Cardno
Shaping the Future

Chianti Private Estate

Stage 1 Wetland Management Plan

Prepared for Watson Property Group

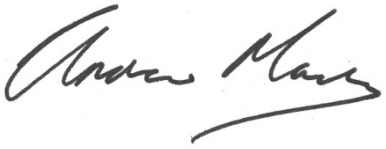
December 2010

Project Number V9076

Cardno (WA) Pty Ltd
ABN 77 009 119 000
2 Bagot Road
Subiaco WA 6008
PO Box 155, Subiaco
Western Australia 6904 Australia
Telephone: 08 9273 3888
Facsimile: 08 9388 3831
International: +61 8 9273 3888
perth@cardno.com.au
www.cardno.com.au

Document Control

Version	Date	Author		Reviewer	
1	July 2010	Matt Field	MJF	Jason Hick	JDH
2	September 2010	Matt Field	MJF	Dave Kabay	EDK
3	October 2010	Dave Kabay	EDK	Andrew Mack	AJM
4	November 2010	Matt Field	MJF	Andrew Mack	AJM
5	December 2010	Matt Field	MJF	Andrew Mack	AJM
Filename	V9076--Mjf10004.50--Mjf				



Author: Matt Field
Position Title: Restoration Ecologist

Reviewer: Andrew Mack
Position Title: Environment Services Business Unit Manager

Printed on 100% Australian Recycled Paper

"© 2010 Cardno (WA) Pty Ltd All Rights Reserved. Copyright in the whole and every part of this document belongs to Cardno (WA) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person without the prior written consent of Cardno (WA) Pty Ltd."

Executive Summary

Cardno (WA) Pty Ltd (Cardno) was commissioned by Watson Property Group (WPG) in October 2009 to prepare a Wetland Management Plan (WMP) for Stage 1 of the Chianti Private Estate residential subdivision development (from herein referred to as the development area). The development area is located on Lots 27, 28 and 801 Wanneroo Road, Woodvale (**Figure 1**) and is within the City of Wanneroo's (CoW) Structure Plan 64 (SP64).

This WMP is required to be produced and implemented to satisfy Condition 38 of (Western Australian Planning Commission (WAPC)) reference 140038 (**Appendix A**) of the development's subdivision conditions. This plan aims to provide detail concerning the management responsibilities and revegetation works required to be undertaken in the buffer area and parts of the wetland (from herein referred to as the site) between Stage 1 of the Chianti Private Estate development and Walluburnup Swamp (UFI 8168).

A Flora and Vegetation Survey Report (Cardno 2010a) and a Level One Fauna Assessment Report (Bamford Consulting Ecologists 2010) were completed separately for the entire SP64 area and these reports found that the vegetation of the site is completely degraded but the *Typha orientalis* dominated wetland could potentially provide habitat for many fauna species.

A rehabilitation program is been proposed to be implemented on the site to create a functioning buffer for the wetland from the proposed development area. This program would consist of one year's worth of weed control before planting, planting of seedlings and a three year maintenance and monitoring program.

The site will be separated into four different revegetation community types and one landscaped garden, which are classed as follows:

- *Baumea – Schoenoplectus* sedgeland community(0.369ha);
- *Melaleuca rhaphiophylla* open forest community (0.391ha);
- *Melaleuca – Eucalyptus* forest community (0.191ha);
- Drainage swale sedgeland community (0.032ha); and
- Feature Native Planting (0.077ha).

Twenty three native plant species will be installed in these different communities as seedlings at the following densities:

- *Melaleuca - Eucalyptus* forest community will be planted to a density of 1 plant per m^2;
- *Melaleuca rhaphiophylla* open forest community will be planted to a density of 4 plants per $10m^2$ for shrub and tree species (ie *Melaleuca rhaphiophylla*) and 5 plants per m^2 for rush and sedge species;
- *Baumea - Schoenoplectus* sedgeland community will be planted to a density of 6 plants per m^2; and
- The drainage swale sedgeland community will also be planted to a density of 6 plants per m^2.

A schedule for revegetation, maintenance and monitoring works has been supplied which details the works to be undertaken, the date of these works and the agencies responsible for the implementation. Once the revegetation program has been implemented, there will be a three year maintenance and monitoring program. The maintenance program would consist of replacement of seedlings, extra weed control and repair of fencing. The monitoring program will consist of setting up permanent quadrats that will be used to assess the revegetation.

Within each monitoring quadrat, the following information will be collected:

- Seedling survival and health (as per seedling and species);
- Weed cover percentage (significant weed species to be recorded);
- Pest attack (either insect or animal);
- Other factors affecting seedling survival; and
- Photo record (taken at the northern west corner of quadrat).

This information will be compiled into reports, which are required to be completed for assessment of the completion criteria for the revegetation. The revegetation completion criteria must be met at the end of the three year monitoring and maintenance program for the CoW and DEC to approve the release of titles for the subdivision.

The rehabilitation completion criteria that is in accordance with the WMRS are as follows:

- All woody weeds are to be removed from site;
- Weeds are effectively controlled across the site with weed species comprising less than 20% of the groundcover;
- A stable *Melaleuca - Eucalyptus* forest community has been established with the following characteristics:
    - All species used in the revegetation works are represented across the site;
    - Plants are established at a rate of 0.75 per m^2 and have a diversity of at least 6 species per 10 m^2 over at least 70% of the area planted;
- A stable *Melaleuca rhaphiophylla* open forest community has been established with the following characteristics:
    - All species used in the rehabilitation works are represented across the site;
    - Rush/sedge species are established with an average projective foliage cover of 50% and/or at a rate of 5 plants per m^2 and have a diversity of at least 6 species per 10 m^2 over at least 70% of the area planted;
    - Tree species are established at a rate of 4 per 10 m^2 over at least 70% of the area planted;
- A stable *Baumea - Schoenoplectus* sedgeland community has been established with the following characteristics:
    - Both species used in the rehabilitation works are represented at the site;
    - Plants are established to an average projective foliage cover of 75% and/or at a minimum rate of 6 plants per m^2 and both species are present over at least 70% of the area planted;
- A stable Drainage Swale sedgeland community has been established with the following characteristics:
    - All species used in the rehabilitation works are represented across the site; and
    - Plants are established to an average projective foliage cover of 75% and/or at a minimum rate of 6 plants per m^2 and at least 4 species per 10 m^2 over at least 70% of the area planted.

The methods and techniques detailed in this WMP aim to ensure the implementation of the revegetation program to create a functional wetland buffer in Stage 1 will be successful in the long term.

Table of Contents

List of Tables

List of Plates

List of Figures

Appendices

1 Introduction

1.1 Background

Cardno (WA) Pty Ltd (Cardno) was commissioned by Watson Property Group (WPG) in October 2009 to prepare a Wetland Management Plan (WMP) for Stage 1 of the Chianti Private Estate residential subdivision development (from herein referred to as the development area).

The development area is located on Lots 27, 28 and 801 Wanneroo Road, Woodvale (**Figure 1**) and is within the City of Wanneroo's (CoW) Structure Plan 64 (SP64), located in the south-western extent of the CoW municipal boundary. In total, SP64 covers an area of approximately 25ha with Stage 1 of the Chianti Private Estate being 2.71ha. The development area is proposed to be subdivided into 33 residential housing lots and three lots of future group housing sites.

1.2 Purpose of Report

This WMP aims to provide detail concerning the management responsibilities and restoration actions required to be undertaken in the buffer area and parts of the wetland (from herein referred to as the site) between Stage 1 of the Chianti Private Estate development and Walluburnup Swamp (**Figure 2**). The WMP is required to be produced and implemented to satisfy Condition 38 of (Western Australian Planning Commission (WAPC) reference 140038 (**Appendix A**) of the development's subdivision conditions.

In regards to Condition 38, Advice Note 12 outlines the Department of Environment and Conservation's (DEC's) expectations for the WMP. This is as follows:

- The WMP is to be consistent with the approved WMRS, be prepared by a qualified revegetation specialist and be submitted to the DEC prior to implementation;
- The WMP is to address issues such as (but not limited to): site preparation, fencing, mulching, revegetation planting densities and species, planting locations, weed control, timing of operations, ongoing care and maintenance, completion criteria, monitoring programs and budget;
- The WMP should also address the issue of how necessary ongoing works will be secured after the issue of titles. The WMRS indicates that works will be bonded with the CoW which is supported by the DEC; and
- The WMP must address the required rehabilitation works outside the application area (within the adjoining Yellagonga Regional Park).

1.3 Relevant Documents

1.3.1 Wetland Boundary Review and Management Category Re-evaluation

Cardno BSD Pty Ltd prepared a Wetland Boundary Review and Management Category Re-evaluation report in 2006 for the entire Walluburnup Swamp. This report provided background information into the flora and vegetation survey report for the SP64 development area.

1.3.2 Gnangara Branch Sewer Rehabilitation Management Plan

The Water Corporation is in the process of installing the Gnangara Branch Sewer main through and adjacent to SP64 area, which is displayed in **Figure 3**. The alignment of the sewer main and construction disturbance zone in the site is shown in **Figure 4**. The Water Corporation has agreed upon an environmental offsets package aimed at providing a net environmental benefit for installing the sewer main through parts of the Yellagonga Regional Park (GHD 2009). GHD Pty Ltd produced a

Rehabilitation Management Plan for the 8ha of revegetation that is planned as part of this offsets package. This plan details the aims and objectives of this plan and specifies the required techniques for the installation of the revegetation project. Several sections of the revegetation area are located adjacent to SP64. Revegetation is planned for the eastern side of Walluburnup Swamp directly south of the site, which is proposed to act as a wetland buffer. Another revegetation area is planned for a site to the north of Lot 800, Wanneroo rd (**Figure 3**).

1.3.3 Local Structure Planning (SP64) and Wetland Management and Rehabilitation Strategy

A Local Structure Plan (LSP) was prepared for SP64, which outlined the areas to support residential development and areas of the wetland buffer and wetland that are required to be rehabilitated. The LSP proposed that in some areas the wetland buffer would vary in size and would not conform to the generic 50m buffer applied by the DEC for all wetlands. As part of the structure planning process, a wetland management package was formulated as an "offset" for the rationalisation of the wetland buffer distance.

The overall principle of the package was that works to be undertaken within and adjacent to the structure plan area would improve the ecological values of the degraded wetland and wetland buffer and therefore provide more effective wetland buffer functions. The package was to create a better environmental outcome than simply providing a generic 50m separation distance from the existing Conservation Category wetland boundary and leaving this area in its current degraded condition.

The proposed wetland offsets package included:

- Rehabilitating the wetland buffer up to the boundary of the development;
- Rehabilitating 20m west of the wetland or property boundary (which ever is further west);
- Undertake weed control in the rehabilitation areas;
- Promote community awareness of the project;
- Install education and interpretive signs about the wetland;
- Encourage community groups and 'friends of groups' to become involved in the management of the wetland and buffer zone; and
- Undertake a three year monitoring and maintenance program in the rehabilitation area.

A Wetland Interface and Landscape Master plan (WILM) was prepared by Emerge Associates for the SP64 area, which graphically displays the wetland offsets that were agreed to by the CoW and the DEC (**Figure 3**). This figure shows the areas that are required to be rehabilitated in the wetland buffer and the design of Public Open Space (POS) areas within the SP64 development.

A Wetland Management and Rehabilitation Strategy (WMRS) document was also prepared for the SP64 development in conjunction and consultation with the CoW and the DEC. This document details the attributes displayed in the WILM and provides a specific framework for the rehabilitation outcomes that are to be met as part of any future WMPs. The WMRS document details all the management commitments and procedures that are required for the DEC and CoW to approve the WMP for the subdivision of Stage 1 of the Chianti Private Estate residential development, which is supplied in **Appendix D.**

The WMRS document also detailed specific restoration techniques and activities that are proposed for the buffer and wetland area, as well as setting out performance criteria, monitoring activities and reporting schedules. WMP's that implement the details of the WMRS, are required to be produced for each of the individual stages of the SP64 area, and will be a requirement for the subdivision approval of these areas. These WMPs will need to be approved by the CoW and the DEC. The WMRS was supplied by the CoW to the land owners in the SP64 development.

2 Existing Environment, Cultural and Social Values

2.1 Environment

2.1.1 Climate

The rainfall average for Perth is approximately 747mm (Bureau of Meteorology 2010) The mean rainfall is highest in July (152.9 mm) and lowest in December (6mm) while the maximum mean temperatures are highest in February (31.3^{o}C) and lowest in July (18.3^{o}C).

2.1.2 Regional Context

Walluburnup Swamp forms part of Yellagonga Regional Park, which is made up of Lake Joondalup, Beenyup Swamp, Walluburnup Swamp and Lake Goollelal and surrounds. This park provides regional importance for its natural, cultural, and recreational resources in a growing suburban area (Yellagonga Regional Park Management Plan 2003-2012). The wetlands within Yellagonga Regional Park are some of the last remaining freshwater wetland systems on the Swan Coastal Plain.

2.1.3 Geology, Geomorphology and Soils

The site is located on Karrakatta soils within the Spearwood Dune system (Churchward and McArthur 1980). Regional Acid Sulphate Soils (ASS) mapping indicates that the western portions of the lots are within an area of high risk of ASS being found within 3 metres from the surface. However, the majority of this high-risk area is located in the portion of the site that will be used for Public Open Space (POS).

The soils identified within the wetland area indicated a black organic peaty sand surface, underlain by black silty sand and black clayey sand as depth increases. The soils within the dry land areas all consisted of medium grain grey sands ranging from light to dark grey for the entire profile investigated (Cardno 2007).

2.1.4 Wetlands

Walluburnup Swamp (referred to as 'the wetland' in this document) is classified as a Conservation Category Wetland (Unique Feature Identifier (UFI) number 8168) under the DEC's Geomorphic Wetland Database and is located within the Yellagonga Regional Park (**Figure 2**).

2.1.5 Hydrology

Groundwater level investigations undertaken by Cardno BSD (2007) have previously determined the average annual maximum groundwater level (AAMGL) and maximum groundwater level (MGL) contours for the broader area of the Woodvale LSP 64. Groundwater within the site flows in a westerly direction towards Walluburnup Swamp and the MGLs for Stage 1 range between 27m Australian Height Datum (AHD) and 24m AHD (Cardno 2010).

Hydrological studies found that the separation distance between the surface and the annual average maximum groundwater level across stage one was greater than 1.2m (maximum level allowed for building construction) for all but six lots proposed by SP64 (Cardno 2010). The majority of the site has a separation distance of more than 4m. Management of maximum groundwater levels is only required for these six lots and this will be achieved by utilising sand fill to raise the surface level (**Figure 5**). Earthworks are also proposed to the west of the development boundary road to support these gradients, which include installing fill material as well as two retaining walls (**Figure 6**).

To facilitate the water sensitive urban design techniques proposed by the Local Water Management Strategy, sand fill is proposed to be used in the construction of these features in the wetland buffer area (**Figure 5**). The Urban Water Management Plan also details the location and specification for the installation of an urban water drainage swale within the wetland buffer and stormwater basin that is to be located to the north of stage 1 (**Figure 7**). The sedge and rush species proposed to be planted in the drainage swale and stormwater basin for the purpose of nutrient stripping and water retention will be detailed in this WMP.

2.1.6 Vegetation and Flora

A Level 1 Terrestrial Flora and Vegetation Survey (**Appendix B**) was completed by Cardno in October 2009 in the wetland buffer and adjacent areas of the wetland for the entire SP64 area. This survey was undertaken in accordance with EPA Guidance Statement No. 51 – Terrestrial flora and vegetation survey environmental impact assessment in Western Australia (Environmental Protection Authority, 2004). A flora and vegetation survey was also completed for the entire wetland (UFI No. 8168) as part of the Wetland Boundary Review and Management Category Re-evaluation (Cardno BSD 2006). Similar results were recorded for the eastern edge of the wetland adjacent to the SP64 area.

A total of 52 vascular plant species were recorded in the SP64 area with only 6 species native to Western Australia, none of which are classed as rare or as a priority. There were no native plant communities that were able to be identified due to the degraded nature of the site. Only several emergent native plants were present, which did not form a structure that enabled identification of a community type. Consequently, it was difficult to determine the Floristic Community Type (FCT) that is present on the site. Vegetation condition across the entire area has been rated as 'Completely Degraded' in accordance with Keighery (1994). This condition rating was due to the site having little to no native vegetation structure and a very high intensity of invasive weed species.

The site has been heavily disturbed in the past due to impacts from agriculture, market gardening and viticulture. The result of this is a highly disturbed wetland and wetland buffer, which is dominated by Kikuyu, Typha and other invasive weed species.

2.1.7 Fauna

A Level 1 Terrestrial Fauna Assessment (**Appendix C**) was completed by Bamford Consulting Ecologists in February 2010 in accordance with EPA Guidance Statement No. 56 – Terrestrial fauna survey for environmental impact assessment in Western Australia (Environmental Protection Authority, 2004a) for the wetland buffer and adjacent areas of the wetland for the entire SP64 area. This assessment consisted of a reconnaissance survey of the site, background research and low intensity fauna sampling. The objective of this assessment was to review the list of fauna expected on site, identify significant or fragile habitats, identify potential impacts upon fauna and provide recommendations to minimise impacts.

The desktop survey identified a fauna assemblage that could potentially occur on the subject site, which consisted of four fish, six frog, 85 bird and 13 mammal species. 20 of these species are classed as being conservation significant. 13 species of birds were observed during the reconnaissance survey and while no mammals were observed onsite. The presence of mammals in neighbouring bushland suggests that they would most likely visit the site at certain times during the year.

Conservation significant fauna that may occur in the area were classed as being at a "low risk" of impact caused by the proposed development. The primary potential impact would arise from the potential increase in predation of fauna species by cats coming from adjacent houses in the proposed development area. Other potential impacts associated with the development include changes in

hydro-ecology, increased fire risk, increase light and noise disturbances and some changes in current grassland habitats. The increase in the native habitat that is proposed as part of the rehabilitation program for this WMP would provide an increase in native fauna habitat in the area, in particular for smaller birds and bandicoots.

Recommendations from the fauna assessment include:

- Avoiding clearing in grassland areas during the spring breeding season of the Rainbow Bee-eater;
- Encouraging responsible pet ownership; particularly with respect to cats;
- Keeping road speeds down to minimise road kill;
- Liaising with the City of Joondalup and the DEC over the management of non-biting midges in the area;
- Encouraging use of native plants in gardens and in verge plantings to enhance wildlife habitat;
- Ensuring that swales designed for stormwater management are effective and provide habitat through plantings and, if possible, the creation of seasonal open water; and
- Providing information to residents on living close to a Regional Park. This could include providing them with information on the impact of fences on tortoises and frogs, the impact of domestic cats on wildlife, awareness of snakes, the risk of bushfire and the value of native plants for wildlife.

2.1.8 Ecological Linkages

The site is located on the eastern edge of the Walluburnup Swamp (within the Yellagonga Regional Park) and at present provides a low level of suitable ecological linkages to other parts of the Yellagonga Regional Park due to the absence of any native vegetation structure. The rehabilitation activities proposed in this WMP will aim to provide an improved ecological linkage to fauna species moving through the wetland and wetland buffer area. The proposed revegetation program that the Water Corporation is undertaking immediately to the south of the site will also provide increased habitat for species movement between Lake Joondalup and Lake Goollelal.

Walluburnup Swamp is a vital linkage between these two wetlands and potentially provides habitat for fauna species that are poorly represented across the swan coastal plain. By retaining and improving the condition of the wetland and its buffer areas, it is hoped that the Yellagonga Regional Park will continue to provide and habitat for these species and promote awareness in the general community of the need to retain such areas for future generations.

2.1.9 Disease

The assessment of the site for *Phytophthora cinnamomi* (Pc) was undertaken by Cardno (2010b) which classed the site as ‘uninterpretable’ due to the lack of susceptible species (indicator species) remaining after past clearing and agricultural practices. The high levels of degraded and absent vegetation and invasive weed infestations have created an environment where it would be very difficult to impossible to conduct interpretations. The degraded nature of the area and lack of species diversity would restrict the opportunity to undertake sampling of plant material for Pc, the only accurate way of determining absence and presence of the pathogen. The lack of susceptible species and the low lying water holding wetland areas would mean that the site would be classified as uninterpretable for Pc according to currently accepted industry standards set by the DEC's Dieback Detection and Mapping Interpreters Guidelines Manual (2007). A Dieback Management Plan produced for Stage 1 of the development (Cardno 2010b), recommended that all earth moving machinery that is brought onto the site is to be free of soil (where practicable).

2.2 Existing Cultural and Social Values

2.2.1 Past and Existing Land uses

The existing land uses of the site and SP64 area include broad scale agricultural grazing, and intensive viticulture and horticulture activities. The wetland is included within the Yellagonga Regional Park which is used as a passive recreation zone by the local community and is reserved for "Parks and Recreation" under the Metropolitan Region Scheme.

2.2.2 Community Use and Access

The Yellagonga Regional Park is used by recreational users and community groups in a variety of ways. The 'Friends of Yellagonga' community group have been active in the management of the park and its environments. There are no recreational or environmental facilities located within or adjacent to the site. There are several tracks that run through the site and into the Yellagonga Regional Park, which would most likely be used by walkers.

2.2.3 Aboriginal Heritage

There are no listed indigenous or non-indigenous heritage sites located within the site with the closest being an indigenous site located on the western side of the Wallebuenup Swamp which is listed as Site S00437 (Department of Indigenous Affairs, 2010). Aspects of heritage within the site will be addressed through condition 34 of the WAPC reference 140038.

3 Existing and Potential Threats and Impacts

3.1 Geology, Geomorphology and soils

Erosion is a minor threat that could potentially cause issues associated with the movement of sand into the wetland and adjacent properties. Acid Sulphate Soils (ASS) have been mapped as a potential threat close to the wetland under the Planning Bulletin 64 (WAPC 2009). Soil contamination on the development area has also been raised as a potential threat. The ASS and soil contamination within the site and wider development area will be addressed through condition 38 and 42 of WAPC reference 140038.

The fill material that is proposed to be installed in the site as part of the Urban Water Management Plan (UWMP) drainage features and the development level construction (retaining walls) will be clean sand that's is required under building codes for batter construction. This fill will be sourced (where possible) from similar soil types in the region and be certified as dieback free. Topsoil from the site will be stripped and retained which will be spread on top of this clean fill material. This topsoil will reduce the risk of failure of the revegetation program in the area due to the topsoil containing the necessary nutrients and microbes required for good plant growth and establishment. This also reduces the need to fertilising the plants, which reduces the risk of increasing nutrient runoff into the wetland.

3.2 Hydrology

A Local Water Management Strategy and UWMP for the site have been prepared to address condition 29 of WAPC reference 140038. These plans aim to address the risk of nutrient rich water entering the wetland and will be implemented as a demonstration site of Water Sensitive Urban Design (WSUD) for future developments (Cardno 2010). As part of the WSUD, techniques such as bio-pockets, porous pavement, soakwells, road soakage structures, vegetated swales and a retention basin will be installed in the development area and the site. The sedge and rush species that will be planted in the drainage swale and retention basin will be detailed in this WMP.

3.3 Flora

The flora of the site has been classified as 'Completely Degraded' due to the lack of native species, vegetation structure and dominance of invasive weed species. The risk to the native flora of the site is very low due to the absence of intact native revegetation.

3.4 Fauna

Based on the fauna assessment undertaken, conservation significant fauna that may occur in the site were determined to be at a low risk from impacts caused by the proposed development. The primary issue would potentially be an increase in predation of fauna species by cats coming from adjacent houses. Other potential impacts associated with the development were determined to be changes in hydro-ecology, increased fires, increase light and noise disturbances and some changes in current grassland habitats. The increase in the native habitat that is proposed as part of the rehabilitation program within this WMP would provide an increase in native fauna habitat in the area, in particular for smaller birds and bandicoot species. Proposed native species for verges in the western edge of the development area would also provide extra habitat for local fauna species.

3.5 Ecological Linkages

The site is devoid of any native vegetation and highly infested with invasive and environmental weed species and therefore there is no risk to ecological linkages from clearing native vegetation. There will however, be some disturbance to fauna habitats located in the Typha wetland area due to the proposed revegetation program. The impact of this disturbance is expected to be minor, with the surrounding Typha wetland area to remain intact and the risk to fauna from habitat loss is considered to be low. Due to the lack of native flora within the site, the potential risk of fragmentation of any ecological linkages is also as considered to be low as the revegetation program will provide vegetation cover in the medium to long term.

3.6 Fire

There is a medium to low risk of wild fire in the wetland adjacent to the site due to the amounts of vegetative material (mainly from Typha) that can become a fuel source in summer if this material dies off. A Fire Management Plan has been prepared for the site to address condition 45 of WAPC reference 140038, which will be updated after two years to take into account the establishment of seedlings as part of the revegetation program in the wetland buffer. This plan recommends that a three metre fire break be slashed and sprayed with herbicide along the western edge of the site which aims to protect the revegetation from fire during the period of plant establishment. Other fire protection measures that are listed in the plan include the primary (development boundary road) and secondary (dual use path) fire break which can be used for access to the site by emergency vehicles, locations of water hydrants, access/egress points for the development area and a hazard assessment of the vegetation currently present in the site.

3.7 Cultural Heritage and Community Use

No significant cultural heritage was identified within the site and therefore the risk of any impacts to site with heritage values is non-existent. Community use and appreciation of the Yellagonga Regional Park remains high with participation from groups such as the Friends of Yellagonga and the Yellagonga Community Advisory Committee. Community use and appreciation of the wetland and wetland buffer area is likely to be enhanced through the completion of the revegetation program, which would aim to increase the biological diversity and sustainability of the wetland buffer.

4 Summary of Management Commitments

4.1 Roles and Responsibilities

WPG is responsible for the production and implementation of the WMP as stated in Condition 38 of WAPC reference 140038. From the WMRS, the time frame associated with the implementation of the WMP would be four years starting in 2011, which would consist of one year for weed control and revegetation and three years for maintenance and monitoring. A summary of the works schedule for the revegetation program is provided in **Section 5**.

4.2 Future Management Responsibilities

Once the implementation of the revegetation and monitoring program is complete and meets the completion criteria stated in this WMP, management of the site will be transferred to the CoW and the DEC. The alignment of the dual use path was the agreed boundary for which the management areas were to be delineated (as stated in the WMRS). The DEC will undertake management of the areas to the west of the dual use path and the CoW would manage areas to the east (and including the path).

4.3 Vision and Objectives

The overarching vision of the WMP is to produce an ecologically diverse and functioning wetland buffer that will protect the wetland from the potential impacts from the development and provide added visual amenity.

The main objectives of the WMP are to rehabilitate and enhance the vegetation contained within the buffer by controlling weed species and replacing these weeds with local endemic plant species, which will act as a suitable buffer for the wetland from the adjacent development area. This rehabilitation program will also aim to improve the aesthetics of the area and promote interaction with the local environment by occupants of the proposed development and surrounding suburbs.

4.4 Geology, Geomorphology and Soils

In order to satisfy Condition 42 of WAPC reference 140038, a soil and groundwater contamination investigation has been undertaken by Cardno. The report produced in May 2009 found that the site is suitable for residential development, provided that groundwater access is appropriately restricted against use for residential purposes (Cardno 2009).

The Water Corporation is in the process of installing the Gnangara sewer main along the western edge of the property boundary. A 30 metre disturbance line (15 metres either side of sewer alignment) is proposed to be cleared along this alignment (**Figure 4**) and the sewer pipe will be buried to a depth of approximately 5 metres. The timing of the revegetation of the site needs to be undertaken with this activity in mind due to possible conflicts with the construction activities.

As part of the offset package for the installation of this sewer main through parts of the wetland and wetland buffer, the Water Corporation will be revegetating two areas adjacent to the site. Part of the wetland buffer to the west of the SP64 area (north of Stage 1) will be rehabilitated along with the wetland buffer area immediately to the south of the site (GHD 2009). This work will have no impacts upon the revegetation program on the site.

To mitigate any potential movement of soil through wind erosion, temporary windbreak fencing will be installed around the site after construction of drainage features and during rehabilitation. Erosion

control measures in the development area will be detailed under the Construction Management Plan that will be prepared by the construction contractor.

The clean sand fill that is proposed to be installed in the site as part of the construction of the development area and the drainage swale is displayed in **Figure 5**. Were possible the area of fill will not exceed the eastern edge of the dual use path, which will be dependent on creating aesthetic slopes in the site that will not pose difficulties in revegetation. There will be no sand fill material constructed inside the wetland boundary.

4.5 Hydrology

All aspects of the hydrological management for the development area and the site are addressed in the Urban Water Management Plan (Cardno 2010) that has recently been prepared. This document outlines objectives, management strategies (including stormwater, drainage and water quality management) and hydrological monitoring across the development area and the site. The sedge and rush species that will be planted in the drainage swale and retention basin are listed in **Table 1** and will be planted to a density of 6 plants/m^2. The planting of these seedlings will be under the same requirements and methods described in **Section 5**.

4.6 Fire

A 3 metre wide firebreak will be slashed and sprayed with herbicide in November and December (and follow up spray in January) each year along the western edge of the site (outside the buffer boundary) to reduce the risk of fire from affecting the revegetation and development area. The dual use path and the road on the western edge of the development area will act as a firebreak for the development and provide access for fire and emergency vehicles. Other aspects such as road design, fire hydrant locations and access points are detailed in the Fire Management Plan (Cardno 2010c) for Chianti Estate.

4.7 Community Use and Appreciation

Community and stakeholder groups' involvement in the maintenance of the rehabilitation areas after the completion of the three year monitoring and maintenance period will be encouraged along with support from the CoW and the DEC.

With DEC and CoW approval, educational signage is proposed to be installed along the dual use path to inform the general public about the wetland and the role that the revegetated wetland buffer will play in protecting the wetland. Other information on the signage will aim to inform the public about local native flora and fauna species and the roles they play in the Yellagonga Regional Park ecosystem. Signage will be developed in conjunction with the Landscape Management Plan.

4.7.1 Access Control

Access control fencing, consistent with the CoW specification for conservation style fencing (Standard Drawing TS01-7, **Plate 1**) will be erected on the eastern edge of the dual use path and the western edge of the feature native plantings to act as a barrier to recreational users adversely affecting the revegetation program (**Figure 6**).

4.7.2 Dual Use Path

The dual use path (DUP) is mapped in an indicative location in **Figure 6, 7 and 8**. This path will be constructed to the DEC specification, which is compliant with the Austroad standards for DUP (Dual use paths – Austroads Part 14 (bicycles), AS 1742, AS2809.3, AS2156.1, and AS2156.2). The DUP location is still an indicative location due to Water Corporation construction works on the Gnangara Sewer main installation expected to continue to the middle of 2011. Once construction has been completed, a site inspection by an engineer would be undertaken which would address the site conditions required for the construction of the dual use path. Discussion will then occur between the CoW and the DEC regarding various aspects of the dual use path location such as site conditions, passive surveillance from the development area, fire access and aesthetic path design. These features were previously raised by the DEC and the CoW during the assessment of the WMP and the LMP.

Plate 1: Example of access control fencing.

5 Implementation of WMP

5.1 Management Zones

After the completion of the revegetation program, the site will be divided into two different management zones, which will indentify which agency will assume management of these areas once the revegetation completion criterion (**Section 5.7**) has been met at the end of the monitoring and maintenance period. The delineation boundary (**Figure 7)** of these zones will be defined by the western edge of the dual use path, with all areas to the west of the path falling under the management of the DEC and the areas to the east of the path (including the dual use path) under the CoW.

5.2 Management Strategies

Specific management strategies, in addition to the requirements of Guidelines Checklist for Producing a Wetland Management Plan (DEC 2008) and the Yellagonga Regional Park Management Plan 2003-2013, are detailed in the WMRS adjusted to present and future time.

The implementation of the WMP will be undertaken in three different stages:

1. The first stage is a weed control program which will be undertaken for one year before any revegetation works and then throughout the maintenance period where required;
2. The second stage involves a revegetation program, which will involve the installation of seedlings and access control fencing in the site; and
3. The third stage of the program will be a three year maintenance and monitoring program which would commence after the initial revegetation program has been completed. This program would aim to maintain the revegetation areas and report on the success of revegetation activities required for signoff under the subdivision applications.

5.3 Rehabilitation Program

Revegetation activities, in accordance with the WMRS, will be undertaken within the site in the following ways:

- Revegetation and maintenance work will be implemented by a suitably qualified and experienced rerevegetation specialist/contractor with knowledge of wetland rehabilitation;
- Weed control, fire break slashing and fencing construction to be completed by suitably experienced and licensed operators (if required);
- Cultivate the soil before the planting of seedlings;
- Plant seedlings into specified revegetation community types in the site; and
- Experienced environmental scientists with knowledge in wetland revegetation monitoring will undertake revegetation monitoring.

5.3.1 Weed Control

As in accordance with the WMRS, weed control within the rehabilitation areas will be dealt with in the following manner:

- Identify and map the intensity of weed species in site before weed control program;
- Manually remove wood weeds from the site which will include mulching of trees and shrubs and painting of stumps with Glyphosate (or Roundup Bi-active ® if close to the wetland) ;
- Broad scale spraying and slashing of weeds on the site will be undertaken 12 months prior to planting program at times that will minimize seed set for the following seasons. Only herbicides

such as Roundup Bi-active ® will be used in and near the wetland to reduce the impacts of surfactants on sensitive animal species such as frogs;
- Targeted weed control will be undertaken after planting where weed species comprise more than 20% ground cover, will not damage planted vegetation and will continue for the three year maintenance period (as required); and
- All spraying and slashing work to be carried out in the wetland buffer will be undertaken by fully licensed and experience personnel.

5.3.2 Revegetation

In accordance with the WMRS, revegetation activities required to be undertaken within the site are to be addressed in the following ways:

- All revegetation and maintenance works will be implemented by a suitably qualified and experienced rehabilitation specialist/contractor with knowledge of wetland revegetation;
- Planting of tubestock (seedlings) will be the primary form of revegetation in the site;
- Opportunities for maintaining views across Walluburnup Swamp will be considered in the planting of seedlings in the site (especially around dual use path);
- Seedlings species are to planted according to their revegetation community types (**Table 1**) in the areas mapped in **Figure 8**;
- All seedlings are to be grown in NIASA accredited nurseries to ensure disease free and quality; and
- Fencing is to be installed along eastern edge of dual use path and western edge of feature native planting area.

The revegetation area will be separated into four different revegetation plant community types and one landscape garden, which are classed as follows:

- *Baumea – Schoenoplectus* sedgeland community(0.369ha);
- *Melaleuca rhaphiophylla* open forest community (0.391ha);
- *Melaleuca – Eucalyptus* forest community (0.191ha);
- Drainage swale sedgeland community (0.032ha); and
- Feature Native Planting (0.077ha).

The Baumea – Schoenoplectus sedgeland community contains two plant species (sedges) that will be planted in the wetland areas of the site in which Typha is currently established and is inundated with water for part or all of the year. Wetland sedge/rush species generally grow as monocultures in natural ecosystems and the two species proposed have similar water/nutrient requirements which means they would be in direct competition with each other. It is therefore proposed that the two species are planted in separate block plantings to reduce competition and enhance growth rates of the plants. This would involve separating the wetland community into four equal sections with the two sedge species to be planted in an alternating block planting arrangement.

The *Melaleuca rhaphiophylla* open forest community will be revegetated with *Melaleucas*, *Eucalyptus rudis* and sedge and rush species. Twelve plant species will be planted as seedlings in the wetland fringe areas of the site, which are currently dominated by Kikuyu.

