ensuring the sites future as an integral stepping stone in the winding Creek corridor.

3.3 THREATENED SPECIES MANAGEMENT

3.3.1 Black-eyed Susan (*Tetradlea juncea*)

As discussed in **Section 2.4**, a total of 70 individuals of black-eyed Susan (*Tetradlea juncea*) were reported to be located in the study area prior to the development of the Hunter Sports Centre (EcoPro 1996). This sub-population was removed as part of the development in 1999. As a result, black-eyed Susan does not currently occur within the Glendale Sport Centre land holding. The species has not previously been recorded within the riparian zone of Winding Creek (EcoPro 1996), and the species was not recorded during the site inspection undertaken during the flowering season of the species in September 2005. The species is not expected to occur and therefore no specific management is required.

3.3.2 Squirrel Glider

A population of squirrel gliders was identified during surveys undertaken prior to the construction of the sports centre. As an impact amelioration measure, nest boxes and felled hollows were erected in bushland to provide denning and nesting resources for this species. No monitoring of the effectiveness of this impact amelioration method has been undertaken since their installation and consultation with LMCC staff has identified the lack of monitoring as an issue to be addressed by the Bushland Management Plan.

LMCC should engage a suitable qualified and experienced ecologist to monitor the usage of the nest boxes erected following disturbance. This will identify whether the squirrel glider continues to utilise the site and determine whether the impact amelioration measures suggested in the SIS were successful in the retention of the species in the local area.

Monitoring should also investigate the status of the boxes and recommend whether replacement of boxes is required to maintain the current levels of arboreal denning and shelter resources.

3.3.3 Other Threatened Species

The powerful owl (*Ninox strenua*) was recorded on the site by ERM Mitchell McCotter (1996) and two threatened microchiropteran bat species, the little bentwing-bat (*Miniopterus australis*) and the common bentwing-bat (*Miniopterus schreibersii oceanensis*), were recorded on the site by Forest Fauna Surveys et al. (1996). The study area does not contain nesting or roosting habitat for the powerful owl due to the lack of mature trees with hollows of sufficient size, however the riparian zone is considered to contain foraging habitat (Forest Fauna Surveys et al. 1996).

The habitat values for the powerful owl and microchiropteran bats, as well as a range of other potentially occurring threatened species, is likely to improve following the rehabilitation of the riparian zone. The removal of weeds and the re-instatement of native vegetation, especially in the ground and shrub layers, is likely to improve the foraging resources for these species as prey species are likely to increase due to increased resources. As both of the identified bats are cave-roosting species, the riparian zone only provides foraging habitat and therefore management of roosting resources is not required.

Specific management strategies to improve the resources for these species are not required and improvement in habitat resources is likely to occur due to the general rehabilitation strategies proposed in **Sections 5.1** and **5.3**.

3.4 SEDIMENT AND EROSION CONTROL

Winding Creek is suffering significant bank erosion. It is considered likely that the significant alteration to the natural flow regimes of the creek because of urban and industrial development in the catchment and the artificial channelisation of the creek has contributed to the erosion and associated sedimentation problem. However, the exact causes and therefore most appropriate amelioration measures cannot be determined until a detailed stormwater study, including assessment of peak flows and velocities, is undertaken for Winding Creek.

Solutions to bank erosion include a variety of techniques from “hard” solutions that require rock or other structures to be placed on the bank, to “soft” solutions based on replanting with native vegetation to stabilise the bank. Preliminary discussions with LMCC have identified a preference for “soft” engineering options in any required bank restoration works. The available “soft” engineering options include methods such as:

- improving vegetation cover and removal of exotic weeds that are preventing the establishment of native vegetation;
- reshaping of banks in areas of existing erosion;
- placement of fallen timber to act as stabilising agents; and
- creation of buffer strips to limit activity / development along the banks of the creek.

The methods listed above have the potential to reduce sediment transport to the creek from surrounding areas and reduce bank erosion and the associated sedimentation of downstream reaches of the creek. However, the suitability of these options cannot be gauged until a detailed stormwater study of the creek is undertaken. It is considered that an integrated management plan for Winding Creek is required as the impacts of erosion are not limited to the study area.