The *Melaleuca – Eucalyptus* forest community will be revegetated with *Melaleucas*, *Eucalypts rudis*, *Hakeas* and various understory species. There are twelve species that will be planted in this community in the dryland areas of the site that is currently dominated by Love grass (*Eragrostis curvula*) and other dryland weed species. These dryland areas are generally not inundated with water or heavily waterlogged at any time of the year.

The information regarding the Feature Native Planting (landscaped garden) that is shown in **Figures 6, 7 and 8** is detailed in the Landscape Management Plan (LMP) for Stage 1 (Emerge Associates 2010). The LMP details the works to be undertaken in the landscaped gardens of the development area and the site and the densities of these plantings. The plant species proposed and numbers of each are contained within **Table 1**. The Landscape Management Plan details other aspects relating to the completion criteria of these works and the transfer of management responsibility to the CoW.

5.3.2.1 Revegetation densities:

In accordance with the WMRS, the seedlings to be planted in the site will be to the following densities:

- *Melaleuca - Eucalyptus* forest community will be planted to a density of 1 plant per m^2.
- *Melaleuca rhaphiophylla* open forest community will be planted to a density of 4 plants per $10m^2$ for shrub and tree species (ie *Melaleuca rhaphiophylla*) and 5 plants per m^2 for rush and sedge species.
- *Baumea - Schoenoplectus* sedgeland community will be planted to a density of 6 plants per m^2; and
- The drainage swale sedgeland community will also be planted to a density of 6 plants per m^2.

5.4 Access Control

Access control fencing will act as a barrier to recreational users adversely affecting the revegetation program and will be installed on the eastern side of the dual use path and western edge of the feature native garden (**Figure 6**). This fencing will be compliant with the conservation style fencing (Standard drawing No. TS01-7) used by the CoW. Revegetation around the dual use path will be set back slightly to reduce maintenance from overhanging tree branches, increase fire protection measures and increase visual surveillance of the area. All shrubs will be planted at least 1m from the path and all trees will be planted between 3 to 5m away subject to aesthetics of the planting.

5.5 Works Schedule

The work schedule for all revegetation activities is detailed in **Table 2**.

Table 1: Revegetation species list for the site.

Revegetation Communities	Plant form	*Baumea- Schoenoplectus* sedgeland		*Melaleuca* open forest		*Melaleuca-Eucalyptus* forest		Drainage swale sedgeland		Feature Native Planting
Species		**Seedlings/ha**	**Amounts**	**Seedlings/ha**	**Amounts**	**Seedlings/ha**	**Amounts**	**Seedlings/ha**	**Amounts**	**Amounts**
Acacia pulchella	Shrub		0		0	1800	343.8		0	0
Banksia littoralis	Tree		0	1200	469.2		0		0	0
Banksia nivea	Shrub		0		0		0		0	430
Baumea articulata	Sedge	30000	11100		0		0	8000	256	0
Baumea juncea	Sedge		0	10000	3910		0	12000	384	0
Baumea preissii	Sedge		0	7000	2737		0	7000	224	0
Bolboschoenus caldwellii	Sedge		0	3000	1173		0		0	0
Carex appressa	Sedge		0	5000	1955		0		0	0
Carex fasicularis	Sedge		0	2000	782		0		0	0
Calothamnus quadrifidus	Shrub		0		0		0		0	155
Corymbia calophylla	Tree		0		0		0		0	430
Eremophila nivea	Shrub		0		0		0		0	258
Eucalyptus rudis	Tree		0		0	1500	286.5		0	0
Ficinia nodosa	Sedge		0	5000	1955		0		0	0
Hakea lissocarpha	Shrub		0		0	200	38.2		0	0
Hakea prostata	Shrub		0		0	1000	191		0	0

Revegetation Communities	Plant form	*Baumea- Schoenoplectus* sedgeland		*Melaleuca* open forest		*Melaleuca-Eucalyptus* forest		Drainage swale sedgeland		Feature Native Planting
Species		**Seedlings/ha**	**Amounts**	**Seedlings/ha**	**Amounts**	**Seedlings/ha**	**Amounts**	**Seedlings/ha**	**Amounts**	**Amounts**
Hardenbergia comptoniana	Shrub		0		0	1000	191		0	0
Hemiandra pungens	Shrub		0		0		0		0	155
Isopogon latifolius	Shrub		0		0		0		0	22
Juncus kraussii	Sedge		0	3000	1173		0	5000	160	0
Juncus pallidus	Sedge		0	15000	5865	500	95.5	20000	640	0
Kennedia prostrata	Shrub		0		0		0		0	155
Kunzea glabrescens	Tree		0	800	312.8	500	95.5		0	0
Lechenaultia floribunda	Shrub		0		0	300	57.3		0	0
Lepidosperma longitudinale	Sedge		0		0		0	8000	256	0
Melaleuca rhaphiophylla	Tree		0	2000	782	1000	191		0	0
Melaleuca teretifolia	Shrub		0		0	800	152.8		0	0
Melaleuca thymiodes	Shrub		0		0	1000	191		0	0
Patersonia occidentalis	Shrub		0		0		0		0	344
Schoenoplectus validus	Sedge	30000	11100		0		0		0	0

Revegetation Communities	Plant form	*Baumea- Schoenoplectus* sedgeland		*Melaleuca* open forest		*Melaleuca-Eucalyptus* forest		Drainage swale sedgeland		Feature Native Planting
Species		**Seedlings/ha**	**Amounts**	**Seedlings/ha**	**Amounts**	**Seedlings/ha**	**Amounts**	**Seedlings/ha**	**Amounts**	**Amounts**
Thryptomene 'Supernova'	Shrub		0		0		0		0	344
Viminaria juncea	Shrub		0		0	400	76.4		0	0
Total		**60000**	**22200**	**54000**	**21114**	**10000**	**1910**	**60000**	**1920**	**2293**

Table 2: Revegetation Works Schedule

Timing	Works Type	Works program	Responsible agency
Start February 2010	Construction	Scalp topsoil, excavate trench, install sewer line and replace topsoil.	Water Corporation
November – December 2010	Fire Management	Survey the boundary of the revegetation area for location of fire break.	Fire management contractor
November - December 2010	Fire Management	Slash 3m firebreak along western edge of site.	Fire management contractor
November – December 2010	Weed control	Slash weed plants inside site in preparation for weed control. Spray Typha plants with Roundup bioactive ® or equivalent herbicide.	Revegetation contractor
December 2010	Fire Management	Spray 3m firebreak along western edge of site with Gylphosate or Roundup bioactive ®.	Fire management contractor
Start Summer 2010 – 2011	Construction	Construction of the dual use path	WPG
Start Summer 2010 – 2011	Construction	Construction of feature native garden and fencing along dual use path and garden.	WPG
Summer 2010 - 2011	Revegetation	Collect/source seed for seedling propagation.	Revegetation contractor
Summer 2010 - 2011	Revegetation	Collect/source seed for seedling propagation.	Revegetation contractor
Summer 2010 - 2011	Weed control	Remove and mulch woody weeds. Treat stumps with glyphosate.	Revegetation contractor
January 2011	Weed control	Follow up spray of Typha plants with Roundup bioactive ® or equivalent herbicide.	Revegetation contractor
March 2011	Weed control	Slash Typha plants to break up biomass	Revegetation contractor
Autumn 2011	Weed control	Blanket spray weeds on the site with Gylphosate or Roundup bioactive ®.	Revegetation contractor
Spring 2011	Weed control	Blanket spray weeds on the site with Gylphosate or Roundup bioactive ®.	Revegetation contractor
November - December 2011	Fire Management	Slash 3m firebreak along western edge of site.	Fire management contractor
December 2011	Fire Management	Spray 3m firebreak along western edge of site with Gylphosate or Roundup bioactive ®.	Fire management contractor
Summer 2011 - 2012	Revegetation	Send required amounts of seed to accredited nursery for seedling propagation.	Revegetation contractor

Timing	Works Type	Works program	Responsible agency
Summer 2011 - 2012	Site preparation	Cultivate the site to break up weed mat and soil structure for planting.	Revegetation contractor
Autumn 2012	Weed control	Blanket spray (if necessary).	Revegetation contractor
Winter 2012	Revegetation	Plant seedlings.	Revegetation contractor
Winter 2012	Construction	Installation of information signage regarding revegetation and fire access controls.	WPG
Spring 2012	Maintenance	Spot spray any weeds (if necessary).	Revegetation contractor
Spring 2012	Monitoring	Install revegetation monitoring quadrats and undertake 1st monitoring assessment.	Environmental Consultants
Summer 2012	Monitoring	Produce 1st monitoring report with recommendations for maintenance work.	Environmental Consultant
December 2012	Fire Management	Slash 3m firebreak along western edge of site.	Fire management contractor
December 2012	Fire Management	Spray 3m firebreak along western edge of site with Gylphosate or Roundup bioactive ®.	Fire management contractor
Autumn 2013	Monitoring	Undertake 2nd monitoring assessment.	Environmental Consultants
Autumn 2013	Maintenance	Spot spray weeds. (if necessary)	Revegetation contractor
Autumn 2013	Monitoring	Produce 2nd monitoring report with maintenance recommendations.	Environmental Consultants
Winter 2013	Maintenance	Plant replacement seedlings (if necessary).	Revegetation contractor
Spring 2013	Monitoring	Undertake 3rd monitoring assessment.	Environmental Consultants
Spring 2013	Maintenance	Spot spray weeds (if necessary).	Revegetation contractor
Spring 2013	Monitoring	Produce 3rd monitoring report with maintenance recommendations.	Environmental Consultants
November - December 2013	Fire Management	Slash 3m firebreak along western edge of site.	Fire management contractor
December 2013	Fire Management	Spray 3m firebreak along western edge of site with Gylphosate or Roundup bioactive ®.	Fire management contractor
Autumn 2014	Monitoring	Undertake 4th monitoring assessment.	Environmental Consultants
Autumn 2014	Monitoring	Produce 4th monitoring report with maintenance recommendations.	Environmental Consultants

Timing	Works Type	Works program	Responsible agency
Autumn 2014	Maintenance	Spot spray weeds (if necessary).	Revegetation contractor
Winter 2014	Maintenance	Plant replacement seedlings (if necessary).	Revegetation contractor
Spring 2014	Maintenance	Spot spray weeds (if necessary).	Revegetation contractor
Spring 2014	Monitoring	Undertake 5th monitoring assessment.	Environmental Consultants
Spring 2014	Monitoring	Produce 5th monitoring report with maintenance recommendations.	Environmental Consultants
November - December 2014	Fire Management	Slash 3m firebreak along western edge of site.	Fire management contractor
December 2014	Fire Management	Spray 3m firebreak along western edge of site with Gylphosate or Roundup bioactive ®.	Fire management contractor
Autumn 2015	Monitoring	Undertake 6th monitoring assessment.	Environmental Consultants
Autumn 2015	Monitoring	Produce 6th and final monitoring report addressing completion criteria.	Environmental Consultants
Autumn 2015	Project handover	Meeting with DEC and CoW regarding handover of responsibilities following the satisfaction of completion criteria.	Environmental Consultants, DEC and CoW

5.6 Monitoring

Monitoring of the revegetation areas after the installation of seedlings will aim to measure the ongoing progress and success of rehabilitation operations in the site. The revegetation monitoring program will involve setting up permanent monitoring quadrats within the site to adequately sample the revegetation. The monitoring will occur twice per year, one each in autumn and spring for the entire three year monitoring period to evaluate seedling survival, weed control, infrastructure and maintenance requirements.

The monitoring period will commence in the spring after the first winter installation of seedlings in the site and will continue until the autumn of the third year. This will involve six monitoring events that will be conducted by experienced environmental scientists with a report produced for each event which will provide details into the success of the rehabilitation and provide recommendations for future maintenance work. A final report will be produced after the completion of the maintenance and monitoring period, which should meet the completion criteria set down in this WMP and provided to the CoW and the DEC.

Three monitoring quadrats will be set up in each revegetation community type to enable a statistical and representative sample set to be monitored for the seedlings and weeds in the site. Due to the swale community being so small, only one quadrat will be installed here. The quadrats will be 5m by 5m square, which would enable approximately 2% of the revegetation areas to be sampled across the site. Photo points will be located on the north west corner of each quadrat which will provide a visual example of the success of the revegetation.

Within each monitoring quadrat, the following information will be collected:

- Seedling survival and health (as per seedling and species);
- Weed cover percentage (significant weed species to be recorded);
- Pest attack (either insect or animal);
- Other factors affecting seedling survival; and
- Photo record (taken at the northern west corner of quadrat).

Health recordings of seedlings will be based on a 0 to 5 number rating system, which identifies the seedlings health on several key factors. These factors include signs of stress, growth rates and pest attack (both flora and fauna). Stress of a seedling can be caused by sand blasting, low moisture rates, weed competition and poor soil conditions, which can result in yellowing of the leaves, loss of leaves, increased pest attack and stunted growth.

The health ratings of seedlings in the revegetation project are listed as follows:

- 0 – **Dead** (all loss of leaves from the seedling and dry woody stems)
- 1 – **Barely alive** (a very small amount of life only just visible on the stems and most of the leaves that are discoloured);
- 2 – **Stressed** (some to many leaves yellow and discoloured with potential signs of pest attack);
- 3 – **Good** (plants relatively healthy with no discolouring of the leaves and limited evidence of pest attack);
- 4 – **Very good** (plant healthy with good growth and no pest attack); and
- 5 – **Excellent** (plant very healthy with lots of new growth and flowering and/or fruiting).

By using this method the surveyor can gauge the health of each species and the percentage of seedling survival throughout the site. Recording the health ratings of each species can aid in assessing the success of the seedling establishment and identify any need for maintenance or replacements.

Outside the quadrats, observational recordings can be taken for the whole site on:

- Weed impacts (actual and predicted);
- Other plant species;
- Erosion impacts;
- Other factors affecting seedling survival ; and
- Fencing condition.

5.6.1 Performance Criteria

The WMRS details that compliance with completion criteria should be met following the end of the three year maintenance and monitoring period. If these criteria are not met, then remedial work will be undertaken until there is an agreement of completion from the CoW and DEC regarding their respective management zones.

In accordance with the WRMS, the rehabilitation completion criteria are as follows:

- All woody weeds are to be removed from site;
- Weeds are effectively controlled across the site with weed species comprising less than 20% of the groundcover;
- A stable *Melaleuca - Eucalyptus* forest community has been established with the following characteristics:
    - All species used in the revegetation works are represented across the site; and
    - Plants are established at a rate of 0.75 per m^2 and have a diversity of at least 6 species per 10 m^2 over at least 70% of the area planted.
- A stable *Melaleuca rhaphiophylla* open forest community has been established with the following characteristics:
    - All species used in the rehabilitation works are represented across the site;
    - Rush/sedge species are established with an average projective foliage cover of 50% and/or at a rate of 5 plants per m^2 and have a diversity of at least 6 species per 10 m^2 over at least 70% of the area planted; and
    - Tree species are established at a rate of 4 per 10 m^2 over at least 70% of the area planted.
- A stable *Baumea - Schoenoplectus* sedgeland community has been established with the following characteristics:
    - Both species used in the rehabilitation works are represented at the site; and
    - Plants are established to an average projective foliage cover of 75% and/or at a minimum rate of 6 plants per m^2 and both species are present over at least 70% of the area planted.
- A stable Drainage Swale sedgeland community has been established with the following characteristics:
    - All species used in the rehabilitation works are represented across the site; and
    - Plants are established to an average projective foliage cover of 75% and/or at a minimum rate of 6 plants per m^2 and at least 4 species per 10 m^2 over at least 70% of the area planted.

5.7 Maintenance

The revegetation contractor upon recommendations provided in the monitoring reports will conduct the maintenance program for the revegetation works over the three year time frame of the program. The maintenance program will consist of planting of replacement seedlings, weed control of any problem weeds within the site (to be carried out twice a year if required or recommended), erosion control measures and repairs to damaged fences to ensure the completion criteria will be met.. An

indicative works schedule is provided in **Table 2**, which details the types of works required for the revegetation/maintenance/monitoring program, timings for each works and the agency responsible for each aspect.

5.7.1 Maintenance Budget

When compiling the budget for work specification, a maintenance budget of approximately 40% of the total cost will be included to address various issues that may arise due to unforeseen events. This budget is to be divided over the three year period of the maintenance program with the majority of this to be most likely used in the first year of the program.

This maintenance budget would take into account unforeseen issues such as:

- Increases in material and labour costs;
- Weather damage (eg. seedling deaths from drought);
- Weed infestation;
- Severe pest attack; and/or
- Public access disturbance.

6 Bonding and Clearing Subdivision Conditions

As the condition of subdivision, the proponent is required to prepare and implement a WMP for the site to gain release of lot titles. Both the CoW and the DEC will be the clearing authorities for Condition 38 of WAPC reference 140038 that is dependent on meeting the revegetation completion criteria stated in this WMP.

Due to the extended timeframe of the revegetation program, WPG will bond the entire works with the CoW. A contract with a revegetation contractor will be secured to ascertain the sum of money required to complete the full implementation of the WMP across the site and be approved by the CoW.

Bonding will only be for works associated with Stage 1 and as shown in this WMP. As soon as a revegetation contractor has been engaged, WPG would lodge a bond for the works that have not been completed at the time clearances are been sought. The CoW would then relinquish this bond, as the works program is progressively undertaken.

7 References

Bureau of Meteorology. 2010. Climate Averages. *Publicly available data prepared by the Bureau of Meteorology, Commonwealth of Australia*. Accessed: http://www.bom.gov.au/climate/averages/tables/ca-wa-names.html

Bamford Consulting Ecologists, 2010. Level 1 Fauna Assessment of Chianti Private Estate, Wanneroo Rd, Woodvale. Prepared for Cardno Pty Ltd.

Cardno. 2007. *Preliminary Site Investigation, Woodvale*. Prepared for Watson Property Group Northern Aspects Ltd.

Cardno, 2009. *Detailed Site Investigation - Lots 801, 27 and 28 Wanneroo Road, Woodvale*. Prepared for Watson Property Group Northern Aspects Ltd.

Cardno. 2010. *Urban Water Management Plan*. Prepared for Watson Property Group Northern Aspects Ltd.

Cardno, 2010a. *Flora and Vegetation Survey*. Prepared for Watson Property Group Northern Aspects Ltd.

Cardno, 2010b, *Chianti Estate Dieback Management Plan - Subdivision application number 140038*, Prepared for Watson Property Group Northern Aspects Ltd.

Cardno, 2010c, *Fire Management Plan,* Prepared for Watson Property Group Northern Aspects Ltd.

Cardno BSD, 2007, *Groundwater Level Investigations: Lots 0,21-23,26-28,32-34,36,83 and PT Lots 6,35, &1 Wanneroo Road, Woodvale, Final Report*.

Churchward, HM and McArthur, WM 1980, *Landforms and soils of the Darling System, in: Atlas of Natural Resources, Darling System*, Department of Conservation and Environment, Perth.

City of Wanneroo and City of Joondalup. 2009. *Yellagonga Integrated Catchment Management Plan – Part 1* Technical Report. Western Australia.

Department of Conservation and Land Management. 2003. *Yellagonga Regional Park Management Plan 2003-2013*. Cities of Joondalup and Wanneroo, the Conservation Commission of Western Australia and the Department of Conservation and Land Management, Perth Western Australia.

Department of Environment and Conservation. 2007. *Detection, Diagnosis, & Mapping Volume 2- Interpreter's Guidelines - January 2007*. DEC, Perth.

Department of Environment and Conservation. 2008. *Guidelines Checklist for Producing a Wetland Management Plan*. Perth, Australia.

Emerge Associates, 2010, *Chianti Private Estate Landscape Management Plan Stage 1*, Prepared for Watson Property Group Northern Aspects Ltd.

Environmental Protection Authority, 2004. *EPA Guidance Statement No. 51 – Terrestrial flora and vegetation survey for environmental impact assessment in Western Australia.* Perth, Western Australia.

Environmental Protection Authority, 2004a. *EPA Guidance Statement No. 56 – Terrestrial fauna survey for environmental impact assessment in Western Australia*. Perth, Western Australia.

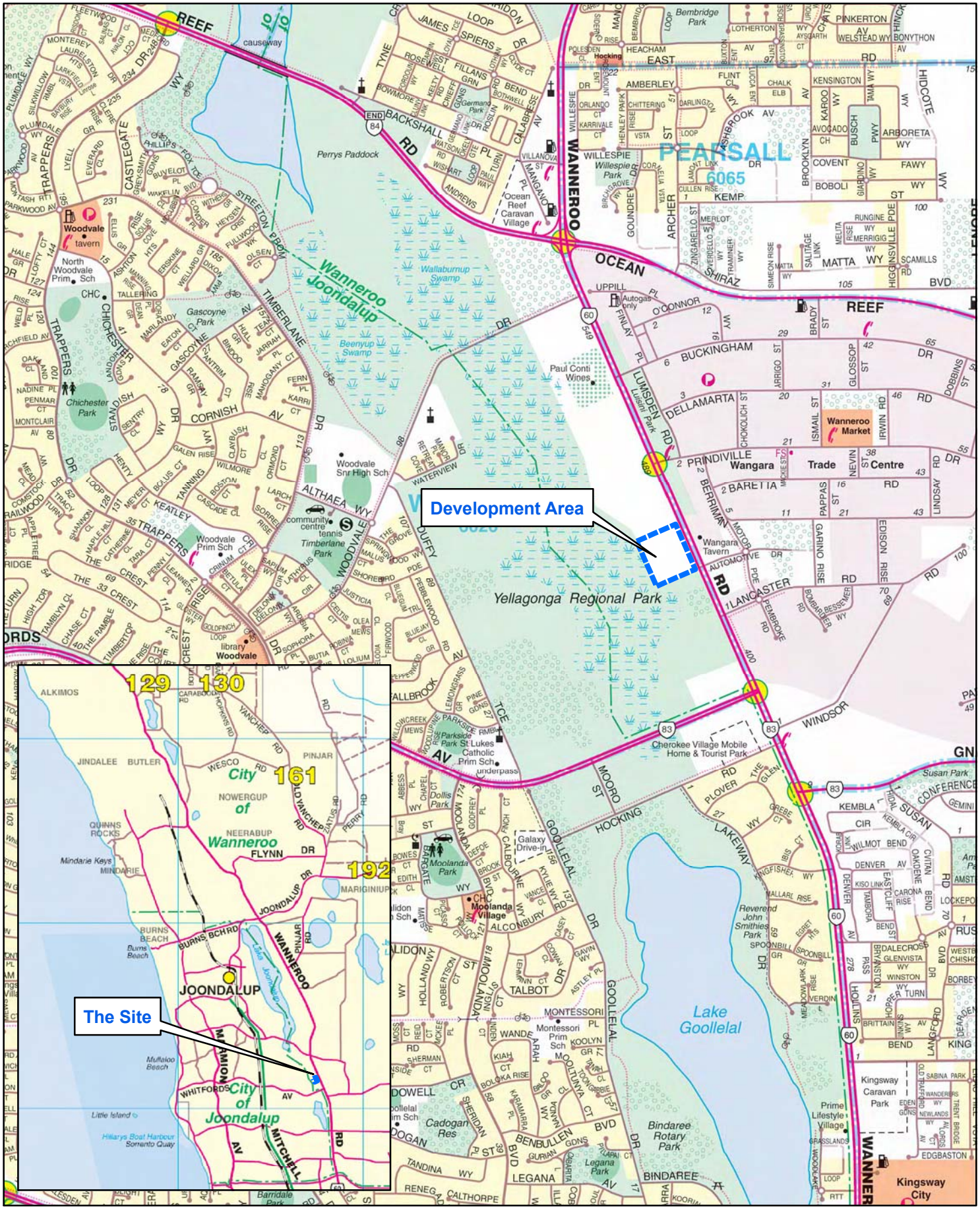
GHD. 2009. *Rehabilitation Management Plan for the Gnangara Sewer Main*. Prepared for Water Corporation

Keighery, BJ 1994, *Bushland plant survey: A Guide to Plant Community Survey for the Community*, Wildflower Society of WA (inc), Nedlands, Western Australia.

Regeneration Technology Pty Ltd. 2002. *Yellagonga Regional Park – Weed Control & Revegetation Management Plan*. Prepared for Department of Conservation and Land Management, Perth Western Australia.

WAPC. 2009. *Bulletin 64 Acid Sulphate Soils*. West Australia Planning Commission, Perth, West Australia.

Figures



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:20,000**

0 200 400 800 1,200 1,600 2,000 Metres

PROJECT **Chinanti Private Estate - Wetland Management Plan**

DRAWING TITLE **FIGURE 1 : Locality Plan**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V9076**

Original **A4**

Drawing Number **SK01**

Revision

Designed MF

Checked

Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 24/02/10

UFI No. 8168

Legend

- Wetland Buffer Boundary
- Development Area
- The Site
- Conservation Category Wetland

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:1,000**

0 15 30 60 90 120 150 Metres

PROJECT **Chianti Private Estate - Wetland Management Plan**

DRAWING TITLE **FIGURE 2: Wetland Boundary, Buffer and Development Area**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V9076**

Original **A3**

Drawing Number **SK02**

Revision

Designed MF

Checked

Drawn MGW

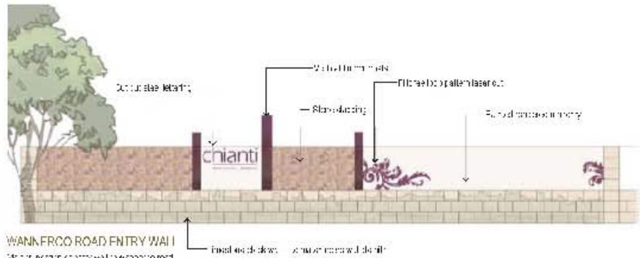
Approved

Local Authority City of Joondalup

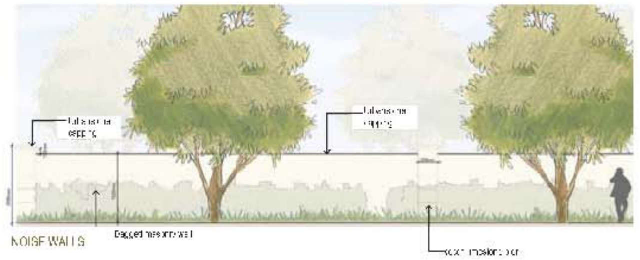
Sheet 1 of 1

Date 24/02/10

re-vegetation of wetland species as per the WMRS and the WMP.



WANNEROO ROAD ENTRY WALL



NOISE WALLS

furniture
Furniture from the Mark Cox promenade range. This range is versatile, aesthetically pleasing, sturdy and affordable. It's also designed & manufactured locally.

pos lighting
Meadow Springs Pole in Grey Lodge

play equipment
Play equipment has been specified for installation in the ABN public open space. This play equipment is nature based free form equipment and is aimed at ages 6-11. If play equipment is added to any future stages the current equipment will be taken into account and emphasis will be placed on providing children of different ages play equipment (specifically, 3-6 and 12 and over.)

conservation / access control fencing

ABN Developments - Masterplan PLAN E

boardwalk to be constructed of steel/ aluminium or recycled wood

Streetscape & POS Plant Species List

Agonis flexuosa
Corymbia calophylla
Corymbia ficifolia
Eucalyptus marginata
Eucalyptus macrocarpa
Eucalyptus rudis
Melaleuca preissiana
Melaleuca rhaphiophylla
Xanthorrhoea preissii
Adenanthos cuneatus
Anigozanthos 'Pink Joey'
Anigozanthos manglesii
Banksia menziesii
Baumea articulata
Baumea juncea
Beaufortia aestiva 'Summer Flame'
Bolboschoenus caldwellii
Callistemon 'Great Balls of Fire'
Calothamnus quadrifidus
Conostylis candicans
Dianella 'Breeze'
Dianella 'Little Rev'
Dryandra nivea
Eremophila 'Canaman grey'
Eremophila nivea
Ficinia nodosa
Grevillea 'Bronze Rambler'
Grevillea 'Ella bella'
Grevillea 'Gin Gin Gem'
Grevillea 'Golden Lyre'
Grevillea 'Lollypops'
Grevillea preissii
Hemiandra pungens
Isopogon latifolius
Kennedia prostrata
Kunzea baxteri
Lomandra longifolia
Melaleuca incana nana
Melaleuca 'Little Penta'
Melaleuca 'Little nessie'
Olearia axillaris
Patersonia occidentalis
Pimelea 'Pink Solitaire'
Regelia ciliata
Thryptomene 'Supernova'
Verticordia nitens
Viminaria juncea

hardworks

concrete - feature areas
Feature areas will be treated with either unit pavers and/or coloured insitu concrete with an exposed aggregate or brush finish. Footpaths will be simple brushed grey concrete with no features. Any future feature pavers or in-situ concrete needs to take into account any existing colours and finishes

concrete - mowing kerb
Mowing kerbs are grey concrete 150mm - 200mm wide.

retaining walls
All retaining walls will be limestone block work to match retaining walls as installed within the civil works.

feature walls
Any feature walls will reference the design of the noise wall with Urbanstone pier capping – 550 x 400 x 80 in 1604 colour – shotblast finish and capping to walls Urbanstone 400x450x40mm single bullnose capping in Golden gunmetal finished in shotblast. Walls will be tagged with limestone block work piers.

road thresholds
Thresholds will be paved with feature road pavers in Charcoal

dual use path
The 2.4m dual use path through the wetland and its buffer is to be constructed from asphalt to the details specified in the WMRS. The dual use path is to be located along, or as close to the agreed DEC and City of Wanneroo Future management boundary as site conditions will allow. Note: The dual use path is to be curvilinear in design where possible. The dual use paths that are to be installed within the Yellagonga Regional Park are to be asphalt sealed (30mm compacted) 2.4 metres wide and coloured red using a crushed granite aggregate with 2% red oxide intrinsic colouring. There is to be a 3 metre wide, 75mm crushed limestone base providing two 300mm limestone shoulders on each side of the asphalt path. The subgrade is to be boxed out to a depth of 200mm.

access control fencing
Access control fencing, consistent with the City of Wanneroo specification for conservation style fencing will be installed on the boundaries of roads, or to the western boundary of the POS and to the northern and southern boundaries to control unauthorised access. The access control fencing is be installed as per the City of Wanneroo standard.

softworks

planting - pos & verges
Focus will be placed on using endemic plants within the public open space, however given the preference for high display gardens and low maintenance allowances have also been made for the use of locally native species and their hybrids.

NOTE: No internationally exotic species or invasive species will be used.

Given the variety of landscape treatment areas and difference in species size within the public open space it is impossible to subscribe a density of planting to the entire area.
However all areas will be planted out within a range 2 plants/sqm – 6 plants/sqm.

planting - drainage basins & swales
Drainage basins and swales will be treated based on their specific requirements, locations and functions. Typically areas used for infiltration will be planted out densely with reeds and sedges suitable for the volumes of water expected within the basin.

re-vegetation of wetland species
Treatment of the wetland buffers and wetland will be as per the WMRS and the WMP.

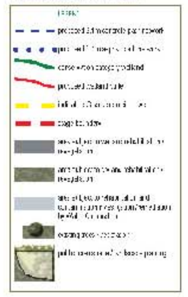
turf - pos
The use of turf should be kept to a minimum in POS and landscaping areas and consideration should be given to the interface between the POS and the wetland buffer to ensure turf and other weed species do not encroach into the rehabilitation areas and conservation wetland. We recommend turf to be a soft leaf buffalo as this species is least likely to invade the wetland through seeds or runners.

maintenance
Management of the landscape will ensure it's long term success. Management will involve monitoring and rectification of failure for the following:
- Garden Beds;
- Weeds establishment;
- Hard works;
- Irrigation infrastructure;
- Pests and diseases
- Water Quality; and
- Fire Risk

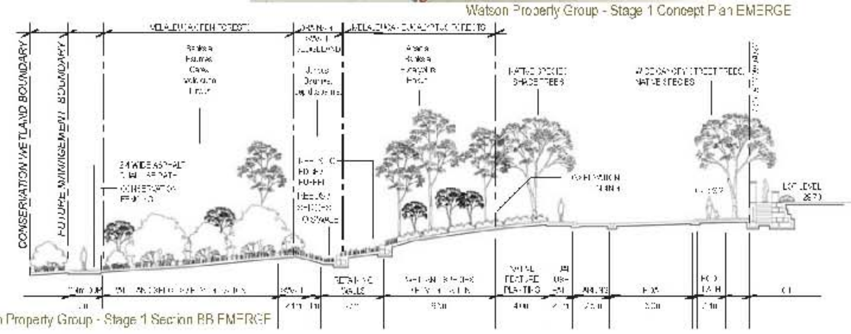
Planting works aim to achieve a sustainable area of plant growth that integrates with surrounding natural landscape areas. Garden beds will be maintained until handover with maintenance crews ensuring the following as required:
- irrigation systems are working;
- mulch is sufficient;
- Weed control is maintained;
- Plants are healthy and dense.

It will be a requirement of the contractor to report maintenance works to the landscape architect on a regular basis.

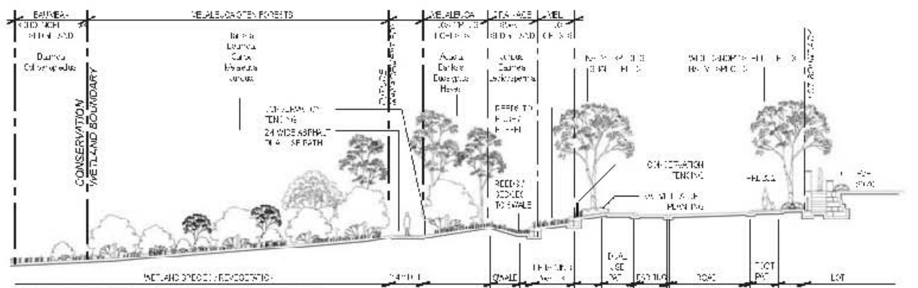
structure plan 64 WNLA



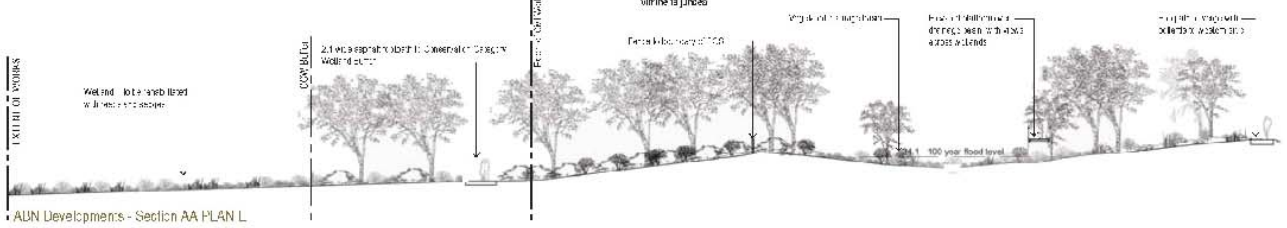
Watson Property Group - Stage 1 Concept Plan EMERGE



Watson Property Group - Stage 1 Section BB EMERGE



ABN Developments - Section AA PLAN E



Watson Property Group - Stage 1 Section CC EMERGE

NOTE: ALL DRAWINGS ARE FOR INFORMATION ONLY AND ARE LIKELY TO CHANGE DURING THE DETAIL DESIGN STAGE.

emerge ASSOCIATES

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD	DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD	DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

PROJECT **Chianti Private Estate - Wetland Management Plan**

DRAWING TITLE **FIGURE 3 : Wetland Interface & Landscape Plan**

PRINCIPAL **Watson Propoerty Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

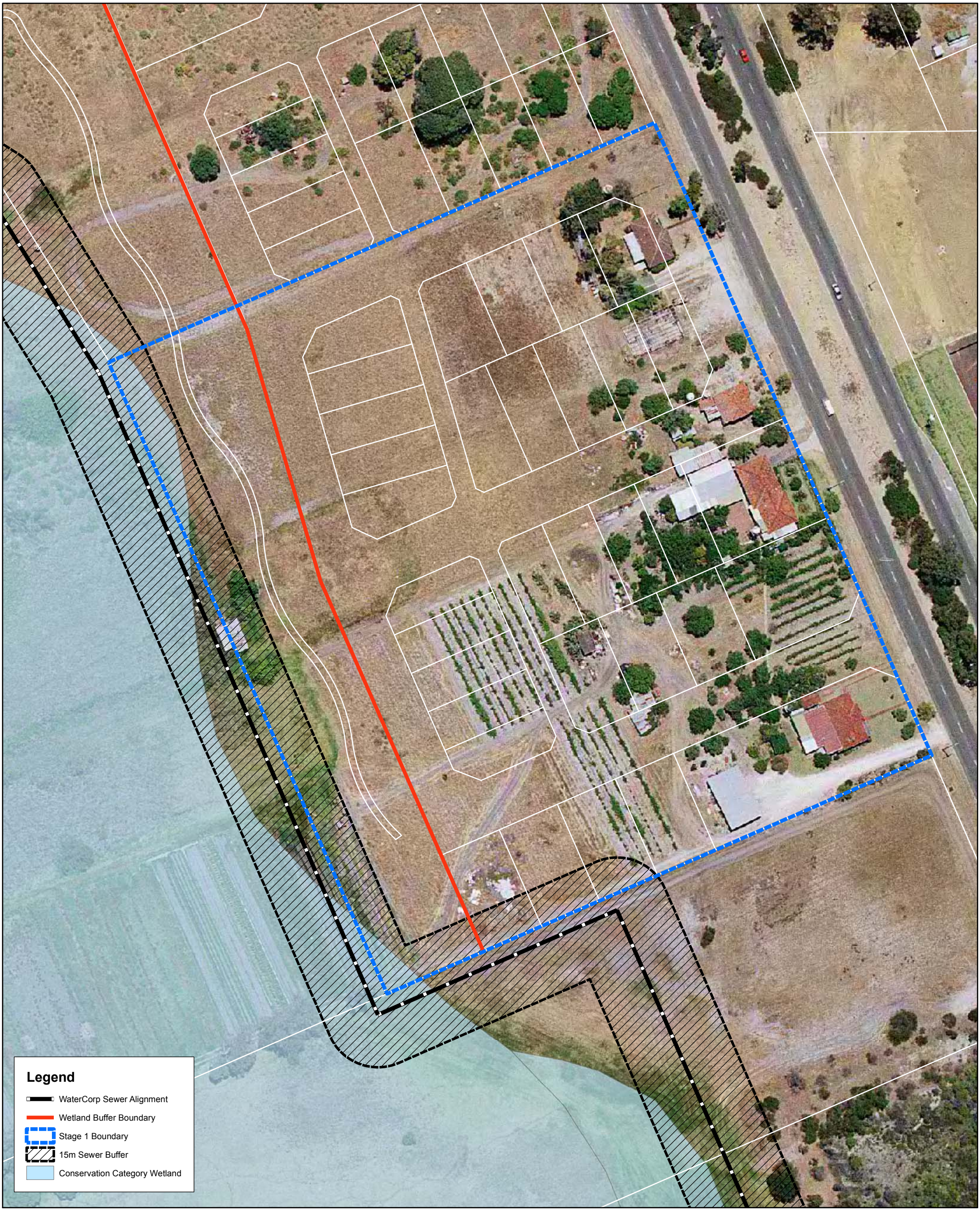
Scale: **Not to Scale**

Cardno
CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904
Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Project Number	Drawing Number	Revision	Original
V9076	SK03	00	A3

Designed MF | Checked | Date: 9/12/2010
Drawn MGW | Approved
Local Authority City of Joondalup | Sheet 1 of 1



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:1,000**

0 10 20 40 60 80 100 120 140 Metres

PROJECT **Chianti Private Estate - Wetland Management Plan**

DRAWING TITLE **FIGURE 4: Area of Disturbance for Sewer Line Installation**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V9076**

Original **A3**

Drawing Number **SK07**

Revision

Designed MF

Checked

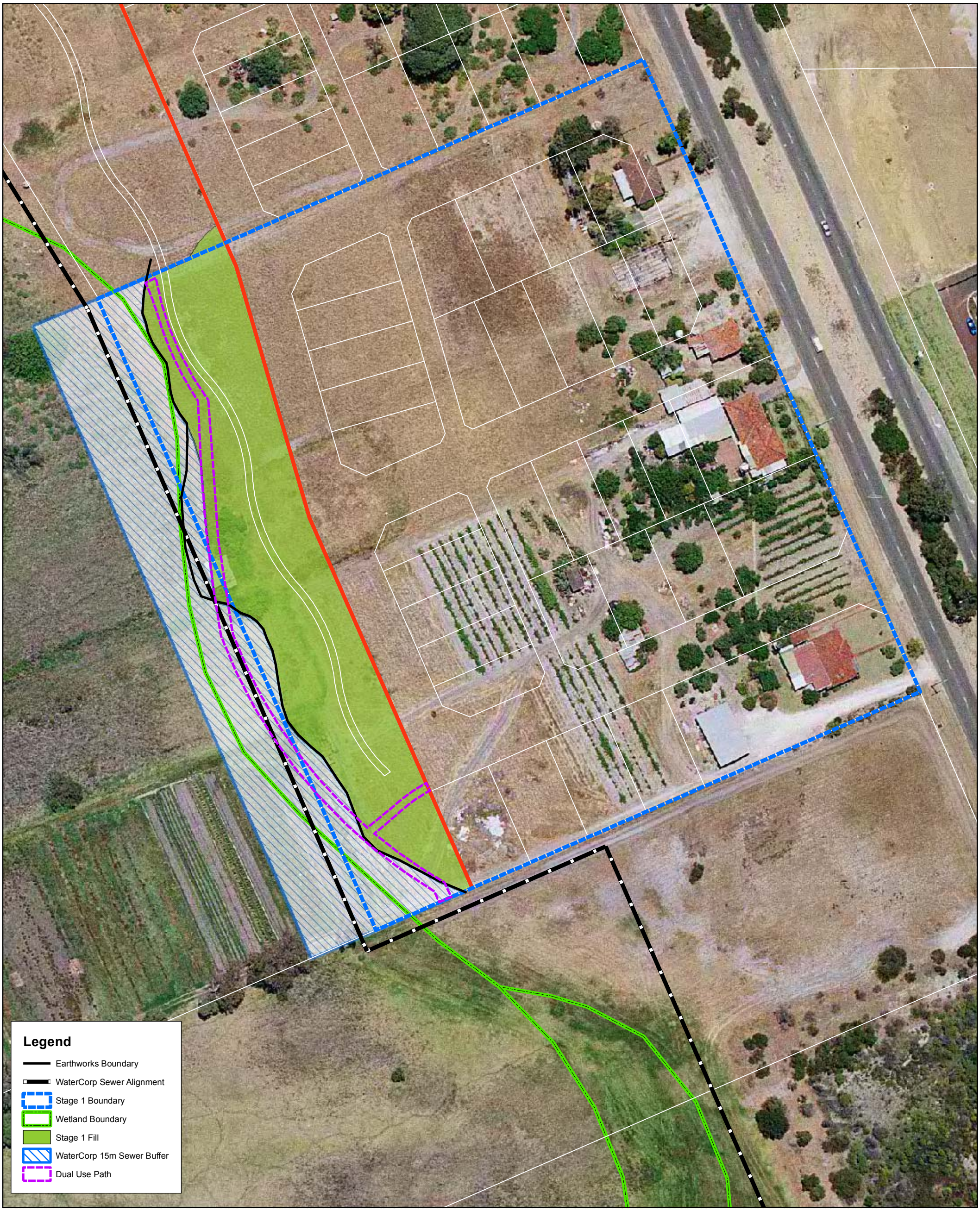
Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 24/02/10



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:1,000**

0 10 20 40 60 80 100 120 140 Metres

PROJECT **Chianti Private Estate - Wetland Management Plan**

DRAWING TITLE **FIGURE 5: Area of Fill**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V9076**

Original **A3**

Drawing Number **SK05**

Revision

Designed MF

Checked

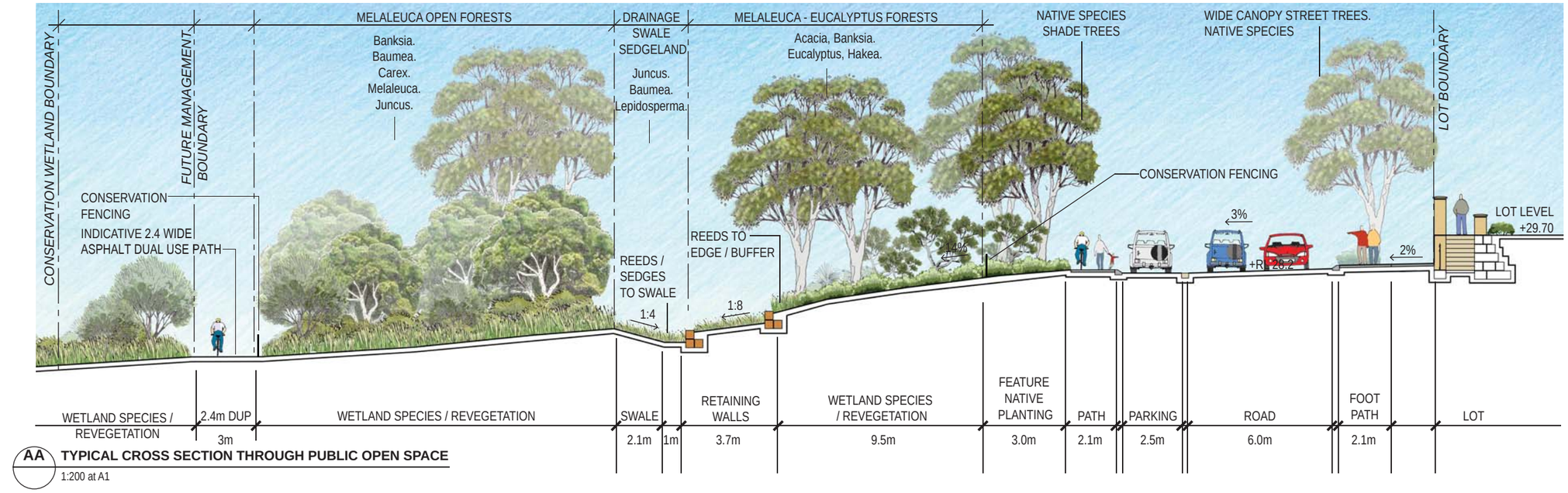
Drawn MGW

Approved

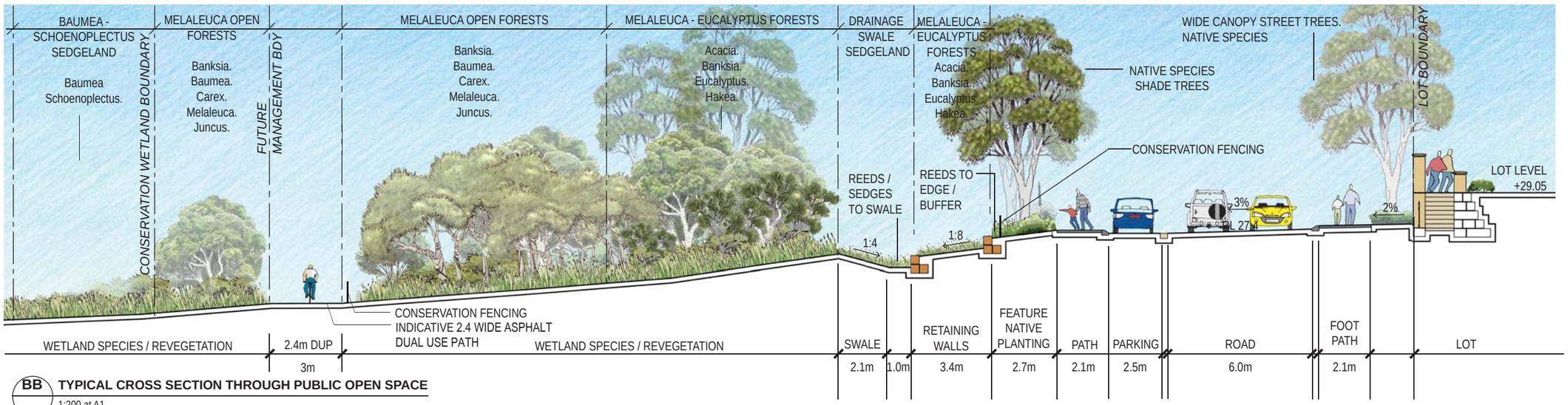
Local Authority City of Joondalup

Sheet 1 of 1

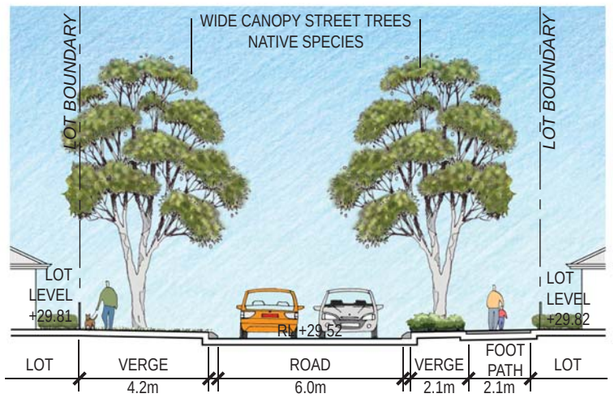
Date 24/02/10



AA **TYPICAL CROSS SECTION THROUGH PUBLIC OPEN SPACE**
1:200 at A1



BB **TYPICAL CROSS SECTION THROUGH PUBLIC OPEN SPACE**
1:200 at A1



CC **TYPICAL STREET SECTION - ROAD 01**
1:200 at A1

emerge ASSOCIATES Integrated Science & Design

chianti private estate, woodvale

Figure 6 - landscape concept - stage 1 - sections
8 december 2010

1:200 at A1

chianti PRIVATE ESTATE – WOODVALE

watson LAND LIVING LIFESTYLE

WANNEROO ROAD

WANNEROO ROAD

LOT 26

LANDSCAPE WORKS BY OTHERS

8
GROUPED
DWELLING SITE

SALES /
DISPLAY VILLAGE

1
GROUPED
DWELLING SITE

STAGE 1 BOUNDARY

ROAD 01

LANE 2

LANE 3

PARKING

INDICATIVE LOCATION OF
2.4m WIDE DUAL USE PATH

DRAINAGE SWALE

FEATURE NATIVE
PLANTING

CONSERVATION WETLAND BOUNDARY

PROPOSED WETLAND BUFFER

WETLAND
REVEGETATION

2 - TIER RETAINING WALL

FUTURE MANAGEMENT
BOUNDARY

INDICATIVE LOCATION OF
2.4m WIDE DUAL USE PATH

YELLAGONGA REGIONAL PARK

FUTURE
DEVELOPMENT

REVEGETATION

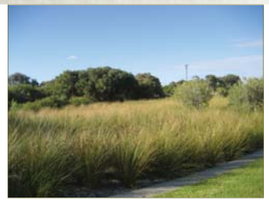
CITY OF WANNEROO
GROUP BASIN

BASE LEVEL
+24.50

LOT 26

LANDSCAPE WORKS BY OTHERS

reeds as buffer planting



re-vegetation

emerge ASSOCIATES
Integrated Science & Design

chianti private estate, woodvale

Figure 7 - landscape concept - stage 1 - plan
8 december 2010

N

1:500 at A1

chianti
PRIVATE ESTATE – WOODVALE

watson
LAND LIVING LIFESTYLE

Legend

- Stage 1 Boundary
- Wetland Buffer Boundary

Plant Revegetation Communities

- *Bumea - Schoenoplectus* Sedgeland
- *Melaleuca Ecalyptus* forest
- *Melaleuca rhaphiophylla* open forest
- Drainage Swale Sedgeland
- Dual Use Path
- Feature native planting

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:1,000**

0 10 20 40 60 80 100 120 140 Metres

PROJECT **Chianti Private Estate - Wetlands Management Plan**

DRAWING TITLE **FIGURE 8: Revegetation Plant Communities**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V9076**

Original **A3**

Drawing Number **SK06**

Revision

Designed MF

Checked

Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 9/12/10

Appendix A

WAPC - 'Approval Subject to Conditions' Statement.

Western Australian Planning Commission

Your Ref :
Enquiries : David Carter (Ph 9264 7678)

Cardno (W A) Pty Ltd
P O Box 713
BUSSELTON WA 6280

Approval Subject To Condition(s)
Freehold (Green Title) Subdivision

Application No : 140038

Planning and Development Act 2005

Applicant	:	Cardno (W A) Pty Ltd P O Box 713 BUSSELTON WA 6280
Owner	:	City Of Wanneroo Locked Bag 1 WANNEROO WA 6946, Watson Property Group Northern Aspects Ltd P O Box 934 BALCATTA WA 6914, Tomar Holdings Pty Ltd Suite 5, 284 Oxford Street LEEDERVILLE WA 6007
Application Receipt	:	08 June 2009

Lot number	:	22, 23, 26, 27, 28, 32, 34, 83, 90, 91, 800, 801
Location	:	-
Diagram/Plan	:	Diagrams 14006, 20508, 30185, 70131, 58082, Deposited Plans 56580, 49539
C/T Volume/Folio	:	1461/769, 1494/13, 1576/632, 2109/43, 2107/742, 1581/988, 1594/419, 2097/613, 1576/635, 1576/630, 2679/543, 2639/749
Street Address	:	Wanneroo Road, Woodvale
Local Government	:	City of Wanneroo

The Western Australian Planning Commission has considered the application referred to and is prepared to endorse a deposited plan in accordance with the plan date-stamped 08 June 2009 once the condition(s) set out have been fulfilled.

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

This decision is valid for four years from the date of this advice, which includes the lodgement of the deposited plan within this period.

The deposited plan for this approval and all required written advice confirming that the requirement(s) outlined in the condition(s) have been fulfilled must be submitted by 23 December 2013 or this approval no longer will remain valid.

Reconsideration - 28 days

Under section 151(1) of the *Planning and Development Act 2005*, the applicant/owner may, within 28 days from the date of this decision, make a written request to the WAPC to reconsider any condition(s) imposed in its decision. One of the matters to which the WAPC will have regard in reconsideration of its decision is whether there is compelling evidence by way of additional information or justification from the applicant/owner to warrant a reconsideration of the decision. A request for reconsideration is to be submitted to the WAPC on a Form 3A with appropriate fees. An application for reconsideration may be submitted to the WAPC prior to submission of an application for review. Form 3A and a schedule of fees are available on the WAPC website: http://www.wapc.wa.gov.au

Right to apply for a review - 28 days

Should the applicant/owner be aggrieved by this decision, there is a right to apply for a review under Part 14 of the *Planning and Development Act 2005*. The application for review must be submitted in accordance with part 2 of the *State Administrative Tribunal Rules 2004* and should be lodged within 28 days of the date of this decision to: the State Administrative Tribunal, 12 St Georges Terrace, Perth, WA 6000. It is recommended that you contact the tribunal for further details: telephone 9219 3111 or go to its website: http://www.sat.justice.wa.gov.au

Deposited plan

The deposited plan is to be submitted to the Western Australian Land Information Authority (Landgate) for certification. Once certified, Landgate will forward it to the WAPC. In addition, the applicant/owner is responsible for submission of a Form 1C with appropriate fees to the WAPC requesting endorsement of the deposited plan. A copy of the deposited plan with confirmation of submission to Landgate is to be submitted with all required written advice confirming compliance with any condition(s) from the nominated agency/authority or local government. Form 1C and a schedule of fees are available on the WAPC website: http://www.wapc.wa.gov.au

Condition(s)

The WAPC is prepared to endorse a deposited plan in accordance with the plan submitted once the condition(s) set out have been fulfilled.

The condition(s) of this approval are to be fulfilled to the satisfaction of the WAPC.

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

The condition(s) must be fulfilled before submission of a copy of the deposited plan for endorsement.

The agency/authority or local government noted in brackets at the end of the condition(s) identify the body responsible for providing written advice confirming that the WAPC's requirement(s) outlined in the condition(s) have been fulfilled. The written advice of the agency/authority or local government is to be obtained by the applicant/owner. When the written advice of each identified agency/authority or local government has been obtained, it should be submitted to the WAPC with a Form 1C and appropriate fees and a copy of the deposited plan.

If there is no agency/authority or local government noted in brackets at the end of the condition(s), a written request for confirmation that the requirement(s) outlined in the condition(s) have been fulfilled should be submitted to the WAPC, prior to lodgement of the deposited plan for endorsement.

Prior to the commencement of any site works or the implementation of any condition(s) in any other way, the applicant/owner is to liaise with the nominated agency/authority or local government on the requirement(s) it considers necessary to fulfil the condition(s).

The applicant/owner is to make reasonable enquiry to the nominated agency/authority or local government to obtain confirmation that the requirement(s) of the condition(s) have been fulfilled. This may include the provision of supplementary information. In the event that the nominated agency/authority or local government will not provide its written confirmation following reasonable enquiry, the applicant/owner then may approach the WAPC for confirmation that the condition(s) have been fulfilled.

In approaching the WAPC, the applicant/owner is to provide all necessary information, including proof of reasonable enquiry to the nominated agency/authority or local government.

The condition(s) of this approval, with accompanying advice, are:

CONDITION(S):

1. Those lots not fronting an existing road being provided with frontage to a constructed road(s) connected by a constructed road(s) to the local road system and such road(s) being constructed and drained at the applicant/owner's cost. As an alternative the WAPC is prepared to accept the applicant/owner paying to the local government the cost of such road works as estimated by the local government subject to the local government providing formal assurance to the WAPC confirming that the works will be completed within a reasonable period as agreed by the WAPC. (Local Government)

2. Street corners within the subdivision are to be truncated to the standard truncation of 8.5 metres. (Local Government)

3. All subdivisional roads being constructed and dedicated to the boundary of the subdivider's landholding, to the satisfaction of the Western Australian Planning Commission. (Local Government)

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

4. Proposed Road "A" on the approved plan (attached) being provided with a temporary cul-de-sac until such time as the temporary access intersection "A" has been disconnected and reinstated to the satisfaction of the Western Australian Planning Commission. (Local Government)

5. The provision of temporary turning areas to those subdivisional roads and rear access lanes which are subject to future extension to the satisfaction of the Western Australian Planning Commission. (Local Government)

6. The provision of traffic management devices on subdivisional roads to the satisfaction of the Western Australian Planning Commission. (Local Government)

7. The provision of vehicular crossovers and bin pads to those lots with restricted frontage to a constructed road to the satisfaction of the Western Australian Planning Commission. (Local Government)

8. The provision of car parking embayments within the road reserves adjoining the proposed public open space sites to the satisfaction of the Western Australian Planning Commission. (Local Government)

9. The rear access lanes being designed and constructed to a minimum width of 6 metres to accommodate the required site distances, truncations, service vehicle movements, lighting, drainage, all necessary services and appropriate connections to the local road system to the satisfaction of the Western Australian Planning Commission. (Local Government)

10. The provision of one car parking bay for every two lots gaining access from a rear access lane being located along the primary road frontage to the satisfaction of the Western Australian Planning Commission. (Local Government)

11. Pursuant to Section 150 of the Planning and Development Act (as amended), a covenant for all lots serviced by rear access lanes prohibiting direct vehicular access onto road frontages, benefiting the local government being lodged on the Certificates of Title of the proposed lots at the full expense of the applicant. (Local Government)

12. Pursuant to Section 150 of the Planning and Development Act (as amended), a covenant preventing motor vehicle access onto the intersection of Wanneroo Road and the subdivision roads benefiting the local government being lodged on the Certificates of Title of the proposed lots at the full expense of the applicant. (Local Government)

13. Pursuant to Section 150 of the Planning and Development Act (as amended), a covenant preventing motor vehicle access onto Wanneroo Road benefiting Main Roads WA being lodged on the Certificates of Title of the proposed lots at the full expense of the applicant. (Main Roads WA)

14. The preparation and implementation of a Noise Study to the satisfaction of the Western Australian Planning Commission. (Main Roads WA)

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

15. A Notification, pursuant to Section 165 of the *Planning and Development Act 2005* is to be placed on the Certificates of Title of the proposed lot(s) advising of the existence of a hazard or other factor. Notice of this Notification is to be included on the Deposited Plan. The notification to state as follows:

"This lot is in close proximity to Wanneroo Road and has the potential to be affected by nearby noise and vibration".

16. The two proposed temporary 'left-in/left-out' access points onto Wanneroo Road, as shown on the approved plan (attached), to be removed at the subdivider's cost when the construction of the connection with Wanneroo Road and Prindiville Drive is complete to the satisfaction of the Western Australian Planning Commission. (Main Roads WA)

17. Notification in the form of a section 70A notification, pursuant to the Transfer of Lands Act 1893 (as amended) is to be placed on the Certificates of Title of the proposed lot(s). The notification to state as follows:

"The proposed 'left-in/left-out' access points onto Wanneroo Road, as shown on the approved plan (attached), are only temporary and all access will be via the Wanneroo Road and Prindiville Drive intersection."

18. The proposed Wanneroo Road and Prindiville Drive intersection being designed by the subdivider to the specification of Main Roads WA as a four-way signal controlled intersection, at the subdivider's cost, to the satisfaction of the Western Australian Planning Commission. (Local Government) (Main Roads WA)

19. The subdivision design to be modified to accommodate the proposed Wanneroo Road and Prindiville Drive intersection required by Condition 18, to the satisfaction of the Western Australian Planning Commission. (Local Government) (Main Roads WA)

20. The existing vehicle crossovers onto Wanneroo Road to be removed and the verge reinstated with grass or landscaping to the specifications of Main Roads WA. (Main Roads WA)

21. Uniform fencing and complementary landscaping along the boundaries of all of the proposed lots abutting Wanneroo Road is to be constructed. (Local Government) (Main Roads WA)

22. The dual use paths/footpaths, as shown on the approved plan (attached), being constructed by the applicant/owner. (Local Government) (Department of Environment & Conservation)

23. The applicant/owner is to provide a geotechnical report certifying that the land is physically capable of development prior to the commencement of site works. (Local Government)

24. The land being graded and stabilised. (Local Government)

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

25. The finished ground levels at the boundaries of the lot(s) the subject of this approval are to match or otherwise co-ordinate with the existing and/or proposed finished ground levels of the land abutting. (Local Government)

26. The subdivider shall provide a written undertaking to the satisfaction of the Western Australian Planning Commission to ensure that prospective purchasers of new lots which have been provided with retaining walls are notified on contracts of sale regarding the positioning of buildings to ensure that they do not surcharge on any subdivisional retaining wall. (Local Government)

27. The land being filled and/or drained at the subdivider's cost to the satisfaction of the Western Australian Planning Commission and any easements and/or reserves necessary for the implementation thereof, being granted free of cost. (Local Government)

28. The drainage facilities proposed within the public open space sites being located outside the agreed wetland buffer and being designed and constructed to the satisfaction of the Western Australian Planning Commission. (Local Government)

29. The implementation of the approved Local Water Management Strategy (May 2009) to the satisfaction of the Western Australian Planning Commission. (Department of Water) (Local Government)

30. The proposed reserve(s) shown on the approved plan of subdivision being shown on the Deposited Plan as a "Reserve for Recreation and/or Conservation" and vested in the Crown under Section 152 of the *Planning and Development Act 2005*, such land to be ceded free of cost and without any payment of compensation by the Crown.

31. Uniform fencing along the eastern boundary of the agreed wetland buffer and along the boundaries abutting the public open space sites and Yellagonga Regional Park is to be constructed. (Local Government) (Department of Environment and Conservation)

32. The provision of bollards along the boundaries of the proposed public open space sites to the satisfaction of the Western Australian Planning Commission. (Local Government)

33. The preparation and implementation of a Landscape Management Plan to the satisfaction of the Western Australian Planning Commission. (Local Government)

34. The preparation and implementation of a Heritage Management Plan to the satisfaction of the Western Australian Planning Commission. (Local Government)

35. Detailed Area Plan(s) are to be prepared and approved for the proposed lots fronting the existing drainage sump and for the proposed lots serviced by rear access lanes. (Local Government)

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

36. The subdivider shall provide a written undertaking to the satisfaction of the Western Australian Planning Commission to ensure that prospective purchasers of lots proposed in this subdivision within 300 metres of existing market garden/nursery operations are notified on contracts of sale of the existence of the market garden operations and the potential for possible nuisances relating to odours, noise, dust, spray drift and the like that this land use may cause. (Local Government)

37. A Notification, pursuant to Section 165 of the *Planning and Development Act 2005* is to be placed on the Certificates of Title of the proposed lot(s) advising of the existence of a hazard or other factor. Notice of this Notification is to be included on the Deposited Plan. The notification to state as follows:

"This lot is located within 300 metres of operating market gardens/nurserys and has the potential to be affected by odours, noise, spray drift and dust that are associated with the continued operation of a market garden".

38. The preparation and implementation of a Wetland Management Plan to the satisfaction of the Western Australian Planning Commission. (Department of Environment and Conservation) (Local Government)

39. Prior to commencement of site works, investigation for soil and groundwater contamination and completion of any remediation, including validation of remediation, is to be carried out to the specifications of the Department of Environment and Conservation. (Department of Environment and Conservation)

40. The preparation and implementation of a Midge Management Plan to the satisfaction of the Western Australian Planning Commission. (Local Government)

41. A Notification, pursuant to Section 165 of the Planning and Development Act 2005 is to be placed on the Certificates of Title of the proposed lots advising of the existence of a hazard or other factor. Notice of this notification is to be included on the Deposited Plan. The notification to state as follows:

"The amenity of this lot may be affected by the presence of midges from the adjoining wetlands".

42. An Acid Sulfate Soils Self-Assessment Form and, if required as a result of the self-assessment, an Acid Sulfate Soils Report and an Acid Sulfate Soils Management Plan shall be submitted to and approved by the Department of Environment and Conservation before any site works are commenced. Where an Acid Sulfate Soils Management Plan is required to be submitted, all site works shall be carried out in accordance with the approved management plan. (Department of Environment and Conservation)

43. Subdivision works, including construction, access and on-going maintenance shall not result in the clearing, disturbance and/or degradation of existing bushland of regional conservation value within the agreed wetland buffer and Bush Forever Area 299 (Local Government)

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

44. Landfill, building materials, rubbish or other deleterious matter are not to be deposited within the agreed wetland buffer and Bush Forever Area 299. (Local Government)

45. The preparation and implementation of a Fire Management Plan to the satisfaction of the Western Australian Planning Commission. (Local Government)

46. The preparation and implementation of a Dieback Management Plan to the satisfaction of the Western Australian Planning Commission. (Local Government)

47. Notification in the form of a section 70A notification, pursuant to the Transfer of Lands Act 1893 (as amended) is to be placed on the Certificates of Title of the proposed lot(s) advising of the existence of the restaurant, winery and vineyard on Lot 33 Wanneroo Road, Woodvale and the potential impacts on the proposed lots.

48. Notification in the form of a section 70A notification, pursuant to the Transfer of Lands Act 1893 (as amended) is to be placed on the Certificates of Title of the proposed lot(s) advising of the risk of peat fires on the proposed lots.

49. A Restrictive Covenant, pursuant to section 129BA of the Transfer of Land Act 1893 (as amended) is to be placed on the Certificates of Title of the proposed lot(s) advising of the existence of a restriction on the use of the land. Notice of this restriction to be included on the Deposited Plan. The restrictive covenant is to state as follows:

"The sinking of domestic groundwater bores is prohibited".

50. Arrangements being made to the satisfaction of the Western Australian Planning Commission and to the specification of Western Power for the provision of an underground electricity supply service to the lot(s) shown on the approved plan of subdivision. (Western Power)

51. Arrangements being made to the satisfaction of the Western Australian Planning Commission and to the specification of Western Power for the provision of suitable easements under the *Energy Operators (Powers) Act 1979* for existing and/or future transmission (33,000 Volt or greater) electricity network infrastructure. (Western Power)

52. The transfer of land as a Crown Reserve, free of cost to Western Power for the provision of electricity supply infrastructure. (Western Power)

53. A detailed plan demonstrating the location and capacity of fire emergency infrastructure, including hydrants, is to be prepared and implemented to the specifications of the Water Corporation and the Fire and Emergency Services Authority. (FESA)

54. Suitable arrangements being made with the Water Corporation so that provision of a suitable water supply service will be available to lot(s) shown on the approved plan of subdivision. (Water Corporation)

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

55. Suitable arrangements being made with the Water Corporation so that provision of a sewerage service will be available to the lot/s shown on the approved plan of subdivision. (Water Corporation)

ADVICE:

1. The approval to subdivide issued by the WAPC should not be construed as an approval to commence development on any of the lots proposed. Approval to Commence Development may be required to be issued by the local government.

2. The applicant/owner is advised to brief all persons involved in site works and associated activities of their legal obligations with respect to the Aboriginal Heritage Act of WA (1972) prior to construction work.

3. In regard to Condition 15, the applicant is advised that this condition only applies to those lots identified by the Noise Study required by Condition 14.

4. In regard to Condition 16, Main Roads WA advise the following:

   * The subdivider is to pay the City of Wanneroo a performance bond to ensure that both of the temporary 'left-in/left-out' access points are removed and the intersection and traffic signals at Prindiville Drive are modified to accommodate the permanent access arrangement for the application area.

   * Appropriate signage to Main Roads WA specifications shall be erected within the application area advising of the temporary nature of the two access points onto Wanneroo Road.

5. In regard to Condition 18, Main Roads WA advise the following:

   * The subdivider shall be responsible for all costs involved in the land acquisition, design and construction of the Wanneroo Road/Prindiville drive intersection. This includes modification of traffic signals, signage, road markings, relocation of services, street lighting and Main Roads WA costs involved in the checking of the design and construction drawings and any site inspections.

   * Approval for the design and construction drawings is required before any work is undertaken within the Wanneroo Road reservation. A detailed traffic management safety plan while working within the Wanneroo Road reservation is to be submitted as part of this approval.

6. Main Roads WA advise the following:

   * No earthworks shall encroach onto the Wanneroo Road reservation.

   * No stormwater drainage shall be discharged onto the Wanneroo Road reservation.

   * The subdivider shall make good any damage to the existing verge vegetation within the Wanneroo Road reservation.

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

Western Australian Planning Commission

7. In regard to Condition 23, if there has been any land-fill, including back-filling, the geotechnical report is to include confirmation that the land has been sufficiently compacted.

8. With regard to Condition 29, the WAPC hereby approves of a cash-in-lieu contribution in accordance with Section 153 of the *Planning and Development Act, 2005*.

9. In regard to Condition 30, the City of Wanneroo advises that the existing landform, vegetation and drainage patterns of the proposed public open space sites are not to be disturbed or modified with the finalisation of the associated Management Plans and the prior approval of the City.