There are also a number of detention basins adjacent to the creek. These basins act as detention and sedimentation ponds for adjacent urban, commercial and industrial developments. To ensure the effectiveness of these basins the detention and sediment settling and deposition zones need to be retained. It is proposed that any existing maintenance strategies for these water management structures that impact on the study area be reviewed and modified where required.

3.5 FERAL ANIMAL CONTROL

Fauna surveys within the bushland remnant identified a number of introduced species which were considered to be common. These species included the black rat (*Rattus rattus*), fox (*Vulpes vulpes*) and rabbit (*Oryctolagus cuniculus*) (Forest Fauna Surveys et al. 1996). It is considered likely that domestic cats (*Felis catis*) and dogs (*Canis familiaris familiaris*) also occur within the area due to the site’s proximity to residential areas.

Foxes, cats and dogs are considered the biggest threats to biodiversity values within the study area. The most effective method for reducing the impact of feral and pest species on native fauna populations is likely to be the education of nearby resident in responsible pet ownership. Education strategies are outline in **Section 5.7**. While rabbits and rats are all known to occur within the study area they are not considered to be a significant threat to biodiversity values at this time and specific control measures are not considered warranted. Similarly, the removal of foxes from urban

bushland is problematic, as baiting is not an option in close proximity to urban areas. Unless it can be demonstrated in the future that foxes are compromising the ecological values of the study area and impacting on fauna populations, specific control strategies are not required.

3.6 BUSHFIRE MANAGEMENT

It is considered that the risk of bushfire on the site is relatively low due to the existing buffer between the Sports Centre and the remaining riparian vegetation. The proximity to Winding Creek also affords the study area some protection against bushfire. The study area's proximity to residential areas does increase the risk of arson related bushfire events.

The reduction of weeds in accordance with the weed control strategy outlined in **Section 5.1** may result in a reduction of fuel loads in the study area which will decrease the risk of bushfire. Maintenance of the native vegetation by a Landcare group or LMCC may incorporate fuel reduction strategies, however the ecological values of the site should not be compromised due to the study area's ecological significance.

3.7 PUBLIC EDUCATION

The education of nearby residents is recommended in an effort to improve the success of bushland regeneration strategies and to limit anthropogenic impacts on the study area. Public education should focus specifically on nearby residents in Glendale and Cardiff, and also residents within the Winding Creek Catchment.

A letter box drop of a pamphlet containing information relating to rubbish dumping, particularly the impact of green waste; responsible pet ownership; water management and the impact of excessive nutrients on Winding Creek; and opportunities for involvement in Landcare would assist in creating awareness of the issues relating to the management of urban bushland, not only in Winding Creek but also in the wider Lake Macquarie area.

The creation of signage at the beginning of the cross-country running track is required to educate users on the ecological values of the riparian vegetation in an effort to limit anthropogenic impacts on the bushland as a result of the track's construction. Interpretive signage may include information relating to the regional significance of vegetation communities and threatened species known to occur; the impact of litter; the impact of uncontrolled access and the involvement of community groups in bushland regeneration initiatives.

4.0 OPPORTUNITIES FOR COMMUNITY INVOLVEMENT AND RECREATION

4.1 CONSTRUCTION OF CROSS-COUNTRY RUNNING TRACK

LMCC has identified the need for a cross-country running track through the riparian bushland at the Hunter Sports Centre and on adjoining land that will come into public ownership in the near future. A proposed location of the cross-country running track determined by Umwelt following a site inspection and identification of the ecological values of the riparian bushland is provided in **Figure 4.1**.

The cross-country running track is approximately 1070 metres long, located adjacent to the riparian zone along an existing access track and then along the boundary of the Hunter Sports Centre and back to the riparian zone around the perimeter of the sports field. The track is positioned to take advantage of the natural features of the area, while limiting any potential impact on native



Source: LMCC

0 100 200 300m
1:6 000

Legend

- Hunter Sports Centre
- Study Area
- Proposed Cross Country Running Track

FIGURE 4.1

Proposed Location of Cross Country
Running Track

vegetation and fauna habitat, including threatened species habitat. Construction of the cross-country running track will need to take into account the location of archaeological sites and potential archaeological deposits. As the track is located in existing disturbed area and it is not proposed to disturb further areas of native vegetation it is considered that archaeological sites are unlikely to be affected. The final location of the track should be designed in consultation with a qualified archaeologist or representatives of the local Aboriginal community to ensure that the construction of the track does not impact on potential archaeological deposits.