10. In regard to Conditions 36 and 37, the subdivider is advised that should all market gardens adjoining the application area and within 300 metres cease operation and the structures be removed, then Conditions 35 and 36 will no longer be relevant.

11. With regard to Conditions 37 and 41, Planning Bulletin No.3 - Record of Information on Titles (Memorials) outlines the process for obtaining clearance from the WAPC.

12. In regard to Condition 38, the Department of Environment and Conservation (DEC) advises the following:

    * The Wetland Management Plan (WMP) is to be consistent with the approved Wetland Management and Rehabilitation Strategy (WMRS), be prepared by a qualified revegetation specialist and submitted to the DEC for approval prior to implementation.

    * The WMP is to address issues such as (but not limited to): site preparation; fencing; mulching; revegetation planting densities and species; planting locations; weed control; timing of operations; ongoing care and maintenance; completion criteria; monitoring programs; and a budget.

    * The WMP should also address the issue of how necessary ongoing works will be secured after the issue of titles. The WMRS indicates that works will be bonded with the City of Wanneroo which is supported by the DEC.

    * The WMP must address the required rehabilitation works outside the application area (within the adjoining Yellagonga Regional Park).

13. In regard to Condition 39, the DEC advises the following:

    * The investigation should be carried out in accordance with the guidelines adopted by the DEC as detailed in the *Contaminated Sites Management Series*.

    * In accordance with Regulation 31(1)(c) of the Contaminated Sites Regulations 2006, a Mandatory Auditor's Report, prepared by an accredited contaminated sites auditor, will need to be submitted to the DEC as evidence of compliance with Condition 38.

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

14. The DEC advises the following:

* Consideration should be given to the elevation of the application area in relation to the agreed wetland buffer and adjoining Yellagonga Regional Park. Retaining walls, particularly greater than one metre in height, should be avoided as they may create access issues, safety issues and loss of amenity. The ground levels of the application area should ensure appropriate integration with the agreed wetland buffer and adjoining Yellagonga Regional Park.

* In order to protect the conservation values of Yellagonga Regional Park, the subdivider should ensure that flora species known to be invasive or environmentally damaging are not used in any landscaping where they may spread into Yellagonga Regional Park.

* In regard to Condition 21, the location of the dual use path is to be in accordance with the WRMS. It has been agreed between DEC and the City of Wanneroo that the location of the dual use path will define future management areas, with areas to the west of the dual use path being managed by DEC and areas to the east (including the dual use path) being managed by the City. The dual use path is to be located approximately 5 meters to the east of the Conservation Category Wetland boundary, however, its exact location will depend upon a number of on-ground factors and construction should not commence until the final alignment has been agreed upon by the DEC and the City.

15. In regard to Condition 43, the Department's Resource Protection and Management Branch advises that the use of clear signage and operator information be used during construction to reduce the inadvertent impacts on remnant vegetation or adjoining Yellagonga Regional Park.

16. With regard to Condition 50, Western Power provides only one point of electricity supply per freehold (green title) lot and requires that any existing overhead consumer service is required to be converted to underground.

17. If an existing aerial electricity cable servicing the land the subject of this approval crosses over a proposed lot boundary as denoted on the approved plan of subdivision, satisfactory arrangements will need to be made for the removal and relocation of that cable.

18. The purpose of Condition 51 is to ensure that any existing or proposed development does not interfere with any existing and/or proposed Western Power assets. The applicant is advised to contact Western Power for further information and advice regarding easement requirements. All costs associated with the registration of easements are to be borne by the applicant.

19. With regard to Condition 52, the specific location and area of land required is to be to the satisfaction of the WAPC on the advice of the local government and Western Power.

Western Australian Planning Commission

20. With regard to Conditions 54 and 55, Water Corporation policy and practice for the locality may involve the provision of land (for plant and works), easements and/or the payment of financial contributions towards infrastructure. You are advised to contact the Water Corporation.

21. The Department of Water advises that the proposed subdivision is located within the Perth Coastal Underground Water Pollution Control Area, which is managed for Priority 3 (P3) source protection. Some activities are considered to be incompatible land uses within P3 areas. For further information please refer to the Department's Water Quality Protection Note (WQPN) *Land Use Compatibility in Public Drinking Water Source Areas* for a list of activities that are considered to be compatible or conditional within P3 areas.

Tony Evans
Secretary
Western Australian Planning Commission
23 December 2009

Albert Facey House, 469 Wellington Street (cnr Forrest Place), Perth, Western Australia 6000
Tel: (08) 9264 7777; Fax: (08) 9264 7566; TTY: (08) 9264 7535; Infoline: 1800 626 477
e-mail: corporate@wapc.wa.gov.au; web address: http://www. planning.wa.gov.au
ABN 35 482 341 493

WANNEROO ROAD

PRINDIVILLE DRIVE

Public Open Space 3085m²

Public Open Space 2345m²

Existing Lot 91
Existing Drainage Basin
11,715m²

Public Open Space 5197m²

Public Open Space 6354m²

Grouped Dwelling Site 2677m²

Grouped Dwelling Site 1026m²

Grouped Dwelling Site 2202m²

Grouped Dwelling Site 1000m²

Grouped Dwelling Site 1000m²

Grouped Dwelling Site 2000m²

Temporary Access Left In / Left Out

Existing Lot

DUAL USE PATH

FOOTPATH

"A" CONDITION 4

INDICATIVE ALIGNMENT

LEGEND

- Existing Lot Boundaries
- Existing Lot 26 Existing Lots
- Existing Vegetation
- Existing Dwellings and Outbuildings
- Contours
- Application Boundary
- New Lot Boundaries
- Public Open Space
- Possible Road Intersecton Treatment

DEPARTMENT FOR PLANNING AND INFRASTRUCTURE
DATE - 8 JUN 2009
FILE 140038

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D
03.06.09	H	DPI Request for Dwelling Setbacks	DCD	DCD	GP	GP
15.05.09	B	Revise Lots Per Client Directions	AKT	AKT		

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D
18.05.09	C	Subdivision Option 1	AKT	AKT		
20.05.09	D	Finalise Subdivision Details	AKT	AKT	GP	GP

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APP'D
21.05.09	F	Add Lot 26 to Subdivision Layout	AKT	AKT	GP	GP
26.05.09	G	Revise POS Areas and Lot/Easement Areas	AKT	AKT	GP	GP

PROJECT: LOTS 22, 23, 26, 27, 28, 32, 34, 83, 90, 91, 800 AND 801

DRAWING TITLE: PROPOSED SUBDIVISION PLAN

PRINCIPAL: WATSON PROPERTY GROUP - NORTHERN ASPECTS LTD

SCALE: 1:1000

Cardno (WA) Pty Ltd
Cardno Centre, 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904
Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Units 2-4, 59 Duchess St
P.O. Box 713 Busselton
Western Australia 6280
Telephone (08) 9754 2307
Facsimile (08) 9762 2471

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Project - Phase - Plan Number: P04018-P760-S06
Revision: H
Original: A1
Designed GP Checked MWS Date 26.05.09
Drawn DLC Approved MWS Sheet Of
Local Authority City of Wanneroo 1 1

This document is produced by Cardno (WA) Pty Ltd solely for the benefit of and use by the client in accordance with the terms of the retainer. Cardno (WA) Pty Ltd does not and shall not assume any responsibility or liability whatsoever to any third party arising out of any use or reliance by third party on the content of this document. This drawing shall be preliminary only and/or not for construction until signed approved.

Appendix B

Flora and Vegetation Survey Report

Cardno
Shaping the Future

Chianti Private Estate

Flora and Vegetation Survey Report

Prepared for Watson Property Group

April 2010

Project Number V9076

Cardno (WA) Pty Ltd
ABN 77 009 119 000
2 Bagot Road
Subiaco WA 6008
PO Box 155, Subiaco
Western Australia 6904 Australia
Telephone: 08 9273 3888
Facsimile: 08 9388 3831
International: +61 8 9273 3888
perth@cardno.com.au
www.cardno.com.au

Document Control

Version	Date	Author		Reviewer	
1	April 2010	Matt Field	MJF	Jason Hick	JDH
Filename	V9076--Mjf100006.10--Mjf				

Author: Matt Field
Position Title: Restoration Ecologist

Reviewer: Jason Hick
Position Title: Principle Environmental Scientist

Printed on 100% Australian Recycled Paper

"© 2010 Cardno (WA) Pty Ltd All Rights Reserved. Copyright in the whole and every part of this document belongs to Cardno (WA) Pty Ltd and may not be used, sold, transferred, copied or reproduced in whole or in part in any manner or form or in or on any media to any person without the prior written consent of Cardno (WA) Pty Ltd."

Executive Summary

Cardno (WA) Pty Ltd was commissioned by Watsons Property Group (WPG) in October 2009 to produce a Flora and Vegetation Survey for the Chianti Private Estate residential subdivision development. Botanists from Cardno visited the site in October 2009 and undertook field surveys, conducted in accordance with EPA Guidance Statement No. 51 – Terrestrial flora and vegetation survey environmental impact assessment in Western Australia (2004) to the level of a detailed survey.

Plants species were recorded during this survey along with vegetation condition and other environmental site data. Most plant species were identified to species level and compared against regional species lists to ascertain whether there are any rare and priority species present.

A total of 52 vascular plant species were recorded in the site with only 6 species native to West Australia, none of which are classed as rare or as a priority. There were no native plant communities that were able to be identified due to the degraded nature of the site and only several emergent native plants that did not form a structure that enabled identification of a community type. Consequently it was difficult to determine the Floristic Community Type (FCT) that is present on the site. Vegetation condition across the site has been rated as being in a 'Completely Degraded' condition (**Figure 3**). This condition rating was due to the site having little to no native vegetation structure and a very high intensity of invasive weed species.

The site has been heavily disturbed in the past due to impacts from agriculture, market gardening and viticulture. The result of these impacts is a highly disturbed wetland and wetland buffer which is dominated by *Pennisetum clandestinum* (Kikuyu), *Typha orientalis* (Typha) and other invasive weed species.

Cardno recommendations that the spread of invasive weed species into and around the site should be restricted (including specifically the movement of One Cape Tulip) and any vegetation and remnant trees should be retained where possible.

Table of Contents

List of Tables

List of Figures

Plates

Appendices

1 Introduction

1.1 Background

Cardno (WA) Pty Ltd was commissioned by Watsons Property Group (WPG) in October 2009 to undertake a Flora and Vegetation Survey for the wetland buffer area of the Structure Plan 64 (SP64) subdivision development. The SP64 development is located on lots 0, 22, 23, 26 - 28, 32 - 34, 83 and 801 Wanneroo Road, Woodvale (**Figure 1**) and is situated in the south-western extent of the City of Wanneroo (CoW) municipal boundary.

The wetland buffer area (to be herein described as the subject site) is located between the Wallenburnup Swamp wetland boundary to the east and the SP64 development to the west. The subject site is approximately 8ha in size and is mapped in **Figure 2**.

1.2 Purpose of Report

This report aims to provide detailed botanical attributes for the subject site and provide recommendations for the management of the site which would be included in the Wetland Management Plan.

This report will include the following aspects:

- A desktop study of publicly available, relevant background material including previous flora surveys of the subject site and relevant policies and legislation;
- The results of a detailed flora survey conducted in spring (October and November) 2009;
- A discussion of the conservation significance of the vegetation encountered across the site; and
- Conclusions and recommendations about the future constraints and protection issues that may arise through the development of the site.

2 Existing Environment

2.1 Geomorphology and Soils

The site occurs on the Swan Coastal Plain, which is the surface expression of a small part of the Perth Basin, and characterises the Perth region and surrounds (Seddon 2004). It is a geomorphologic unit approximately 20 – 30 km wide consisting of two sedimentary belts of different origin. On the eastern side of the Swan Coastal Plain (SCP), the Pinjarra Plain has been formed from the deposition of alluvial material whilst the three dune systems (Quindalup, Spearwood and Bassendean) that form the western part of the Swan Coastal Plain are of Aeolian origin (Seddon 2004). The subject site is located within the Spearwood dune system on the Swan Coastal Plain.

The site contains two soil complexes which are classed as:

- Herdsman complex: - which is described as peaty swamps with black organic sands, peaty loams, black clays and true peats; and
- Karrakatta complex: - which is described an undulating landscape with deep yellow brown sands.

2.2 Climate

The climate of the Yellagonga area can be described as a warm Mediterranean climate with mild wet winters and hot dry summers, with 5-6 dry months per year (Beard 1990). Climatic data from the closest climatic station (Perth metro), utilising data from 1965 to 2010, indicates an annual rainfall average of 744.0mm. July has the highest mean rainfall, with 152.9mm, and December has the lowest with 6.0mm. The mean maximum temperature ranges from 31.3^{o}C in February to 18.3^{o}C in July, and the mean minimum temperature ranges from 18^{o}C in February to 7.8^{o}C in August (Bureau of Meteorology 2010).

2.3 Vegetation Description and Soil and Vegetation Relationships

The site lies within the Swan Coastal Plain Interim Biogeographic Regionalisation for Australia (IBRA) region (Thackway and Cresswell 1995). The Swan Coastal Plain IBRA Region is broadly compatible with the Swan Coastal Plain (Drummond Botanical Subdistrict) Phytogeographical Subregion as described by Beard (1990). This region is characterised by *Banksia* low woodlands on leached sands, woodlands of Tuart (*Eucalyptus gomphocephala*), Jarrah (*Eucalyptus marginata*) and Marri (*Eucalyptus calophylla*) on less leached soils and *Melaleuca* swamps.

Vegetation complex mapping undertaken by Heddle et al. (1980) indicates the basic relationship between vegetation, soils and rainfall. Two vegetation complexes have been mapped for the subject site, which are the Herdsman Complex in the wetland and the Karrakatta Complex - Central and South in the fringing and dryland areas. These complexes are described below:

- Herdsman Complex: - Wetland complex that is dominated by sedgelands of *Typha, Juncus* and *Baumea*; and woodlands of *Eucalyptus rudis* and *Melaleuca* species. The species of *Melaleuca* depend the local drainage and adjacent soils; and
- Karrakatta Complex: - The fringing and dryland areas upland from the wetland which are dominated by Jarrah-Marri-Tuart woodlands that exist with *Banksia attenuata* and *B. menziesii*. Tuarts tend to occur on deeper sands in more upland locations. Shrubs species include *Jacksonia, Acacia, Casuarina, Hibbertia* and *Calothamnus*.

3 Methods

3.1 Field Survey

Botanists from Cardno visited the site in October 2009 and undertook level 1 field surveys, conducted in accordance with EPA Guidance Statement No. 51 – Terrestrial flora and vegetation survey environmental impact assessment in Western Australia (2004). The site was traversed on foot and the vegetation assessed at six survey locations (**Figure 2**), which were selected to adequately sample each plant community observed within the subject site. The position of each survey location was recorded with a hand-held GPS unit and all vascular plant species were recorded within a radius of at least 15 metres from that point. In addition, opportunistic plant taxa that were observed, but not located at a particular survey location, were also recorded through the course of the survey. An estimate of the Foliage Projective Cover (FPC) percentage was made for each species at each survey location.

Environmental data recorded from each survey location included topographic position, aspect, slope, soil colour and texture class, rock outcropping, litter cover as well as the degree of disturbance and an estimate of the time since the last fire event. The condition of the vegetation was assessed to assist in determining the conservation values of the site. The vegetation condition was rated according to Keighery (1994), a vegetation condition scale commonly used in the Perth Metropolitan Region, but which is also appropriate for other urbanised and agricultural areas. The categories are listed and defined in Table 1.

All plant specimens collected during the field survey were dried, pressed and then sorted in accordance with requirements of the Western Australian Herbarium. Identification of specimens occurred through comparison with named material and through the use of taxonomic keys.

Table 1: Vegetation Condition Scale (Keighery 1994)

Vegetation Condition	Definition
1. Pristine (1)	Pristine or nearly so, no obvious signs of disturbance.
2. Excellent (2)	Vegetation structure intact, disturbance affecting individual species and weeds are non-aggressive species.
3. Very Good	Vegetation structure altered and obvious signs of disturbance. For example, disturbance to vegetation structure caused by repeated fires, the presence of some more aggressive weeds, dieback, logging and grazing
4. Good	Vegetation structure significantly altered by very obvious signs of multiple disturbances. Retains basic vegetation structure or ability to regenerate it. For example, disturbance to vegetation structure caused by very frequent fires, the presence of some very aggressive weeds at high density, partial clearing, dieback and grazing.
5. Degraded	Basic vegetation structure severely impacted by disturbance. Scope for regeneration but not to a state approaching good condition without intensive management. For example, disturbance to vegetation structure caused by very frequent fires, the presence of very aggressive weeds, partial clearing, dieback and grazing.
6. Completely Degraded	The structure of the vegetation is no longer intact and the area is completely or almost completely without native species. These areas are often described as 'parkland cleared' with the flora comprising weed or crop species with isolated native trees or shrubs.

3.2 Limitations of the Assessment

It is generally not possible to obtain a comprehensive species list of an area from a single visit or even multiple visits, due to some species, especially herbaceous ones, being inconspicuous for much of the year and becoming obvious only during flowering. In addition, not all species will flower in the same season and some will not flower every year.

However, the assessment was conducted in spring 2009 and followed the field methods in accordance with the EPA Guidance Statement No. 51 (EPA 2004) level 1 survey. A level 1 survey indicates that there was background information gathered along with a reconnaissance field survey into the floristics of the area. One site visit was undertaken during in the main flowering period (spring) to survey within different vegetation units and a second survey in a different season (Level 2 survey method) was judged to not be required due to the completely degraded nature of the site.

4 Results

4.1 Site observations

The site was observed to comprise two distinctly different areas:

- A wetland area that is the Wallenburnup Swamp which is highly degrade and is dominated by *Typha*, Kikuyu and several patches of *Melaleuca rhaphiophylla*; and
- The wetland buffer/fringe area which is also high degraded and is dominated by *Ehrharta calycina*, *Eragrostis curvula* and *Pennisetum clandestinum*.

4.2 Flora

A total of 52 vascular plant species were recorded in the site with only six species native to West Australia, none of which are classed as "Declared Rare" or "Priority" flora pursuant to the Wildlife Conservation Act 1952. The species were split into 16 families with the dominant families being *Poaceae* (16 species), *Fabaceae* (10 species) and *Asteraceae* (6 species). The dominant plant species recorded in the wetland buffer and fringe areas included *Typhya orientalis, Ehrharta calycina, Eragrostis curvula and Pennisetum clandestinum*. The wetland area was dominated by *Pennisetum clandestinum and Typhya orientalis*, with some areas showing a projective foliage cover (FPC) of over 90%. A full species list is provided in **Appendix A** and the raw data from the quadrants are provided in **Appendix B**.

There were no native plant communities that were able to be identified due to the degraded nature of the site and only several emergent native plants that did not form a structure that enabled identification of a community type. Consequently it was difficult to determine the Floristic Community Type (FCT) that is present on the subject site.

4.3 Declared Weeds

One weed species recorded within the site is classed as a 'Declared' weed species as listed on the Declared Plants of Western Australia list (Department of Agriculture and Food 2009) pursuant to the *Agriculture and Related Resources Protection Act 1976*. 'Declared' status means weed species are highly invasive and aggressive and should be controlled by the landholder. One leafed Cape Tulip (*Moraea flaccida*) is declared a Priority 1 (P1) weed which occurs across the entire state. P1 status prohibits the movement of plants or their seeds within the State. This means active control of this weed is not required but the movement of contaminated machinery and produce including livestock and fodder is prohibited.

The one leafed cape tulip (*Moraea flaccid*) was recorded at survey locations 3 and 6, with 3 showing a 5% projective foliage coverage while 6 only had a few recordings.

4.4 Vegetation Condition

Vegetation condition across the site has been rated as being 'Completely Degraded' (**Figure 3**). This condition rating was due to the site having little to no native vegetation structure. The site is also highly infested with invasive weeds species which have overtaken the vast majority of the site, are smothering any native species currently growing there.

5 Discussion

The subject site has been heavily disturbed in the past due to impacts from agriculture, market gardening and viticulture. These disturbances included extensive clearing of native vegetation, infilling parts of the wetland, introduction of invasive weed species, use of chemicals and fertilizers close to and dumping of rubbish. The result of all of these impacts is a highly disturbed buffer which is dominated by Typha, Kikuyu and other weed species.

Only six out of the 52 plant species indentified within the site are native to West Australia and the occurrence of these native species is extremely sparse and isolated from other remnant vegetation in the surrounding areas. Due to the dominance of weed species and the lack of native vegetation structure in the site, the vegetation condition is 'Completely Degraded.'

The nature of the dominant highly invasive weed species present in the site has resulted in the inability of native vegetation of the surrounding areas to naturally recolonise disturbed sites which is thus preventing the improvement in the condition of this vegetation.

The vegetation communities that would have most likely occurred in the site prior to European settlement (as stated in the regional vegetation mapping) would have been Melaleuca shrublands with a sedge and rush understory in the wetland, a mixture of Melaleuca, Eucalyptus, sedges and rushes and woodland shrubs in the wetland fringe area and Jarrah/Marri/Tuart woodland in the dryland areas.

6 Conclusions and Recommendations

A detailed flora and vegetation survey was undertaken by Cardno in spring 2009 in accordance with EPA Guidance Statement No. 51. The following botanical information was gathered about the site:

- 52 flora species from 16 families were recorded within the site;
- No Declared Rare or Priority flora species were identified, pursuant to the Wildlife Conservation Act 1952;
- Vegetation condition within the site was in 'Completely Degraded' condition, in accordance with the Keighey (1994) scale; and
- There were no native plant communities described within the site due to vegetation structure being absent and the dominance of weed species.

In summary, Cardno recommends that:

- Restrict the spread of invasive weed species into and around the site (including specifically the movement of One Cape Tulip); and
- Retain vegetation and remnant trees where possible.

7 References

Beard, JS 1990, Plant life of Western Australia, Kangaroo Press, Perth.

Environmental Protection Authority, 2004, Guidance statement No. 51. Guidance for the Assessment of Environmental Factors – Terrestrial flora and vegetation surveys for environmental impact assessment in Western Australia, Environmental Protection Authority, Perth.

Gibson, N, Keighery, BJ, Keighery, GJ, Burbidge, AH and Lyons, MN 1994, A floristic survey of the southern Swan Coastal Plain, Unpublished Report for the Australian Heritage Commission prepared by the Department of Conservation and Land Management and the Conservation Council of Western Australia (Inc), Perth.

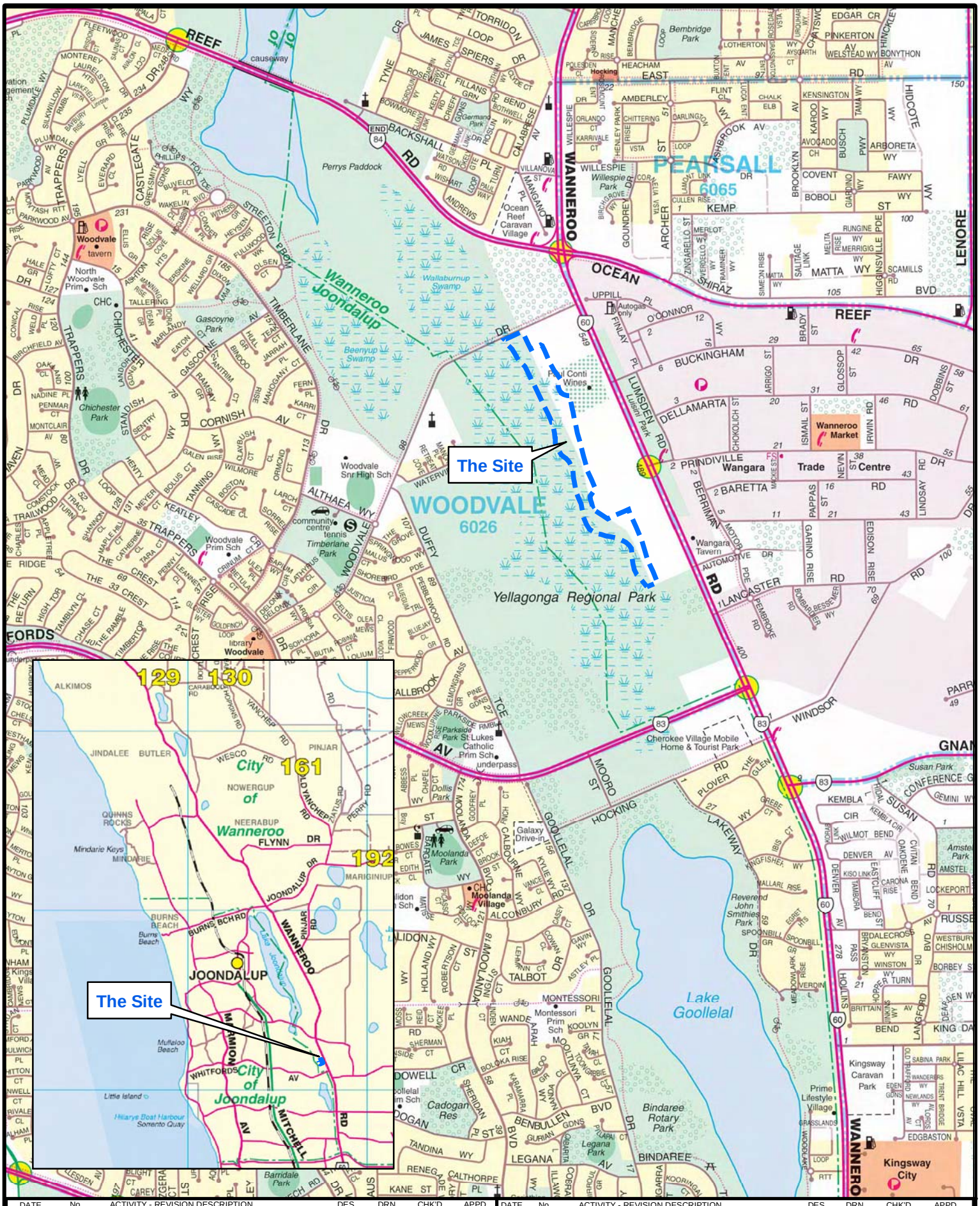
Heddle, EM, Loneragan, OW and Havel, JJ 1980, 'Darling Systems – Vegetation Complexes' in Atlas of Natural Resources Darling System, Western Australia, Department of Conservation and Environment, Perth.

Keighery, BJ 1994, *Bushland plant survey: A Guide to Plant Community Survey for the Community*, Wildflower Society of WA (inc), Nedlands, Western Australia.

Seddon, G 2004, A Sense of Place, Blooming Books, Melbourne.

Thackway, R and Cresswell ID 1995 (Eds), An Interim Biogeographical Regionalisation for Australia: a framework for establishing the national system of reserves, Version 4.0, Australian Nature Conservation Agency, Canberra.

Figures



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:20,000**

PROJECT **Woodvale Flora and Vegetation Survey**

DRAWING TITLE **FIGURE 1 : Locality Plan**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V9076**

Original **A4**

Drawing Number **SK01**

Revision

Designed MF

Checked

Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 24/02/10

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:3,500**

0 50 100 200 300 400 500 Metres

PROJECT **Woodvale Flora and Vegetation Survey**

DRAWING TITLE **FIGURE 2 : Vegetation Survey Locations**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V9076**

Original **A3**

Drawing Number **SK02**

Revision

Designed GT

Checked

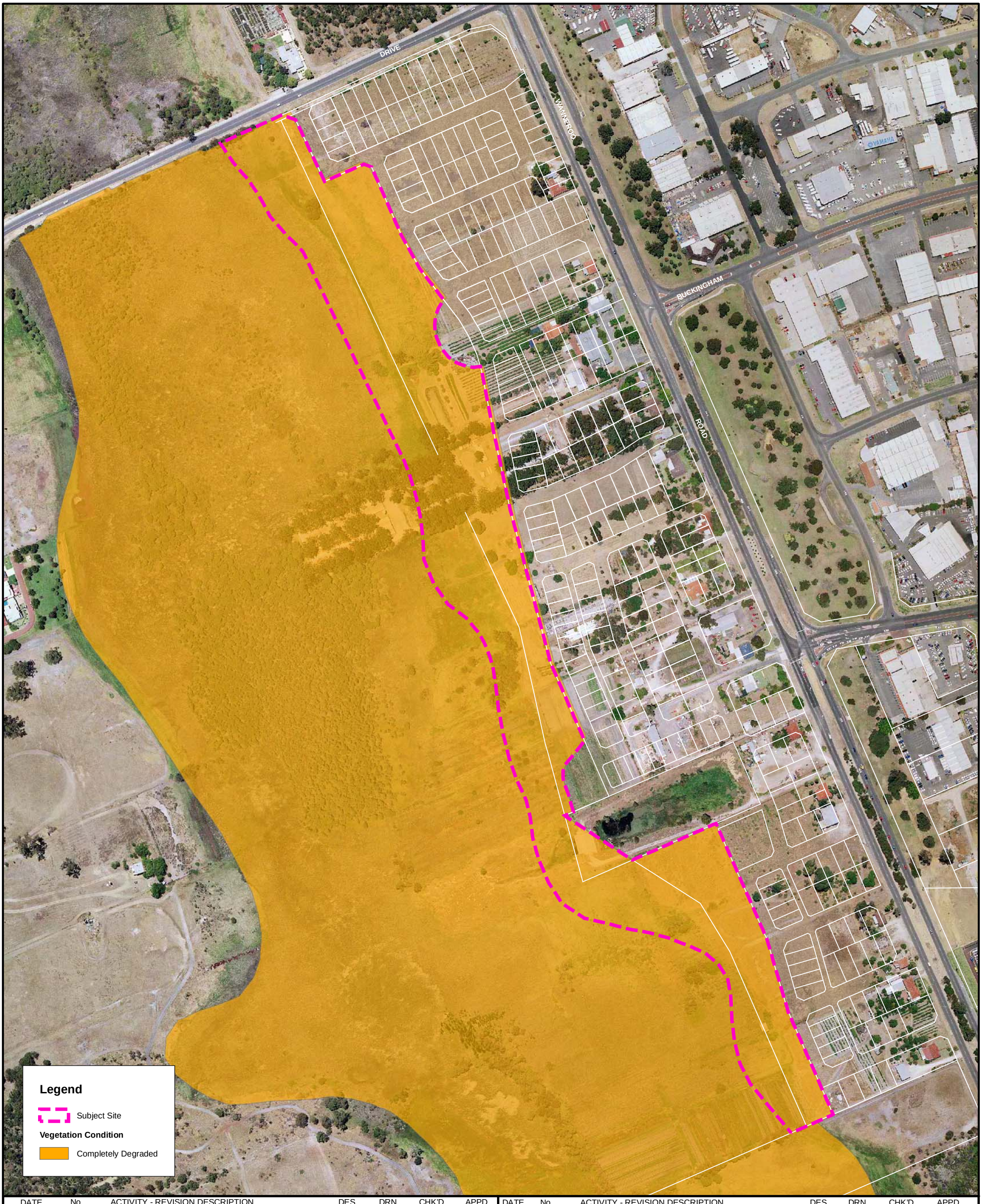
Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 15/03/10



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:3,500**

0 50 100 200 300 400 500 Metres

PROJECT **Woodvale Flora and Vegetation Survey**

DRAWING TITLE **FIGURE 3: Vegetation Condition Map**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V9076**

Original **A3**

Revision

Drawing Number **SK03**

Designed MF

Drawn MGW

Checked

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 24/02/10

Plates

Plate 1: Survey Location 1

Plate 2: Survey Location 2

Plate 3: Survey Location 3

Plate 4: Survey Location 4

Plate 5: Survey Location 5

Plate 6: Survey Location 6

Appendix A

Flora and Vegetation Species List

Appendix A: Plant Taxa Recorded within Woodvale Wetland and Buffer Area, October 2009.

Family Name		Plant Taxa
Aizoaceae	*	*Carpobrotus edulis*
Apiaceae	*	*Centella asiatica*
	*	*Foeniculum vulgare*
Asteraceae	*	*Arctotheca calendula*
	*	*Conyza bonoriensis*
	*	*Gazania linearis*
	*	*Hypochaeris glabra*
	*	*Lactuca serriola*
	*	*Sonchus oleraceus*
Basellaceae	*	*Anredera cordifolia*
Brassicaceae	*	*Brassica fruiticulosa*
	*	*Brassica tournefortii*
Cyperaceae		*Baumea articulata*
	*	*Cyperus triangle*
		Juncus pallidus
Euphorbiaceae	*	*Euphorbia terracina*
	*	*Ricinis communis*
Fabaceae		*Acacia iteaphylla*
		Jacksonia furcellata
	*	*Lotus subbiflorus*
	*	*Lupinis cosentinii*
	*	*Melilotus albus*
	*	*Trifolium arvense*
	*	*Trifolium campestre*
	*	*Trifolium subterraneum*
	*	*Vicia sativa subsp. nigra*
	*	*Viminaria juncea*
Geraniaceae	*	*Pelargonium capitatum*
Iridaceae	*	*Moraea flaccida*
Moraceae	*	*Ficus carica*
Myrtaceae		*Eucalyptus rudis*
	*	*Eucalyptus sp.*
		Melaleuca lateritia
Oleaceae	*	*Olea europaea*
Poaceae	*	*Avena barbata*
	*	*Bromus catharticus*
	*	*Bromus diandrus*
	*	*Cortedaria selloana*

Family Name		Plant Taxa
	*	*Cynodon dactylon*
	*	*Ehrharta calycina*
	*	*Ehrharta longiflora*
	*	*Eragrostis curvula*
	*	*Holcus lanatus*
	*	*Hordeum vulgare*
	*	*Lagurus ovatus*
	*	*Lolium rigidum*
	*	*Pennisetum clandestinum*
	*	*Phalaris paradoxa*
	*	*Stenotaphrum secondatum*
	*	*Vulpia myuros*
Typhaceae	*	*Typha orientalis*
Vitaceae	*	*Vitis vinifera*

Appendix B

Raw Data

Site:	1	Camera	SC			
Date:	17/10/09	Photo #	3077: 3078			
Initials:	sc	Direction	W: E			
Zone:	50	Soils	ls			
Datum:	GDA	Soil colour:	black			
Easting:	387115	Soil comments:	saturated			
Northing:	6482489	Outcrop:	n/a			
Topography	ls	Outcrop Type:				
Aspect	w	Litter cover (%)	Logs	Twigs	Leaves	
Slope	<5		0	0	0	
Fire (yrs)	>5	STRATA		Ht (cm)	% Cover	
Disturbance	HIGH		Upper			
Condition	CD		Mid			
Bare ground (%):	0		Lower	100	100	
Observations	Paddock					

Community Description pasture grasses

Coll. No.	Species	% Cover	
	Typha orientalis	100	
	Pennisetum clandestinum	30	
	Bromus diandrus	25	
	Ehrharta calycina	25	
	Holcus lanatus	15	
	Ehrharta longiflora	10	
	Lolium rigidum	5	
	Trifolium subterraneum	4	
	Carpobrotus edulis	2	
	Avena barbata	1	
	Vicia sativa subsp. nigra	1	where present

Site:		2	Camera	SC	
Date:		17/10/09	Photo #	3079: 3080	
Initials:	sc		Direction	W: E	
Zone:		50	Soils	ls	
Datum:	GDA		Soil colour:	brown	
Easting:		387215	Soil comments:	dry; hard packed	
Northing:		6482227	Outcrop:	n/a	
Topography	f		Outcrop Type:		
Aspect	w		Litter cover (%)	Logs	Twigs
Slope	<5			0	5
Fire (yrs)	>5		STRATA		Ht (cm)
Disturbance	HIGH			Upper	2500
Condition	CD			Mid	
Bare ground (%):		5		Lower	100
Observations	planted eucs; west of Conti's - old dam with typha , patch of bamboo, patch of Arun				

Community Description exotic eucs over grasses

Coll. No.	Species	% Cover
	Lactuca serriola	few
	Pennisetum clandestinum	60
	Eucalyptus sp.	50
	Bromus diandrus	15
	Ficus carica	10
	Ehrharta calycina	5
SC01	*Anredera cordifolia*	3
	Cynodon dactylon	3
	Ricinis communis	3
SC05	*Bromus catharticus*	2
	Hordeum vulgare	2
	Conyza bonoriensis	1
	Lolium rigidum	1

Site:		3	Camera	SC		
Date:		17/10/09	Photo #	3082: 3083		
Initials:	sc		Direction	W: E		
Zone:		50	Soils	ls		
Datum:	GDA		Soil colour:	brown		
Easting:		387289	Soil comments:	wet		
Northing:		6482024	Outcrop:	n/a		
Topography	ls		Outcrop Type:			
Aspect	w		Litter cover (%)	Logs	Twigs	Leaves
Slope	<5			0	1	3
Fire (yrs)	>5		STRATA		Ht (cm)	% Cover
Disturbance	HIGH			Upper	1500	50
Condition	CD			Mid	400	25
Bare ground (%):		0		Lower	100	100
Observations	pennisetum clandestinum grassland between this site and chook farm; Chamelaucium uncinata 50m to the east					
Community Description			eucalyptus rudis over pennisetum clandestinum			

Coll. No.	Species	% Cover
	Pennisetum clandestinum	95
	Eucalyptus rudis	50
	Ficus carica	20
	Typha orientalis	20
	Bromus diandrus	5
SC03	*Melilotus albus*	5
	Moraea flaccida	5
	Jacksonia furcellata	2
	Vicia sativa subsp. nigra	2
	Centella asiatica	1
	Pelargonium capitatum	1

Site:		4	Camera	SC		
Date:		17/10/09	Photo #	3084: 3085		
Initials:	sc		Direction	W: E		
Zone:		50	Soils	ls		
Datum:	GDA		Soil colour:	brown		
Easting:		387313	Soil comments:	wet in parts below sump		
Northing:		6481853	Outcrop:	n/a		
Topography	ls		Outcrop Type:			
Aspect	w		Litter cover (%)	Logs	Twigs	Leaves
Slope	<5			0	0	0
Fire (yrs)	>5		STRATA		Ht (cm)	% Cover
Disturbance	HIGH			Upper		
Condition	CD			Mid	300	25
Bare ground (%):		5		Lower	100	95

Observations

Community Description: Eragrostis grassland , typha orientalis where wet

Coll. No.	Species	% Cover
	Acacia iteaphylla	few
	Cortedaria selloana	few
	Gazania linearis	few
	Melaleuca lateritia	few
	Sonchus oleraceus	few
	Eragrostis curvula	60
	Typha orientalis	20
	Trifolium campestre	15
	Lolium rigidum	10
	Trifolium arvense	5
	Vulpia myuros	5
	Avena barbata	4
	Brassica tournefortii	4
	Lotus subbiflorus	4
	Foeniculum vulgare	3
	Stenotaphrum secondatum	3
	Lagurus ovatus	1
	Lupinis cosentinii	1
	Phalaris paradoxa	1
SC04	*Viminaria juncea*	1
	Vitis vinifera	1

Site:		5	Camera	SC			
Date:		17/10/09	Photo #	3086: 3087; 3088; 3089			
Initials:	sc		Direction	W: S: E: N			
Zone:		50	Soils	ls			
Datum:	GDA		Soil colour:	grey			
Easting:		387527	Soil comments:	dry			
Northing:		6481806	Outcrop:	n/a			
Topography	ls		Outcrop Type:				
Aspect	w		Litter cover (%)	Logs	Twigs	Leaves	
Slope	<5			3	1	3	
Fire (yrs)	>5		STRATA		Ht (cm)	% Cover	
Disturbance	HIGH			Upper	500	5	
Condition	CD			Mid	300	10	
Bare ground (%):		2		Lower	150	95	

Observations

Community Description grassland with fennel

Coll. No.	Species	% Cover
	Bromus diandrus	40
	Eragrostis curvula	40
	Ehrharta calycina	10
	Foeniculum vulgare	10
	Lupinis cosentinii	10
	Carpobrotus edulis	8
	Avena barbata	5
	Euphorbia terracina	5
	Olea europaea	5
	Ehrharta longiflora	3
	Hypochaeris glabra	1

Site:		6	Camera	SC			
Date:		17/10/09	Photo #	3090; 3091			
Initials:	sc		Direction	W: E			
Zone:		50	Soils	ls			
Datum:	GDA		Soil colour:	grey			
Easting:		387607	Soil comments:	wet			
Northing:		6481573	Outcrop:	n/a			
Topography	ls		Outcrop Type:				
Aspect	w		Litter cover (%)	Logs	Twigs	Leaves	
Slope	<5			0	0	0	
Fire (yrs)	>5		STRATA		Ht (cm)	% Cover	
Disturbance	HIGH			Upper	1000	5	
Condition	CD			Mid			
Bare ground (%):		0		Lower	150	100	
Observations							

Community Description pennisetum clandestinum with emergent eucalyptus rudis

Coll. No.	Species	% Cover
	Arctotheca calendula	few
	Baumea articulata	few
	Brassica fruiticulosa	few
	Cyperus triangle	few
	Moraea flaccida	few
	Phalaris paradoxa	few
	Sonchus oleraceus	few
	Pennisetum clandestinum	40
	Avena barbata	25
	Cynodon dactylon	20
	Typha orientalis	20
	Ehrharta calycina	15
	Lupinis cosentinii	10
	Eucalyptus rudis	5
	Trifolium campestre	5
	Conyza bonoriensis	3
	Holcus lanatus	3
	Bromus diandrus	2
SC02	*Lolium rigidum*	2
	Trifolium subterraneum	2
	Hypochaeris glabra	1
SC06	*Juncus pallidus*	1

Appendix C

Fauna Survey Report

Level 1 Fauna Assessment of Chianti Private Estate, Wanneroo Road, Woodvale

Prepared for: Cardno WA Pty Ltd
PO Box 155
Subiaco, WA, 6008

Prepared by: **Mike Bamford**

M.J. & A.R. BAMFORD
CONSULTING ECOLOGISTS
23 Plover Way
KINGSLEY WA 6026

11th April 2010

CONTENTS

1 INTRODUCTION

Urban development for the Chianti Private Estate is proposed for a series of lots along Wanneroo Road in Woodvale, between Woodvale Drive and Whitfords Avenue. The site is mostly cleared, with extensive areas of weeds and very little of the original vegetation remaining, but it does lie alongside wetlands of Yellagonga Regional Park. Therefore, Cardno WA Pty Ltd is developing a Wetland Management Plan to ensure that the urban development is compatible with the conservation values of the adjacent wetland. Bamford Consulting Ecologists was commissioned to prepare a Level 1 fauna assessment to provide information to support the development of this plan, and to provide general information on fauna values and impacts. The objectives of this assessment are therefore to:

- review the list of fauna expected to occur on the site in the light of fauna habitats present, with a focus on significant species;
- identify significant or fragile fauna habitats within the study area;
- identify potential impacts upon fauna and propose recommendations to minimise impacts.

Note that the focus of this report is upon vertebrate fauna, on which most information is available, but invertebrate fauna is considered in the case of significant species or where potential impacts can be identified.

2 DESCRIPTION OF THE PROJECT AREA AND PROPOSED DEVELOPMENT

The project area lies south of Woodvale Drive and between Wanneroo Road and Yellagonga Regional Park, in Wanneroo. It lies to the east of the Regional Park and has an area of 25ha. The project area consists largely of cleared paddocks with some trees, and the adjacent Regional Park is mostly a shallow wetland covered with Bulrush *Typha* sp., but with some riparian trees. A more detailed site description appears in Section 4.

The development is an urban sub-division but includes a rehabilitation zone at the interface between the development and the Regional Park. This interface is to be developed as a buffer between the residential development and the Regional Park. Management of this interface will be important for fauna conservation.

3 METHODS

3.1 Impact Assessment

The general approach used by Bamford Consulting Ecologists to assess impacts of development projects is outlined in Appendix 1. This provides a framework for assessment for the current project.

Investigations carried out for this project constituted a Level 1 Fauna Assessment (*sensu.* Environmental Protection Authority 2002, 2004), which involves a reconnaissance survey, background research and low intensity fauna sampling. Where fauna and fauna habitats are well-known from existing studies, a Level 1 Assessment provides detailed information on the nature and requirements for management of impacts.

3.2 Personnel

Personnel involved in this project were:

- Dr Mike Bamford (B.Sc. Hons. Ph.D.) – field assessment and report preparation.

3.3 Licences and Permits

The site inspection involved no interaction with fauna other than passive observation and therefore on advice from the Wildlife Licencing branch of DEC no licence was issued.

3.4 Nomenclature and Taxonomy

As per the recommendations of EPA (2004), the nomenclature and taxonomic order presented in this report are generally based on the Western Australian Museum's *Checklist of the Vertebrates of Western Australia*. The authorities used for each vertebrate group are: amphibians and reptiles (Aplin and Smith, 2001), birds (Christidis and Boles, 2008), and mammals (How *et al.*, 2001).

Latin and (where available) English common names are given in the species tables. English names are used in the text where possible, with Latin names used where there is no English alternative.

3.5 Sources of Information for Desktop Assessment

The project area lies within the northern suburbs of Perth, less than five kilometres from the residence and office of Bamford Consulting, where fauna records in the adjacent Yellagonga Regional Park have been maintained for 21 years. This area of Yellagonga includes Lake Goollelal where there is more open water than in the study area, but otherwise the environment is similar with parkland cleared areas, some Flooded Gums and Paperbarks, and extensive areas of Bulrush. In addition, Bamford Consulting has done numerous studies in Yellagonga, Wangara, Gnangara, Whiteman Park (about 15km to the east) and Neerabup, and in coastal areas from Burns Beach to Two Rocks. Some of these studies have involves intensive trapping. As a result, Bamford Consulting has extensive fauna records for the area. Databases the DEC Naturemap database (URL - http//.naturemap.dec.wa.gov.au), the Birds Australia Atlas Database, DEC Threatened Fauna Database and EPBC Protected Matters Search Tool have been interrogated for

the northern suburbs areas for other studies, as recently as January 2010. Therefore, and in the light of personal records, these databases were not accessed for the present study.

3.6 Interpretation of species lists

Species lists generated from the review of sources of information are very generous as they include records from environments not represented in the project area. The overall species lists are presented in the appendices, but only species actually likely to rely upon the project area and/or the adjacent Regtional Park appear in tables presented in the body of the report. Species that may occur only in the adjacent Regional Park are included as they may be affected by activities in the project area.

3.7 Site inspection

The project area was visited by M. Bamford on 16th February 2010 for the site inspection. Weather conditions were typical for the time of year, being hot and dry. There had been no recent rain. Activities undertaken during the site inspection included:

1. Habitat descriptions;
2. Opportunistic observations, including recording conspicuous fauna and looking for evidence of fauna such as diggings, tracks and scats.

Most of the length of the study area was visited on foot, and parts of the adjacent Regional Park were also visited to provide context.

4 RESULTS

4.1 Site description

The project area is largely cleared and consists of fallow, weed-infested paddocks that slope down to wetlands dominated by Bulrush *Typha* sp. on the margin with Yellagonga Regional Park. The Bulrush extends into the project area in places. There are several houses along Wanneroo Road. There are some introduced trees within the project area and very few remnant native trees such as Flooded Gum *Eucalyptus rudis*. The adjacent Regional Park consists largely of a wetland with limited surface water in summer but that floods extensively in winter. The only surface water at the time of the site inspection was in a central drain within the Regional Park; this is probably the remnant of a canal used to transport produce along the chain of lakes from Joondalup to Goollelal. This wetland is covered with Bulrush (ie. there is effectively no open water) but with some riparian trees such as Flooded Gum and Freshwater Paperbark *Melaleuca rhaphiophylla.* There are also some exotic trees within the Regional Park, including Figs and some non-local eucalypts. Note that Yellagonga Regional Park is narrow but long, and extends from Hepburn Avenue in the south to Burns Beach Road in the north. The project area lies about one third of the length of the Regional Park, from the south. Most of the Regional Park is wetland but it includes some upland vegetation and is the major north-south wildlife corridor in Perth's northern suburbs. There is extensive but degraded upland native vegetation (mainly *Banksia* woodland) on the western side of the Regional Park, opposite the project area.

Overall, both the project area and the adjacent Regional Park are highly modified environments with high levels of weed invasion, but they are large areas of undeveloped land within the northern suburbs. Key features of the environment that provide habitat for fauna are:

- Cleared areas dominated by weeds; mostly within the project area (Figure 1);
- Isolated and occasional groups of non-native trees; within the project area and adjacent Regional Park (Figure 2);
- Rushbeds of Bulrush with seasonal water;(mostly within the Regional Park but extending into the project area in places (Figure 3); and
- Riparian woodland of Flooded Gum and Freshwater Paperbark; largely within the Regional Park (Figure 3).

Banksia woodland lies within Yellagonga Regional Park but outside the project area.

Figure 1. Cleared pasture dominated by weeds within project area.

Figure 2. Scattered, non-native trees over pasture.

Figure 3. Rushbed of Bulrush *Typha* sp. with adjacent riparian woodland of Flooded Gum and Freshwater Paperbark.

4.2 Vertebrate fauna of the project area

Fauna species known to occur in the general region of the northern suburbs based on the sources of information (see Section 3.5) are listed in Appendix 3 (vertebrate species only). The majority of these species are not likely to occur in the project area due to the lack of suitable habitat. Species that are or may be present are discussed below.

The desktop study identified a fauna assemblage that may occur in the project area consisting of: 4 fish, 6 frog, 19 reptile, 85 bird and 13 mammal species. Twenty-two of the species expected to occur in the project area are of conservation significance.

4.2.1 Freshwater Fish

All the freshwater fish listed in Appendix 3, the Swan River Goby, Goldfish, Carp and Mosquitofish, are present in Yellagonga Regional Park. They can therefore be expected to occur adjacent to the project area. Only the Swan River Goby is native.

4.2.2 Frogs

Only six of the frog species listed in Appendix 3 are likely to occur within the project area (Table 1). All are widespread species in the northern suburbs and the Motorbike Frog makes extensive use of garden ponds. The Moaning Frog and Pobblebonk are notable for being strictly terrestrial for much of the year and occur away from wetlands outside the breeding season (autumn/early winter and winter/spring respectively). There are anecdotal accounts of these two species being adversely affected by garden fencing, which interferes with their migration, and the Moaning Frog is reliant upon predictable water level rises in autumn in order to breed successfully.

Table 1. Frog species likely to occur in the project area.

Species	
Hylidae (tree-frogs)	
Slender Tree-Frog	*Litoria adelaidensis*
Motorbike Frog	*Litoria moorei*
Myobatrachidae (ground frogs)	
Clicking Froglet	*Crinia glauerti*
Sandplain Froglet	*Crinia insignifera*
Moaning Frog	*Heleioporus eyrei*
Pobblebonk	*Limnodynastes dorsalis*

4.2.3 Reptiles

Appendix 3 lists 50 reptile species as occurring in the northern suburbs of Perth; 19 of these may be present in the project area (Table 2). Of these 19, the Bobtail, Two-toed Skink, Dwarf Skink and Tiger Snake were recorded during the site inspection. Several of the reptile species expected to be present (eg. Long-necked Tortoise, Cool Skink and Tiger Snake) are aquatic or associated with vegetation round wetlands, while the remaining species are known to occur in disturbed and degraded environments around Perth. These do not necessarily require native vegetation and some can survive in urban gardens, but others require more continuous habitat. For example, the larger, mobile species (eg. Bearded Dragon and Gould's Sand Goanna) seem to persist around Lake Goollelal only because of large areas of degraded upland vegetation. Twelve of these species have been observed in a garden in Kingsley, just south of the project area, but several of these have been noted (M. Bamford pers. obs.) as sensitive to predation by domestic cats (Bearded Dragon, West Coast Ctenotus and probably Gould's Sand Goanna).

Table 2. Reptile species likely to occur in the project area.

Species	
Chelidae (side-necked tortoises)	
South-West Long-necked Tortoise	*Chelodina oblonga*
Gekkonidae (geckoes)	
Marbled Gecko	*Christinus marmoratus*
Spiny-tailed Gecko	*Strophurus spinigerus*
Pygopodidae (legless lizards)	
Sandplain Worm Lizard	*Aprasia repens*
Burton's Legless Lizard	*Lialis burtonis*
Agamidae (dragon lizards)	
Western Bearded Dragon	*Pogona minor*
Varanidae (monitors or goannas)	
Gould's Sand Goanna	*Varanus gouldii*
Scincidae (skink lizards)	
South-west Cool Skink	*Acritoscincus trilineatum*
Fence Skink	*Cryptoblepharus buchananii*
West Coast Ctenotus	*Ctenotus fallens*
Two-toed Skink	*Hemiergis quadrilineata*
Four-toed Lerista	*Lerista elegans*
Western Worm Lerista	*Lerista praepedita*
Dwarf Skink	*Menetia greyii*
Spotted Morethia	*Morethia lineoocellata*
Dusky Morethia	*Morethia obscura*
Bobtail	*Tiliqua rugosa*
Elapidae (front-fanged snakes)	
Tiger Snake	*Notechis scutatus*
Dugite	*Pseudonaja affinis*

4.2.4 Birds

Appendix 3 lists 181 bird species as occurring in the northern suburbs of Perth. This excludes marine species and probably some vagrants. Approximately half of these (85 species, see Table 3) may occur in the project area or in the adjacent Regional Park.

Many of the birds expected utilise degraded environments, including pasture, but there are also species that rely on the riparian vegetation and on remnant native vegetation. Some of the bird species are of conservation significance and this is indicated in Table 3. Significant species are discussed in Section 5.

Table 3. Bird species likely to occur in the project area. Species of conservation significance are noted, using categories as outlined in Appendix 1 (Section 5.1.1). [int] indicates introduced species. Species observed during the site inspection are indicated "X".

Species		Conservation Significance
Anatidae (ducks, geese and swans)		
Australian Shelduck	*Tadorna tadornoides*	
Pacific Black Duck	*Anas superciliosus*	
Grey Teal	*Anas gibberifrons*	
Australian Wood Duck	*Chenonetta jubata*	
Columbidae (pigeons and doves)		
Rock Dove (Domestic Pigeon)	*Columba livia*	
Laughing Dove	*Streptopelia senegalensis*	X
Spotted Dove	*Streptopelia chinensis*	
Crested Pigeon	*Ocyphaps lophotes*	
Podargidae (frogmouths)		
Tawny Frogmouth	*Podargus strigoides*	
Ardeidae (herons and egrets)		
Australasian Bittern	*Botaurus poiciloptilus*	CS1
Australian Little Bittern	*Ixobrychus dubius*	CS2
White-faced Heron	*Egretta novaehollandiae*	
White-necked Heron	*Ardea pacifica*	
Eastern Great Egret	*Ardea modesta (alba)*	CS1
Nankeen Night Heron	*Nycticorax caledonicus*	
Threskionithidae (ibis and spoonbills)		
Australian White Ibis	*Threskiornis molucca*	
Straw-necked Ibis	*Threskiornis spinicollis*	
Yellow-billed Spoonbill	*Platalea flavipes*	
Accipitridae (kites, hawks and eagles)		
Black-shouldered Kite	*Elanus axillaris*	
Whistling Kite	*Haliastur sphenurus*	

Species		Conservation Significance
Swamp Harrier	*Circus approximans*	
Brown Goshawk	*Accipiter fasciatus*	CS3
Collared Sparrowhawk	*Accipiter cirrhocephalus*	CS3
Falconidae (falcons)		
Peregrine Falcon	*Falco peregrinus*	CS1
Australian Hobby	*Falco longipennis*	
Nankeen Kestrel	*Falco cenchroides*	X
Rallidae (crakes and rails)		
Buff-banded Rail	*Rallus philippensis*	
Baillon's Crake	*Porzana pusilla*	
Australian Spotted Crake	*Porzana fluminea*	
Spotless Crake	*Porzana tabuensis*	
Dusky Moorhen	*Gallinula tenebrosa*	CS3
Purple Swamphen	*Porphyrio porphyrio*	
Eurasian Coot	*Fulica atra*	
Recurvirostridae (stilts and avocets)		
Black-winged Stilt	*Himantopus himantopus*	
Charadriidae (lapwings and plovers)		
Black-fronted Dotterel	*Elseyornis melanops*	
Red-kneed Dotterel	*Erythrogonys cinctus*	
Banded Lapwing	*Vanellus tricolor*	
Cacatuidae (cockatoos)		
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*	CS1
Galah	*Cacatua roseicapilla*	X
Long-billed Corella [int]	*Cacatua tenuirostris*	
Little Corella	*Cacatua sanguinea*	
Psittacidae (lorikeets and parrots)		
Rainbow Lorikeet [int]	*Trichoglossus haematodus*	
Australian Ringneck	*Barnardius zonarius*	
Red-capped Parrot	*Purpureicephalus spurius*	
Elegant Parrot	*Neophema elegans*	
Cuculidae (cuckoos)		
Pallid Cuckoo	*Cuculus pallidus*	
Strigidae (hawk-owls)		
Southern Boobook	*Ninox novaeseelandiae*	
Tytonidae (barn owls)		
Barn Owl	*Tyto alba*	
Halcyonidae (forest kingfishers)		
Sacred Kingfisher	*Todiramphus sanctus*	

Species		Conservation Significance
Laughing Kookaburra	*Dacelo novaeguineae*	
Meropidae (bee-eaters)		
Rainbow Bee-eater	*Merops ornatus*	CS1
Maluridae (fairy-wrens)		
Splendid Fairy-wren	*Malurus splendens*	CS3
Variegated Fairy-wren	*Malurus lamberti*	CS3
Pardalotidae (pardalotes)		
Striated Pardalote	*Pardalotus striatus*	
Spotted Pardalote	*Pardalotus punctatus*	
White-browed Scrubwren	*Sericornis frontalis*	CS3
Weebill	*Smicrornis brevirostris*	CS3
Western Gerygone	*Gerygone fusca*	
Inland Thornbill	*Acanthiza apicalis*	CS3
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	CS3
Meliphagidae (honeyeaters)		
Red Wattlebird	*Anthochaera carunculata*	X
Western Wattlebird	*Anthochaera lunulata*	CS3
Singing Honeyeater	*Lichenostomus virescens*	X
Brown Honeyeater	*Lichmera indistincta*	X
White-cheeked Honeyeater	*Phylidonyris nigra*	CS3
New Holland Honeyeater	*Phylidonyris novaehollandiae*	CS3
Acrocephalidae (reed-warblers)		
Australian Reed-Warbler	*Acrocephalus australis*	X
Megaluridae (grassbirds)		
Little Grassbird	*Megalurus gramineus*	
Zosteropidae (white-eyes)		
Silvereye	*Zosterops lateralis*	X
Pachycephalidae (whistlers)		
Rufous Whistler	*Pachycephala rufiventris*	
Dicruridae (flycatchers)		
Magpie-lark	*Grallina cyanoleuca*	
Grey Fantail	*Rhipidura fuliginosa*	
Willie Wagtail	*Rhipidura leucophrys*	X
Neosittidae (sittella)		
Varied Sittella	*Daphoenositta chrysoptera*	CS3
Campephagidae (cuckoo-shrikes)		
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	X
White-winged Triller	*Lalage sueurii*	
Artamidae (woodswallows)		

Species		Conservation Significance
Black-faced Woodswallow	*Artamus cinereus*	CS3
Grey Butcherbird	*Cracticus torquatus*	
Australian Magpie	*Gymnorhina tibicen*	X
Corvidae (ravens and crows)		
Australian Raven	*Corvus coronoides*	X
Motacillidae (pipits and true wagtails)		
Australian Pipit	*Anthus novaeseelandiae*	X
Dicaeidae (flower-peckers)		
Mistletoebird	*Dicaeum hirundinaceum*	
Hirundinidae (swallows)		
White-backed Swallow	*Cheramoeca leucosternus*	
Welcome Swallow	*Hirundo neoxena*	
Tree Martin	*Petrochelidon nigricans*	

4.2.5 Mammals

Appendix 3 lists 24 mammal species as occurring in the northern suburbs of Perth, of which 13 (Table 3) may occur in the project area or in the adjacent Regional Park. These 13 species include five introduced species, all of which are regularly observed around Lake Goollelal, so only eight native mammal species are likely to be present. Western Grey Kangaroos occur west of Yellagonga Regional Park, where a mob of about 30 animals is present (M. Bamford pers. obs.), and fresh scats were found in the project area, indicating some animals at least visit the area. The Rakali or Water-rat and Brush-tail Possum both occur around Lake Goollelal (M. Bamford pers. obs) and are therefore very likely to be present in the project area. The four bat species have also been recorded in the vicinity of the project area (M. Bamford pers. obs.), but the remaining native species, the Quenda, is not known from Lake Goollelal but is present at bushland reserves round wetlands to the east, such as Little Badgerup Swamp. It also occurs just to the north of Yellagonga Regional Park, so has the potential to colonise the project area.

The Rakali is aquatic and may occur where-ever there is surface water, probably moving into the area in winter and retreating to permanent water, such as at Lake Goollelal, for the rest of the year. The Quenda favours dense, low vegetation such as occurs around wetlands, and will inhabit dense weeds as well as dense native vegetation. The possum and bats rely on large, old trees for roosting, although both the White-striped and Gould's Wattled Bats have been found roosting in hollow metal cross-members of power poles in nearby Craigie (M. Bamford pers. obs.). The possum and bats will also use constructed nest-boxes. The Yellagonga mob of Kangaroos shelters in degraded banksia woodland and forages in degraded pasture north of Whitfords Avenue and just east of Duffy Terrace.

Some of the mammal species are of conservation significance and this is indicated in Table 3. Significant species are discussed in Section 4.

Table 4. Mammal species likely to occur in the project area. Species of conservation significance are noted, using categories as outlined in Appendix 1. [int] indicates introduced species. Species observed around Lake Goollelal and that are therefore very likely to occur in the project area are indicated "X".

Species		Status
Peramelidae (bandicoots)		
Quenda or Brown Bandicoot	*Isoodon obesulus*	CS2
Phalangeridae (brushtail possums)		
Brush-tailed Possum	*Trichosurus vulpecula*	X
Macropodidae (kangaroos and wallabies)		
Western Grey Kangaroo	*Macropus fuliginosus*	X
Mollosidae (mastiff bats)		
White-striped Bat	*Tadarida australis*	X
Vespertilionidae (vesper bats)		
King River Eptesicus	*Vespadelus (Eptesicus) regulus*	
Gould's Wattled Bat	*Chalinolobus gouldii*	X
Lesser Long-eared Bat	*Nyctophilus geoffroyi*	
Muridae (rats and mice)		
House Mouse [int]	*Mus musculus*	X
Rakali or Water-rat	*Hydromys chrysogaster*	CS2 X
Black Rat [int]	*Rattus rattus*	X
Leporidae (rabbits and hares)		
Rabbit [int]	*Oryctolagus cuniculus*	X
Canidae (foxes and dogs)		
European Red Fox [int]	*Vulpes vulpes*	X
Felidae (cats)		
Feral Cat [int]	*Felis catus*	X

4.3 Fauna – species of conservation significance

Details on species of conservation significance are discussed below. Impact upon these species are considered in Section 5.

4.3.1 Frogs

None of the frog species expected is of conservation significance.

4.3.2 Reptiles

None of the reptile species expected is of conservation significance. However, a number of the species do not occur in urban areas so their presence is of at least local interest. These include the Sandplain Worm-Lizard, Burton's Legless-Lizard, Western Bearded Dragon and Gould's Goanna.

4.3.3 Birds

The bird assemblage includes five species of CS1 (high conservation significance listed under legislation), one species of CS2 (listed as Priority by the DEC) and 13 species of CS3 (locally significant because they have declined in the Perth area). These species are briefly discussed below. The majority of the significant species are likely to be infrequent visitors in small numbers, and furthermore are likely to occur in Yellagonga Regional Park and particularly the remnant upland woodland rather than within the project area. Several of the significant species are waterbirds but they usually require some open water, although the Australasian and Little Bitterns occur in dense bulrush. The Rainbow Bee-eater is almost certainly present as a breeding migrant in spring/summer.

Conservation Significance Level 1.

Australasian Bittern (DEC Schedule 1)

The Australasian Bittern is listed as Vulnerable under the WA Wildlife Conservation Act. This species frequents reedbeds and dense vegetation in wetlands. The bulrush area within and adjacent to the project area are suitable habitat, but there are no recent records of the species around Perth, so it is very unlikely to be present.

Eastern Great Egret

The Eastern Great Egret is a large, Australian breeding waterbirds listed as Migratory under the EPBC Act and under Schedule 3 of the WA Wildlife Conservation Act. It is common and widespread in Australia, and is a regular sight on wetlands around Perth, including Lake Goollelal. However, riparian vegetation at the project area and adjacent Regional Park is so dense that the species probably only occurs as an occasional visitor, perhaps when flooding creates open water on grassland areas.

Peregrine Falcon (DEC Schedule 4)

The Peregrine Falcon is classified as "Specially Protected Fauna" under Schedule 4 of the Wildlife Conservation Act. It is a widespread species with several pairs living within Perth, where at least one pair nests on a ledge of a tall building in the CBD (natural nest sites are cliffs and very large trees). A pair is seen regularly in the Kingsley/Woodvale area and they probably

nest in a large hollow spout in a Tuart in Pinnaroo Valley (M. Bamford pers. obs.). There is no suitable nesting habitat in the project area nor are there large trees in the adjacent Regional Park, but the birds undoubtedly overfly and forage through the project area.

Carnaby's Black-Cockatoo (DEC Schedule 1)
Carnaby's Cockatoo is listed as Endangered under the EPBC Act, the Wildlife Conservation Act and according to Garnett and Crowley (2000). Carnaby's Cockatoo is dependent on large tree hollows (in Eucalypts) to breed. As a result of extensive clearance of woodlands in the Wheatbelt region, large hollow-bearing Eucalypts (and therefore breeding sites for the Carnaby's Cockatoo) are scarce, and this species has declined. The decline of Carnaby's Cockatoo has been exacerbated by the clearing of foraging habitat (typically *Banksia* woodland) along the west coast, partly due to urban expansion. Loss of such foraging habitat is recognised as a major threatening process by Garnett and Crowley (2000). There is little if any foraging habitat and no nesting habitat within the project area, but *Banksia* woodland is present in the adjacent Yellagonga Regional Park so the species is very likely to over-fly the project area.

Rainbow Bee-eater
The Rainbow Bee-eater is listed as Migratory under the EPBC Act and is a spring-summer migrant around Perth. It is common across much of Australia, occurs regularly around Lake Goollelal and constructs its nesting burrows in open ground in Yellagonga Regional Park. It almost certainly nests within the project area in the fallow paddocks in the October to January period.

Conservation Significance Level 2.
Little Bittern.
Listed as Priority 4 by DEC and occasionally recorded around Perth wetlands, generally in areas of dense rushbeds. The bulrush in the Regional Park adjacent to the project area is suitable habitat and the species has been recorded in the generally area in the past, and was recorded at Lake Goollelal during a recent (November 2009) survey by Birds Australia (R. Pickering pers.comm.).

Conservation Significance Level 3.
Fourteen bird species (see Table 3) are considered to be of local conservation significance. The majority of these are identified by the WA Department of Environmental Protection (DEP, 2000) as having declined in the Perth area due to impacts associated with urban development. A few of these are birds of prey, but the majority are small birds that rely on woodlands and shrublands where they are either residents (eg. fairy-wrens and thornbills) or seasonal visitors (honeyeaters). The fairy-wrens and thornbills are particularly sensitive to habitat loss and fragmentation, whereas the honeyeaters have a greater ability to access suitable habitat even when it is fragmented by urban development. One species, the Dusky Moorhen, is a waterbird that occurs on the fringes of rushbeds. The majority of the species listed by the DEP (2000) are also noted as having declined Australia-wide by more than 20% in the New Atlas of Australian Birds (Barrett *et al.* 2003). While these 14 species may be occasional visitors to the project area, the most suitable habitat for them is within the adjacent Regional Park.

4.3.4 Mammals

The mammal assemblage includes two species of CS2 (listed as Priority by the DEC). These species are briefly discussed below. The other native species (several bats, the Grey Kangaroo and the Brush-tailed Possum) could be considered of local significance as they have generally declined around Perth, but all are common elsewhere. Note that several species of high conservation significance would have occurred in the area historically, but are now locally extinct.

Conservation Significance Level 2.

Quenda or Southern Brown Bandicoot

Listed as Priority 5 by DEC and present at several locations nearby, but not found in the project area and not recorded at Lake Goollelal. Despite this, the dense vegetation around the margins of the wetland, including dense weeds within the project area, are suitable habitat. With nearby populations, the project area could thus provide a corridor for movement of the species through the region.

Rakali or Water Rat

Listed as Priority 4 by DEC and is of concern because the species' population is in decline, particularly along rivers affected by salinity or degradation. The species appears to be common in Yellagonga Regional Park, with regular sightings around Lake Goollelal and several trapped at this lake in a low intensity trapping programme in 2009 (N. Huang pers. comm..). The Rakali is therefore almost certainly present in the Regional Park adjacent to the project area, and is probably a regular visitor in the project area, especially during winter when water levels are high.

4.3.5 Invertebrates

Less information on invertebrate species is available than is the case for vertebrate species, but a number of conservation significant invertebrate species are known from the northern suburbs region of Perth. These include the Graceful Sunmoth *Symenon grantiosa* (Castniidae), listed under the EPBC as Endangered and as Schedule 1 (Endangered) of the WA Wildlife Conservation Act, and three Priority 3 species: *Austrosaga spinifer* (a cricket), *Hyaleus globuliferus* and *Leioproctus contrarius* (both native bees). The Graceful Sun Moth has a very restricted distribution and is only known to occur in association with two species of Lomandra, *Lomandra hermaphrodita* and *Lomandra maritima.* Given the level of weed invasion in the project are, and the degradation of the *Banksia* woodland in the adjacent Regional Park, it is unlikely these plant species are present. The cricket and native bees are associated with heaths and/or banksia woodlands with healthy understorey and therefore it is unlikely that the habitats are suitable for them.

5 IMPACT ASSESSMENT

Developments such as that proposed for the Woodvale site can impact upon fauna in a number of ways. For example:

- Loss of habitat (clearing);
- Fragmentation of habitat;
- Obstructions (e.g. pipes on ground, roads) to the movements of terrestrial fauna;
- Impacts to surface and groundwater flows (through vegetation clearing, interception of the ground water table and dewatering);
- Introduction of permanent water storages;
- Death/injury of fauna during clearing, grading and impacts with vehicles/machinery;
- Disturbance of fauna in nearby areas from light, blasting vibrations, noise, dust and even people feeding selected species;
- Creation of new and sometimes novel habitats; and
- Changes in the abundance of feral species.