The location of the cross-country running track has been determined to limit potential disturbance to the ecologically significant remnant vegetation and fauna habitat of the riparian zone of Winding Creek. The positioning of the track in this location will ensure that its construction will have acceptably low impacts on Winding Creek and the riparian zone of the study area.

4.2 COMMUNITY INVOLVEMENT IN WEED AND BIODIVERSITY MANAGEMENT

The need for a significant amount of weed and biodiversity management in the study area has created an opportunity for further community involvement in the area. The opportunity for a Landcare or Bushcare group exists to take on the responsibility to co-ordinate and facilitate the management of weeds and biodiversity issues, in partnership with LMCC.

As the most significant issue for the study area is management of weed infestations it is considered prudent to co-ordinate efforts at bush regeneration with other Landcare groups working within the Cockle Bay catchment, through which Winding Creek flows. There are 17 Landcare groups currently active in the Cockle Bay catchment, including three groups working within the Winding Creek sub-catchment (LMCC web site, accessed October 2005). These groups include Jennabee Landcare which is regenerating the riparian zone in the upper reaches of the Winding Creek catchment; and Charlestown Landcare and Survival of the Species Landcare groups which are undertaking bush regeneration behind Creswell Avenue, which is also in the upper reaches of the Winding Creek catchment.

Opportunities also exist for community involvement in threatened species monitoring. Residents and Landcare group members could participate in directed threatened species monitoring, with follow up monitoring of fauna populations undertaken at the direction of the Landcare facilitators. Results can be provided to LMCC and recorded on the DEC Atlas of NSW Wildlife.

Both initiatives would require strong coordination and support roles to be carried out by LMCC.

5.0 ACTION PLAN

An action plan is included as **Table 5.1** detailing recommended ecological management strategies for the Winding Creek riparian zone at the Hunter Sports Centre, including opportunities for community involvement and recreation. The table includes all of the actions recommended in **Sections 3 and 4**, as well as timeframes, priorities and cost estimates for each of the identified actions. Cost estimates refer to an actual dollar amount and do not include in kind support or employment costs.

Table 5.1 - Action Plan for Ecological Management Strategies for Winding Creek riparian zone at the Hunter Sports Centre

Ecological Management Strategies	Comment	Timeframe	Priority	Cost Estimate
General Strategies				
Investigate opportunity for joint rehabilitation initiative with adjoining land owners	To improve success of ecological management strategies	Within 6 months of adoption of Plan	High	Nil
Weed Control Strategy				
Remove or suppress noxious weeds	LMCC to do	Within 6 months of adoption of Plan	High	\$1000
Remove or suppress other identified weeds	LMCC to do	Within 6 months of adoption of Plan	Medium	\$5000
Implement ongoing weed maintenance strategy	Landcare to facilitate	ongoing	Following initial weed control works undertaken by LMCC	Nil
Undertake inspection of weed control success	LMCC Landcare officer	12 months after weed strategy implementation	medium	
Determine the need for additional native species plantings	LMCC Landcare officer	12 months after weed strategy implementation	medium	
Threatened Species Management				
Engage suitably qualified and experienced ecologist to undertake squirrel glider nest box monitoring		Within 3 months of adoption of Plan	low	\$5000
Determine status of nest boxes and identify the need for boxes to be replaced	Replace boxes if necessary	Within 3 months of adoption of Plan	low	\$1000
Community involvement in ongoing monitoring schedule		ongoing	ongoing	nil

Table 5.1 - Action Plan for Ecological Management Strategies for Winding Creek riparian zone at the Hunter Sports Centre (cont)

Ecological Management Strategies	Comment	Timeframe	Priority	Cost Estimate
Sediment and Erosion Control				
Undertake water management study to determine most appropriate methods for sediment and erosion control		Within 6 months of adoption of Plan	High	\$20000
Implement recommendations of water management study			High	To be determined
Opportunities for Community Involvement and Recreation				
Construct cross-country running track, as shown on Figure 4.1			High	Funding already secured
Create Landcare group to co-ordinate bush regeneration activities		Following initial weed control works	high	LMCC to provide in kind support
Consult with other Landcare groups working in catchment to determine a coordinated approach		Following initial weed control works	High	Nil
Public Education				
Conduct letterbox drop	Assist in community ownership of study area through awareness of issues	Within 6 months of adoption of the Plan	medium	\$3000

6.0 RESPONSIBILITIES

LMCC is responsible for the implementation, funding; co-ordination of this Bushland Management Plan and is responsible for determining the effectiveness of bushland rehabilitation strategies. LMCC will also be responsible for the establishment of a Landcare group.