Some impacts upon fauna are unavoidable. Of concern are long-term, deleterious impacts upon biodiversity that are significant within the context of a site. Of interest are impacts that may be positive rather than negative. Impacts are re discussed below under the following categories:

- Habitats. Impacts may be significant if the habitat is rare, a large proportion of the habitat is affected and/or the habitat supports significant fauna.
- Significant fauna. Impacts may be significant if species of conservation importance are affected.
- Processes. Ecological processes are complex and can include hydrology, fire, predator/prey relationships and spatial distribution of a population (see discussion below). Impacts upon ecological processes may be significant if large numbers of species or large proportions of populations are affected.
- Patterns of biodiversity. Species are not distributed evenly across the landscape or even within one vegetation/landform type. There may be zones of high biodiversity such as particular habitats or ecotones (transitions between habitats).

Table 4 summarises impacts upon fauna according to criteria set out in the EPA Guidance Statement No. 56. This assessment recognises that the project area is of local importance because most of the surrounding areas are urbanised and the project area is adjacent to a Regional Park that acts as a wildlife corridor.

TABLE 4. The potential impacts to fauna of the proposal as assessed following the guidance of the EPA's Guidance Statement No. 56. (Terrestrial fauna surveys for environmental impact assessment in Western Australia, EPA 2004).

Factor	**Impact and explanation**
Degree of habitat degradation or clearing within the local area or region.	Low to Moderate (project lies within a region of fragmented and degraded ecosystems and the project area supports degraded ecosystems)
Size/scale of proposal/impact.	Low (small area of disturbance).
Rarity of vegetation and landforms.	Low to moderate (vegetation and landforms present in project area are poorly-represented regionally, but are of low value for fauna).
Refugia.	Low (project area does not have refugial habitats)
Fauna protected under international agreements or treaties, Specially Protected or Priority Fauna.	Low (very few species of high conservation significance present).
Size of remnant and condition/intactness of habitat and faunal assemblage.	Low to moderate (project area is small, degraded and with an incomplete fauna assemblage, but the assemblage is more complete than in surrounding urban areas so has some importance in a regional context).
Ecological linkage.	Moderate (The area is part of an ecological linkage at the regional or local scale.).
Heterogeneity or complexity of the habitat and faunal assemblage.	Moderate (The habitat and fauna assemblage of the project area are not complex, but they are distinctive in the context of the surrounding urban environment).

5.1 Habitat Types

The main habitat types are described is section 4.1 (above). The extent and impact on each habitat type can be summarised as follows:

Cleared areas dominated by weeds. These will be extensively impacted (directly) by the development but are of low value for fauna and are represented within Yellagonga Regional Park.

Isolated and occasional groups of non-native trees. These are mostly within the Regional Park so will not be directly impacted. Although not native, they are important, mostly for birds and some mammals. There will be an increase in plantings of non-native trees with urban development, so this habitat type will increase within the project area.

Rushbeds of Bulrush with seasonal water. These are mostly within the Regional Park so will not be directly impacted, except for possibly for some loss along the boundary of the Regional Park. They may, however, be indirectly affected through hydrological change, disturbance, etc. Such indirect, process-related impacts are discussed in section 5.3. There may also be some creation of rushbeds within public open space where swales a created to treat stormwater before it enters the Regional Park.

Riparian woodland of Flooded Gum and Freshwater Paperbark. These are mostly within the Regional Park and will not be directly impacted adversely, but will be positively impacted through plantings on public open space where the project area lies alongside the Regional Park.

Banksia woodland. This lies entirely within the Regional Park so will not be directly impacted. There may be some indirect, adverse impacts through disturbance and fire, which are discussed in section 5.3. There may also be some positive impacts on this vegetation type through use of native plants in gardens and public open space.

In summary, most impacts upon habitats affect the cleared areas dominated by weeds; this habitat is least important for fauna and is well-represented in the adjacent Regional Park. There are also potential positive impacts through the creation of habitat in public open space and gardens. Indirect impacts are discussed in section 5.3.

5.2 Conservation Significant Fauna

The desktop review found that 22 vertebrate species of conservation significance may occur in the project area, with four significant invertebrate species known from the region but unlikely to be present (see section 4.3). The status of the significant vertebrate fauna and predicted impacts of the proposed development upon them are presented in Table 5. Predicted impacts are drawn largely from personal experience with the species in urban landscapes. A range of impacts is expected:

- Negligible impacts (eight species).
- Some benefit through an increase in habitat (through revegetation of public open space and gardens) but may suffer an increase in predation from domestic pets (five species;

effect of domestic pets has been documented on the fairy-wrens at Lake Goolellal (Bamford 2008).

- Some benefit through an increase in habitat (seven species not expected to be affected by domestic pets. This includes the Quenda).
- Loss of habitat (two species; both well-represented elsewhere).

In summary, impacts upon significant species vary, with most species unaffected or potentially benefitting from the proposed development due to rehabilitation. There is, however, concern due to the impact of domestic pets, and two species (the Rainbow Bee-eater(CS1) and Black-faced Woodswallow (CS3)) will lose habitat. This loss is not expected to have a significanty impact on these species as both are widespread and there is suitable habitat nearby.

Table 5. Conservation significant vertebrate fauna that may occur in the project area; status and predicted impacts of the proposed development.

Species	Status in project area	predicted impacts
CS1		
Australasian Bittern	Possible very infrequent visitor	Negligible
Eastern Great Egret	Occasional visitor in small numbers	Negligible
Peregrine Falcon	Regular flyover	Negligible
Carnaby's Black-Cockatoo	Regular flyover	Negligible; possibility of creation of foraging habitat
Rainbow Bee-eater	Regular breeding visitor	Loss of nesting habitat but this is not limited in area
CS2		
Little Bittern	Present in general area and probably in Bulrush of adjacent Regional Park	Negligible
Quenda	Not present but potential to colonize	Improved connectivity through rehabilitation, but potential increase in predation
Rakali	Present in waterways	Negligible; they appear tolerant of urbanisation around Lake Goollelal
CS3		
Brown Goshawk	Resident or regular visitor	Negligible
Collared Sparrowhawk	Resident or regular visitor	Negligible
Dusky Moorhen	Infrequent visitor	Negligible
Splendid Fairy-wren	Probably resident or regular visitor (population around Lake Goollelal)	Increase in habitat but also potential increase in predation
Variegated Fairy-wren	Probably resident or regular visitor (population around Lake Joondalup)	Increase in habitat but also potential increase in predation
White-browed Scrubwren	Probably resident or regular visitor (population around Lake Joondalup)	Increase in habitat but also potential increase in predation
Weebill	Resident	Increase in foraging habitat
Yellow-rumped Thornbill	Probably resident or regular visitor (population around Lake Joondalup)	Increase in habitat but also potential increase in predation
Inland Thornbill	Probably resident or regular visitor (population around Lake Joondalup)	Increase in habitat but also potential increase in predation
Western Wattlebird	Regular visitor	Increase in foraging habitat
White-cheeked Honeyeater	Regular visitor	Increase in foraging habitat
New Holland Honeyeater	Regular visitor	Increase in foraging habitat
Varied Sittella	Probably resident or regular visitor (population around Lake Goollelal)	Increase in foraging habitat

Black-faced Woodswallow	Occasional visitor	Decline in open grassland habitat

5.3 Ecological Processes

Many of the potential impacts of proposed developments upon fauna can be related to ecological processes, and this is recognised under the EPBC Act, in which threatening processes are listed, and in the literature (see Appendix 1). A number of ecological processes can be related to the impacts upon fauna of the project, and these are discussed below. In general, impacts associated with ecological processes are likely to be low, with main impacts related to:

- Increase in abundance of introduced predators;
- Hydrological changes;
- Effects of light; and
- Increase in available habitat

These and other threatening processes are discussed below.

5.3.1 Initial and ongoing mortality

Increased mortality is inevitable during clearing operations and from ongoing activities, such as roadkill due to animals being struck by vehicles. The area to be developed is mostly poor quality habitat so direct mortality of fauna during clearing is expected to be low, but clearing during late spring could destroy active nests of the CS1 Rainbow Bee-eater. Roadkill during and after construction may adversely affect populations of species such as the Bobtail and Gould's goanna, which are probably small and therefore vulnerable to the loss of even a few animals.

5.3.2 Changes in amount of habitat affecting population survival

The proposed project is likely to result in an increase rather than a decrease of habitat due to revegetation of public open space and even development of gardens and verge plantings. This should benefit a number of bird and possibly mammal species. At Lake Goollelal, the Splendid Fairy-wren recolonised the area in about 2008, with the birds occupying shrubs planted as part of a revegetation programme in the 1990s (M. Bamford pers. obs.). Carnaby's Black-Cockatoos now forage in garden trees in suburbs established near Lake Goollelal in the early 1990s, while Weebills and Varied Sittellas have spread into the suburb from the Regional Park (M. Bamford pers. obs.). Swales designed to treat stormwater and prevent it from directly entering the Regional Park may provide seasonal open water that is currently a habitat not available in the area.

There will be a decline in grassland habitat used by species such as the Black-faced Woodswallow, Rainbow Bee-eater and Nankeen Kestrel, and local declines of these species were observed around Lake Goollelal following urban development in the late 1980s (M. Bamford pers. obs.). However, it is not anticipated that these local declines will affect the status of these species in the area, as there will remain extensive grasslands in Yellagonga Regional Park.

5.3.3 Changes in distribution of habitat affecting population movements and gene flow

The proposed development is situated adjacent to Yellagonga Regional Park, recognised as regionally significant fauna corridor. The project area to some extent supplements this role of

the Regional Park by increasing its width, but the habitat is generally poor. Rehabilitation of the public open space on the Regional Park side of the project area may have the effect of enhancing the linkage function of the Regional Park. Even gardens and verge plantings may have this effect, so the outcome of the proposed development may be enhanced linkage function. However, the development may introduce barriers to the movement of wildlife to and from the lake due to the construction of roads and fences. This may be a particular concern for frog species such as the Pobblebonk and Moaning Frogs, as these species effectively migrate between upland habitats where they spend most of their lives, and wetlands where they breed. There are anecdotal reports from residents of Kingsley that these species were initially common but declined as house and fences were established, with accounts of "large numbers" of frogs trapped against fences.

5.3.4 Species interactions, including predators and other feral species

Introduced species, including the Feral Cat, Fox and Rabbit, are present in the area and are probably having adverse impacts upon some native species. The cat population in particular may increase with the introduction of domestic cats into homes established in the area. The local extinction of fairy-wrens at Lake Goollelal correlated with the arrival of domestic cats in the area (Bamford 2008).

5.3.5 Hydroecology

The project area is adjacent to wetlands of Yellagonga Regional Park and these may be vulnerable to hydrological changes from increased runoff and reduced fringing vegetation. The proposed development has a drainage plan to manage stormwater via infiltration through swale wetlands, thus preventing major flood events that can carry sediment and chemicals from the roads into the main wetland. Such swales to manage stormwater have been created around Lake Goollelal. With this management, impacts associated with altered hydrology should be minimal.

5.3.6 Fire

The Bulrush areas are very prone to fire and regenerate rapidly, but the riparian woodland of Flooded Gums and Freshwater Paperbark is sensitive to fire, with bulrush suppressing trees if fires are too frequent. Development of a residential area adjacent to the Regional Park may increase the likelihood of fires being started, either accidentally or deliberately. A recent (December 2009) fire at Lake Goollelal started alongside a newly-established dual-use pathway that gave people access to riparian woodland at the lake.

5.3.7 Light, noise and disturbance

Light, noise and disturbance already occur around Yellagonga Regional Park and the project area, but the proposed development will reduce the distance between these and the Park. Rich and Longcore (2006) review the effects of lighting on biodiversity and include accounts of declines of insect populations in urban woodlands due to the mortality of adults at street lights. It is not known if such an effect is a concern at Yellagonga Regional Park. One effect of lights, however, is that non-biting midges are attracted into the suburbs, sometimes resulting in spraying programmes in the wetlands. Advice from the City of Joondalup and the DEC is that such spraying is benign if carried out correctly, but these agencies can also advise on how to minimise midge "problems". These include reducing nutrient-rich runoff into the lake, screen planting and minimising outside lighting.

The effect of noise is not likely to change due to the proposed development, as the location is already noisy with major roads nearby, but disturbance may increase with increased recreational use of the adjacent Regional Park by people.

5.4 Patterns of Biodiversity

The project area is generally of low value for biodiversity, with higher biodiversity values in the adjacent Regional Park. Even in this area the vertebrate fauna is depauperate, but it is significant because of the very low fauna values of the surrounding suburbs. Adverse impacts upon the biodiversity of the Regional Park are anticipated to be low, but some management needs to be considered (see below). There are also ways in which the proposed development could enhance the biodiversity of the Regional Park through the creation of additional fauna habitat.

6 CONCLUSIONS: FAUNA VALUES, IMPACTS AND MANAGEMENT

Sections 4 and 5 present information on the fauna assemblage of the project area (and the adjacent Regional Park) and how this assemblage may be affected by the proposed development. The identification of values and impacts provides guidance for management. Fauna values, impacts and recommendations for management are summarised below. Note that while it is the project area where development will occur, the juxtaposition with the Regional Park means that values, impacts and recommendations need to consider both the project area and the Regional Park.

6.1 Values for fauna

The fauna assemblage is poor because of the degraded nature of the site and degraded nature of adjacent Regional Park, but is still significant in the urban setting. Key values are:

- An incomplete but still substantial assemblage of vertebrate fauna compared with surrounding suburbs. For example, over a third of the reptiles present on the northern outskirts of Perth may occur within the project area and adjacent Regional Park, and almost half the bird species of the northern outskirts of Perth may be present at least occasionally. The population of Western Grey Kangaroos is valued by local residents. Despite the presence of wetlands, waterbirds are poorly represented beaue the wetlands are almost entirely covered with Bulrush, there being almost no open water.
- The fauna assemblage includes a few species of listed conservation significance, such as the Rakali or Water-rat, Carnaby's Black-Cockatoo and Rainbow Bee-eater.
- The fauna assemblage includes a number of species that are at least locally significant, such as some reptiles, mammals such as the Brush-tailed Possum and a suite of birds that has declined in urban areas (thornbills, fairy-wrens).
- Several species of high conservation significance could be present, but probably only as infrequent visitors (eg. Australasian and Little Bitterns may be present in the Bulrush areas of the regional park).
- The regional park is the major north-south corridor for wildlife movements through the local suburban area. This is probably very important for some birds and mammals. Most

of this function probably on the western side of the Regional Park where there is remnant (albiet degradede) upland woodland.
- While the vegetation in both the project area and adjacent Regional Park is degraded, it does provide habitat, and the extensive Bulrush areas probably act as a biological filter for water entering the Regional Park from nearby suburbs and light industrial areas.

6.2 Impacts upon fauna

There could be both positive and negative impacts upon fauna from the propsoed development.

Impacts: negative

- Loss of even upland habitats in the project area that currently support a few species, including breeding Rainbow Bee-eaters. However, the significance of this impact is thought to be low as there is extensive similar habitat within the Regional Park.
- Some loss of fringing Bulrush areas that provide habitat and may filter water entering the Regional Park. However, Bulrush is very extensive and there is no recent evidence of species of high conservation significance (bitterns) being present in ther area.
- Increased predation presure on reptiles and small birds, and possibly also mammals, from domestic cats. This may be a serious concern as local extinctions from such predation have been documented.
- Increased mortality of some reptiles due to roadkill. This could threaten the persistence of small populations.
- Increased disturbance of wildlife and potential for fires due to increased levels of human activity in the Regional Park.
- Disruption of fauna movement such as frogs travelling to and from the Regional Park, due to installation of roads and fences.
- Increased lighting close to the Regional Park may increase mortality of insects. Location of homes close to the Regional Park may result in an increase in demand for midge control by spraying in the Regional Park.
- Hydrological changes such as increased runoff into the Regional Park.

Impacts: positive

- Rehabilitation in public open space, development of gardens and verge plantings have the potential to increase habitat available for a range of bird and possibly mammal species.
- The increase in fauna habitats from rehabilitation and other plantings may improve the linkage function of the Regional Park. This effect likely to be especially important for birds that have declined in the urban area, and has already been documetned for the Splendid Fairy-wren at nearby Lake Goollelal.
- Swales in public open space may provide seasonal open water which is currently a habitat not available in the adjacent Regional Park.

6.3 Recommendations

A number of recommendations can be made to enhance the positive and manage the negative impacts. For example:

- Avoid clearing in grassland during the spring breeding season of the Rainbow Bee-eater.
- Encourage responsible pet ownership; particularly with respect to cats.
- Keep road speeds down to minimise roadkill.
- Liaise with the City of Jondalup and the DEC over the management of non-biting midges in the area.
- Encourage use of native plants in gardens and in verge plantings to enhance wildlife habitat.
- Ensure that swales designed for stormwater management are effective and provide habitat through plantings and, if possible, the creation of seasonal open water.
- Provide information to residents on living close to a Regional Park. This could include providing them with information on the impact of fences on tortoises and frogs, the impact of domestic cats on wildlife, awareness of snakes, the risk of bushfire and the value of native plants for wildlife.

7 REFERENCES

Aplin, K.P. and Smith, L.A. (2001). Checklist of the frogs and reptiles of Western Australia. Rec. WA Museum Suppl. No. 63: 51-74.

Bamford, M.J. (2008). Local Extinction of Fairy-wrens due to Cat Predation? Amytornis 1(1): 25-26.

Barrett, G., Silcocks, A., Barry, S., Cunningham, R. and Poulter, R. (2003). The New Atlas of Australian Birds. Royal Australasian Ornithologists Union, Melbourne.

Blakers, M., Davies, S.J.J.F. and Reilly, P.N. (1984). The Atlas of Australian Birds. Royal Australasian Ornithologists Union. Melbourne University Press.

Burbidge, A.A. and McKenzie, N.L. (1989). Patterns in the Modern Decline of Western Australia's Vertebrate Fauna; Causes and Conservation Implications. Biol. Cons. 50: 143-198.

Christidis, L. and Boles, W.E. (2008). Systematics and Taxonomy of Australian Birds. CSIRO Publishing, Collingwood.

Clevenger, A. P. and Waltho, N. (2000). Factors Influencing the Effectiveness of Wildlife Underpasses in Banff National Park, Alberta, Canada. *Conservation Biology* **14**: 1-11

Cogger, H.G.,Cameron, E.E., Sadlier, R.A. and Eggler, P. (1993). The Action Plan for Australian Reptiles. Environment Australia, Canberra

Department of Environmental Protection (2000). Bush Forever Volume 2. Government of Western Australia, Perth.

Dufty, A.C. (1989). Some Population characteristics of *Perameles gunnii* in Victoria. Wildlife Research: **18** (3) 355 – 365.

Duncan, A., Baker, G.B. and Montgomery, N. (1999). The Action Plan for Australian Bats. Environment Australia, Canberra.

Environmental Protection Authority. (2002). Terrestrial Biological Surveys as an Element of Biodiversity Protection. Position Statement No. 3. Environmental Protection Authority, Perth, Western Australia.

Environmental Protection Authority. (2004). Guidance for the assessment of environmental factors: Terrestrial fauna surveys for environmental impact assessment in Western Australia. No. 56. Environmental Protection Authority, Perth, Western Australia.

Garnett, S.T. and Crowley, G.M. (2000). The Action Plan for Australian Birds 2000. Environment Australia, Canberra.

How, R.A., Cooper, N.K. and Bannister, J.L. (2001). Checklist of the mammals of Western Australia. Rec. WA Museum Suppl. No. 63: 91-98.

Jackson, S. D. and Griffin, C. R. (2000). A Strategy for Mitigating Highway Impacts on Wildlife. Pp. 143 – 159, In Messmer, T. A and B. West, (eds) Wildlife and Highways: Seeking Solutions to an Ecological and Socio – economic Dilemma. The Wildlife Society.

Jones, M.E. (2000). Road upgrade, road mortality and remedial measures: impacts on a population of eastern quolls and Tasmanian devils. *Wildlife Research* **27**: 289 – 296.

Lee, A.K. (1995). The Action Plan for Australian Rodents. Environment Australia, Canberra.

Mace, G. and Stuart, S. (1994). Draft IUCN Red List Categories, Version 2.2. Species; Newsletter of the Species Survival Commission. IUCN - The World Conservation Union. No. 21-22: 13-24.

Maxwell, S., Burbidge, A.A. and Morris, K. (1996). Action Plan for Australian Marsupials and Monotremes. Environment Australia, Canberra.

Rich, C. and Longcore, T. (2006). *Ecological Consequences of Artificial Night Lighting*. Island Press.

Scheick, B.K. and Jones, M.D. (1999). Locating Wildlife Underpasses Prior To The Expansion Of Highway 64, In North Carolina. In Proceedings of the International Conference on Wildlife 1999.

8 APPENDIX 1. IMPACT ASSESSMENT

8.1 Background to Impact Assessment

Development of the project area may adversely impact upon fauna in a number of ways and some impacts upon fauna are unavoidable. Of concern are long-term, deleterious impacts upon biodiversity. These can be considered under the following categories:

- "Habitats" – "Habitats", which are really associations of vegetation type, soil and landform, can be important for biodiversity if they are rare and support unusual species assemblages, or if they support naturally high levels of biodiversity. Impacts may therefore be significant if the impacted "habitat" is rare or biodiverse. Thus, "habitats" considers both the diversity of the environments in a project area and the pasterns of distribution of fauna across those environments.
- Fauna of Conservation Significance - Impacts may be significant if species of conservation importance are affected. The assessment of conservation significance is discussed below.
- Ecological Processes - Ecological processes are complex and can include hydrology, fire, predator/prey relationships and spatial distribution of a population. Impacts upon ecological processes may be significant if large numbers of species or large proportions of populations are affected. Ecological processes that may be important in the assessment of impacts are discussed below and in Appendix 2.

8.1.1 Assessment of Conservation Significance

The conservation status of fauna species is assessed under Commonwealth and State Acts such as the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) and the Western Australian *Wildlife Conservation Act 1950*. The EPBC Act also provides protection for threatened ecological communities. The significance levels for fauna used in the EPBC Act are those recommended by the International Union for the Conservation of Nature and Natural Resources (IUCN) and reviewed by Mace and Stuart (1994). The Wildlife Conservation Act uses a set of Schedules but also classifies species using some of the IUCN categories. These categories and Schedules are described in Appendix 1.

The EPBC Act also has lists of migratory species that are recognised under international treaties such as the China Australia Migratory Bird Agreement (CAMBA), the Japan Australia Migratory Bird Agreement (JAMBA), the Republic of Korea Australia Migratory Bird Agreement (ROKAMBA) and the Bonn Convention (The Convention on the Conservation of Migratory Species of Wild Animals). In addition, the federal Department of Environment, Water, Heritage and the Arts (DEWHA, formerly Environment Australia) has supported the publication of reports on the conservation status of most vertebrate fauna species e.g. reptiles (Cogger *et al.* 1993), birds (Garnett and Crowley 2000), monotremes and marsupials (Maxwell *et al.* 1996), rodents (Lee 1995) and bats (Duncan *et al.* 1999) These publications also use the IUCN categories, although those used by Cogger *et al.* (1993) differ in some respects as these reports pre-date Mace and Stuart's review (1994).

In Western Australia, the Department of Environment and Conservation (DEC) has produced a

supplementary list of Priority Fauna, being species that are not considered Threatened under the *Wildlife Conservation Act* but for which the DEC feels there is cause for concern. Some Priority species, however, are also assigned to the IUCN Conservation Dependent category. Levels of Priority are described in Appendix 1.

Fauna species included under conservation acts and/or agreements are formally protected under state or federal legislation. Species listed only as Priority by DEC, or that are included in publications such as Garnett and Crowley (2000) and Cogger *et al.* (1993), but not in State or Commonwealth Acts, are also of recognised conservation significance but are not formally protected under legislation. In addition, species that are at the limit of their distribution, those that have a very restricted range and those that occur in breeding colonies, such as some waterbirds, can be considered of conservation significance, although this level of significance has no legislative or published recognition and is based on interpretation of distribution information. The then Department of Environmental Protection (2000, now DEC) used this sort of interpretation to identify significant bird species in the Perth metropolitan area as part of Perth Bushplan (DEP, 2000).

On the basis of the above comments, three levels of conservation significance are recognised in this report:

3. ***Conservation Significance (CS) 1***: Species listed under State and/or Commonwealth Acts.
4. ***Conservation Significance (CS) 2***: Species not listed under State or Commonwealth Acts, but listed in publications on threatened fauna or as Priority species by the DEC.
5. ***Conservation Significance (CS) 3***: Species not listed under Acts or in publications, but considered of at least local significance because of their pattern of distribution. This level may have links to preserving biodiversity at the genetic level (EPA 2002). For example, if a population is isolated but a subset of a widespread (common) species, then it may not be recognised as threatened, but may have unique genetic characteristics. Species on the edge of their range, or that are sensitive to impacts such as habitat fragmentation, may also be classed as CS3.

In addition to these conservation levels, species that have been introduced (INT) are indicated.

8.1.2 Ecological Processes and Impact Assessment

Many of the potential impacts of proposed developments upon fauna can be related to ecological processes. This is recognised under the EPBC Act, in which threatening processes are listed, and in the literature (see Appendix 2). A number of ecological processes are relevant to the proposal and can be related to the potential impacts of the project upon fauna. These are discussed below.

8.1.3 Increased mortality

Direct mortality of common species during clearing is unavoidable but can be minimised. Direct mortality of rare species, and ongoing mortality such as due to roadkill, may have a significant impact. Fragmentation of habitat can severely affect wildlife and lead to mortality through collision with vehicles (Jackson and Griffen 2000; Scheik and Jones 1999; Clevenger and Waltho 2000). Dufty (1989) suggested that the greatest cause of adult mortality in populations of

Eastern Barred Bandicoots (*Peremeles gunni*) was due to collisions with vehicles. Jones (2000) documented the sudden decline in a population of Eastern Quolls (*Dasyurus viverrinus*) and Tasmanian Devils (*Sarcophilus harrisii*) directly attributed to increased road mortality following the upgrade of a local road. Direct and ongoing mortality (in particular from road collisions) may be a concern for the viability of species that occur at low population densities in areas adjacent to the Project area.

8.1.4 Loss of habitat affecting population survival

Some loss of habitat in the Project area is inevitable but can be minimised through controls during clearing. Excessive loss of habitat can reduce the size of a population to the point where it is unsustainable or more vulnerable to other impacts.

8.1.5 Loss of habitat affecting population movements and gene flow

Loss of habitat can affect population survival through fragmentation particularly if the affected habitat is linear and distinctive. This can occur in agricultural landscapes where remnant habitat is often linear, such as along roads, but also in substantially intact landscapes where there are distinctive habitats along watercourses or associated with geological features.

8.1.6 Species interactions, including predators and over-abundant native species

Introduced species, including the feral Cat, Fox and Rabbit may have adverse impacts upon native species, and the abundance of these species can alter during development projects. In particular, some mammal species are very sensitive to introduced predators and the decline of many mammals in Australia has been linked to predation by the Fox, and to a lesser extent the cat (Burbidge and McKenzie 1989). Introduced grazing species, such as the rabbit and domestic livestock, can also degrade habitats. Changes in the abundance of some native species can also be a concern, such as the increase in abundance of some birds, at the expense of others, due to the provision of watering points.

8.1.7 Hydroecology

Interruptions of hydroecological processes can have massive effects because they underpin primary production in ecosystems and there are specific, generally rare habitats that are hydrology-dependent. Development may alter both surface and sub-surface hydrology.

8.1.8 Fire

Fire is a natural feature of the environment but frequent, extensive fires may adversely impact some fauna, particularly mammals and short-range endemic species. Long-unburnt habitats are important for fauna, but regeneration after fire can also be significant for some species.

8.1.9 Light and noise

Impacts of light and noise upon fauna are difficult to predict. As such, it is best to take a precautionary approach. The death of very large numbers of insects has been reported around some remote mine sites and attracts other fauna (including introduced predators), as well as presumably reducing the populations of insects in surrounding habitats. Some studies have demonstrated a decline in the abundance of some insects due to mortality around lights, although

this is in fragmented landscapes where populations are already under stress (Rich and Longcore 2006). Light is also a concern for nestling turtles. Impacts of noise on wildlife are less certain.

8.2 Impact Assessment Methodology

An assessment of the potential impacts of the project on fauna and habitat was conducted based on the results of the field surveys, desktop surveys and the past experience of the authors. The severity of impacts was quantified on the basis of predicted population change as outlined in Table A. Population change can be the result of direct habitat loss and/or impacts upon ecological processes as discussed above.

Table A. Assessment Criteria for Impacts upon fauna

Severity of impact	Observed Impact
Minimal	No population decline
Low	Short-term population decline (recovery after end of project) within project area, no change in viability of conservation status of population
Moderate	Permanent population decline, no change in viability of conservation status of population
High	Permanent population decline resulting in change in viability or conservation status of population
Extreme	Taxon extinction

9 APPENDIX 2

Categories used in the assessment of conservation status.
IUCN categories (based on review by Mace and Stuart 1994**) as used for the Environmental Protection and Biodiversity Conservation (EPBC) Act and the WA Wildlife Conservation Act**.

Extinct. Taxa not definitely located in the wild during the past 50 years.

Extinct in the Wild. Taxa known to survive only in captivity.

Critically Endangered. Taxa facing an extremely high risk of extinction in the wild in the immediate future.

Endangered. Taxa facing a very high risk of extinction in the wild in the near future.

Vulnerable. Taxa facing a high risk of extinction in the wild in the medium-term future.

Near Threatened. Taxa that risk becoming Vulnerable in the wild.

Conservation Dependent. Taxa whose survival depends upon ongoing conservation measures. Without these measures, a conservation dependent taxon would be classed as Vulnerable or more severely threatened.

Data Deficient (Insufficiently Known). Taxa suspected of being Rare, Vulnerable or Endangered, but whose true status cannot be determined without more information.

Least Concern. Taxa that are not Threatened.

Schedules used in the WA Wildlife Conservation Act.

Schedule 1. Rare and Likely to become Extinct.

Schedule 2. Extinct.

Schedule 3. Migratory species listed under international treaties.

Schedule 4. Other Specially Protected Fauna.

WA Department of Conservation and Land Management Priority species (species not listed under the Conservation Act, but for which there is some concern).

Priority 1. Taxa with few, poorly known populations on threatened lands.

Priority 2. Taxa with few, poorly known populations on conservation lands; or taxa with several, poorly known populations not on conservation lands.

Priority 3. Taxa with several, poorly known populations, some on conservation lands.

Priority 4. Taxa in need of monitoring. Taxa which are considered to have been adequately surveyed, or for which sufficient knowledge is available, and which are considered not currently threatened or in need of special protection, but could be if present circumstances change.

Priority 5. Taxa in need of monitoring. Taxa which are not considered threatened but are subject to a specific conservation program, the cessation of which would result in the species becoming threatened within five years (IUCN Conservation Dependent).

10 APPENDIX 3. SPECIES LISTS FOR THE REGION

Freshwater fish the northern suburbs of Perth, generally west of Wanneroo Road and south of Yanchep.

Species	
Gobidae (gobies)	
Swan River Goby	*Pseudogobius olorum*
Cyprinidae (goldfish, carp and allies)	
Goldfish [int]	*Carassius auratus*
Common Carp [int]	*Cyprinus carpio*
Poeciliidae (livebearers)	
Mosquitofish	*Gambusia holbrooki*

Frogs of the northern suburbs of Perth, generally west of Wanneroo Road and south of Yanchep.

Species	
Hylidae (tree-frogs)	
Slender Tree-Frog	*Litoria adelaidensis*
Motorbike Frog	*Litoria moorei*
Myobatrachidae (ground frogs)	
Clicking Froglet	*Crinia glauerti*
Sandplain Froglet	*Crinia insignifera*
Moaning Frog	*Heleioporus eyrei*
Pobblebonk	*Limnodynastes dorsalis*
Turtle Frog	*Myobatrachus gouldii*
Guenther's Toadlet	*Pseudophryne guentheri*

Reptiles of the northern suburbs of Perth, generally west of Wanneroo Road and south of Yanchep.

Species	
Chelidae (side-necked tortoises)	
South-West Long-necked Tortoise	*Chelodina oblonga*
Gekkonidae (geckoes)	
Marbled Gecko	*Christinus marmoratus*
Clawless Gecko	*Crenadactylus ocellatus*
White-spotted Gecko	*Diplodactylus alboguttatus*
Spotted Gecko	*Diplodactylus polyophthalmus*
Spiny-tailed Gecko	*Strophurus spinigerus*
Barking Gecko	*Underwoodisaurus milii*
Pygopodidae (legless lizards)	
Javelin Legless Lizard	*Delma concinna*
Sandplain Worm Lizard	*Aprasia repens*
Fraser's Legless Lizard	*Delma fraseri*
Gray's Legless Lizard	*Delma grayii*
Burton's Legless Lizard	*Lialis burtonis*
Keeled Legless Lizard	*Pletholax gracilis*
Common Scaleyfoot	*Pygopus lepidopodus*
Agamidae (dragon lizards)	
Western Bearded Dragon	*Pogona minor*
Sandhill Dragon	*Rankinia adelaidensis*
Varanidae (monitors or goannas)	
Gould's Sand Goanna	*Varanus gouldii*
Black-tailed Tree Goanna	*Varanus tristis*
Scincidae (skink lizards)	
South-west Cool Skink	*Acritoscincus trilineatum*
Fence Skink	*Cryptoblepharus buchananii*
Limestone Ctenotus	*Ctenotus australis*
West Coast Ctenotus	*Ctenotus fallens*
Jewelled Ctenotus	*Ctenotus gemmula*
Odd-striped Ctenotus	*Ctenotus impar*
Western Slender-bluetongue	*Cyclodomorphus celatus*
King's Skink	*Egernia kingii*
Mourning Skink	*Egernia luctuosa*
Salmon-bellied Skink	*Egernia napoleonis*
Two-toed Skink	*Hemiergis quadrilineata*
Four-toed Lerista	*Lerista elegans*
Line-spotted Lerista	*Lerista lineopunctulata*
Western Worm Lerista	*Lerista praepedita*
Dwarf Skink	*Menetia greyii*
Spotted Morethia	*Morethia lineoocellata*
Dusky Morethia	*Morethia obscura*

Species	
Western Bluetongue	*Tiliqua occipitalis*
Bobtail	*Tiliqua rugosa*
Typhlopidae (blind snakes)	
Southern Blind Snake	*Ramphotyphlops australis*
Fat Blind Snake	*Ramphotyphlops pinguis*
Boidae (pythons)	
Carpet Python	*Morelia spilota imbricata*
Elapidae (front-fanged snakes)	
Half-ringed Snake	*Brachyurophis semifasciata*
Narrow Banded Snake	*Brachyurophis fasciolata*
Yellow-faced Whip-Snake	*Demansia psammophis*
Bardick	*Echiopsis curtus*
Black-naped Snake	*Neelaps bimaculatus*
Black-striped Snake	*Neelaps calonotos*
Tiger Snake	*Notechus scutatus*
Dugite	*Pseudonaja affinis*
Gould's Snake	*Parasuta gouldii*
Jan's Bandy-Bandy	*Simoselaps bertholdi*

Birds of the northern suburbs of Perth, generally west of Wanneroo Road and south of Yanchep (excluding strictly marine species). [int] indicates introduced species.

Species	
Dromaiidae (emus)	
Emu	*Dromaius novaehollandiae*
Phasianidae (pheasants and quails)	
Stubble Quail	*Coturnix pectoralis*
Anatidae (ducks, geese and swans)	
Freckled Duck	*Stictonetta naevosa*
Domestic Goose [int]	*Anser anser*
Black Swan	*Cygnus atratus*
Australian Shelduck	*Tadorna tadornoides*
Muscovy Duck [int]	*Cairina moschata*
Mallard [int]	*Anas platyrhynchos*
Muscovy/Mallard hybrid [int]	NA
Pacific Black Duck	*Anas superciliosus*
Grey Teal	*Anas gibberifrons*
Chestnut Teal	*Anas castanea*
Australasian Shoveler	*Anas rhynchotis*

Species	
Pink-eared Duck	*Malacorhynchus membranaceus*
Hardhead (White-eyed Duck)	*Aythya australis*
Australian Wood Duck	*Chenonetta jubata*
Musk Duck	*Biziura lobata*
Blue-billed Duck	*Oxyura australis*
Podicepididae (grebes)	
Great Crested Grebe	*Podiceps cristatus*
Hoary-headed Grebe	*Poliocephalus poliocephalus*
Australasian Grebe	*Tachybaptus novaehollandiae*
Columbidae (pigeons and doves)	
Rock Dove (Domestic Pigeon)	*Columba livia*
Laughing Dove	*Streptopelia senegalensis*
Spotted Dove	*Streptopelia chinensis*
Common Bronzewing	*Phaps chalcoptera*
Brush Bronzewing	*Phaps elegans*
Crested Pigeon	*Ocyphaps lophotes*
Podargidae (frogmouths)	
Tawny Frogmouth	*Podargus strigoides*
Caprimulgidae (nightjars)	
Spotted Nightjar	*Eurostopodus argus*
Aegothelidae (owlet-nightjars)	
Australian Owlet-nightjar	*Aegotheles cristatus*
Apodidae (swifts)	
Fork-tailed Swift	*Apus pacificus*
Anhingidae (darters)	
Darter	*Anhinga melanogaster*
Phalacrocoracidae (cormorants)	
Great Cormorant	*Phalacrocorax carbo*
Pied Cormorant	*Phalacrocorax varius*
Little Black Cormorant	*Phalacrocorax sulcirostris*
Little Pied Cormorant	*Phalacrocorax melanoleucos*
Pelecanoididae (pelicans)	
Australian Pelican	*Pelecanus conspicillatus*
Ardeidae (herons and egrets)	
Australasian Bittern	*Botaurus poiciloptilus*
Australian Little Bittern	*Ixobrychus dubius*
White-faced Heron	*Egretta novaehollandiae*
White-necked Heron	*Ardea pacifica*
Eastern Great Egret	*Ardea modesta (alba)*

Species	
Cattle Egret	*Ardea ibis*
Little Egret	*Egretta garzetta*
Eastern Reef Egret	*Egretta sacra*
Nankeen Night Heron	*Nycticorax caledonicus*
Threskionithidae (ibis and spoonbills)	
Glossy Ibis	*Plegadis falcinellus*
Australian White Ibis	*Threskiornis molucca*
Straw-necked Ibis	*Threskiornis spinicollis*
Yellow-billed Spoonbill	*Platalea flavipes*
Accipitridae (kites, hawks and eagles)	
Eastern Osprey	*Pandion cristatus*
Black-shouldered Kite	*Elanus axillaris*
Square-tailed Kite	*Lophoictinia isura*
Whistling Kite	*Haliastur sphenurus*
White-bellied Sea-Eagle	*Haliaeetus leucogaster*
Spotted Harrier	*Circus assimilis*
Swamp Harrier	*Circus approximans*
Brown Goshawk	*Accipiter fasciatus*
Collared Sparrowhawk	*Accipiter cirrhocephalus*
Wedge-tailed Eagle	*Aquila audax*
Little Eagle	*Hieraaetus morphnoides*
Falconidae (falcons)	
Peregrine Falcon	*Falco peregrinus*
Australian Hobby	*Falco longipennis*
Brown Falcon	*Falco berigora*
Nankeen Kestrel	*Falco cenchroides*
Rallidae (crakes and rails)	
Buff-banded Rail	*Rallus philippensis*
Baillon's Crake	*Porzana pusilla*
Australian Spotted Crake	*Porzana fluminea*
Spotless Crake	*Porzana tabuensis*
Dusky Moorhen	*Gallinula tenebrosa*
Purple Swamphen	*Porphyrio porphyrio*
Eurasian Coot	*Fulica atra*
Otididae (bustards)	
Australian Bustard	*Ardeotis australis*
Haematopodidae (oystercatchers)	
Australian Pied Oystercatcher	*Haematopus longirostris*
Sooty Oystercatcher	*Haematopus fuliginosus*

Species	
Recurvirostridae (stilts and avocets)	
Black-winged Stilt	*Himantopus himantopus*
Banded Stilt	*Cladorhynchus leucocephalus*
Red-necked Avocet	*Recurvirostra novaehollandiae*
Charadriidae (lapwings and plovers)	
Grey Plover	*Pluvialis squatarola*
Lesser Sand Plover	*Charadrius mongolus*
Red-capped Plover	*Charadrius ruficapillus*
Black-fronted Dotterel	*Elseyornis melanops*
Red-kneed Dotterel	*Erythrogonys cinctus*
Hooded Plover	*Thinornis rubricollis*
Banded Lapwing	*Vanellus tricolor*
Scolopacidae (sandpipers and stints)	
Bar-tailed Godwit	*Limosa lapponica*
Marsh Sandpiper	*Tringa stagnatalis*
Common Greenshank	*Tringa nebularia*
Wood Sandpiper	*Tringa glareola*
Common Sandpiper	*Tringa hypoleucos*
Ruddy Turnstone	*Arenaria interpres*
Sanderling	*Calidris alba*
Red-necked Stint	*Calidris ruficollis*
Long-toed Stint	*Calidris subminuta*
Sharp-tailed Sandpiper	*Calidris acuminata*
Curlew Sandpiper	*Calidris ferruginea*
Turnicidae (button-quails)	
Painted Button-quail	*Turnix varia*
Laridae (gulls and terns)	
Fairy Tern	*Sternula nereis*
Caspian Tern	*Sterna caspia*
Whiskered Tern	*Chlidonias hybrida*
Crested Tern	*Sterna bergii*
Pacific Gull	*Larus pacificus*
Silver Gull	*Larus novaehollandiae*
Cacatuidae (cockatoos)	
Carnaby's Black-Cockatoo	*Calyptorhynchus latirostris*
Forest Red-tailed Black-Cockatoo	*Calyptorhynchus banksii naso*
Galah	*Cacatua roseicapilla*
Long-billed Corella[i]	*Cacatua tenuirostris*
Western Corella	*Cacatua pastinator*

Species	
Little Corella	*Cacatua sanguinea*
Sulphur-crested Cockatoo [int]	*Cacatua galarita*
Psittacidae (lorikeets and parrots)	
Rainbow Lorikeet [int]	*Trichoglossus haematodus*
Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*
Regent Parrot	*Polytelis anthopeplus*
Western Rosella	*Platycercus icterotis*
Australian Ringneck	*Barnardius zonarius*
Red-capped Parrot	*Purpureicephalus spurius*
Rock Parrot	*Neophema petrophila*
Elegant Parrot	*Neophema elegans*
Cuculidae (cuckoos)	
Fan-tailed Cuckoo	*Cacomantis flabelliformis*
Pallid Cuckoo	*Cuculus pallidus*
Horsfield's Bronze-Cuckoo	*Chrysococcyx basalis*
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*
Strigidae (hawk-owls)	
Southern Boobook	*Ninox novaeseelandiae*
Tytonidae (barn owls)	
Barn Owl	*Tyto alba*
Halcyonidae (forest kingfishers)	
Sacred Kingfisher	*Todiramphus sanctus*
Laughing Kookaburra	*Dacelo novaeguineae*
Meropidae (bee-eaters)	
Rainbow Bee-eater	*Merops ornatus*
Maluridae (fairy-wrens)	
Splendid Fairy-wren	*Malurus splendens*
Variegated Fairy-wren	*Malurus lamberti*
White-winged Fairy-wren	*Malurus leucopterus*
Southern Emu-wren	*Stipiturus malachurus*
Pardalotidae (pardalotes)	
Striated Pardalote	*Pardalotus striatus*
Spotted Pardalote	*Pardalotus punctatus*
White-browed Scrubwren	*Sericornis frontalis*
Weebill	*Smicrornis brevirostris*
Western Gerygone	*Gerygone fusca*
Inland Thornbill	*Acanthiza apicalis*
Western Thornbill	*Acanthiza inornata*
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*

Species	
Meliphagidae (honeyeaters)	
Red Wattlebird	*Anthochaera carunculata*
Western Wattlebird	*Anthochaera lunulata*
Yellow-throated Minor	*Manorina flavigula*
Singing Honeyeater	*Lichenostomus virescens*
Brown Honeyeater	*Lichmera indistincta*
White-naped honeyeater	*Melithreptus lunatus*
White-cheeked Honeyeater	*Phylidonyris nigra*
New Holland Honeyeater	*Phylidonyris novaehollandiae*
Tawny-crowned Honeyeater	*Phylidonyris melanops*
Western Spinebill	*Acanthorhynchus superciliosus*
White-fronted Chat	*Epthianura albifrons*
Petroicidae (Australian robins)	
Scarlet Robin	*Petroica multicolor*
Red-capped Robin	*Petroica goodenovii*
Hooded Robin	*Melanodryas cucullata*
White-breasted Robin	*Eopsaltria georgiana*
Acrocephalidae (reed-warblers)	
Australian Reed-Warbler	*Acrocephalus australis*
Megaluridae (grassbirds)	
Little Grassbird	*Megalurus gramineus*
Rufous Songlark	*Cincloramphus mathewsi*
Brown Songlark	*Cincloramphus cruralis*
Zosteropidae (white-eyes)	
Silvereye	*Zosterops lateralis*
Pachycephalidae (whistlers)	
Golden Whistler	*Pachycephala pectoralis*
Rufous Whistler	*Pachycephala rufiventris*
Grey Shrike-thrush	*Colluricincla harmonica*
Crested Bellbird	*Oreioca gutturalis*
Dicruridae (flycatchers)	
Magpie-lark	*Grallina cyanoleuca*
Grey Fantail	*Rhipidura fuliginosa*
Willie Wagtail	*Rhipidura leucophrys*
Neosittidae (sittella)	
Varied Sittella	*Daphoenositta chrysoptera*
Campephagidae (cuckoo-shrikes)	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*
White-winged Triller	*Lalage sueurii*

Species	
Artamidae (woodswallows)	
Black-faced Woodswallow	*Artamus cinereus*
Dusky Woodswallow	*Artamus cyanopterus*
Grey Butcherbird	*Cracticus torquatus*
Australian Magpie	*Gymnorhina tibicen*
Corvidae (ravens and crows)	
Australian Raven	*Corvus coronoides*
Motacillidae (pipits and true wagtails)	
Australian Pipit	*Anthus novaeseelandiae*
Dicaeidae (flower-peckers)	
Mistletoebird	*Dicaeum hirundinaceum*
Hirundinidae (swallows)	
White-backed Swallow	*Cheramoeca leucosternus*
Welcome Swallow	*Hirundo neoxena*
Fairy Martin	*Petrochelidon ariel*
Tree Martin	*Petrochelidon nigricans*

Mammals of the northern suburbs of Perth, generally west of Wanneroo Road and south of Yanchep (excluding strictly marine species). [int] indicates introduced species.

Species	
Tachyglossidae (echidnas)	
Echidna	*Tachyglossus aculeatus*
Dasyuridae	
Chuditch	*Dasyurus geoffroii*
White-tailed Dunnart	*Sminthopsis granulipes*
Grey-bellied Dunnart	*Sminthopsis griseoventer*
Peramelidae (bandicoots)	
Quenda or Brown Bandicoot	*Isoodon obesulus*
Phalangeridae (brushtail possums)	
Brush-tailed Possum	*Trichosurus vulpecula*
Tarsipedidae (honey possum)	
Honey Possum	*Tarsipes rostratus*
Macropodidae (kangaroos and wallabies)	
Western Grey Kangaroo	*Macropus fuliginosus*
Brush or Black-gloved Wallaby	*Macropus irma*
Mollosidae (mastiff bats)	
White-striped Bat	*Tadarida australis*
Western Freetail Bat	*Mormopterus planiceps*

Species	
Vespertilionidae (vesper bats)	
King River Eptesicus	*Vespadelus (Eptesicus) regulus*
Gould's Wattled Bat	*Chalinolobus gouldii*
Chocolate Wattled Bat	*Chalinolobus morio*
Lesser Long-eared Bat	*Nyctophilus geoffroyi*
Greater Long-eared Bat	*Nyctophilus major*
Muridae (rats and mice)	
House Mouse [int]	*Mus musculus*
Rakali or Water-rat	*Hydromys chrysogaster*
Noodji or Ashy-grey Mouse	*Pseudomys albocinereus*
Moodit or Bush-Rat	*Rattus fuscipes*
Black Rat [int]	*Rattus rattus*
Leporidae (rabbits and hares)	
Rabbit [int]	*Oryctolagus cuniculus*
Canidae (foxes and dogs)	
European Red Fox [int]	*Vulpes vulpes*
Felidae (cats)	
Feral Cat [int]	*Felis catus*

Appendix D

Wetland Management and Rehabilitation Strategy .

Structure Plan No 64

Wetland Management and Rehabilitation Strategy

Contents

Introduction

Background

The City of Wanneroo Structure Plan 64 (SP64) covers a parcel of land in the locality of Woodvale, within the south-western extent of the City's municipal boundary. In total, SP64 covers an area of approximately 25 hectares and includes 15 individual lots, inclusive of Lots 0, 800, 22, 23, 26-28, 32-34, 90, 83 and part lots 35 and 1 Wanneroo Road (**Figure 1**). The SP64 area is bounded by Wanneroo Road to the east, the Wallubuenup swamp to the west and south, and Woodvale Drive to the north.

This Wetland Management and Rehabilitation Strategy (WMRS), focuses on the Wallubuenup Swamp and its associated buffer zone within and adjacent to the boundary of SP64. Wallubuenup Swamp (referred to as 'the wetland' in this document) is classified as a Conservation Category Wetland (Unique Feature Identifier number (UFI) 8168)) and is displayed in **Figure 2**. The wetland is located to the west and south of SP64 and is part of the Yellagonga Regional Park. The Yellagonga Regional Park is a 1400ha wetland system that also includes Lake Joondalup, Beenyup swamp, Lake Goollelal and surrounding lands reserved under the Metropolitan Region Scheme for 'Parks and Recreation.'

Watsons Property Group (WPG), on behalf of the combined landowners within the SP64 area, undertook structure planning for the area now covered by SP64. One of the key aspects that required consideration during the preparation of the structure plan was the presence of the wetland that is adjacent to the SP64 area, and in some areas extends within the structure plan area.

SP64 provides for the development of a WMRS to detail the strategic measures to be undertaken to protect and enhance the wetland area.

Purpose

The WMRS lays out the framework to coordinate the rehabilitation of the wetland in association with the SP64 development. This document is designed to demonstrate the onground rehabilitation outcomes, at an appropriate strategic level, to support the SP64 development.

The WMRS is not a wetland management plan; specific management plans will be developed as a condition of subdivision in accordance with planning processes. The Strategy, rather, provides a benchmark and standards for more detailed management plans, to ensure consistency of efforts across fragmented landholdings in the development of individual Wetland Management Plans (WMP).

Approvals

As a condition of subdivision, each approval for a lot that is adjacent to Yellagonga Regional Park will require the preparation and implementation of a WMP. The WMRS will be provided to each applicant and it will be necessary for the applicant to demonstrate that the WMP prepared is consistent with the strategic requirements.

In some circumstances, it is likely that some of the larger landholdings will be subdivided/developed in a staged manner and there may be multiple subdivision applications lodged. In these cases, applicants should prepare a single WMP that spans their full landholding to provide a broader context for their individual applications (given the wider landholdings) and are also encouraged to liaise with adjoining landowners to ensure consistency across landholdings with aspects such as a dual use path and fencing alignments. Where possible, landholders should consider collaborative development of a WMP that extends across individual landholdings.

Both the City of Wanneroo (CoW) and the Department of Environment and Conservation (DEC) will be the clearing authorities for the condition requiring the production of a WMP. It is therefore recommended that applicants discuss the intended approach to address the requirements of this document with both of these stakeholders prior to commencing the preparation of a WMP and before submitting any document for review and clearance.

Existing Environment

Climate

The rainfall average for Perth from 1905-2007 is around 807mm (rainfall data from the Bureau of Meteorology Perth Regional Office). Since 1976, a nine percent reduction from the long-term average has been observed. From 2001 to 2007, average rainfall was recorded at 683mm, reflecting a further decline of 15 percent below the long-term average. A drying climate and resultant groundwater decline is a key threat for the Yellagonga wetlands (City of Wanneroo and City of Joondalup, 2009). From 1981 to 2008, mean daily evaporation ranged from 10.1mm in January to 2.1mm in July.

Regional Context

Wallubuenup Swamp forms part of Yellagonga Regional Park. The Park, made up of Lake Joondalup, Beenyup and Wallubuenup Swamps, Lake Goollelal and surrounds, provides regional importance from its natural, cultural, and recreational resources in a growing suburban area (Yellagonga Regional Park Management Plan 2003-2012). The wetlands within Yellagonga Regional Park are some of the last remaining freshwater wetland systems on the Swan Coastal Plain.

Geology, Geomorphology and Soils

The SP64 development is located on Karrakatta soils within the Spearwood Dune system. Regional Acid Sulphate Soils (ASS) mapping indicates that the western portions of the lots are within an area of high risk of ASS being found within 3 metres from the surface. However, the majority of this high-risk area is located in the portion of the study area that will be used for Public Open Space (POS); thus, it is not expected that these potential ASS will be disturbed.

Wetland soils are generally black, fine grain and peaty soils with an organic topsoil layer. These soils were inundated and saturated in some areas, with hydric soils also evident. Dry land soils are categorised as grey, medium to fine-grained sands, dry to a depth of at least 0.5 metres (Cardno, 2006).

Hydrology

Groundwater within the SP64 area flows in a westerly direction towards Wallubuenup Swamp. Within the wetland rehabilitation area, predicted Historical Maximum Groundwater levels give an estimated depth to groundwater of zero to two metres (Cardno, 2009).

Hydrological studies found that the separation distance between the surface and the Annual Average Maximum Groundwater Level across the study area is greater than 1.2m (maximum level allowed for building construction) for all but six lots proposed by SP64 (Cardno, 2009). The majority of the site has a separation distance of more than 4m. Management of maximum groundwater levels is only required for these six lots and this will be achieved by utilising sand fill.

To facilitate water sensitive urban design techniques proposed by the Local Water Management Strategy, some fill would be introduced to the area adjacent to the wetland buffer. The impact of fill on wetland function must be considered by WMP and Urban Water Management Plan developed as conditions of subdivision.

Vegetation and flora

Vegetation and flora surveys undertaken for the entire wetland, identified three plant community types present (Cardno, 2006). Communities were classed as Melaleuca-Tuart woodland, Melaleuca-Typha shrubland, and exotic grassland dominated by Typha and Kikuyu with intermittent exotic trees. Community types are displayed in **Figure 3.** No declared rare or priority flora species or threatened ecological communities were identified in the wetland. Vegetation condition mapping was also completed as part of surveys and is included in **Figure 4**.

Significant weed species, such as Kikuyu (*Pennisetum clandestinum*) and Typha (*Typha orientalis*), are present in the rehabilitation area. Both of these weed species are aggressive colonisers and require control and management over time. The control of large woody weeds within the rehabilitation area (for example exotic *Eucalyptus* species) also requires attention.

Fauna

A reconnaissance fauna survey based on assessment of potential habitat quality suggests that the range and diversity of potential fauna habitats in the study area is very low. However, the wetland area to the west of SP64 and the wider Yellagonga Regional Park does provide suitable habitat for many mammals, reptiles and bird species.

Within the study area, there is limited habitat available for native fauna. *Typha* is extensive within the wetland area and is known to provide some nesting habitat for native birds. The removal of *Typha* may require staging to prevent any impact on existing habitat values.

Ecological Linkages

The site forms part of the eastern boundary of Wallubuenup Swamp, which forms part of Yellagonga Regional Park. The Park provides an important north south link with Neerabup National Park and Yanchep National Park.

Due to the nature of the surrounding urban catchment there is limited scope within the SP64 area to contribute to any linkages from the Park to wetlands in the east, however rehabilitation of the site does enhance the ecological linkage provided in the local area.

Cultural and Social Values

Within the local community, Yellagonga Regional Park, including Wallubuenup Swamp, is viewed as a place to relax and unwind, providing important natural aesthetic in an urban environment.

There is significant Indigenous and European history centred on the wetlands of Yellagonga Regional Park. Wetlands were, and continue to be, places of important spiritual connected for Aboriginal people. Also, the area was important for European settlers for gardening and agriculture. A number of listed Aboriginal and European heritage sites are listed and known in the surrounding area (City of Wanneroo and City of Joondalup, 2009).

Past and Existing Landuses

The past and existing landuses of the SP64 development area ranged from broadscale agricultural to viticulture and poultry farming. The section of the poultry farm (Lot 801) shown in **Figure 5** that is located outside the SP64 area was previously earmarked for rehabilitation as part of this strategy. The Water Corporation have since agreed to remediate and rehabilitate this area as part of a separate offsets package (GHD 2009) associated with the installation of the

Gnangara sewer main proposed to be installed along the border of the SP64 boundary (**Figure 6).**

Potential Impacts and Threats

Previous land uses in the structure plan area and adjacent wetland area are displayed **Figure 5.**

Possible impacts and threats to the surrounding environment resulting from previous land uses to be addressed at a site specific level in each WMR Plan may include:

- High levels of nutrient runoff;
- Clearing of native fringing wetland vegetation;
- Continued presence and spread of established environmental weed species; and
- Soil contamination from agricultural and industrial runoff.

Residential development proposed by SP64 may potentially impact on the wetland, if not appropriately managed. Potential threats include weed infestation from landscaping and gardens, recreation impacts, and nutrient input due to stormwater runoff.

Key mechanisms to alleviate impact of previous land use and manage any potential impact from SP64 include:

- Local Water Management Strategy and Urban Water Management Plans to address urban water runoff and reduce nutrient input;
- Wetland Management and Rehabilitation Strategy and Wetland Management and Rehabilitation Plans to rehabilitate Wallubuenup Swamp and its buffer; and
- Structure Plan No. 64, which includes provisions to manage wetland impacts and provide information to purchasers regarding wetland protection.

Overall, it is expected that the implementation of the key mechanisms above will result in a net benefit to Wallubuenup Swamp and Yellagonga Regional Park.

Strategic Management Commitments

Detailed management commitments will be set out in WMPs as a condition of subdivision. Key guidelines and information sources to be used in the development of a WMP are set out in **Appendix 1**. The development of a WMP will require further consultation and site assessment, as guided by the strategic direction of the WMRS in accordance with key guidelines, particularly *Guidelines Checklist for Producing a Wetland Management Plan* (DEC 2008).

The following provides a strategic commitment for the rehabilitation of the subject area to support Local Structure Plan 64.

Vision

The overall vision for the WMRS, and subsequent WMPs, is to provide a greater understanding of all the impacts and threats to wetland functions, attributes and values of Wallubuenup Swamp and to provide a detailed management approach for the restoration of the wetland and buffer area. The restoration and management of the wetland and buffer will aim to improve the level of ecological function of the wetland and interface (buffer) area both within and adjacent to the management area.

Objectives

Ensure consistency in delivery of the overall wetland management and restoration outcomes across the individual landholdings as envisaged during the structure planning process for the entire wetland and wetland buffer area.

Provide a greater understanding of all functions, attributes and values of the wetland through a robust and consistent assessment process.

Provide for restoration and rehabilitation of the wetland and associated buffer to improve the level of ecological function.

Provide for an increase in bushland connectivity within the wetland and wetland buffer areas with the remainder of the Yellagonga Regional Park.

Promote recreational interaction and environmental awareness within the management area while protecting the local environment from adverse human disturbance impacts.

Provide for a decrease in all weed species within the management area to a point where they are not adversely affecting planted and established native vegetation.

Provide for consultation with the COW and the DEC in the rehabilitation of Wallubuenup Swamp adjacent to SP64.

Wetland Rehabilitation

Management Zones

The rehabilitation area will divided into two different management zones which are shown in **Figure 7**. These zones will indentify which agency will assume management of these areas once the completion criterion has been met at the end of the monitoring and maintenance period. The delineation boundary of these zones will be defined by the dual use path, with all areas to the west of the path falling under the management of the DEC and the areas to the east of the path (including the dual use path) under the CoW.

The dual use path is to be located approximately 5 metres to the east of the wetland boundary which will also delineate the wetland and dryland plant communities. The exact alignment of this path will be determined by actual flooding levels of the wetland, access to active POS areas, access to the development and passive surveillance of the path from the development. Communication between the landholder, the CoW and the DEC should be undertaken before the installation of the path to ensure these particular aspects are taken into account.

Management Strategies

The Wetland Interface and Landscape Masterplan (**Figure 6**) provides a strategic plan for the rehabilitation of Wallubuenup Swamp within and adjacent to the Woodvale Structure Plan area.

Specific management strategies, in addition to the requirements of *Guidelines Checklist for Producing a Wetland Management Plan* (DEC 2008) and the *Yellagonga Regional Park Management Plan 2003-2013*, which are to be undertaken in the development of a WMP are set out in **Table 1**.

The implementation of the WMP would be separated into three different stages:

- The first stage would be a weed control program which would be undertaken for one year before any revegetation works and then throughout the maintenance period where needed;
- The second stage would be the revegetation program which would involve the installation of seedlings, fertilizer and access control fencing in the revegetation areas (which would take place in winter to spring); and
- The third stage of the program would be a three year maintenance and monitoring program which would commence after the initial revegetation program has been completed. This program would aim to maintain the revegetation areas and report on the success of revegetation activities required for signoff under the subdivision applications.

Weed Control

Weed control within the rehabilitation areas should be dealt with in the following manner:

- Identify and map the intensity of weed species in the management areas;
- Develop a weed control program to eradicate or significantly control the presence of weed species (including woody weeds), consistent with the Yellagonga Regional Park Weed Control and Revegetation Plan;
- Spraying of weeds to be undertaken 12 months prior to planting program at times that will minimize seed set for the following seasons. Only herbicides such as Roundup Bio-active should be used in and near the wetland to reduce the impacts of herbicide on sensitive animal species such as frogs;
- Develop and implement management actions, including techniques and maintenance requirements to minimise and manage reinfestation of rehabilitated areas; and

- Targeted weed control should be undertaken prior to and after planting, as required, where weed species comprise more than 20% ground cover and should continue for the three year maintenance period.

Revegetation

Revegetation activities required to be undertaken within the rehabilitation areas both within the wetland and within the associated buffer areas should be addressed in the following ways:

- Develop and implement rehabilitation strategies to establish native plant communities that are self sustaining and that approach the density, diversity and species richness of the communities that would likely have existed before clearing for agricultural purposes;
- Rehabilitation work is to be planned and implemented by a suitably qualified and experienced rehabilitation specialist/contractor;
- Establish a mix of *Melaleuca rhaphiophylla/Eucalyptus rudis* forest community in dryland areas of the buffer;
- Establish a *Baumea articulata/Schoenoplectus validus* sedgeland community and *Melaleuca rhaphiophylla* open forest community within the wetland areas of the buffer; and
- Species used to establish the plant communities need to be consistent with the Yellagonga Regional Park Weed Control and Revegetation Plan (Regeneration Technology Pty Ltd 2002). A list of appropriate species is provided in **Appendix C.**

<u>Revegetation techniques:</u>

- Planting of tubestock should be the primary means of revegetation;
- Tubestock should preferably be sourced from the nursery of Friends of Yellagonga or alternatively any NIASA accredited nurseries;
- Rehabilitation may also use direct seeding in areas that are relatively free of weeds. Seed should preferably be collected from within the park or from the surrounding region by a suitable qualified and licensed seed collection contractor. Relevant seed germination treatment techniques such as smoking and scarification should be applied to the seed where required;
- Any mulch applied should be 'Biowise' (or approved equivalent), which is certified as being weed and pathogen (dieback) free;
- Opportunities for maintaining views across Wallubuenup Swamp should be considered in the development of the WMP; and
- The DEC should be consulted during the development of the detailed WMP.

<u>Suggested revegetation densities:</u>

To meet the rehabilitation completion criteria stated below, the following revegetation densities are suggested:

- *Melaleuca rhaphiophylla/Eucalyptus rudis* forest communities be planted to a density of 1 plant per m^2;
- *Melaleuca rhaphiophylla* open forest communities be planted to a density of 4 to 6 plant per $10m^2$ for shrub and tree species (ie *Melaleuca rhaphiophylla*) and 5 to 8 plants per m^2 for rush and sedge species; and
- *Baumea articulata/Schoenoplectus validus* sedgeland community be planted to a density of 6 to 8 plants per m^2.

Suggested plant community installation locations:

- *Melaleuca rhaphiophylla/Eucalyptus rudis* forest communities (Dryland) should be installed in dryland areas of the wetland buffer, which are not inundated with water or heavily waterlogged for any time of the year;
- *Melaleuca rhaphiophylla* open forest community (Transitional) should be installed between the wetland and dryland areas of the buffer zone. A site assessment would need to be undertaken to identify accurate community boundary locations to reduce the likelihood of installing in unsuitable areas; and
- *Baumea articulata/Schoenoplectus validus* sedgeland community (Wetland) should be only installed in areas of the wetland which are inundated with water for part or all of the year.

Contamination

Develop, and implement, a soil remediation program, to remediate (if applicable) any contaminated soils within SP64 development area in accordance with the requirements of the *Contaminated Sites Act 2003*, as part of the subdivision approval and condition clearing process.

Contours

In association with the Local Water Management Strategy and Urban Water Management Plans for SP64, provide for appropriate re-contouring of ground levels to manage altered topography in the development area. Any fill material that is brought onto site for the use in re-contouring work, must be free of pathogens (ie. Dieback), weeds and other contaminants.

Access Control

Provide for access control fencing, consistent with the CoW specification for conservation style fencing, Standard Drawing TS01-7, to act as a barrier to recreational users adversely affecting wetland rehabilitation consistent with **Figure 9** – Access Controlled Fencing Locations. Revegetation should be set back at least three metres from both sides of the dual use path to reduce maintenance from overhanging tree branches, increase fire protection mesures and increase visual surveillance of the area.

Monitoring

Develop a rehabilitation monitoring and reporting program to assess plant survival, condition and weed cover. Monitoring should occur twice per year for the entire three year monitoring period at the end of summer and in mid-winter to evaluate weed control maintenance requirements. Reporting of monitoring results is to be provided in report form to the CoW.

Timings and Priorities

Develop a schedule that outlines the proposed timing for all works associated with the implementation of WMPs. Consult with the DEC, Water Corporation and other adjacent landholders to stage revegetation and weed control works especially for the removal of *Typha*.

Performance Criteria

There are set performance criteria that will enable the evaluation of rehabilitation works that are divided up into the areas of the dryland and wetland buffers. Compliance of the criteria set down should be met following the end of the three year maintenance and monitoring period. If these criteria are not met then remedial work would be required to be undertaken till such time there is an agreement of completion from the CoW and DEC regarding their respective management zones.

The rehabilitation performance criteria are stated as follows:

Dryland revegetation areas:

- All woody weeds are to be removed from site;
- Weeds are effectively controlled with weed species comprising less than 20% of the groundcover;
- A stable *Melaleuca rhaphiophylla/Eucalyptus rudis* forest community has been established with the following characteristics:
  - All species used in the rehabilitation works (listed in **Appendix C**) are represented at the site; and
  - Plants are established at a rate of 0.75 per m^2 and have a diversity of at least 4 species per 10 m^2 over at least 70% of the area planted.

Wetland revegetation areas:

- Weeds are effectively controlled with weed species comprising less than 20% of the groundcover;
- A stable *Baumea articulata/Schoenoplectus validus* sedgeland community has been established with the following characteristics:
  - Both species used in the rehabilitation works (listed in **Appendix C**) are represented at the site;
  - Plants are established to an average projective foliage cover of 75% and/or at a minimum rate of 6 plants per m^2 and both species are present over at least 70% of the area planted;
- A stable *Melaleuca rhaphiophylla* open forest community has been established with the following characteristics:
  - All species used in the rehabilitation works (listed in **Appendix C**) are represented at the site;
  - Rush/sedge species are established with an average projective foliage cover of 50% and/or at a rate of 5 plants per m^2 and have a diversity of at least 4 species per 10 m^2 over at least 70% of the area planted;
  - *Melaleuca rhaphiophylla* plants are established at a rate of 4 per 10 m^2 over at least 70% of the area planted;

If for any reason that the rehabilitation performance completion criteria are not met for one or more areas, then the rehabilitation program should be to the satisfaction of the CoW and the DEC.

Roles and Responsibilities

The overall responsibility for the production of the WMP, implementing proposed works, and the subsequent three-year maintenance and monitoring period (of the wetland and associated buffer areas) will ultimately lie with individual landholders. Specific roles for individual contractors, supervisors, superintendents and the like should be provided within the WMP.

Recreational Activation

Management Strategies

The Wetland Interface and Landscape Masterplan (**Figure 6**), provides a strategic plan for recreation adjacent to Wallubuenup Swamp. The provision of recreational facilities shall be in accordance with the Masterplan (**Figure 6**).

Specific strategies to provide and manage recreation to be undertaken in the development of the WMP are set out in **Table 1**. Plates illustrating the type of recreational facilities expected within the area are set out in **Appendix 2**.

Table 1: Key strategies to activate wetland buffer for recreational use.

Fencing	Install conservation style fencing in accordance with CoW Standard Drawing TS01-7 to restrict access in accordance with locations depicted on **Figure 9.**
Dual Use Path	Install dual use paths through the rehabilitation area, as guided by the locations identified on **Figure 6** and the Structure Plan. Where possible the path should be located five metres from the mapped wetland boundary, varied as required by the Structure plan to achieve passive surveillance and integrate with active open space areas.
	Ensure all constructed access paths are consistent with the existing paths in the Yellagonga Regional Park***** and Australian Standards, in particular: • Dual use paths – Austroads Part 14 (bicycles), AS 1742, AS2809.3, AS2156.1, and AS2156.2; and • Wetland boardwalks – AS1170.1 and AS2156.2.
Active areas	Provide two active recreational areas depicted by **Figure 6 and 9**, to be a minimum distance of 20m from the mapped wetland boundary, one of which to be a minimum size of 25m by 50m.
Timing and priority	Provide a detailed schedule for proposed works associated with recreational infrastructure, and how works shall be integrated with the wetland rehabilitation and management.

*****: - The dual use paths that are to be installed within the Yellagonga Regional Park are to be asphalt sealed (30mm compacted), 2.4 metres wide and coloured red using a crushed granite aggregate with 2% red oxide intrinsic colouring. There is to be a 3 metre wide, 75mm crushed limestone base providing two 300mm limestone shoulders on each side of the asphalt path. The subgrade is to be boxed out to a depth of 200mm.