7.0 REFERENCES

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APPENDIX 1

Flora Species Suitable for Use in Rehabilitation

Appendix 1 - Species Suitable for Use in Rehabilitation

The vegetation communities described in the Supplementary Flora Report (EcoPro 1996) confirms the LHCCREMS description and mapping of Alluvial Tall Moist Forest within the study area. The riparian zone community and white mahogany (*Eucalyptus acmenoides*) / stringybark (*Eucalyptus agglomerata*) open forest are considered to conform to the description of Alluvial Tall Moist Forest. **Table 1** identified the range of species recorded within the riparian community and White Mahogany / Stringybark Forest, and also the species which characterize Alluvial Tall Moist Forest, which are suitable for use in rehabilitation of the study area.

Table 1 - Species Suitable for Use in Rehabilitation

Growth Form	Alluvial Tall Moist Forest	Riparian Community	White Mahogany/Stringybark Forest
Trees	<i>Angophora floribunda</i>	<i>Eucalyptus saligna</i>	<i>Eucalyptus acmenoides</i>
	<i>Casuarina glauca</i>	<i>Eucalyptus piperita</i>	<i>Eucalyptus agglomerata</i>
	<i>Corymbia gummifera</i>	<i>Angophora floribunda</i>	<i>Angophora floribunda</i>
	<i>Corymbia maculata</i>	<i>Callistemon salignus</i>	<i>Angophora costata</i>
	<i>Eucalyptus acmenoides</i>		<i>Corymbia gummifera</i>
	<i>Eucalyptus deanei</i>		<i>Eucalyptus piperita</i>
	<i>Eucalyptus grandis</i>		
	<i>Eucalyptus microcorys</i>		
	<i>Eucalyptus pilularis</i>		
	<i>Eucalyptus piperita</i>		
	<i>Eucalyptus resinifera</i> subsp. <i>resinifera</i>		
	<i>Eucalyptus robusta</i>		
	<i>Eucalyptus saligna</i>		
	<i>Eucalyptus tereticornis</i>		
	<i>Syncarpia glomulifera</i> subsp. <i>glomulifera</i>		

Table 1 - Species Suitable for Use in Rehabilitation (cont)

Growth Form	Alluvial Tall Moist Forest	Riparian Community	White Mahogany/Stringybark Forest
Tall Shrubs	<i>Acmena smithii</i>	<i>Melaleuca linariifolia</i>	<i>Allocasuarina littoralis</i>
	<i>Allocasuarina torulosa</i>	<i>Commersonia fraseri</i>	<i>Glochidion ferdinandi</i>
	<i>Alphitonia excelsa</i>	<i>Acacia irrorata</i> subsp. <i>Irrorata</i>	<i>Notelaea longifolia</i>
	<i>Backhousia myrtifolia</i>	<i>Pittosporum revolutum</i>	<i>Allocasuarina torulosa</i>
	<i>Callistemon salignus</i>		<i>Pittosporum revolutum</i>
	<i>Ficus coronata</i>		<i>Callistemon salignus</i>
	<i>Glochidion ferdinandi</i>		
	<i>Livistona australis</i>		
	<i>Melaleuca biconvexa</i>		
	<i>Melaleuca linariifolia</i>		
	<i>Melaleuca styphelioides</i>		
	<i>Symplocos stawellii</i>		
	<i>Acacia irrorata</i> subsp. <i>irrorata</i>		
Shrubs	<i>Breynia oblongifolia</i>	<i>Bursaria spinosa</i>	<i>Polyscias sambucifolia</i>
	<i>Gahnia clarkei</i>	<i>Synoum glandulosum</i>	<i>Breynia oblongifolia</i>
	<i>Gymnostachys anceps</i>	<i>Gompholobium grandiflorum</i>	<i>Daviesia ulicifolia</i>
		<i>Acacia ulicifolia</i>	<i>Bursaria spinosa</i>
		<i>Acacia terminalis</i>	<i>Dodonaea triquetra</i>
			<i>Banksia spinulosa</i> var. <i>spinulosa</i>
			<i>Persoonia levis</i>
			<i>Leptospermum polyanthum</i>
			<i>Leptospermum polygalifolium</i> subsp. <i>polygalifolium</i>
			<i>Leptospermum trinervium</i>
			<i>Acacia myrtifolia</i>
			<i>Gompholobium grandiflorum</i>
			<i>Pultenaea villosa</i>