Roles and Responsibilities

The management responsibilities for the recreational use of the areas adjacent to the wetland area and within the buffer will lie with the landholder/developer during the rehabilitation, maintenance and monitoring period. The WMP should outline specific roles and responsibilities for individual contractors, supervisors, superintendent and the like.

Recreational and revegetation areas shall revert to the management of the authority in which the reserve is vested after the three year maintenance and monitoring period. Modified management zones, as recommended by **Figure 7**, will be negotiated and coordinated by the DEC and CoW at that time

Wetland Management

Management Strategies

Ongoing management of Wallubuenup Swamp and its buffer is essential to achieve an environmental benefit and secure offset proposals.

Key management strategies, in addition to the requirements of *Guidelines Checklist for Producing a Wetland Management Plan* (DEC 2008), to be undertaken in the development of the WMP are set out in **Table 2**.

Table 2: Specific strategies for monitoring and maintenance.

Monitoring	Monitoring requirements are stated above in the Wetland Rehabilitation section.
Maintenance	Provide details for a three-year period of maintenance following the initial revegetation and rehabilitation works proposed. This shall include the maintenance of all works in the rehabilitation areas, including additional weed control, replacement planting, fire management, and infrastructure.
	Develop a schedule for the works associated with the monitoring and maintenance program for the management areas.
Timing and priority	Provide a detailed schedule for maintenance works for within the three year maintenance period, and an annual schedule of works for ongoing maintenance for the time thereafter.

Roles and Responsibilities

The short-term management responsibility for the wetland and buffer areas will lie with the individual landholders within SP64. Implementation roles for individual contractors, supervisors, superintendents and the like should be provided within the WMP.

The location of the dual use path is recommended to define the future management zones, with all areas located to the west to be vested with the DEC and all areas to the east (including the dual use path) with the CoW (**Figure 7**). Upon meeting the completion criteria following the rehabilitation program and three year monitoring and maintenance period, consultation with the CoW and the DEC would determine the manner in which this management handover should occur.

Wetland Offsets Package

As part of the structure planning process, a wetland management package was formulated as an "offset" for the rationalisation of the wetland buffer distance. The overall principle of the package is that works to be undertaken within and adjacent to the structure plan area would improve the ecological values of the wetland. The package would create a better environmental outcome than simply providing a generic 50-metre separation distance from the existing Conservation Category wetland boundary. **Table 3** details the areas of wetland and wetland buffers that will be revegetated, which is illustrated in **Figure 6, 8 and 9**.

Each WMP must address the area outside the SP64 area (and individual lot areas) that are part of the overall offset package and comply with all relevant commitments made in the offsets package as described within **Table 3** as well as all other requirements/commitments contained within this strategy. Each WMP shall provide a detailed schedule for the timing of the offsets works, with rehabilitation works undertaken as early as possible in the development process.

Securing Offsets Works

Given that works will be undertaken as part of a subdivision approval process, it is envisaged that the preparation of the WMP and the implementation of associated works will be conditional on the subdivision approval. Each WMP should provide details of the works program in relation to the expected issue of individual lot titles, and outline how works undertaken after the issue of title would be secured (for example bonded with the CoW).

Each WMP shall provide details of how the full suite of offset works, particularly those outside lot boundaries, will be secured.

Table 3: Offset details to support rationalisation of wetland buffer width.

Direct Offsets	Rehabilitate the wetland and associated wetland buffer both within and adjacent to the SP64 area, up to the most westerly point of either the structure plan boundary plus a 20 metre wetland rehabilitation strip or the Conservation Category wetland boundary plus a 20 metre wetland rehabilitation strip.	
	Undertake a weed control program to address weed infestation both within and adjacent to the wetland and buffer area.	
	Install access control fencing around the rehabilitation areas in the wetland and wetland buffer.	
Indirect Offsets	Promote community awareness and provide an education program for the wetland values and restoration process.	
	Install interpretive signage to contribute to education and awareness of the wetland in consultation with all other landowners and DEC.	
	Encourage involvement and support from local community groups in the restoration programs, including facilitated establishment of a "Friends of" group for the Wallubuenup Swamp or promoted participation in the Friends of Yellagonga group to provide additional maintenance of rehabilitation works.	
	Undertake a three year monitoring and maintenance program for the wetland and wetland buffer rehabilitation areas.	
Offset Area	Area of passive POS (revegetation areas to the east of the dual use path) adjacent to the wetland to be rehabilitated.	2.24 ha
	Area of wetland to be directly impacted by development.	0 ha
	Area of wetland vegetation cleared through future development.	0 ha
	Area of wetland outside LSP to be rehabilitated (proposed 20 metre strip).	3.70 ha
	Area of wetland buffer outside LSP area to be rehabilitated.	1.68 ha
	Total area of wetland buffer to be rehabilitated.	5.82 ha
	Total area inside the wetland to be rehabilitated	4.14 ha

References

Cardno 2006. *Wetland Boundary Review and Management Category Re-evaluation – Wetland 8168 Woodvale.* Prepared for Watson Property Group Northern Aspects Ltd.

Cardno 2009. *Woodvale LSP 64 – Local Water Management Strategy*. Prepared for Watson Property Group Northern Aspects Ltd.

City of Wanneroo and City of Joondalup 2009. *Yellagonga Integrated Catchment Management Plan – Part 1 Technical Report*. Western Australia.

Department of Conservation and Land Management. 2003. *Yellagonga Regional Park Management Plan 2003-2013*, Cities of Joondalup and Wanneroo, the Conservation Commission of Western Australia and the Department of Conservation and Land Management, Perth Western Australia.

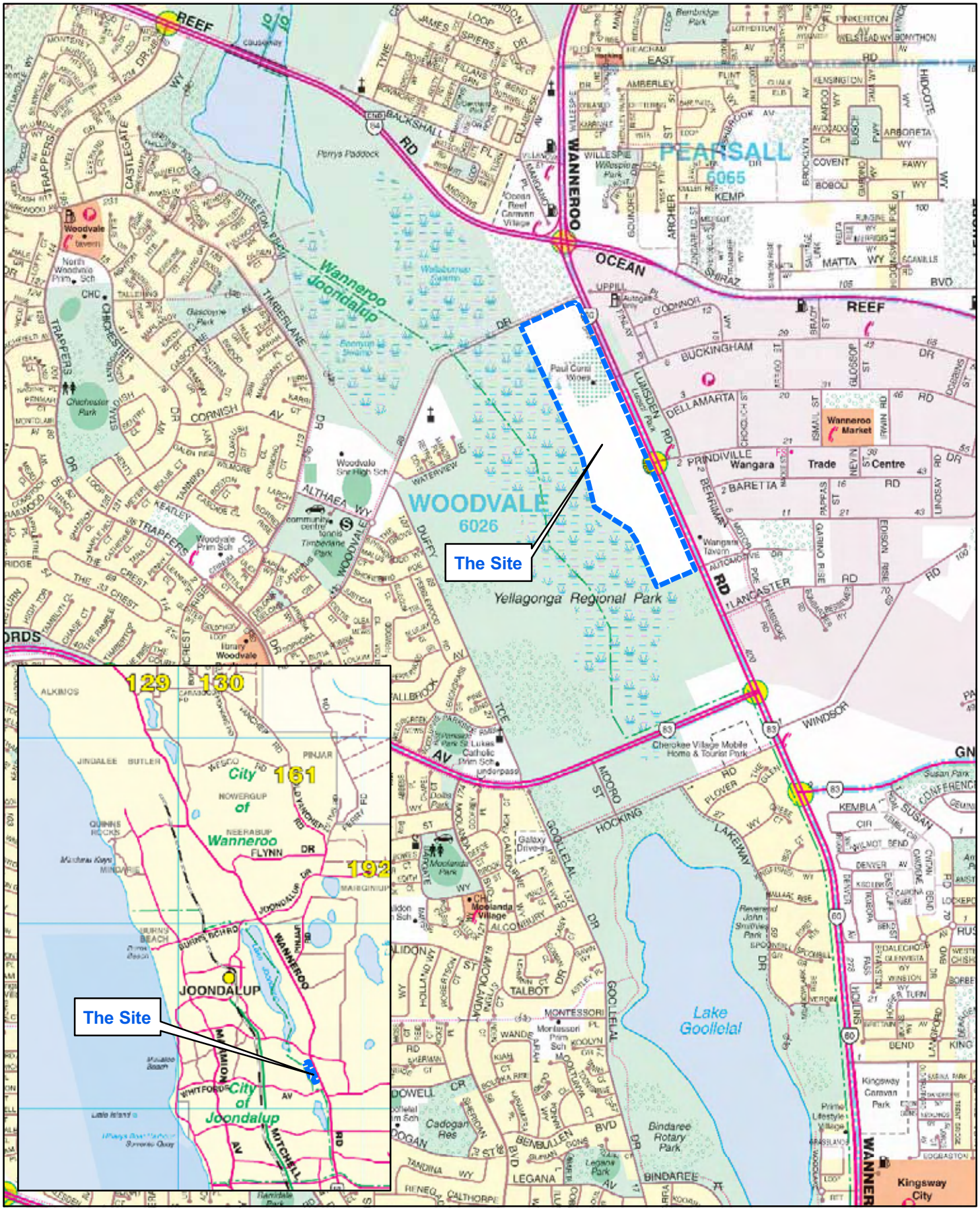
Department of Environment and Conservation. 2008. *Guidelines Checklist for Producing a Wetland Management Plan*. Perth, Australia.

GHD 2009. *Rehabilitation Management Plan for the Gnangara Sewer Main.* Prepared for Water Coporation

Local Structure Plan No. 64 – Part 2 Explanatory Report.

Regeneration Technology Pty Ltd 2002. Yellagonga Regional Park – Weed Control & Revegetation Management Plan. Prepared for Department of Conservation and Land Management, Perth Western Australia.

Figures



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD	DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: 1:20,000

0 200 400 800 1,200 1,600 2,000 Metres

PROJECT **Woodvale - Wetlands Revegetation Management Plan**

DRAWING TITLE **FIGURE 1 : Locality Plan**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V7016**

Original **A4**

Drawing Number **SK01**

Revision

Designed MF

Checked

Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 26/02/09

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: 1:3,500

0 50 100 200 300 400 500 Metres

PROJECT Woodvale Wetland Revegetation Management Plan

DRAWING TITLE FIGURE 2: Management & Wetland Boundaries

PRINCIPAL Watson Property Group Northern Aspect Ltd

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number V7016

Original A3

Drawing Number SK02

Revision

Designed MF

Checked

Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 26/02/09

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:3,500**

0 50 100 200 300 400 500 Metres

PROJECT **Woodvale Wetland Revegetation Management Plan**

DRAWING TITLE **FIGURE 3: Plant Communities**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V7016**

Original **A3**

Drawing Number **SK03**

Revision

Designed MF

Checked

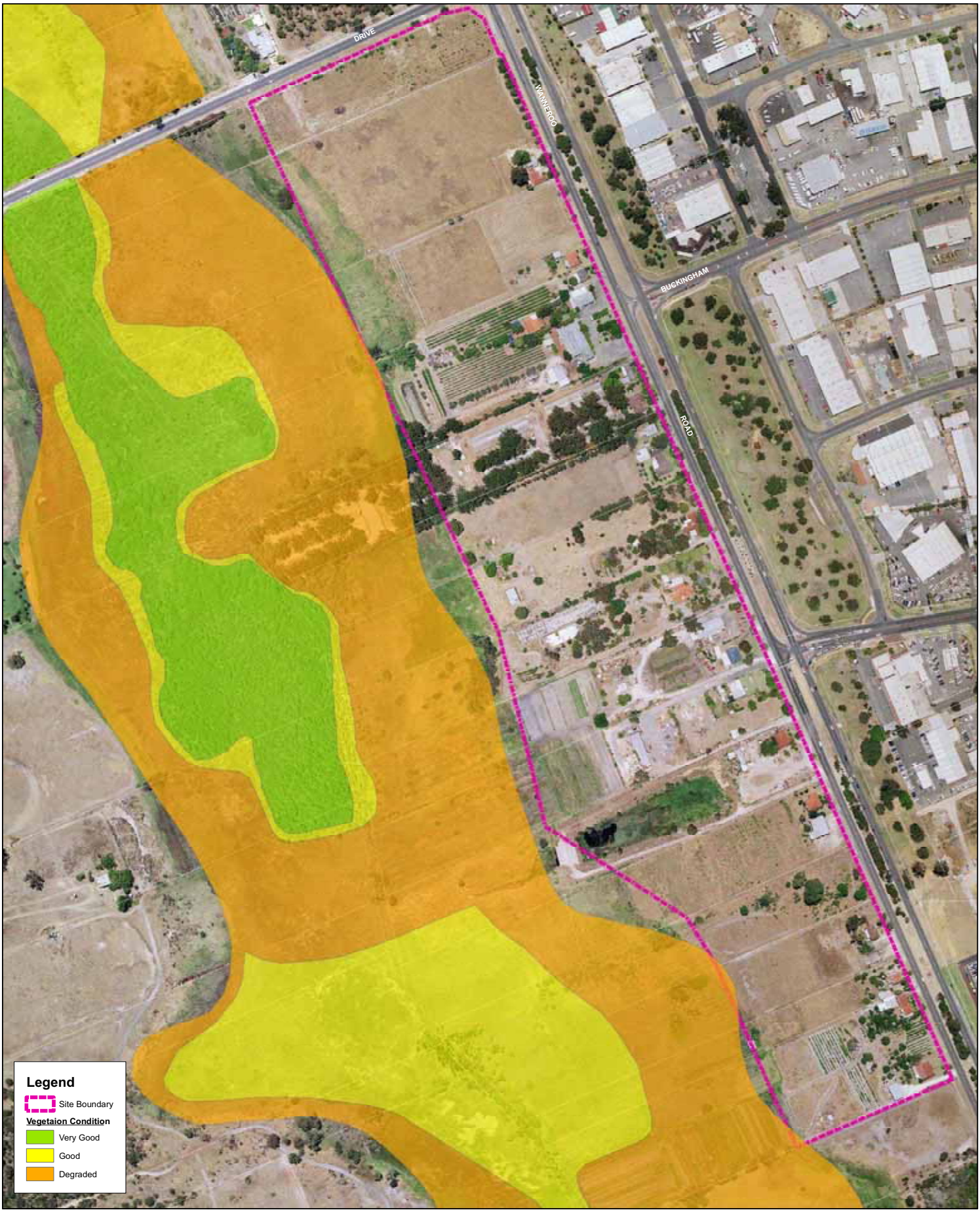
Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 26/02/09



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: 1:3,500

0 50 100 200 300 400 500 Metres

PROJECT **Woodvale Wetland Revegetation Management Plan**

DRAWING TITLE **FIGURE 4: Vegetation Condition**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V7016**

Original **A3**

Drawing Number **SK04**

Revision

Designed MF

Checked

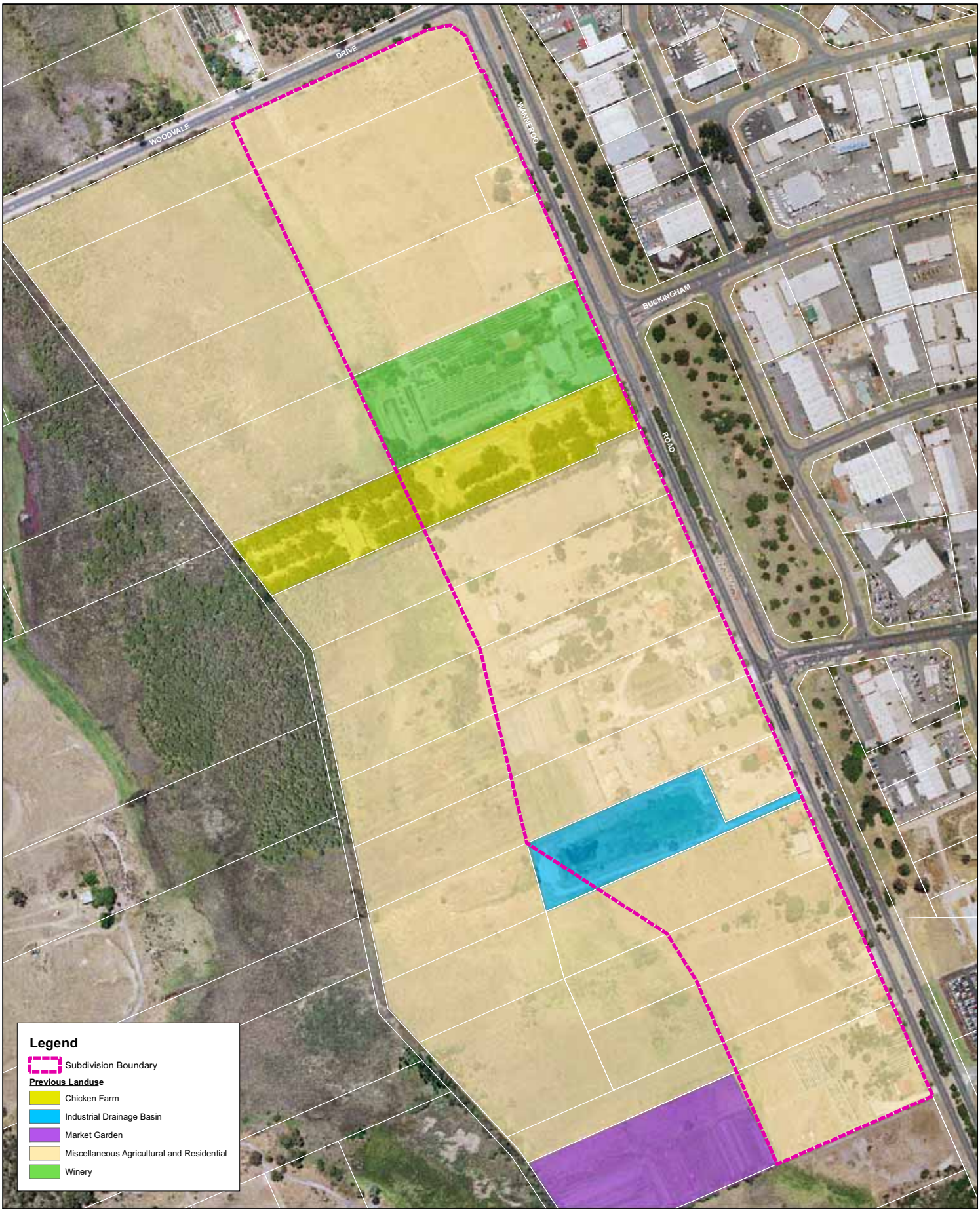
Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 17/04/09



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:3,500**

0 50 100 200 300 400 500 Metres

PROJECT **Woodvale Wetland Revegetation Management Plan**

DRAWING TITLE **FIGURE 5: Previous Landuse**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V7016**

Original **A3**

Drawing Number **SK05**

Revision

Designed MF

Checked

Drawn MGW

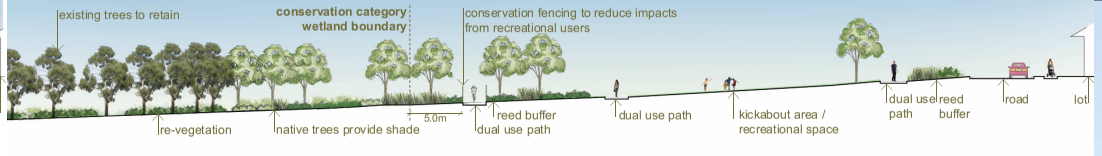
Approved

Local Authority City of Joondalup

Sheet 1 of 1

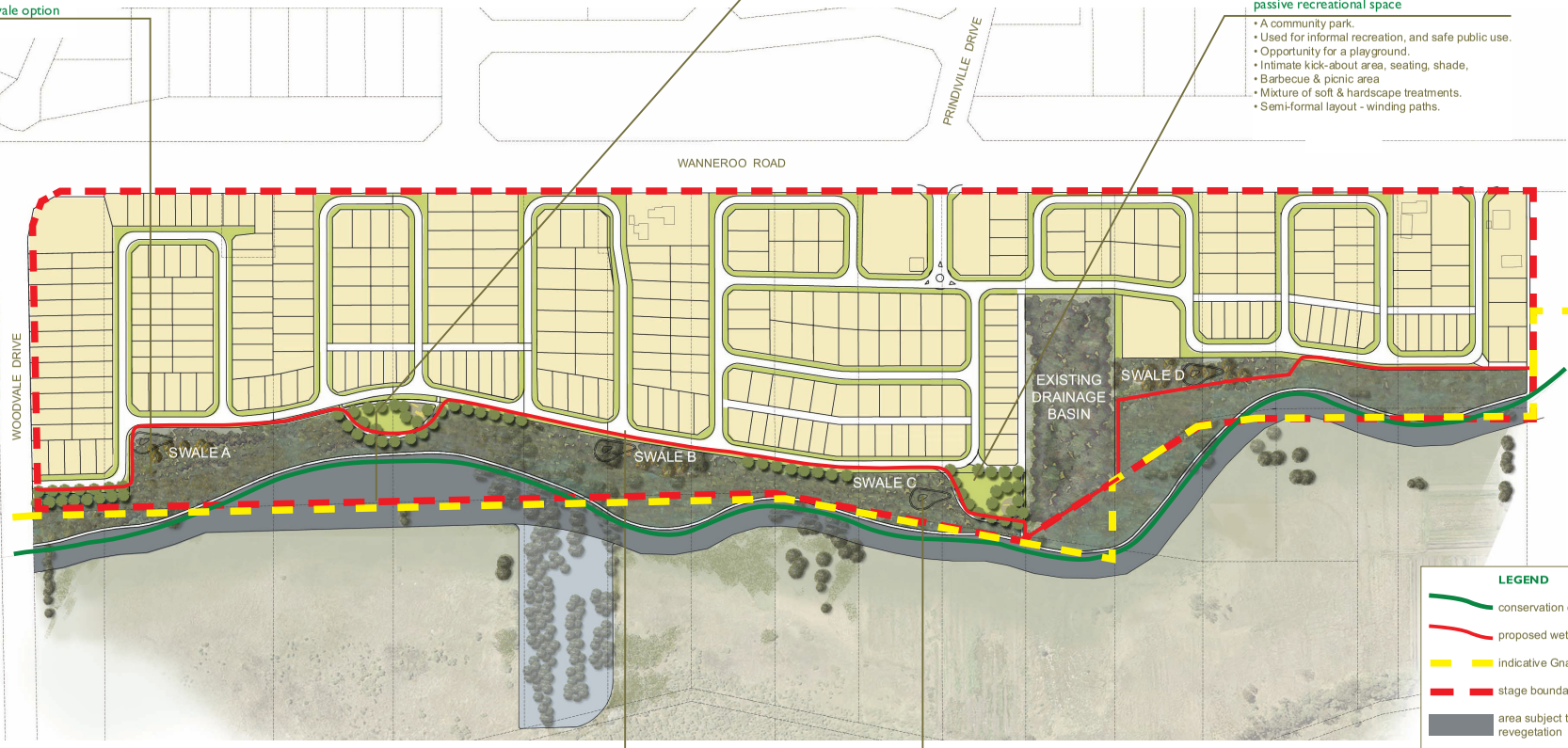
Date 27/02/09

A typical section - swale A - planted swale option
1:500 @ A3



B typical section - kickabout /recreational space
1:500 @ A3

re-vegetation



passive recreational space
- A community park.
- Used for informal recreation, and safe public use.
- Opportunity for a playground.
- Intimate kick-about area, seating, shade,
- Barbecue & picnic area
- Mixture of soft & hardscape treatments.
- Semi-formal layout - winding paths.

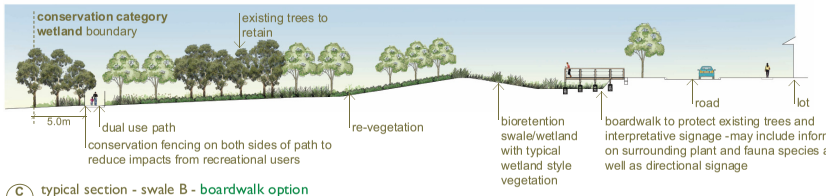
re-vegetation of wetland species

boardwalk to be constructed of steel/aluminium or recycled wood

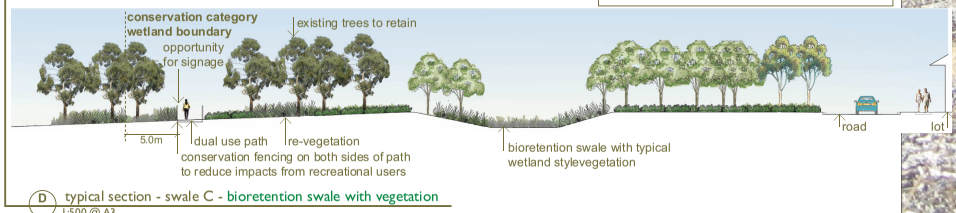
conservation fencing

LEGEND
- conservation category wetland
- proposed wetland buffer
- indicative Gnangara main sewer
- stage boundary
- area subject to wetland rehabilitation / revegetation
- area subject to dryland rehabilitation/ revegetation
- area subject to rehabilitation and contamination investigation / remediation by Water Corporation
- existing trees / vegetation

NOTE:
All trees in sections are shown at 2/3 of their mature tree size.



C typical section - swale B - boardwalk option
1:500 @ A3
- Retains existing Eucalyptus and Melaleuca trees.
- Re-vegetate wetland plant species
- Will retain existing native endemic species.



D typical section - swale C - bioretention swale with vegetation
1:500 @ A3

NTS

FIGURE 6

wetland interface & landscape masterplan
august 2009

structure plan 64

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: **1:3,500**

0 50 100 200 300 400 500 Metres

PROJECT **Woodvale Wetland Revegetation Management Plan**

DRAWING TITLE **FIGURE 7: Recommended Indicative Future Management Zones**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V7016**

Original **A3**

Drawing Number **SK07**

Revision

Designed MF

Checked

Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 5/08/09

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: 1:3,500

0 50 100 200 300 400 500 Metres

PROJECT **Woodvale Wetland Revegetation Management Plan**

DRAWING TITLE **FIGURE 8: Revegetation**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V7016**

Original **A3**

Drawing Number **SK08**

Revision

Designed MF

Checked

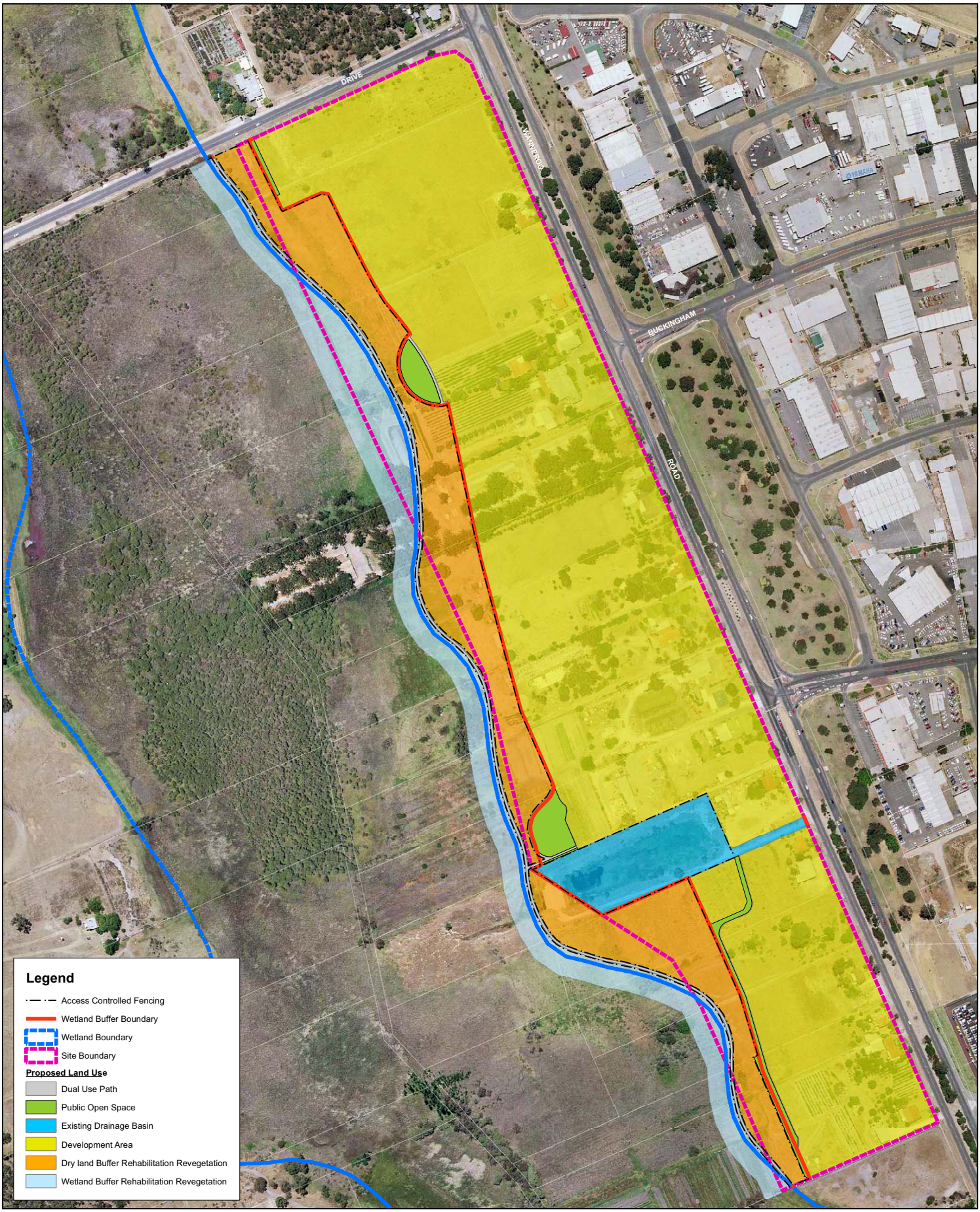
Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 26/02/09



DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

DATE	No.	ACTIVITY - REVISION DESCRIPTION	DES	DRN	CHK'D	APPD

Cardno

CONSULTING ENGINEERS
TOWN PLANNERS
PROJECT MANAGERS
ENVIRONMENTAL CONSULTANTS

Cardno Centre 2 Bagot Road
P.O. Box 155 Subiaco
Western Australia 6904

Telephone (08) 9273 3888
Facsimile (08) 9388 3831

Scale: 1:3,500

0 50 100 200 300 400 500 Metres

PROJECT **Woodvale Wetland Revegetation Management Plan**

DRAWING TITLE **FIGURE 9: Access Controlled Fencing Locations**

PRINCIPAL **Watson Property Group Northern Aspect Ltd**

This drawing has been prepared in accordance to Cardno Quality Management System. It remains the property of Cardno WA Pty. Ltd. and shall not be used without permission. The drawing shall be preliminary only and/or not for construction until signed approved.

Project Number **V7016**

Original **A3**

Drawing Number **SK09**

Revision

Designed MF

Checked

Drawn MGW

Approved

Local Authority City of Joondalup

Sheet 1 of 1

Date 26/02/09

Appendix A: Key Information Sources and Guidelines

Detail regarding the existing environment of Wallubuenup Swamp is available within:

- Cardno (2006). *Wetland Boundary Review and Management Category Re-evaluation – Wetland 8168 Woodvale.* Prepared for Watson Property Group Northern Aspects Ltd;
- Cardno (2009). *Woodvale LSP 64 – Local Water Management Strategy*. Prepared for Watson Property Group Northern Aspects Ltd; and
- Local Structure Plan No. 64 – Part 2 Explanatory Report.

General information regarding the Yellagonga Regional Park and its catchment is available within:

- Yellagonga Integrated Catchment Management Plan – Part 1 Technical Report (City of Wanneroo and City of Joondalup); and
- Yellagonga Regional Park Management Plan 2003-2013 (Department of Environment and Conservation).

Information on the requirements of a wetland management plan is provided by *Guidelines Checklist for Producing a Wetland Management Plan* (DEC 2008). Specific guidance for rehabilitation within and adjacent to Yellagonga Regional Park is available within the *Yellagonga Regional Park Weed Control and Revegetation Plan*. Any WMR Plan prepared within SP64 should be consistent with these documents (as amended) and will be required to address each section to a standard suitable (i.e. to the satisfaction of the DEC and the City of Wanneroo) for clearance of the relevant subdivision conditions.

WMR Plans shall be developed in consideration of the above information sources. Further information and surveys may be required in the development of WMR Plans to meet the requirements of wetland management plans. This is likely to include:

- Detailed site investigations undertaken to support subdivision process, as detailed by Structure Plan No. 64;
- Weed and vegetation survey; and
- Level 1 fauna survey.

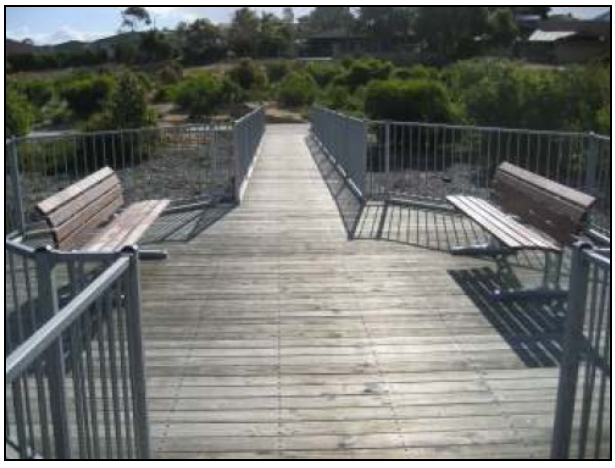
Appendix B: Examples of Recreational Infrastructure

Conservation Style Fencing



Dual Use Path

Wetland Boardwalks/Lookouts




Appendix C: Examples of Species List for Revegetation

Community Type	Species Name	Common Name	Family	Growth Form
***Baumea articulata/ Schoenoplectus validus* Sedgeland**				
	Baumea articulata	Jointed Twig Rush	Cyperaceae	Rush or Sedge
	Schoenoplectus validus	Lake Club Sedge	Cyperaceae	Rush or Sedge
***Melaleuca rhaphiophylla* Open Forest**				
	Baumea juncea	Bare Twig Rush	Cyperaceae	Rush or Sedge
	Baumea preissii	Broad Twig Rush	Cyperaceae	Rush or Sedge
	Baumea vaginalis	Sheath Twig Rush	Cyperaceae	Rush or Sedge
	Bolboschoenus caldwellii	Marsh Club Rush	Cyperaceae	Rush or Sedge
	Carex appressa	Tall Sedge	Cyperaceae	Rush or Sedge
	Carex fasicularis	Tassel Sedge	Cyperaceae	Rush or Sedge
	Carex inversa	Knob Sedge	Cyperaceae	Rush or Sedge
	Melaleuca rhaphiophylla	Swamp Paperbark	Myrtaceae	Shrub or Tree
***Melaleuca rhaphiophylla/ Eucalyptus rudis* Forest**				
	Banksia littoralis	Swamp Banksia	Proteaceae	Shrub or Tree
	Eucalyptus rudis	Flooded Gum	Myrtaceae	Shrub or Tree
	Melaleuca rhaphiophylla	Swamp Paperbark	Myrtaceae	Shrub or Tree
	Melaleuca teretifolia	Marsh Honey Myrtle	Myrtaceae	Shrub or Tree
	Melaleuca thymoides		Myrtaceae	Shrub or Tree
	Rhagodia baccata		Chenopodiaceae	Shrub or Tree
	Viminaria juncea	Swishbush	Papilionaceae	Shrub or Tree