Table 1 - Species Suitable for Use in Rehabilitation (cont)

Growth Form	Alluvial Tall Moist Forest	Riparian Community	White Mahogany/Stringybark Forest
Shrubs (cont)			<i>Acacia falcata</i>
			<i>Acacia longifolia</i> subsp. <i>longifolia</i>
			<i>Acacia terminalis</i>
			<i>Acacia ulicifolia</i>
			<i>Pultenaea daphnoides</i>
			<i>Pultenaea ferruginea</i> var. <i>deanei</i>
			<i>Pultenaea retusa</i>
			<i>Bossiaea stephensonii</i>
			<i>Dillwynia retorta</i>
			<i>Acacia irrorata</i> subsp. <i>irrorata</i>
Herbs/Ground Covers	<i>Youngia japonica</i>	<i>Persicaria strigosa</i>	<i>Hibbertia aspera</i>
	<i>Lomandra longifolia</i>	<i>Alpinia caerulea</i>	<i>Lomandra longifolia</i>
		<i>Juncus continuus</i>	<i>Lomandra multiflora</i> subsp. <i>Multiflora</i>
		<i>Juncus usitatus</i>	<i>Lomandra obliqua</i>
		<i>Lomandra longifolia</i>	<i>Dianella caerulea</i> var. <i>caerulea</i>
			<i>Dianella caerulea</i> var. <i>producta</i>
			<i>Viola hederacea</i>
			<i>Lepidosperma elatius</i>
			<i>Pimelea linifolia</i> subsp. <i>linifolia</i>
			<i>Gonocarpus tetratgynus</i>
			<i>Gonocarpus teucrioides</i>
			<i>Hibbertia scandens</i>
Grasses	<i>Entolasia marginata</i>	<i>Cynodon dactylon</i>	<i>Themeda australis</i>
	<i>Oplismenus aemulus</i>	<i>Digitaria parviflora</i>	<i>Entolasia stricta</i>
	<i>Oplismenus imbecillis</i>	<i>Oplismenus aemulus</i>	<i>Echinopogon caespitosus</i>
			<i>Oplismenus aemulus</i>
			<i>Aristida vagans</i>
			<i>Digitaria parviflora</i>

Table 1 - Species Suitable for Use in Rehabilitation (cont)

Growth Form	Alluvial Tall Moist Forest	Riparian Community	White Mahogany/Stringybark Forest
Climbers	<i>Cissus antarctica</i>	<i>Eustrephus latifolius</i>	<i>Cissus antarctica</i>
	<i>Dioscorea transversa</i>	<i>Rubus rosifolius</i>	<i>Eustrephus latifolius</i>
	<i>Eustrephus latifolius</i>	<i>Hardenbergia violacea</i>	<i>Billardiera scandens</i> var. <i>scandens</i>
	<i>Morinda jasminoides</i>	<i>Cissus antarctica</i>	<i>Hardenbergia violacea</i>
	<i>Pandorea pandorana</i> subsp. <i>pandorana</i>		<i>Kennedia rubicunda</i>
	<i>Sarcopetalum harveyanum</i>		
	<i>Stephania japonica</i> var. <i>discolor</i>		
	<i>Austrosteenisia blackii</i>		
Ferns	<i>Doodia aspera</i>	<i>Adiantum aethiopicum</i>	
	<i>Adiantum aethiopicum</i>	<i>Calochlaena dubia</i>	
	<i>Calochlaena dubia</i>		
	<i>Hypolepis muelleri</i>		
Aquatics	<i>Sparganium subglobosum</i>	<i>Eleocharis sphacelata</i>	

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